SYSTEMIC RISKS AND FINANCIAL FRAGILITY IN A SMALL OPEN ECONOMY: THE CASE OF BOSNIA-HERZEGOVINA

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Abstract

This thesis investigates the sources of financial system fragility in a small open economy with a traditional banking system, with a focus on Bosnia and Herzegovina. Conducting research on Western Balkan countries is challenging given the shortness of time series, unrepresentative samples, numerous structural breaks, poor quality data and the historical absence of the phenomenon that is the focus of investigation. For this reason, the common assumption that the findings associated with other regions or countries are applicable to the Western Balkans is rejected. Instead, two measures of systemic risk are constructed to assess a country's financial system fragility that reflects the specific characteristics of a country such as Bosnia and Herzegovina. The liquidity index measures how vulnerable the financial system is to a currency crisis represented by the abandonment of the currency board arrangement. The solvency index is an indicator of banking system fragility at a point in time. Changes over time in both these measures of systemic risk are related to changes in a set of macroeconomic and banking sector specific variables. This thesis contributes to a better understanding of financial system fragility in Bosnia and Herzegovina and similar countries in several ways. It is found that both country and period specifics must be accounted for. Accordingly, each country should develop its own tailored measure of systemic risk, since some of the widely used set of indicators, such as the level of foreign reserves, may distort the perception of risk. A disaggregated approach to systemic analysis is favoured: it is more efficient to interpret two measures of systemic risk jointly rather than to merge them into a single indicator. However, there are substantial gains in modelling the risks of banking and currency crises as a system. It is demonstrated that even in a country with a simple financial system and dominant banking sector a single model cannot explain the evolution of systemic risk over the cycle. The nature of the risk factors, their relations with the perceived level of fragility, as well as the relationship between the measures of systemic risk were found to differ in pre-shock from the post-shock periods. Finally, it is shown that even simple financial systems are inherently unstable, with destabilizing relationships between the risks of banking and currency crises and developments in the real economy. It is concluded that developing a set of country-specific risk measures that indicate the evolution of the risk of banking or currency crises is an imperative.

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Abbreviations

ADF	Augmented Dickey-Fuller test
ARDL	Autoregressive Distributed Lag
BAM	Bosnian Konvertible Mark
BARS	Banking Agency of the Republika Srpska
BCBS	Basel Committee on Banking Supervision
BCPS	Bank credit to private sector
BH	Bosnia and Herzegovina
BHAS	BH Statistical Agency
BIS	Bank for International Settlements
BoP	Balance of payments
BSI	Banking stability index
CAR	Capital adequacy ratio
CBA	Currency board arrangement
CBBH	Central Bank of Bosnia and Herzegovina
CDS	Credit Default Swap
CEE	Central and Eastern Europe
CESEE	Central, Eastern and South-Eastern Europe
CGFS	Committee on Global Financial System
CoVaR	Cointegrated Value at Risk
CPSS	Committee on Payments and Settlements System
CPU	Currency Poll Unit
CRC	Central Register of Credit
CRMPG	Counterparty Risk Management Policy Group
DEM	German mark
DIA	Deposit Insurance Agency
DSGE	Dynamic stochastic general equilibrium
EBCI	European Bank Coordination Initiative (a.k.a. Vienna Initiative)
DSGE	European Bank for Reconstruction and Development
EC	European Commission
EC term	Error correction term
ECB	European Central Bank
EMH	Efficient Market Hypothesis
EUR	Euro
EWI	Early Warning Indicators
EWS	Early-warning systems
FATF	Financial Action Task Force
FBA	Banking Agency of the FBH
FBH	Federation of Bosnia and Herzegovina
FCIC	The U.S. Financial Crisis Inquiry Commission
FDI	Foreign direct investment
FED	Federal Reserves
FSAP	Financial Sector Assessment Program
FSB	Financial Stability Board

FSF	Financial Stability Forum
FSFDI	Financial sector foreign direct investment
FSI	Financial Soundness Indicators
FSR	Financial Stability Report
FSR	Financial Stability Report
GBP	British pound
GDP	Gross domestic product
GFC	Global financial crisis
GFSR	Global Financial Stability Report
G-SIFI	Globally Systemically Important Financial Institutions
HHI	Herfindahl-Hirschman Index
IAIS	International Association of Insurance Supervisors
IASB	International Accounting Standards Board
IFAC	International Federation of Accountants
IFS	International Financial Statistics
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
JPoD	Joint probability of default
JPY	Japanese yen
KPSS	Kwiatkowski, Phillips, Schmidt and Shin test
LDC	Less Developed Countries
LGD	Loss given default
LI	Liquidity index
LOLR	Lender of last resort
LP	Lumsdaine and Papell test
MCO	Microcredit organizations
MOFT	BH Ministry of finance and treasury
MPI	Macro-prudential indicators
NPL	Nonperforming loans
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
OMO	Open market operations
OTC	Over-the-counter
PCA	Principal Component Analysis
PNFE	Private non-financial enterprises
PoD	Probabilities of default
PP	Phillips-Perron test
REER	Real effective exchange rate
ROAE	Return on Average Equity
RS	Republic of Srpska
RTGS	Real Time Gross Settlement
RWA	Risk-weighted assets

Country codes

AL	Albania
AM	Armenia
AO	Angola
AR	Argentina
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CD	Congo, Dem. Rep. of
CF	Central African Rep.
CG	Congo, Republic of
CI	Côte d'Ivoire
CM	Cameroon
CR	Costa Rica
DO	Dominican Republic
DZ	Algeria
EC	Ecuador
EE	Estonia
EG	Egypt
ET	Ethiopia
FI	Finland
FJ	Fiji
GA	Gabon
GE	Georgia
GH	Ghana
GM	Gambia, The
GN	Guinea
GQ	Equatorial Guinea
GW	Guinea-Bissau
HK	China: Hong Kong
HN	Honduras
HT	Haiti
ID	Indonesia
IR	Iran
JM	Jamaica
KE	Kenya
KG	Kyrgyz Republic
KH	Cambodia
KM	Comoros
KR	Korea, Republic of

KZ	Kazakhstan
LA	Lao People's Dem. Rep
LB	Lebanon
LT	Lithuania
LV	Latvia
LY	Libya
MD	Moldova
MG	Madagascar
ML	Mali
MM	Myanmar
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
MY	Malaysia
NE	Niger
NG	Nigeria
NI	Nicaragua
NP	Nepal
PG	Papua New Guinea
PH	Philippines
PY	Paraguay
RO	Romania
RS	Serbia, Republic of
RU	Russian Federation
RW	Rwanda
SD	Sudan
SE	Sweden
SL	Sierra Leone
SN	Senegal
SR	Suriname
ST	São Tomé & Príncipe
TD	Chad
TG	Togo
TH	Thailand
TJ	Tajikistan
TR	Turkey
TZ	Tanzania
UA	Ukraine
UY	Uruguay
VE	Venezuela, Rep. Bol.
YE	Yemen, Republic of
ZM	Zambia
ZW	Zimbabwe

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Preface

In the first half of the 1990s 56 banking crises, 73 currency crises, 3 sovereign debt crises and 17 twin crises were identified by Laeven and Valencia (2008), while 3 triple crises were recorded in 1998. In less than 10 years the EMS crisis, the Swedish crisis, the Tequila crisis, the Asian crisis, the Brazilian crisis, the Russian crisis and the failure of Long-Term Capital Management (LTCM) occurred. The latest global financial crisis that started as a relatively limited and localized event, the subprime loan crisis in the U.S., resulted in a global liquidity crunch in 2007 followed by a series of banking and sovereign debt crises that still continues five years later. There appears to be no geo-political or economic system that is immune to financial crises and the stage of economic development or the level of financial system sophistication seem to make no difference. This high incidence of financial crises and their increasing severity suggest that either significant systemic and idiosyncratic risks were not recognized or the measurements were biased downwards.

Theory has identified the likely causes of different types of financial crises and established the relationships between them. Speculative attacks (Krugman, 1979; Flood and Garber, 1984; Obstfeld, 1994, 1996; Jeanne, 2000; Disyatat, 2001; Liu, 2009) and external imbalances (Krugman, 1999; McKinnon and Pill, 1999, 2001; Burnside et al., 2003; Eichengreen, 2003) are viewed as the most likely causes of currency crises. One strand of literature on the causes of currency crises links them to the issue of banking sector liquidity (Diamond and Dybvig, 1983; Eichengreen and Hausmann, 1999; Chang and Velasco, 2000). The causes of banking crises were found to range from excessive government interference (Honohan, 1997; Tang et al., 2000; Enoch et al., 2002; Bonin and Wachtel, 2003; Barisitz, 2008) to poor management and microeconomic deficiencies in banks amplyfied by the "financial accelerators" by which the real economy effects of shocks to asset prices are amplified through balance sheet effects (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Bernanke et al., 1999). Laeven and Valencia (2008) confirm that currency and banking crises often coincide, but orthodox theory is still undecided on the causality between them. Once the pre-requisites for a crisis were identified, a step forward was an attempt to estimate how far the financial systems are from the brink of a crisis (Frankel and Rose, 1996; Sachs et al., 1996; Eichengreen and Rose, 1998; Kaminsky and Reinhart, 1999; Goldstein et al. 2000; Andreou et al. 2007). From the perspective of a small open economy such as BH, these models may be unsuitable for a couple of reasons: an individual country may have never experienced any financial crisis, as traditionally defined, since its financial system had been established in its current form; or country specific factors may be significant.

The starting point of this research is the proposition that every financial system is a story to itself. Some general trends and relationships may exhibit similar patterns in similar geo-political systems, similar stages of economic development or financial systems with similar structure. However, the analysis of financial stability requires the linking of the balance sheet of the financial sector to the real economy and the inclusion of reverse feedbacks. Therefore, even if two economies are at similar stages of financial system development, differences in underlying domestic macroeconomic conditions and exposure to shocks may result in significantly different shock-absorbing capacities in the two economies. Building upon the need for a customised measure of systemic risk, two propositions were initially acknowledged: the measure of systemic risk does not necessarily have to be a single indicator; and that the significance of a specific level of systemic risk may be interpreted differently by different interest groups.

The empirical investigation in this research is conducted on quarterly observations in the period 2003 - 2010 and covers a complete business cycle in the post-transition period. The absence of a systemic crisis in the observed period was not considered as a limitation in our investigation, but rather as an opportunity to observe a financial system of a simple structure through the business cycle. By doing so, the aim was to capture the key underlying relationships between the measures of the systemic risk and the real economy that tend to get amplified as the complexity of the financial system increases. From that perspective, the estimated relationships in this research concur with Minsky's (1992) hypothesis that a certain level of instability in embedded in every financial system. By definition, the financial system of a country consists of its currency, financial institutions and their supervising bodies, payment systems and financial markets. The presence of financial instability implies either an impaired ability of the financial system to perform its main tasks such as channelling funds, or the instability of key institutions and markets. If a single model cannot capture the changes in the level of systemic risks in the periods before and after a shock episode in a relatively simple financial system such as BH, then it is not likely that the model, no matter how sophisticated, will perform any better in complex financial systems.

Based on Minsky (1975; 1982; 1986; 1992), each financial system can be viewed as going through four distinct stages, each associated with a different level of instability. This research views the constructed country-specific measures of the systemic risks as the continuous strings of different levels of instability, enabling the identification of which stage of the Minsky cycle reflects the financial system's current position. Linking the perceived levels of instability to various macroeconomic and banking-sector specific variables enables researchers to test whether the relationships in the economy are the same at different stages of the business cycle. Furthermore, if it is possible to detect at which of the four stages of financial instability, as specified by Minsky, the system is at each point in time then the policy actions could be tailored in ordered to fine tune the balance between the tolerated level of systemic risks and economic activity.

Each of the three types of financial crises, namely the banking, currency and sovereign crisis, primarily affect one segment of the financial system. A banking crisis affects the financial intermediaries' ability to efficiently channel funds from those who have excess funds to those who have more productive uses for them. A currency crisis directly affects the value of national currency thus resulting in the process of re-pricing of domestic and foreign debts, whilst a sovereign crisis may directly affect either financial intermediaries or the currency depending on the nature of sovereign risk. In the cases where the central bank has weak autonomy in the policy making process, the initial pressure is on the national currency. If the financial intermediaries are exposed to the government, either via lending or via acquisition of the government issued securities, then the efficient allocation of funds in the economy may be impaired. In the case of BH, given the high degree of the independence of the CBBH and constraints on its budget deficits in terms of both the allowed level of deficit conditioned on the past periods' budget surpluses and an inability to borrow long-term from the commercial banks in the periods covered by this thesis, it was decided that the appropriate measures of systemic risk should indicate the sensitivity of the BH financial system to currency and banking crises. The law on public debt and budget deficits in BH was changed in the years following the global financial crisis. As a consequence, the widening budget deficits in the years following 2010 were financed by increased borrowing from the banking sector and the issuing of debt securities. As a result, it is likely that in the future a measure of the risk of a sovereign debt crisis will also need developing.

Acknowledging that the perception of risk and interpretation of any measure of systemic risk may vary across different interest groups, the aim was to construct a measure that indicates the level of risk at a point in time compared to the past periods. The interpretation of the estimated level of systemic risk is left to the discretion of individual users.

This research was conducted to assess the determinants and the level of financial fragility in BH, a small, open economy with a simple-structured financial system that has not experienced a financial crisis, as traditionally defined, since the Central Bank was established in 1997. Moreover, it was investigated whether the measures of risk of different types of financial crises should be observed separately, jointly as a system, or merged into a single measure of financial fragility. The thesis is organized as follows. Chapter 1 presents an overview of the financial sector and macroeconomic developments in BH for the period 1997-2010. It explains in detail the evolution of the financial system and the relevant regulatory framework and lays the grounds for the following chapters. Chapter 2 defines financial stability in the context of BH. The chapter starts with a summary of the debate on what is generally understood under the term financial stability and what are the possible reasons for the limitations of the current measures of financial stability and their bias towards overly optimistic predictions. The relation between financial stability and the real economy is examined and the components of the existing definitions of financial stability are evaluated. The conclusion of the chapter is that there is a need for a measure of financial system fragility which is specific to BH.

The two measures of systemic fragility applicable to BH, namely the liquidity and solvency indices were developed in Chapter 3. The liquidity index (LI) measures how vulnerable is the BH financial system to a currency crisis represented by the abandonment of the currency board arrangement (CBA). The solvency index (SI) is an indicator of the banking system's fragility at a point in time as it utilizes the size of the shock to banks' assets that would fatally deplete banks' capital. The construction of these measures of systemic risk represents a unique contribution. Not only does the quantification of the systemic risks enable inter-temporal comparisons of the level of risk, it also enables measurement of the impact of changes in the chosen macroeconomic and bank-specific variables on the perceived level of systemic fragility in a system that has never experienced a financial crisis.

Chapters 4 and 5 are the key empirical chapters of the thesis and aim to establish the relations between the liquidity and solvency indices respectively and the chosen macroeconomic and bank specific variables. The starting point in both chapters was identification of the variables recognized by the existing literature as the main causes of an elevated systemic risk. A data driven approach such as the vector error correction model (VECM) was found to be suitable for estimation in the case of both the solvency and liquidity indices. Long-term relationships for each of these two measures of systemic risk were found to hold in the pre-macroeconomic shock periods. The post-shock periods are characterised by a series of the short-term adjustments, indicating that differences in the nature of risk in the pre- and post-shock periods make a single model inefficient in explaining the evolution of systemic risk across the business cycle, even in a relatively simple financial system like BH's. The level of systemic risk may be quite accurately predicted in the pre-shock periods but the post-shock period is characterised by a series of adjustments towards the new equilibrium which makes modelling close to impossible. Depending on the speed at which the systemic risk was increasing over time, it was found that there is no single tool appropriate for econometric analysis.

Chapter 6 demonstrates that the two measures of systemic risk should be estimated in a single VECM and interpreted jointly. The findings also suggest that, while the country and period specifics were found to be important in explaining changes in the measures of the systemic risk, the relation between the risks in BH was found to be similar to that in other countries in the region in the sense that an increased risk of a currency crisis was a pre-requisite for raising the risk of a banking crisis. A long-term, potentially destabilizing cointegrating relationship between the different types of systemic risk, economic activity and the level of domestically funded long-term lending activities was detected which exhibits the characteristics of a 'Minsky moment'. Chapter 7 highlights the main findings of the thesis and offers policy proposals based on those findings.

Chapter 1: The development of the banking sector in Bosnia and Herzegovina

1.1. Introduction

The financial system of Bosnia and Herzegovina (BH) had to be re-created in the period immediately following the 1992-1995 war. The People's Bank of Bosnia and Herzegovina, one of the successors of the People's Bank of Yugoslavia, was operating during the war period and issuing the legal tender for one of the geo-political entities, the Federation of Bosnia and Herzegovina (FBH). The other geo-political entity, the Republic of Srpska (RS) had its own form of payment[1]. The Central Bank of Bosnia and Herzegovina (CBBH) was established in 1997 and that was the cornerstone of BH's new financial system. The Preface of this thesis identified the key research question of this research: what are the sources of financial system fragility in a small open economy with a traditional banking system such as BH? It also presented the main building blocks of this research programme and explained how the arguments will be organized by chapters. The starting point of this research is the proposition that every financial system is specific. Therefore, conditional on their stage of financial development and their underlying macroeconomic conditions, the shock-absorbing capacities of any two economies may differ substantially.

The aim of this chapter is to illustrate how the financial system of BH and its entire infrastructure emerged and which events and circumstances shaped it up to and during the period covered by this research. This thesis focuses on the period 2003 through 2010. The year 2003 is chosen as the starting period since significant lending activity by the BH banking sector started about that time. By the end of 2010 both the financial system and the real economy have gone through a full cycle. In a sense, the year 2003 can be viewed as time zero, or the stage when the economy has just passed the through the lowest point of a business cycle and begins to recover. As will be discussed in more detail later in the thesis, banking sector activities at that period stimulates the economic

[1] Entity in this context relates to a geo-political, and not to physical or organizational units. BH consists of two entities, Federation of BH (FBH) and Republika Srpska (RS), and the Brčko District. In addition, FBH consists of 10 cantons, each of them encompassing several municipalities. RS does not have cantonal level of government.

activity. Gradually, the bank lending accelerates and the fragility of the system increases. Finally, a financial crisis occurs, all sectors of the economy adjust towards the new equilibrium and another cycle begins. The role of this chapter is to explain BH's financial sector's initial endowments in 2003 and to explain the context in which this research is conducted. Understanding the environment that shaped the BH financial system is of crucial importance for understanding why the focus of this research is on the risk of currency and banking crises, but not the risk of a solvency crisis, or why some widely used indicators of changes in the perception of systemic risk are not suitable in the case of BH and what might be the alternatives.

The rest of the chapter is structured as follows. Section 1.2 examines the role of financial system in terms of economic development. By focusing on the nexus between the financial system and the real economy, this section briefly explains the significance of the financial systems. Section 1.3 provides an overview of banking sector developments. It explains how the financial system of BH evolved from the immediate post-war years through to 2003 when the lending activities of the banking sector, and primarily of foreign-owned banks, intensified. Furthermore, Section 1.3 highlights the main consequences of an increased lending activity that are of importance for the analyses in the following chapters. Section 1.4 briefly addresses the difference between the regulation and supervision and touches upon the views of the existing research on both issues. Section 1.5 highlights the sets of regulatory changes in the BH framework that will be addressed in more detail later in the thesis, especially in the empirical Chapters 3, 4 and 5. Section 1.6 concludes.

1.2. The role of the financial system in economic development

The financial system of a country consists of its currency, financial institutions and their supervising institutions, payment systems and financial markets. The main functions of the financial system, according to Levine (1997) are: mobilization of savings; allocation of resources; exerting corporate controls; facilitating risk management; and facilitating the exchange of goods, services and contracts. Views on the relationship between financial development and economic growth have been changing through time. Depending on the timeframe under study, the primary scope of interest of the author, geographical region and timing of the cases covered in the study and the choice between general and specific approach, the literature offers numerous explanations of the relationship between financial development and growth. Most development economists are of the view that financial development plays no role in economic growth. The most commonly referred to source for this point is Stern (1989) who ignores the financial system in his review of development economics. De La Dehesa (2006) reviews the findings of theoretical and empirical research undertaken from the 1990s that seemingly established a stronger link between the financial system and long-term economic growth: the effect of finance on reducing information and transaction costs; its effect on savings, investment and technological innovations; its connections with political, legal, regulatory and institutional frameworks; and its effects on income distribution and poverty reduction. In the early 1990s some empirical studies, primarily that of King and Levine (1993), investigated contemporaneous association between financial development and the sources of growth and found that financial development is positively associated with both the rate of physical capital accumulation and a measure of improvements in economic efficiency. Many subsequent empirical studies are based on this article that concludes that

> "…financial depth, the relative importance of banks vis-à-vis central banks, the percentage of credit allocated to non- financial private firms, and credit to the private sector divided by GDP are strongly associated to growth, the growth rate of physical capital, the investment share and efficiency after controlling for initial conditions and common economic indicators" (p. 728).

Most empirical studies came to the conclusion that there is a positive relationship between financial development and economic growth, but the consensus on the underlying causality was hard to reach. Blum et al. (2002) in their review of the literature provided an overview of 54 empirical studies conducted in the period 1964-2002 and concluded that both supply-leading and demand-following patterns have been observed, i.e. financial depth drives economic growth, but the growing economy in return causes financial sector growth. Theoretical, empirical and descriptive investigations covered by their work in the majority of cases rejected the possibility of no causal relation between the financial and real sector performance. This finding of Blum et al. (2002) relates to the work of Patrick (1966) who also recognized that the relationship between financial development and economic growth can be supply-leading or demand-following and that in practice there is likely to be an interaction between those two phenomena.

Although the views of Robinson (1952) and Lucas (1988) are frequently interpreted as to underline a disparate relationship between financial sector development and economic growth, they only argue on causality running from growth to financial sector development. Robinson (1952, p. 86) states that "where enterprise leads finance follows" which depicts a demand-following relationship. Similarly, Lucas's statement (1988, p. 6) that "the importance of financial matters is very badly over-stressed" cannot be identified as no relationship between the financial sector and economic growth, but, again, rather as an argument towards financial sector development dependence on economic growth. Patrick (1966), on the other hand, argues that supply-leading finance is more likely to play a more significant role at the beginning of the growth process rather than later, which is of special importance for countries like BH. As will be demonstrated in the following section, this is exactly what happened in the case of BH; the limited sources of domestic funding were an obstacle to economic growth in the periods prior to early 2000s.

Recent studies on the question of the stability of the relationship between financial sector development and economic growth investigate different regions or different stages of development of countries. By using the sample of 84 both developed and developing countries in the period 1960-2003, Rousseau and Wachtel (2005) found that the finance-growth relationship was not as strong as was suggested in the original studies of King and Levine (1993) with data from the period 1960-1989. Further, they found that the usual results disappear when fixed or random effects for countries are included in the specifications, suggesting that the measures of financial depth in the standard growth equation might be picking up some unobserved country-specific factors. Another strand of the literature on the financial sector-growth nexus argues that the observed association between financial sector deepening and growth should not be translated into unreserved encouragement of unrestricted growth of financial intermediaries (Wachtel, 2003), since a stronger financial sector activity caused by the inflationary liquidity creation or deterioration in lending standards does not enhance growth in the long run.

The work of Hagmayr et al. (2007) provides empirical evidence on the relationship between financial sector development and growth in emerging market and transition economies. Numerous studies listed in their work, applying different theoretical frameworks, reach the conclusion of a positive relationship and causality running from bank sector development to economic growth in these markets. Their findings are in line with Fink et al. (2005) for Central and Eastern Europe (CEE) and Rousseau and Wachtel (2005): the aggregate effect of finance on growth varies with the level of economic development. Moreover, the work of Mehl et al. (2005) did not find evidence that financial deepening impacted growth positively in Southeast Europe. All these recent studies confirm the arguments of Patrick (1966) that the privatization of the banking sector led to easier access to funds that boosted economic growth. However, the entry of foreign banks that caused growth of the banking sector, measured by the growth of assets and availability of credit, did not necessarily result in strengthening of the underlying sources of growth. The signs of financial development listed in King and Levine (1993) that are associated with growth cannot be interpreted as preconditions of economic growth. Similarly, Ahmad and Malik (2009) using a panel of 35 countries over the period 1970-2003 reached a conclusion that financial sector developments affect per capita GDP mainly by increasing the efficiency of resource allocation, rather than stimulating capital accumulation. In other words, the welfare gain is more a function of a more efficient allocation of the available resources rather than their availability. In the same study it was argued that domestic, rather than foreign capital accumulation is increasing per worker output and, hence, promoting economic growth in the long run. Furthermore, it was also found that foreign capital does not stimulate domestic capital accumulation, while domestic capital plays a significant role in attracting foreign capital.

The findings above may also be used to explain the relationship between financial sector development and consumption patterns in the CEE countries. In the late 1990s and early 2000s financial depth was not substantial in any of the CEE countries due to their low base, so the entry of foreign-owned banks resulted in the rapid growth of banking sector assets. The relative importance of banks vis-à-vis central banks was high after the central planning system was abolished, but the impact on economic growth is conditional on whether the credit is used for the investment purposes or the purchase of the non-durable consumer goods. Finally, the impact on growth also depends upon the term structure of loans and the specific industries to which the majority of these loans were extended to. This assertion is confirmed by the findings of Cecchetti and Kharroubi (2012) that are in line with the inverted U-shaped effect of financial development. By examining the impact of financial system size on productivity growth in a sample of 50 advanced and emerging economies over the period 1980-2009, they reached the conclusion that there comes a point where further enlargement of the financial system reduces real growth. The effect of the financial sector size on economic growth is tested for both output measures like private credit to GDP and input measures such as financial sector's share in total employment. In both cases it was confirmed that there is a point where more finance becomes detrimental for economic growth.

Given the focus of this research, the finding of Cecchetti and Kharroubi (2012) that too much lending activity may be harmful for the real economy is most important since, as it will be discussed in more detail in Sections 2.4, 3.4 and 5.2, the risk of a banking crisis, ultimately caused by a macroeconomic shock to a rapidly expanding banking system, is one of the key systemic risks in BH. The following section provides more information on how the BH banking system developed since 1997, the main causes behind the growth of banking sector balances and the main consequences of this banking sector expansion.

1.3. An overview of banking sector developments in BH

The financial system of BH consists of: the national currency, the Bosnian Konvertible Mark (BAM); the financial institutions and the supervising bodies; the payment systems operating within the CBBH; and the financial markets. The main goals and tasks of the CBBH, as defined by the Law and in accordance with the General Peace Agreement in BH, are to maintain monetary stability by issuing domestic currency according to the Currency Board arrangement (1 BAM: 0.51129 EUR) and to support and maintain appropriate payment and settlement systems. Prior to January 1st 2002 BAM was fixed to German mark (DEM) in the ratio 1 BAM: 1 DEM. The current fixed rate of BAM to EUR is the conversion rate of DEM to EUR during the Euro Changeover.

All market participants in both BH capital markets including investment funds, fund management companies and authorised intermediaries are under the supervision of the entity-level Securities and exchange commissions. The BH financial sector has a relatively simple structure, especially when compared to developed countries. The banking sector consists of commercial banks that are under the supervision of two entity-level banking agencies, the Banking Agency of the FBH (FBA) and the Banking Agency of the Republika Srpska (BARS). The banks in BH are conducting all foreign exchange and money market operations in the country, but the interbank market is still rather underdeveloped since all banks were on the supply side of liquidity before the financial crisis.

The non-bank financial sector consists of: the insurance companies that are under the supervision of the entity-level insurance supervising agencies and the national-level BH Insurance Agency with a coordinating role assigned to it; and the microcredit organizations (MCO) and leasing companies, both formally under the FBA and BARS supervision as of the end of 2006. The latter two types of financial intermediaries were unsupervised until 2007 since their operations were not regulated by the law on the whole national territory until the end of 2006. The leasing companies usually operate as separate legal entities within banking groups, and the microcredit organizations were initially established and funded by international creditors through the programmes of post-war aid to the country. As of 2013 there are still no private pension funds.

As a consequence of a sharp deterioration in the quality of assets in the periods following the macroeconomic shock in 2008, towards the end of 2011 the need for efficient debt resolution strategies for banks was recognized. The issue of high non-performing loans became a problem throughout the Western Balkans as well in the more developed financial systems as the financial crisis continued even five years after its onset in 2007. As a consequence of the region-wide efforts of foreign banking groups to resolve the non-performing loans issue, as well as a completely unregulated mechanism of transmission of the non-performing assets of banks to a special-purpose vehicle, a systemically important banking group in BH used this lack of regulation to clean its balance sheets of their non-performing loans (NPL). Subsequently, the entity Laws on factoring were drafted in 2012 and placed into Parliamentary procedure. Therefore, it is expected that sometimes in the future the list of the non-bank financial intermediaries in BH will be expanded by the factoring institutions.

The banking sector, as measured by the size of assets, dominates the financial sector in BH (Table 1.1). Therefore, unless stated otherwise, the focus of this research will be on the banking sector. The table below has not been updated for the periods after 2010 since this chapter is explaining the context relevant to the sample used in this research (period 2003-2010).

Table 1. 1: Assets of financial sector intermediaries

Type of intermediary	2005		2006		2007	
	Value, millions of BAM	share, %	Value, millions of BAM	share, %	Value, millions of BAM	share, %
Banks	11,440	77.3	14,622	79.6	19,570	79.9
Investment funds	1,793	12.1	1,553	8.5	1,762	7.2
Leasing companies	660	4.5	1,025	5.6	1,422	5.8
Insurance companies	587	4.0	684	3.7	800	3.3
Microcredit organizations	314	2.1	486	2.6	946	3.9
Total	**14,794**		**18,370**		**24,500**	

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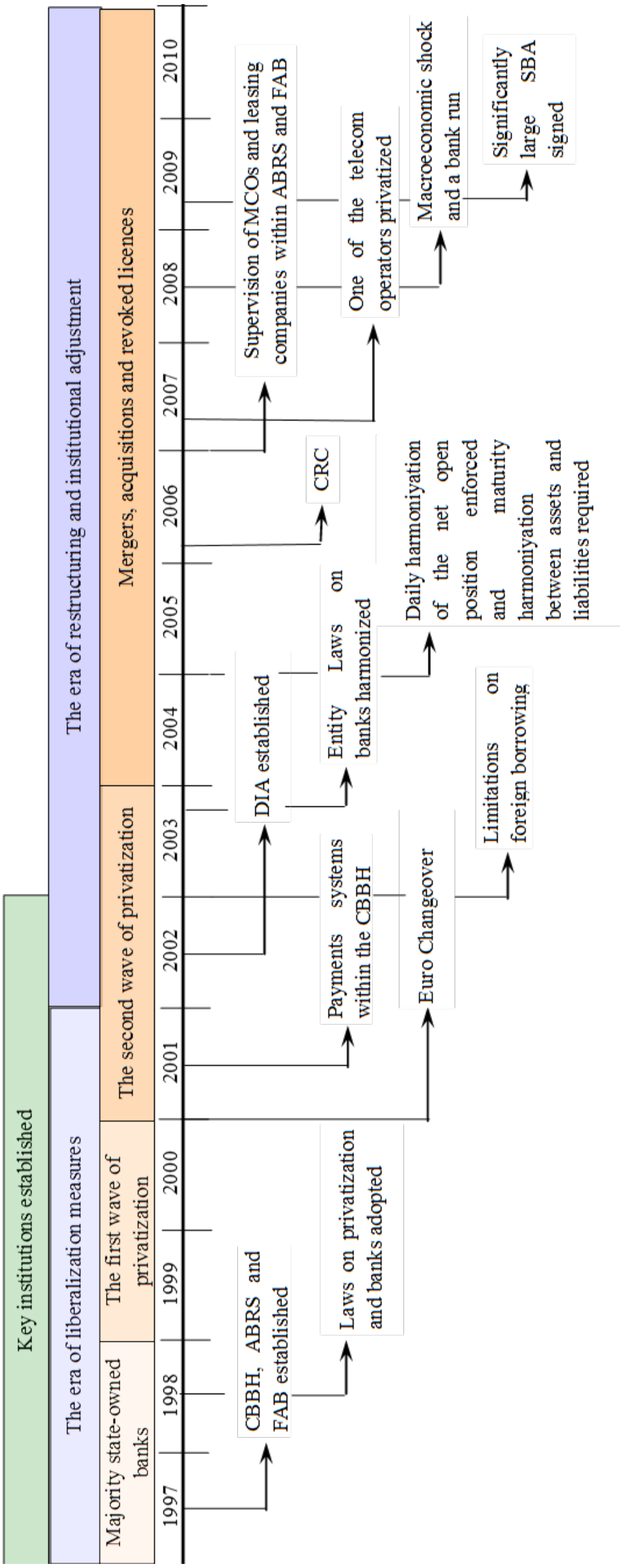
Type of intermediary	2008		2009		2010	
	Value, millions of BAM	share, %	Value, millions of BAM	share, %	Value, millions of BAM	share, %
Banks	20,815	80.9	20,608	82.5	20,416	85.4
Investment funds	1,225	4.8	871	3.5	888	3.7
Leasing companies	1,600	6.2	1,416	5.7	744	3.1
Insurance companies	890	3.5	1,000	4.0	1,003	4.2
Microcredit organizations	1,213	4.7	1,087	4.4	853	3.6
Total	**25,743**		**24,982**		**23,905**	

Source: CBBH.

The banking sector in BH started developing rather late compared to those in most CEE countries. After a systemic banking crisis in 1992, when the banking system suffered from a high proportion of NPL caused by the break-up of ex-Yugoslavia, the country virtually had no banking sector until the Dayton Peace Agreement ended the war. In the period 1996-August 1998 several, mainly state-owned, banks were operational, but banking activity was almost non-existent. The operating banks in that period were regulated by the Laws inherited from the previous system with some minor adjustments but were not supervised by any authority. The cornerstones of the banking sector, and to a certain extent the rest of financial sector, were set in 1997 with the establishment of the CBBH and the two entity-level banking agencies. The state-level Deposit Insurance Agency (DIA) of BH was established in 2002. Drawing any comparison between the banking sector that exists in BH today and the banking sector before 2001 is very difficult since the banking sector has undergone numerous structural changes that significantly altered its shape. In order to facilitate understanding how the BH financial sector was shaped into its current state, the most important events are recorded on a time scale on the following figure.

Figure 1. 1: The time scale of banking sector development



After the key institutions were established, the further stages of banking sector reforms achieved banking sector liberalization and refinement of the existing legislation and creating new legislation where none previously existed. Barisitz (2008) distinguishes two waves of the banking sector reform that each of the 13 CEE countries examined in that study needed to go through in order to mature: the first reform wave focuses on liberalization measures and the second wave mostly consists of restructuring/institutional adjustment. He argues that, while the first wave of reforms contributed to establishing a market-oriented economy based on the abolition of central credit and cash plans, the liberalization of bank licensing that followed, accompanied by the soft budget constraints, created a temporary equilibrium, unsustainable in the long run. The absence of the concept of bankruptcy in socialism was carried over in transition which finally triggered the second wave of reforms that included: applying stricter banking rules; upgraded bookkeeping standards; and tighter supervision. The liberalization wave in the case of BH covered the period 1998-2001. A lack of political will and time inconsistency in legislative procedure were key restraining factors to banking sector reform. BH had two laws on banks (not harmonized until 2003), two banking agencies each overseeing the banks under their jurisdiction and no legislation covering the privatization of banks. Banks had very few or no branches in the other entity until 2001, since the payment systems in the country were still under payment bureaus and the cross-entity linkages between the economic agents were rather weak[2].

The Law on Privatization of Banks was adopted in 1998, but it took far too long to prepare the Initial Balance Sheets and actually start the privatization process. Although banks were privatized in the two different entities, the chosen method of privatization was identical and occurred at the same time. According to the entity Laws on Privatization of Banks, only solvent banks were to be privatized and the decision on a bank's solvency was taken by the entity banking agency for the banks under their

[2] The payment bureaus were the infrastructure inherited by all states created in the process of disintegration of ex-Yugoslavia. During the war and in the post-war years, before the modern payment and settlement systems were established within the CBBH with help of the international community, each of the major three ethnic groups maintained their own payment bureau. In a system where all payment transactions in the country are settled within a single payment bureau, all companies and individuals were requested to keep their money deposited with the bureau. Strict regulations regarding the cash register maximum required businesses to deposit almost all their cash at the end of the day and to request permission to withdraw the cash the following morning. Each transaction within the bureau was charged a fee. With the reform of the payment system all deposits were moved to banks' balance sheets that created a base for a more active role of banks in the financial system. Furthermore, the payment systems operating within a state-level institution, such as the central bank, enabled better linkages between the economic agents within the country. The two payment systems, the Real Time Gross Settlement (RTGS) and gyro clearing with the settlements three times a day, transferred all payment system transactions to commercial banks and the CBBH at the beginning of 2001.

jurisdiction. It was stipulated by this Law that shares could be bought by both domestic and foreign physical and legal entities for cash only. The nominal price of shares was set by the government of the entity based on the recommendation of the entity's Ministry of Finance. Voucher privatization was avoided in the case of privatization of banks, which may have been fortunate for the BH banking system[3]. With initial balance sheets prepared and the government announcing the sale of the state-owned capital in banks the first wave of privatization occurred and the liberalization phase of banking sector reform (Figure 1.1) ended.

The second wave of banking sector reforms started with foreign bank entry to BH. The first foreign-owned bank entered the BH banking market in 1997, but the vast majority of them entered in 2000 and 2001. A small number of foreign banks that entered the market through greenfield investments, most of the other foreign owned banks acquired banks that were privately owned before the war. The majority of privatized banks in BH initially became majority-domestically owned banks. Newly privatized banks were acquired by the foreign banks a couple of years after their privatization. This pattern is not uncommon. Poghosyan and de Haan (2008) found that foreign banks were targeting relatively large and efficient banks in transition economies that had made less progress in economic and institutional reform. This finding provides support to the market power hypothesis according to which banks are acquired with the objective of increasing their market power. At the end of 2008 as much as 88.4% of equity and 94.9% of total assets of commercial banks in BH was foreign owned (Table 1.2).

The number of banks in BH decreased from 55 at the end of 2000 to 30 at the end of 2008. This changing number of banks does not reflect the extent of structural changes in the BH banking system. Between January 2001 and December 2010 11 banks had their licences revoked, seven new banks entered the market, the number of banks decreased

[3] As Ellerman (1998) argues, the quickest and most politically popular technique of privatization among post-socialist reformers was mass voucher privatization that assumes no inflow of capital, but gives away for free the bulk of assets on the asset side of the public balance sheet. In his study of privatization in the Czech Republic, that is very similar to the case of BH, Török (2011) identified some of the main negative consequences of the mass voucher privatization: the fragmented ownership structure and loose and inconsistent company bankruptcy proceedings that resulted in a semi-state, semi-market ownership relation. The fragmented ownership structure, a consequence of weak involvement of citizens [some 28% in Török, (2011)] and creation of the Privatization Investment Funds in most cases resulted in development of excessive power of the chief executive officers (Simonetti and Böhm, 1999 and Török, 2011). In the case of BH, the excessive power of chief executive officers, very often the same person that 'bought' the company in the process of voucher privatization, coupled with the weak enforcement of bankruptcy proceedings resulted in a large number of companies that were struggling for years before they were shut down by their new owners. The final outcome was similar in the case of privatization by employee buyouts where the main problem was a lack of managerial expertise.

by 20 due to mergers and acquisitions, one bank was transformed into a development bank and there were also numerous structural changes caused by additional capitalization. A set of tables 1.2 through 1.4 below illustrate changes in the number of banks, equity and total assets by type of majority ownership in the period 2000-2010.

Table 1. 2: Changes in the number of banks in BH 2000-2010

Source: CBBH.

Year	State owned	Domestically private owned	Foreign owned	Total
2000	20	21	14	55
2001	12	15	21	48
2002	6	12	22	40
2003	7	10	19	36
2004	6	10	17	33
2005	6	7	20	33
2006	5	5	22	32
2007	3	8	21	32
2008	2	7	21	30
2009	2	7	21	30
2010	1	9	19	29

Table 1. 3: Changes in the ownership of equity in BH banks

in millions of BAM

Year	State owned	Domestically private owned	Foreign owned	Total
2000	418	208	133	759
2001	280	152	336	769
2002	87	165	443	695
2003	103	175	538	816
2004	170	178	599	947
2005	162	109	887	1,159
2006	166	61	1,108	1,334
2007	144	131	1,387	1,662

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Source: CBBH.
Notes: Equity is the average for the observed period. In Q4 2010 there was only one state-owned bank left. In order to protect the confidentiality of data the state-owned and domestically private owned groups are merged.

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2008	43	179	1,688	1,909
2009	43	191	1,922	2,156
2010	-	286	1,977	2,263

Table 1. 4: Changes in the structure of ownership of banking sector assets in BH

in millions of BAM

Year	State owned	Domestically private owned	Foreign owned	Total
2000	1,216	970	951	3,138
2001	742	768	2,971	4,480
2002	345	929	4,197	5,472
2003	370	1,048	5,571	6,989
2004	373	1,402	7,489	9,265
2005	423	652	10,652	11,726
2006	475	404	13,804	14,683
2007	381	839	18,358	19,578
2008	189	857	19,769	20,815
2009	162	969	19,477	20,608
2010	-	1,472	18,944	20,416

Source: CBBH.
Notes: In Q4 2010 there was only one state-owned bank left. In order to protect the confidentiality of data the state-owned and domestically private owned groups are merged.

Although the financial infrastructure was developing, the banking market lacked significant activity before 2001 (Figure 1.2)[4]. The introduction of the Euro caused an increase in foreign currency deposits, since DEM savings were taken from “under the mattress” and deposited in commercial banks. Also, the increasing number of bank clients due to the reform of the payments systems and increased number of payroll accounts contributed significantly to the increase in BAM denominated deposits (Figure 1.3). This change in banks’ balance sheets enabled the stronger lending activity of the banks.

[4] Loans to private sector are the sum of total loans to households and private non-financial enterprises. Details on the term structure of loans to public, private and other sectors are provided in Table A1.1 (p. 329).

Figure 1. 2: Loans to private sector by contractual maturity

Source: CBBH.

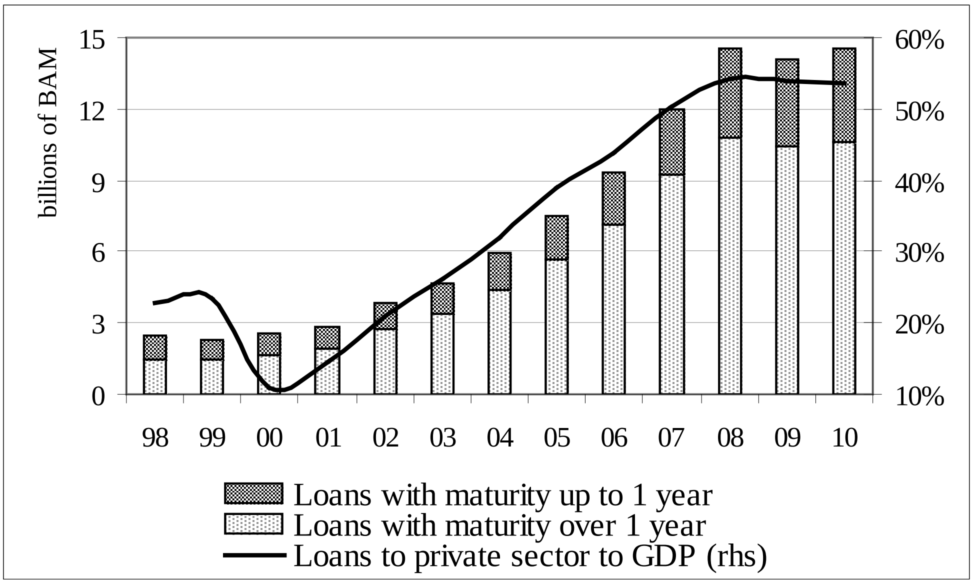
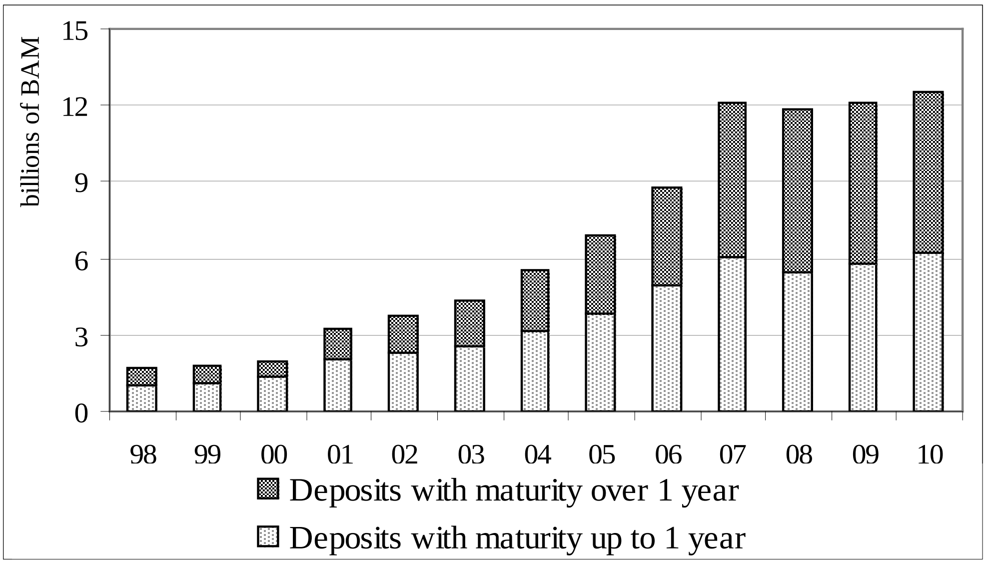


Figure 1. 3: Total deposits by contractual maturity

Source: CBBH.



At the end of December 2001, the month preceding the Euro Changeover, when compared to the end of December of 2000, time and savings deposits had increased by 113% to a level of BAM 1.2 billion[5]. Over 76% of the increase was due to an increase in the time and savings, foreign currency denominated deposits of households. Over the same period, demand deposits increased by 49% to the level of BAM 2.1 billion. An

[5] Monetary and financial statistics at the CBBH refer to all deposits with maturity up to one year as demand deposits. In reality, these consist of: transaction accounts, demand deposits and time and savings deposits with remaining maturity up to one year. Time and savings deposits have remaining maturity over one year. Detailed information on deposits by sectors by the term and currency structure is given in the Table A1.2 (p.330).

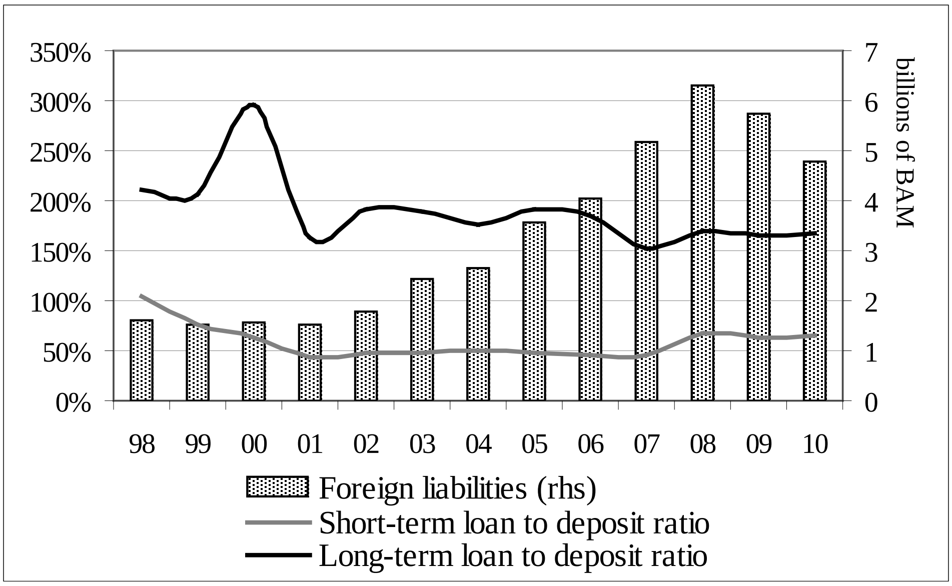
increase in demand, primarily foreign currency denominated, deposits of households, accounted for 68% of the increase in demand deposits. In the case of the deposits of private non-financial enterprises (PNFE), the BAM component of demand deposits of this category particularly increased, which was caused by the transfer of all payment system transactions to commercial banks and the CBBH at the beginning of 2001. An increase in the demand deposits of PNFE accounted for 26% of the increase in demand deposits in the period December 2000 through December 2001.

Cotarelli et al. (2005) examined the causes of the expansion of lending to private sector in 15 CEE and the Balkans countries. BH was placed into a group of "Late Risers" together with Lithuania and, at the time, Serbia and Montenegro. In the case of BH the year 2001 was identified as a turning point[6]. The turning point in the case of each of the "Early Bird" was: Slovenia (1992); Croatia and Estonia (1994); Poland (1996), Hungary and Latvia (1997); and Bulgaria (1998). By the year 2002 none of the "Sleeping Beauties" (Albania, Czech Republic, FYR Macedonia, Romania and Slovak Republic) had a turning point. One of the offered explanations for the rise in the bank credit to private sector (BCPS) ratio in the "Late Risers" was a surge in deposits due to the introduction of the euro that caused a permanent shift in holdings from cash to deposits. The low post-war credit base, the accelerated momentum in post-war reconstruction and an increase in consumption led to increase in demand for loans, but the maturity mismatch between banks' assets and liabilities induced a significant growth in banks' foreign liabilities (Figure 1.4).

[6] The year when bank credit to private sector (BCPS) to GDP ratio starts rising in countries where, thereafter, the average rise in the ratio as of that year has been at least 1.5 percentage points per year.

Figure 1. 4: Loan to deposit ratio and foreign liabilities

Source: CBBH.



Long-term maturity mismatch between domestic assets and domestic liabilities led to increasing borrowing from abroad in order to finance credit expansion in BH. The change in the financing structure of commercial banks resulted in balance sheet segmentation: long-term loans are mainly financed from abroad, reserves account with the CBBH is financed by the short-term BAM denominated deposits of the residents, while the euro denominated deposits of residents finance the accounts with correspondent banks. The pattern by which the credit expansion is financed from abroad is present in the case of all 15 CEE countries (Cotarelli et al., 2005). The turning point when domestic credit becomes increasingly dependent on inflows of funds from non-residents identified for each country roughly corresponds to the year in which international claims of the Bank for International Settlements (BIS) reporting banks on individual countries started to raise[7]. According to the *Guidelines to the International Consolidated Banking Statistics* (BIS, 2012), the business to be reported in case of on-balance sheet financial claims (immediate borrower basis) also include deposits and balances placed with banks and loans and advances to banks and non-banks. Burcu (2008) examined the role of foreign banks in credit booms in CEE countries and found that foreign-owned banks relied increasingly on interbank funding in the 2000s.

In the early 2000s a large body of literature addressed the impact of foreign direct investment (FDI) on the banking sector and, indirectly, on the economy as a whole in terms of an increase in productivity or capitalization of the banking sector. However, not much attention was devoted to the structure of either foreign direct or portfolio and other investment. It was generally acknowledged that foreign bank entry into transition and developing economies and the subsequent inflow of financial sector foreign direct investment (FSFDI) generated benefits for host countries in the form of: transfers of technology and related expertise and new financial products and services (BIS, 2004; Eller et al., 2005); higher efficiency of the host country financial system (BIS, 2004; Goldberg 2007; Eller et al., 2005) and balance of payments (BoP) finance (BIS, 2004). The issue of the structure of foreign investment became more important in the second half of the 2000s when it became obvious that rapidly expanding balance sheets of banking sector became increasingly vulnerable to external shocks, with potentially devastating consequences for real economy (Sorsa et al., 2007; Maechler and Ong, 2009). More specifically, in the process of cross-border financial integration some of the Central, Eastern and South-Eastern European (CESEE) countries were exposed to a relatively high risk of a sudden withdrawal of short-term external funding (Maechler and Ong, 2009).

International financial integration has been a central aspect of the CEE countries' growth strategy, it has contributed to sustained inflows of capital, including bank lending and portfolio flows in addition to foreign direct investment (Fabrizio et al., 2009). The IMF *Balance of Payments Manual* (1993) classifies investment into four broad categories: direct investment; portfolio investment; other investment; and reserve

[7] Data on claims on individual countries by the BIS reporting banks are available from BIS Quarterly Review, Table 9A: Consolidated Claims of reporting banks- immediate borrower basis.

assets. Very often the role and characteristics of FDI are simplified, since the values of FDI are usually reported in total amounts and the structure remains unknown, or ever worse, it assumed that everything is equity related. According to the IMF *Manual*, FDI consists of equity capital, reinvested earnings and other capital associated with various inter-company debt transactions. Likewise, portfolio investment does not exclusively represent acquiring less than 10 percent of equity, but, according to the *Manual*, it also includes debt securities in the form of bonds and notes, money market instruments and financial derivatives such as options. Other investment, also according to the *Manual*, consists of trade credits, loans (including the use of Fund credit and loans from the Fund), currency and deposits (both transferable and other), and other assets and liabilities (for example, miscellaneous accounts receivable and payable). At this stage, it is worth pointing to an important characteristic of banking sector FDI in BH: more than in any other industry, portfolio and other investment followed banking sector FDI.

According to CBBH Notes on Methodology, foreign investments in the banking sector consist of FDI and portfolio and other investment. FDI encompass: equity in excess of 10% of ownership (categories cash, equipment and other goods and services and other); inter-company loans; and other non-capital. The following categories of investment fall into portfolio and other investment: deposits of foreign direct investors; equity (up to 10% of ownership); bonds; money market instruments; long- and short-term loans from other non- residents; deposits of other non-residents; and other. The structure of stock foreign investment in the BH banking sector indicates two things: the share of mother-bank loans in FDI increases to roughly 50% and, most importantly, the largest part of foreign investment in the BH banking sector is in the form of mother-bank's deposits (Table A1.3, p.331).

Both deposits of and loans from mother-banks are used to finance credit expansion in BH. Loans from mother-banks are a form of contract agreement and cannot be easily broken, but deposits of mother-banks can be easily withdrawn. By the end of 2008 there was still no evidence of significant mother-bank deposits withdrawal, but the banks that financed credit activities in BH primarily by the mother-bank deposits were shifting towards loans from mother-banks and other non-residents (Figures 1.5a and 1.5b). With the significant deterioration in both domestic and international macroeconomic environment in 2008, followed by a bank run in October 2008, a lending freeze occurred and the domestic demand for long-term loans was significantly reduced. Consequently, lending to all domestic sectors, and households especially, strongly contracted (Table A1.4, p.332). Given that the increasing borrowing from abroad in the past was caused by the credit expansion and a mismatched maturity structure between banking sector's assets and liabilities, the events of the second half of 2008 reversed the trend: banks were repaying their foreign liabilities as they matured which resulted in a strong capital outflow in the years following the shock. This trend of a reduction in banking sector foreign liabilities continued in the years beyond the sample used in this research.

Figure 1. 5a: Flow of foreign investment from foreign owners

Source: CBBH.

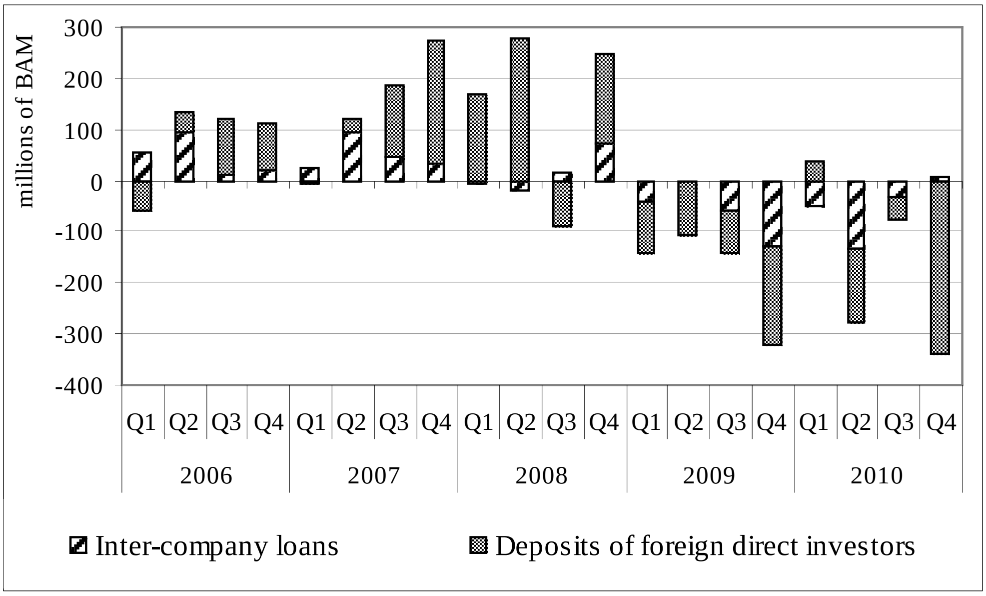
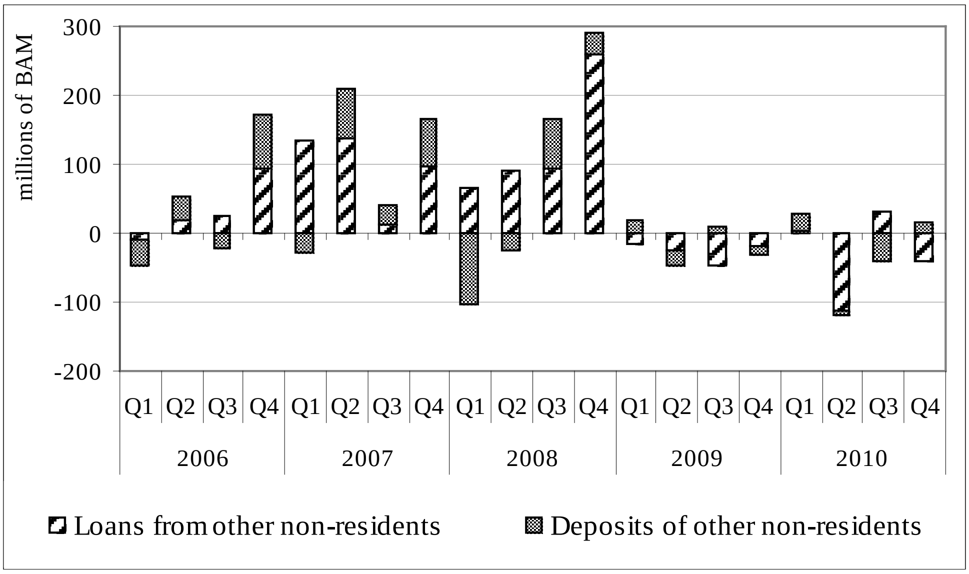


Figure 1. 5b: Flow of foreign investment from other non-residents

Source: CBBH.



The outflow of foreign investment affected the capitalization of the banking sector. One of the traditional measures of banking sector soundness is the capital adequacy ratio (CAR). It is calculated as the ratio of bank's net capital, or regulatory capital, to risk-weighted assets (RWA). Net capital equals the sum of core capital and additional capital net of supervisory deductions. Equity is just one of the items in core capital. On the other hand, additional capital consists of items such as subordinated debt to the maximum amount of up to 50% of core capital, as currently prescribed in BH. There are certain conditions that need to be met in order to classify subordinated debt as additional capital, but the fact that the solvency of the bank depends on the borrowed funds and that those same funds are used to finance credit expansion in the country is enough to raise concerns. Table A1.5 (p.333) provides the structure of regulatory capital in BH, while Table 1.5 provides an overview of equity, Tier 1 and regulatory capital in BH for majority foreign-owned and domestic banks. Until the end of 2008 net capital was significantly higher than Tier 1, which suggests that in the years of credit expansion the categories such as general reserves for loan losses or subordinated debt were greatly affecting the level of capitalization. In other words, capital buffers set by the regulators against the credit risk included funds borrowed abroad (subordinated and hybrid debts) to finance credit expansion that increases credit risk and provisions set aside for the low-risk assets (general reserves for loan losses). With a deteriorating macroeconomic environment, the banking sector started recording losses, which is suggested by lower Tier 1 capital with respect to equity in years 2009 and 2010. Losses were met by capital injections, which is evident in Table 1.5 in the increase in equity in the last two years of the sample.

Table 1. 5: Banking sector capital

in millions of BAM

Year	Equity			Tier 1/ Core capital			Net capital		
	Domestically owned	Foreign owned	Total	Domestically owned	Foreign owned	Total	Domestically owned	Foreign owned	Total
2000	626	133	759	491	150	641	502	185	687
2001	432	336	769	316	335	651	335	396	731
2002	252	443	695	260	524	785	274	610	884
2003	278	538	816	274	550	824	299	751	1,051
2004	348	599	947	339	656	995	350	899	1,248
2005	272	887	1,159	254	887	1,141	258	1,230	1,488
2006	227	1,108	1,334	222	1,208	1,430	226	1,630	1,856
2007	275	1,387	1,662	316	1,410	1,726	323	2,022	2,345
2008	221	1,688	1,909	217	1,734	1,951	223	2,418	2,642
2009	247	1,962	2,209	236	1,803	2,039	241	2,402	2,643
2010	286	1,977	2,263	285	1,848	2,134	295	2,435	2,730

Source: CBBH.
Notes: Equity is the average for the observed period.

In periods of expansion, one of the reasons for the disproportionate increase in equity with respect to net capital is the targeted return on equity of the foreign banking groups. At the peak of cross-border inflows of funds to the banking sector, at end of 2007, the external exposure of BH banks to their mother-banks in Austria made up for 95.2% of their total external exposure and as high as 59% of total external exposure of all BH banks. In contrast, the exposure of Austrian banks to BH was just 1.3%. One might argue that such low exposure of mother-banks to the domestic banking sector might even be beneficial in case of a distress, since it is more likely that the mother-banks will tend to reduce their larger exposures first. The counter argument might be that, in case of distress, mother-banks would first cut the exposures in case of the smallest return on own funds, i.e. where the leverage effect is the lowest. DuPont analysis decomposes Return on Average Equity (ROAE) in the fashion that indicates where the majority of return is coming from: operating efficiency, measured by the net profit margin; asset use efficiency, measured by the total assets turnover; or financial leverage, measured by the equity multiplier.

ROAE = Net profit margin **x** Total assets turnover **x** Equity multiplier,

that is,

$$\frac{PN}{CP} = \frac{PN}{V_o} \times \frac{V_o}{AT} \times \frac{AT}{CP} \tag{1.1}$$

where PN denotes net profit, V_0 is income, AT is total assets and CP is average equity[8].

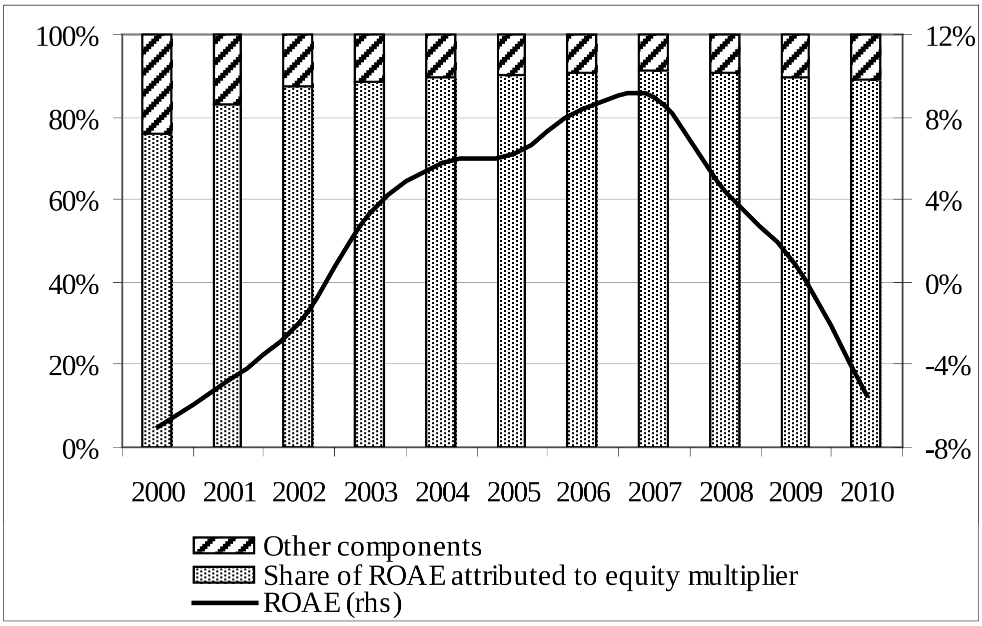
ROAE analysis based on the DuPont identity indicates that the increase in return on equity was mainly caused by the financial leverage. In the period 2000 through 2007 the share of the equity multiplier in ROAE for the banking sector as a whole increased from 76% to over 90% (Figure 1.6). In the post 2007 period ROAE recorded a steep decline, while the negative ROAE in 2010 indicates that foreign investors were losing money on their investment. Since host country banks have targeted rates of return set by the mother-banks, this finding implies that if the increased cost of borrowed funds cannot be compensated by an increase in BH active interest rates, or if the return elsewhere in the region is higher, the mother-banks would, most likely, channel their investments to other countries. This sudden stop or even reversal of foreign investments to the banking sector would result in slowdown in economic growth (McKinnon and Pill, 1996 and Kaminsky and Reinhart, 1999). Edwards (2004) concludes that sudden stops and current account reversals are closely related[9]. Furthermore, current account reversals were found to have a negative effect on real growth that went beyond the direct effect on investment.

Figure 1. 6: The importance of financial leverage for return on average equity

[8] Originally, this model of performance measurement used sales instead of income, but nothing is changed by substituting income since it can be treated as sales in the case of the banking sector. The source of data is the CBBH and the series used to calculate state-level Financial Soundness Indicators (FSI) are based on data submitted by the FBA and BARS. Equity is the average for the observed period, profit is reported as the net amount after extraordinary items and taxes and, income is reported gross and represents the sum of interest and non-interest income, while assets reported are stock, end of period.

[9] A sudden stop is defined as a situation where net capital inflows decline by at least 5% of GDP in one year. A current account reversal is identified as a reduction in current account deficit of at least 4% of GDP in one year.

Source: ABRS, FAB, own calculations.



The number of banks in BH (Table 1.2) has gradually fallen since 2000. This process was partly caused by mergers and acquisitions. Although industrial organization studies have frequently associated market concentration with more intense market competition and some authors imply that the two terms can be used interchangeably (Berger et al., 2009), there is a need to differentiate between them. It is entirely possible that a market is concentrated; in case of some of the Baltic States more than 90% of banking sector assets is concentrated in 3-5 largest banks. This, however, does not necessarily imply that the banks are competing for the same clients.

At the end of 2010, the BH banking sector consisted of 29 banks, with a significant number belonging to the same banking groups. Although the concentration, as measured by the Herfindahl-Hirschman Index (HHI), is growing in all segments of the banking market (assets, loans and deposits), the HHI by the number of registered banks indicates a competitive market[10]. The average HHI calculated for the periods after 2005 based on the total number of banks indicates a relatively low concentration of assets, loans or deposits, only sporadically exceeding the 1,000 points threshold. On the other hand, if one observes the BH banking sector based on common foreign owners (the last row in Table 1.6)[11], the HHI indices point to a moderate level of concentration in December 2010. For the sake of comparison December 2010 values of the HHI in all three categories based on the total number of banks are provided as well.

Table 1. 6: Concentration of the BH banking sector

[10] HHI is a measure of concentration calculated as the sum of squares of the individual shares in the observed segment. According to the U.S. Department of Justice Guidelines (2010), a value of the index below 1,000 points indicates low concentration and that the market has characteristics of a competitive market. An index ranging from 1,000 to 1,800 points indicates a moderately concentrated market, while a value of above 1,800 points indicates a highly concentrated market. More information can be found at http://www.usdoj.gov/atr/public/testimony/hhi.htm.

[11] Grouping banks by their common major foreign owner reduces the number of banks to 25 since there are 5 banking groups in BH. Two banks belong to each of the following banking groups: Unicredit, Hypo-Alpe-Adria, Volksbank and Nova Ljubljanska Bank. The majority owner of the remaining two banks is the Poteza Adriatic Fund from Luxembourg.

Source: CBBH (2011).

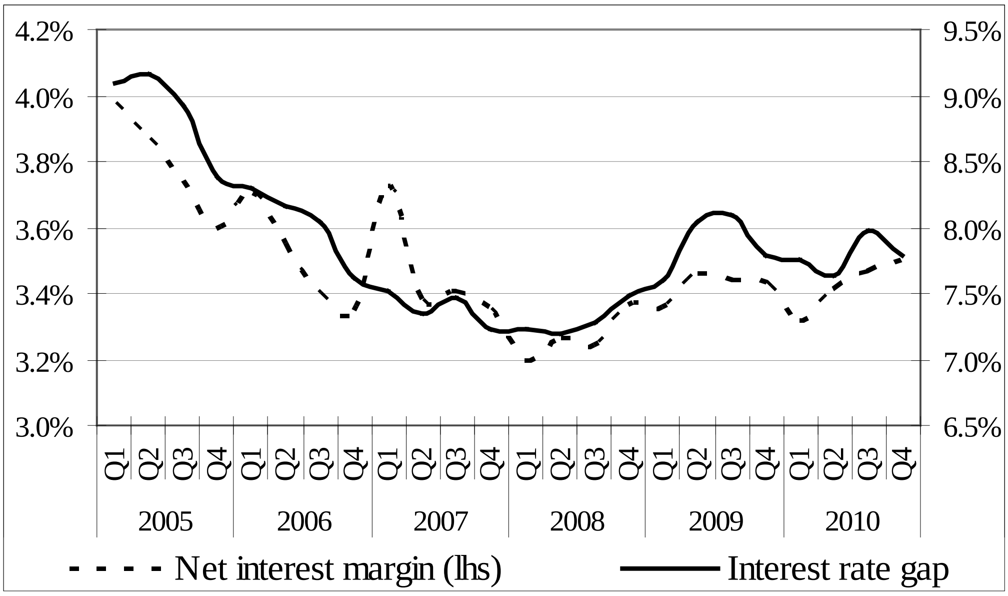
			HHI points
	Assets	Loans	Deposits
2005, the annual average	919	939	1,097
2006, the annual average	920	963	1,035
2007, the annual average	883	985	928
2008, the annual average	973	1,079	990
2009, the annual average	999	1,007	1,050
2010, the annual average	943	920	1,090
Dec. 2010 by the number of registered banks:	900	903	1,092
Dec. 2010 by the banking groups	1,202	1,279	1,354

Traditional indicators of an increase in banking sector competition, according to Schulz (2004), are decreasing interest rate margins and decreasing operating costs. According to the same source, many studies have found that banks with greater market power charge higher loan rates and offer lower deposit rates. Accordingly, a decreasing gap between these interest rates should imply an increase in competitiveness. The decline in both this gap and the net interest margin suggests increasing competition in BH banking sector until the end of 2008. In the latest period the trend reverses, perhaps as a consequence of an increased demand for domestic sources of long-term funding and the deteriorating quality of assets (Figure 1.7)[12].

[12] The net interest margin is calculated as the ratio of annualized net interest income to total assets in the observed quarter. The interest rate gap is calculated as the difference between domestic lending and deposit interest rates. Both lending and deposit interest rates for each quarter are calculated as the average of the corresponding month's weighted average interest rates on new loans to and new deposits from private sector.

Figure 1. 7: Net interest margin and interest rate gap

Source: CBBH, own calculations.



Unfortunately, one cannot tell with certainty whether the decline in interest rate gap in Figure 1.7 was due to an increase in competition or a reduction in default risk. The interest rates reported are those for new loans disbursed and deposits collected in the observed month so they, at best, indicate banks' perception of the new clients' creditworthiness. On the other hand, it is safe to assume that the banks, in general, treated the risk factor as low since the vast majority of loans were issued with variable interest rate clause and there was no evidence of an increase in interest rates on existing loans until August 2008. The financial crisis caused a shift from foreign to domestic sources of financing, which resulted in a hike in interest rates on domestic time and savings deposits. As a result, lending interest rates increased as well, but not proportionally, since the interest rate gap was decreasing through mid-2008 (Figure 1.7).

In contrast to the trends in the cost of funding, until late 2008 operating costs were increasing over time, primarily due to increases in wages and labour taxes that made up roughly 50% of all operational costs[13]. The main reasons for this constant increase in personnel expenses were both increases in the number of employees and in the average wage in the banking industry. In this context an increase in operating costs could be seen as an increase in competition, given the increase in the number of organizational units of the banks.

The moderately high concentration in the market for loans based on the number of banks grouped by the criteria of ownership (Table 1.6) and increasing competition as the market got saturated resulted in more aggressive lending policies of banks in the period before the macroeconomic shock occurred in mid-2008. Given that international financial markets were experiencing a global financial crisis for at least two quarters before the macroeconomic shock occurred in BH, it is safe to assume that BH banks knew the systemic risk was much greater than it was acknowledged in the past. This is also evident from the interest rate gap that started increasing a quarter before the net interest margin (Figure 1.7). A final push to secure a higher market share before the lending freeze in the third quarter of 2008 resulted in an extraordinarily high inflow of deposits from the mother-banks from the end of 2007 through to mid-2008 (Figure 1.5a). These were used to extend more loans at a time when interest rates in domestic markets had already started to increase. These trends in competition in the market for loans and resulting changes in the perception of quality of the banking sector's loan portfolio will be the focus through the rest of this section.

Despite the strong dependence on external financing and the series of increases in the ECB referent interest rates, domestic nominal lending interest rates were decreasing until mid-2008 (Figures 1.8a and 1.8b). Simultaneously, interest income from loans and leasing activities was increasing due to increases in new loans to the private sector. Commercial banks in BH were compensating profit lost due to increasing cost of

[13] Operating costs are the sum of: the cost of wages and labour taxes; the cost of business premises and utilities; and other costs.

borrowing funds from abroad by extending more loans. As of mid-2008, banks adjusted their perception of credit risk upwards, which, together with lower demand for loans caused by the higher lending interest rates, resulted in significant slowdown in credit growth (Table A1.4, p.332).

Figure 1. 8a: New short-term loans and interest rates

Source: CBBH, own calculations.

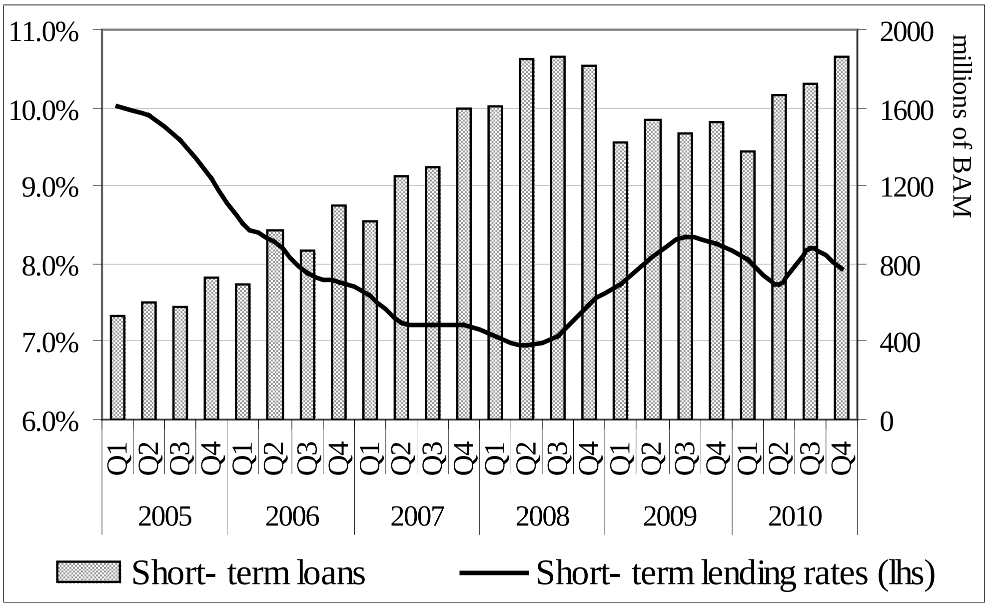
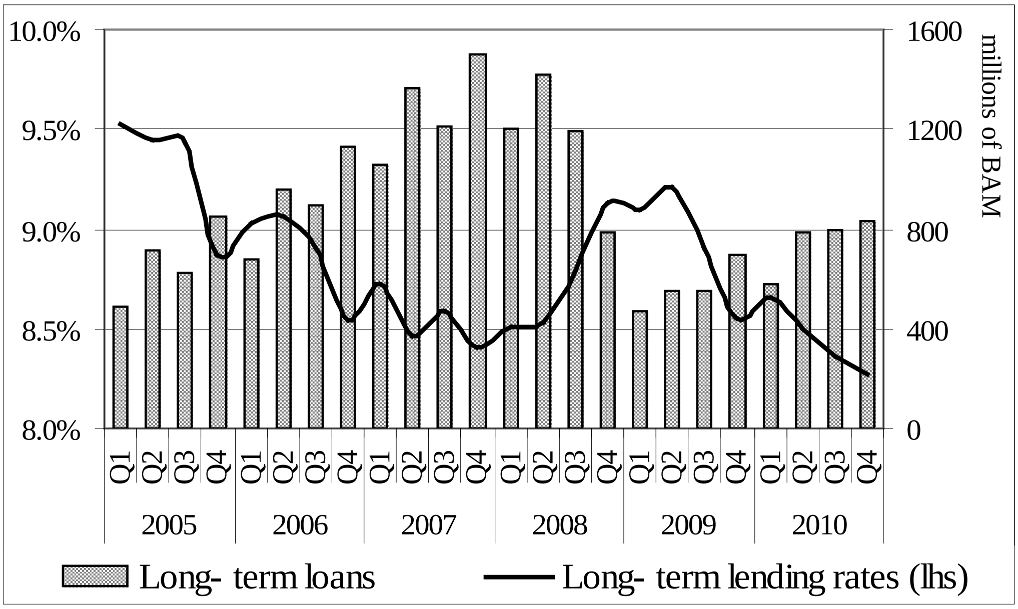


Figure 1. 8b: New long-term loans and interest rates

Source: CBBH, own calculations.



As a consequence of the aggressive lending policies by banks in the period of economic expansion, the stock of loans was increasing (Table A1.4, p.332) causing, as explained below, the ratio of the NPL to total loans, the NPL ratio, to decrease over time. A strain of research considers a decrease in the NPL ratio as a sign of improvement in banking sector health and foreign bank entry is usually credited with reducing the level of bad loans in the economy. Berger et al. (2009) use the NPL ratio as a proxy for financial stability. Schulz (2006) finds that the key driver behind productivity growth in Mexican banks in the period 1997-2006 was an improvement in asset quality reflected in reduced provisions for non- performing loans. In the same research it was claimed that foreign ownership had a negative and highly significant effect on nonperforming loans provisions. However, these findings of Schulz (2006) and similar studies may not be valid in BH for two reasons. Firstly, the level of NPL is taken into the account when the foreign bank is making an offer to buy a domestic bank, therefore the foreign bank has already taken into account possible write-offs. Secondly, almost all loans are good loans at the beginning. In BH the NPL ratio decreased from 21.2% in year 2000 to 3.1% at the end of 2008. After the initial cleaning of balance sheets is taken into the account (write-offs were against capital in most cases, rarely against the earnings since they were rather poor in that period), when one observes the period between the fourth quarter of 2003 and the fourth quarter of 2008, the situation is significantly different. The NPL ratio in the years before 2008 was decreasing not because of a decrease in NPLs, but because of the faster growth in total loans (Table 1.7). While the stock of NPL moved in +/- 10% band around BAM 360 million, with the exception of 2008, total loans increased from BAM 4.18 billion to BAM 14 billion. This fall in the NPL ratio stopped in 2008, not only because of the slowdown in credit growth, but also due to a significant increase in NPLs.

Table 1. 7: NPL ratio

Source: ABRS, FAB.

Year	On balance sheet data			Off balance sheet data included		
	Total loans, millions of BAM	NPL, millions of BAM	NPL ratio, %	Total loans, millions of BAM	NPL, millions of BAM	NPL ratio, %
2000	1,652	351	21.22	2,031	730	35.91
2001	2,101	376	17.91	2,510	785	31.28
2002	3,215	354	11.02	3,659	798	21.81
2003	4,178	350	8.39	4,660	832	17.86
2004	5,455	331	6.07	5,938	814	13.70
2005	7,054	372	5.28	7,591	910	11.98
2006	8,856	354	4.00	9,431	929	9.85
2007	11,595	382	3.29	12,189	975	8.00
2008	14,040	434	3.09	14,617	1,011	6.92
2009	13,497	792	5.87	14,152	1,448	10.23
2010	13,936	1,592	11.42	14,559	2,215	15.21

The purpose of Table 1.7 is to illustrate how the regulatory framework may conceal the actual levels of risk. On the left hand side are the reported total loans and NPL consist of on-balance sheet items only, which is in line with the existing national regulations. Until 2010 E category assets, the losses 100% provisioned for, were recorded off-balance. In other words, the regulatory figures for the stock of loans being reported net, did not include E category loans. Similarly, the stock of NPL consisted of loan categories C and D alone. Given this regulatory framework, the loan portfolio of the BH banking sector appeared to be better than it actually was. At the end of 2010, banks operating in RS were instructed to return the E category assets to on-balance sheet items. A part of the large increase in the stock of NPL in the left-hand half of Table 1.5 is a consequence of this regulatory change. A similar measure was implemented in FBH a year later.

The purpose of this section was to illustrate the context in which the research is conducted. Unlike in most other CEE countries, in BH's transformation from a centrally planned to a market economy, the financial system of a country had to be established from foundations following the 1992-1995 war. Similar to the cases of other CEE countries, the BH financial system went through two distinct stages as indicated by Barisitz (2008): the era of liberalization measures and the era of restructuring and institutional adjustment (Figure 1.1). The key institutions for functioning of the financial system were established and the first wave of privatization was completed during the period of liberalization. With stronger liberalization of the capital account, the presence and activity of foreign banking groups increased. Without any doubt, the presence of subsidiaries of foreign banking groups resulted in stronger economic activity in BH since domestic funds were insufficient to finance long-term investments. However, the presence of foreign banking groups, strong domestic demand for loans that coincided with the periods of high liquidity in international markets and *post festum* changes in the regulatory framework increased the fragility of the system. With a macroeconomic shock of a significant magnitude these vulnerabilities became apparent. The consequences of changes in regulatory framework have been illustrated in this section. Section 1.4 reviews some general conclusions from the theory of banking sector regulation, while Section 1.5 explains each of the major changes in BH banking regulatory framework in more detail.

1.4. The theory of banking sector regulation

In this research the term *regulation* is used for the regulatory framework, the process of rulemaking. *Supervision* is used for the process of checking compliance with the existing rules, which is a broader term and an adequate regulatory framework is only one of the pillars of effective supervision. Since the focus of this research is on the BH's banking sector, both regulation and supervision relate to that sector.

The increasing number of financial crises over the past several decades (Laeven and Valencia, 2008), and the general view that a well-functioning banking sector is beneficial for economic growth, resulted in more frequent calls for reforms in bank regulation and stronger supervision. The relevant international organizations promoted an excessive list of "best practices" to be adopted by each country. These may come in the form of either principles or standards and the key 12, as identified by the Financial Stability Board (FSB) are listed in Davis (2011) and presented in the following table.

Table 1. 8: The key international standards

Source: Davis (2011).

Area		Standard	Issuing Body
Macroeconomic Policy and Data Transparency	Monetary and Financial Policy Transparency	Code of Good Practices on Transparency in Monetary and Financial Policies	International Monetary Fund (IMF)
	Fiscal policy transparency	Code of Good Practices on Fiscal Transparency	
	Data dissemination	Special Data Dissemination Standard / General Data Dissemination System	
Institutional and Market Infrastructure	Insolvency	Insolvency and Creditor Rights	World Bank (WB)
	Corporate governance	Principles of Governance	Organization for Economic Cooperation and Development (OECD)
	Accounting	International Accounting Standards (IAS)	International accounting Standards Board (IASB)
	Auditing	International Standards on Auditing (ISA)	International Federation of Accountants (IFAC)
	Payment and settlement	Core Principles for Systemically Important Payment Systems	Committee on Payments and Settlements System (CPSS)
		Recommendations for Securities Settlement Systems	CPSS / International Organization of Securities Commissions (IOSCO)
	Market integrity	The Forty Recommendations of the Financial Action Task Force / 9 Special Recommendations Against Terrorist Financing	Financial Action Task Force (FATF)
Financial Regulation and Supervision	Banking supervision	Core Principles for Effective Banking Supervision	Basel Committee on Banking Supervision (BCBS)
	Securities regulation	Objectives and Principles of Securities Regulation	IOSCO
	Insurance supervision	Insurance Core Principles	International Association of Insurance Supervisors (IAIS)

More information on international bodies that have a mandate for systemic risks monitoring and enhancing cooperation between national and international supervisory bodies is provided in Section 2.2.

Following the global financial crisis of 2007, it was commonly found that the policy and regulatory frameworks of a more recent history (post the dot com bubble) are observed through three stages: the pre-crisis framework; policies during the crisis and recovery; and policy frameworks in the long-term (Pain and Röhn, 2011). The pre-crisis policy and regulatory frameworks were based on the Efficient Market Hypothesis (EMH) that, as Davis (2011) underlines, asserts that financial prices reflect all currently available information, not that those prices are 'right' nor that the information is correct or complete. An excessively accommodative monetary policy in the pre-crisis periods (Ahrend, 2010 and Bean et al., 2010) created a climate of deregulation where the calls for abandonment of all regulation were present. Wallison (2005) suggested that: "The only reason we regulate banks is because we want to, not because we have to" (p.19). The prevailing opinion at that time, including Barth et al. (2004), was that there was no evidence that best practices being advocated by international agencies are better than existing national alternatives or that successful practices from one country can be implemented in a different economic environment with equal success. It was believed that the existing regulatory framework was suitable and provided minimum standards for prudent conduct of banking operations. However, there were underlying risks unrecognized by the supervisors and financial institutions that were building up over the years and, once they materialized, the world faced the most severe financial crisis in recent history. A finding of Allen and Carletti (2008) that, regardless of the type of market failure, in incomplete markets the financial system is typically a shock amplifier indicates the flaws in the frameworks based on the EMH.

The global financial crisis of 2007 indicated that the view of Barth et al. (2004) was correct; there was no evidence that best international practices were any better than existing national regulations. The failure to adequately regulate Systemically Important Financial Institutions (SIFIs), and particularly those who are active globally (G-SIFIs), promoted instability of financial systems in the pre-crisis period (Davis, 2011). The immediate policy responses to crisis were in the form of countercyclical monetary policies, which were soon exhausted so discretionary fiscal and structural measures were increasingly utilized (Pain and Röhn, 2011). Furthermore, recognizing that some of the SIFIs were outside the regulatory framework, a series of changes in the international regulatory framework occurred (Davis, 2011). In June 2009 the IOSCO presented new principles for the oversight of hedge funds. In the U.S. the Dodd-Frank Act altered registration requirements for large hedge-funds. In January 2011 the Securities and Exchange Commission (SEC) announced new registration and information provision requirements for hedge funds with assets exceeding USD 150 million and in November 2010 the European Parliament passed the Alternative Investment Fund Managers Directive.

According to Pain and Röhn (2011), the key aspects of the new post-crisis policy framework, that are largely in line with the activities in post-crisis financial reform specified by the Financial Stability Board (2010), include:

- Restoring a clear assignment of policy instruments to policy objectives thus improving the accountability and efficacy of policy decisions;
- Combining improved micro-prudential regulation and supervision with the establishment of effective macro-prudential policies to help ensure financial stability;
- Enacting structural reforms to help strengthen the prospects for long-term growth and enhance resilience to shocks;
- Enhancing international co-operation under the auspices of the G20, both in regard to the design and harmonized implementation of financial reforms;
- Ensuring that national policy frameworks have adequate tools to deal with spillover effects from policies in other countries.

The international regulatory and policy frameworks went through significant changes over the past 15 years: from the trend of deregulation, via short-term remedial actions in the initial period of the global financial crisis, towards stricter regulation at the international level and an emphasis on better coordination between the regulatory and policy frameworks. National responses to changes in the macroeconomic environment during and in the post-global financial crisis periods in some cases went towards imposing higher regulatory requirements upon particular financial institutions (Davis, 2011). In the case of BH, the banking sector regulation was always a *post festum* response to trends in banking sector. The framework currently in place is a mixture of national regulations and practices outlined by Basel I. Basel II, already obsolete in international terms, is not targeted for implementation until 2018. The timeframe for implementation of Basel III has not been defined yet. The following section provides an initial analysis of major changes in the BH regulatory framework.

1.5. Development of banking sector regulation in BH

The phase in BH banking sector's development that started in early 2002 and lasts until today might be referred to as the harmonization phase and it led to increased activity in the banking sector. This reform is in line with Barisitz's (2008) argument that the second wave of reforms consist mostly of restructuring/institutional adjustments that include: applying stricter banking rules; upgraded bookkeeping standards and tighter supervision. At first, the two territorial political units, the entities, started harmonizing regulation between them. In doing so, they were also adjusting the existing regulations to those prescribed by the BCBS and other international norms and standards. These activities led to the final elevation of the segmented banking sector to a national-level system. The regulatory changes were perceived by the foreign banks as a sign of improvement in the investment climate in BH, so this was also a period of increased acquisition of domestic banks.

From this perspective, it is clear that the regulators in BH were trying to cope with one problem at the time without looking too much into the future. Aware of the fact that the lack of capital is a limiting factor in development, the policymakers treated banking sector reform with deserving urgency. The necessary institutions, with an exception of the DIA, were established in 1997, the Law(s) on Banks were passed in 1998, but the Law on Privatization of Banks was still in the parliamentary procedure. Finally, the latter Law was passed in late 1998, but the by-laws were old and in great part inherited from the previous system. By 2002 the majority of banks had been privatized, with a significant number of foreign owned banks.

The increased number of amendments in applicable Laws and by-laws, such as the amendments to the Law on Banks in FBH (in 2000, 2001, 2002 and 2003) and a new Law on banks adopted in RS in 2002 and by-laws regulating liquidity and risk exposure of the banking sector followed. The significant growth in the RWA, primarily loans, in the period 2000-2004 was not followed by what was felt to be a sufficient growth in capital so changes were introduced to both the Law on Banks and the by-laws regulating the banking market[14]. The CAR remained at the level where it was set from the beginning, at 12% for all banks, which is well above the levels prescribed by Basel I, but probably suitable in the case of BH given its currency board arrangement and the lack of a Lender of Last Resort (LOLR) function of the central bank. The minimum regulatory capital was raised a couple of times to the level of BAM 15 million effective as of the end of 2002 (which is above the minimum required level for the EU)[15] and this increase triggered further consolidation in the banking sector. One country specific factor that is a consequence of the sub-state level banking supervision is that some banks had the same foreign owners but were registered as separate legal entities in the FBH and the RS[16]. The supervisors also brought in two important changes in regulation regarding the net capital:

- As of 2000 banks were required to provide reserves for potential credit loss either against the banks' profit or against their capital, in which case the capital should still be above the prescribed minimum level and

- As of the end of 2002 net capital does not include the nominal amount of shares issued that were financed by bank loans up to the amount of the remaining debt. This regulation was introduced in order to avoid the cases like Riječka Banka in Croatia.

Aware of a maturity mismatch between the banks' financial assets and financial liabilities, the banking agencies removed the limitations on foreign borrowing of the banks at the end of 2002. This was a crucial moment in BHs' banking sector development. By allowing the banks to finance credit expansion in BH by borrowing from abroad, primarily from the mother-banks, the maturity mismatch issue was resolved but a problem of increasing foreign exchange risk emerged. Loans, primarily

[14] The list of all amendments to both entities sets of laws and the accompanying by-laws is too long to be mentioned in the thesis. They are all published on the web sites of the banking agencies at http://www.fba.ba/ and http://www.abrs.ba/index_eng.htm.

[15] The minimum required capital in the EU is EUR 5 million. Basel I prescribe a CAR of 8% for internationally active banks and 4% for domestically active banks. BH legislators chose the level of 12% given the restrictions of the currency board arrangement. The financial systems of developed and number of regional countries are in the process of implementing Basel III that requires 9% Core Tier I capital adequacy ratio. BH still operates under a cross between national regulations and Basel I. The year targeted for the implementation of Basel II standards is 2018.

[16] Banks in BH must be registered as separate and independent legal entities. Therefore, a foreign bank can have a subsidiary, but not a branch. On the other hand, a subsidiary of a foreign bank registered in either of the entities can have many organizational units across the state. The banking agency in charge of the bank and all its territorial units is the agency in charge of the headquarters of the bank.

long- term, were issued in BAM, but they were financed by borrowing in foreign currencies, meaning that banks' balance sheets became more sensitive to changes in foreign exchange. The low levels of capital with respect to foreign exchange exposure raised concerns that banking sector capital would not be able to absorb potential losses incurred by unfavourable changes in the exchange rates. This is why the limitations of forex activities of the banks were amended in June 2003 in a sense that a bank could have an individual overnight forex position in EUR up to 30%, or 20% in other foreign currencies, of its Tier 1 and that foreign currency indexed assets and liabilities were included.

Daily harmonization of the net open position was mandatory as of 2004 and it put an end to huge variations in the country's foreign reserves within a single month. Until then, banks would buy the Euro at the beginning of the month, deposit it abroad and then return it back at the end of the month and re- purchase BAM in order to satisfy the dynamics of harmonization with the regulation on minimum standards for the management of forex risk. This problem returned at the beginning of 2012 due to the "disinvesting" of foreign owned banks.

In 2003, the CBBH also changed the regulations on required reserves maintenance in that cash in vaults could no longer be used for meeting the reserve requirement, and the deposit base for the calculation of required reserves was extended to foreign currency denominated deposits. The CBBH was raising required reserves rate a few times up to 18% that was effective until the third quarter of 2008. The CBBH used each rise in required reserves rate as a message to the public that the loans were growing too fast. However, high liquidity in the markets and the deep pockets of mother-banks left the actions of the CBBH at the level of signals. Facing the financial crisis in the world, and a classical bank run that was triggered by the news that the overall rating of one of the mother-banks was downgraded, the CBBH decided to reduce the rate of required reserves to 14% in October 2008. Another attempt to fight the liquidity constraint was to exclude all new funds borrowed from abroad from the basis for the required reserves calculation. This measure was effective as of November 2008. It is estimated that these actions provided additional liquidity to the market of BAM 700 million. The CBBH decided to change its required reserves policy again, effective as of the beginning of 2009; the required reserves rate was reduced to 10% on assets and borrowed funds with contractual maturity over one year.

As for the harmonization of the term structure between the financial assets and liabilities, in 2004 the regulation was amended in the sense that all items of financial assets that are exposed to credit risk should be valued at net book value, while the term structure harmonization up to 180 days should be observed for both contractual and remaining maturity. The term structure harmonization between bank's assets and liabilities was relaxed again at the beginning of 2008 in that more long-term assets can be financed by the short-term liabilities. This measure was undertaken in order to reduce the dependence of BH credit markets on financing from abroad.

High liquidity in world markets in the years prior to the current financial crisis, the deep pockets of the mother-banks, the high demand for loans and the attempt of banks to maintain current or even increase their market share led to strong credit expansion in BH. Over time the problem of increasing debt of both households and enterprises became so serious that no one in the system knew what the level of potential debt was. In the absence of a credit bureau (with the exception of LRC, a private credit bureau that provided limited information on major enterprises in BH), there was no register of potential debt in the country; there was no information on so-called framework loans and no data on guarantors/co-debtors in the household sector. Also, there was no information on card debt. Technically speaking, it was entirely possible for a person to open a bank account in one bank, receive her/his salary on that account, and get a deferred payment card (usually up to 50 days with allowed overdraft in the amount of one monthly salary or cash inflow to the account). Then that person could withdraw all cash and go to another bank and physically deposit the cash and get the same type of deferred payment card. On top of that, the same person could have been a guarantor on someone else's loan. The person would have no loans but the exposure was great. That is why the CBBH introduced the Central Register of Credit (CRC) in April 2006. In the initial phase the CRC covered only legal entities, but it was extended to physical persons in January 2007. Updating the CRC once a month became an obligation and a responsibility of each commercial bank. Access to the CRC is granted to all financial intermediaries that provide data for the register (intermediaries other than commercial banks still provide data on a voluntary basis) and to the CBBH and the banking agencies[17]. By the end of 2008 the minimum standards for the identification,

[17] The whole register is physically placed in the CBBH. The information that a commercial bank can see differs from what an authorised person from the CBBH or the banking agency can see.

measurement, control and monitoring of market risks had to be met by the commercial banks and micro-credit organizations.

It is important to note that none of the mentioned changes in regulation seemed to significantly hamper the smooth functioning of the banking sector, since the banks met the new requirements with ease (all actions were announced well in advance and the banks were given time to adjust their policies). On the other hand, some aspects, like reduced volatility of foreign reserves, stronger prudential regulations and better insight into credit history of borrowers, improved macro-financial stability. There is a clear record of constant improvements in financial infrastructure. The reserve payment and settlement system was introduced in order to minimize systemic risk. In order to improve payment and settlement systems, a Central Register of Transaction Accounts was introduced as an extension to the gyro clearing system. The CBBH has the role of fiscal agent in the treasury market and the necessary infrastructure needed for the introduction of a primary treasury market is established within the CBBH. The interbank electronic money market was fully operational as of 2008. An agreement on clearing of international payments between the central banks of BH, Serbia and Montenegro was signed in September 2007.

Despite the banking sector development and the resulting improvements, there are still numerous areas for potential improvements in the functioning of the financial and banking sector. The biggest issue is the unification of the banking supervision and its effective functioning in accordance with the Basel Core Principles for Effective Banking Supervision [BCBS, (2006)] at the national level, which is also one of the requirements of the Stabilization and Association Agreement. The Core Principles consist of 25 principles categorized into 7 groups. Only in the case of corrective and remedial powers of supervisors has full compliance been achieved. Most of Prudential regulations and requirements have been met since 2002 by the actions previously listed. This means that the banking sector in BH is regulated, and mainly in line with the internationally accepted best practices, but that the supervision is ineffective. Even the key principles, such as the independence of the regulator, permitted activities of the banks, and licensing criteria are violated. Segmented banking supervision might also pose a problem for cross-border cooperation with home country supervisors in cases when the mother-bank has two subsidiaries, one in each entity. Although the CBBH is given a coordinating role in banking supervision, there were episodes of a total absence of coordination between the CBBH and the banking agencies which resulted in opposing decisions with results mutually cancelling each other out.

1.6. Conclusion

The aim of this chapter was to illustrate the key trends and developments in BH's banking sector. Understanding them is of importance for understanding the analysis that is developed in this thesis. For example, Sections 1.2 and 1.3 will be drawn upon extensively in Chapters 3, 4 and 5. In Chapter 3 the country specifics in the form of the low exposure to the government will be a reason why the measures of systemic risk developed do not cover the risk of sovereign crisis. In Chapters 4 and 6 the relationship between the domestic demand for loans and foreign liabilities will be central to explaining the relationship between the risks of currency and banking crises. In Chapter 5, the discussion of interest rates in Section 1.2 will be one of the arguments for rejecting widely-used indicators of forthcoming banking crisis. The next chapter will investigate what is understood by the term of financial stability, how it is measured and what are its linkages with other macroeconomic sectors.

Chapter 2: What is financial stability?

2.1. Introduction

In the first half of the 1990s, 56 banking crises, 73 currency crises, 3 sovereign debt crises and 17 twin crises were identified by Laeven and Valencia (2008), while 3 triple crises were recorded in 1998[18]. Such a high frequency resulted in renewed concern amongst policymakers and regulators with financial stability. Financial stability analyses are complicated by the lack of a clear and quantifiable definition of 'financial stability', so the operational definitions vary across the various uses and models. Conditional on the assumptions on the origins of the shocks, an assessment of financial stability is based on a wide range of risk factors. However, none of the currently available techniques for measuring financial stability were able to anticipate the current global financial crisis that started in 2007 and continues to this day.

The aim of this chapter is to explain what is understood under the term financial stability and examine what are the possible reasons for inefficiencies in the current measures of financial stability and their bias towards overly optimistic predictions. The rest of this chapter is organized as follows. The second section explains why there is a heightened interest in financial stability; Section 2.3 addresses the components of the definition of financial stability; the fourth section examines the relationship between financial stability and the real economy; Section 2.5 provides an overview of the measures of financial stability currently used and the final section concludes.

2.2. Why is there an interest in financial stability?

Financial crises are costly, in terms of both output lost and fiscal costs, and this is one of the main reasons why policymakers consider financial stability to be one of their priorities. It has been found that the estimated costs of the crises depend on the period under observation, the sample of countries, the type of financial crisis and its severity. In an overview of cross-country experiences of major bank insolvencies, Caprio and Klingebiel (1996) recorded 89 banking crises in 69 countries over the period 1977-1996. The cost of restructuring varied greatly, with Argentina's banking crisis in the

[18] According to Laeven and Valencia (2008) a twin crisis indicates a banking crisis in year t and a currency crisis during [t-1, t+1]. A triple crisis indicates a banking crisis in year t and a currency crisis during [t-1, t+1] and a debt crisis during [t-1, t+1].

early 1980s being the most expensive with a cost amounting to 55.3% of GDP to Malaysia's reported losses equivalent to 4.7% of GNP. Bordo et al. (2000) did not find significant evidence that more recent crises were more severe or lasted longer, but they had become more frequent. Only a few years later the global financial crisis (GFC) of 2007 disputed one part of their conclusions. As Blanchard (2009) illustrates, the decrease in stock market capitalization over all markets from July 2007 to November 2008 was more than a 100 times larger than the estimated losses of the subprime loan crisis in the U.S. in October 2007. In addition, with the estimated costs of bailouts worldwide, economic output lost and duration already exceeding five years, the GFC of 2007 became the second largest financial crisis, behind only the Great Depression of the early 1930s. Bordo et al. (2000) and IMF (1998) did, however, made a clear distinction between banking, currency and twin crises, acknowledging that the cost of a banking crisis alone is less than the cost of the twin crises and that a crisis accompanied by a recession is more costly than an episode of crisis that did not cause output losses. The GFC of 2007 is specific in a sense that it started as a banking crisis, transformed itself into a sovereign one and threatened to become a currency crisis that would spread over mainly developed countries in different regions.

In a study that also encompasses the crises in the period beyond Caprio and Klingebiel's (1996) sample, Laeven and Valencia (2008) conclude that fiscal costs associated with a crisis management, net of recoveries, were found to be 13.3% of GDP on average, while output losses averaged 20% of GDP during the first four years of the crisis. In research that expands the original list of systemic banking crises from Laeven and Valencia (2008) for the episodes following the U.S. mortgage crisis of 2007, Laeven and Valencia (2010) conclude that the economic cost of the latest crises is much higher compared to that of past crises. The median output loss was found to be 25% of GDP, while the median increase in public debt was estimated to 24% of GDP compared to a historical median of 16% of GDP. The negative correlation found between output losses and fiscal costs led to the conclusion that the cost of a crisis is paid through either larger fiscal costs or larger output losses. Furthermore, they argue that indirect fiscal consequences of the banking crises, such as a sharp decline in tax revenue and a significant increase in government spending, are higher than the usual bank bailout costs, which additionally increases the fiscal costs of the financial crises. Similar finding was presented in Reinhart and Rogoff (2008) where it was reported that the cumulative increase in central government debt in the three years following the banking crisis is about 86 percent. As for the differences in the real effects of banking crises in advanced economies with respect to emerging and developing countries, the findings of Laeven and Valencia (2012) suggest that the former tend to experience larger output losses and increases in public debt, which is mainly a consequence of the more developed banking systems in advanced economies.

Financial stability has moved up the agenda of public policymakers for several reasons: the explosive growth in the volume of financial transactions (Crockett, 1997; Čihàk, 2006a); the increased complexity of new instruments (Crockett, 1997; Čihàk, 2006a); the high costs of financial crises (Crockett, 1997; Hoggarth and Saporta, 2001; Čihàk, 2006a); and an increased number of high profile mishaps at individual institutions (Crockett, 1997). As for the cause of increased financial instability, a large number of recent studies point to the consequences of financial deregulation (Crotty, 2009; Jickling, 2010), accompanied by an inadequate regulatory framework (Blundell-Wignall et al., 2008; BCBS, 2010; Davis, 2011; FCIC, 2011; Pain and Röhn, 2011) and the excessively accommodative monetary stance (Taylor, 2007; Ahrend et al., 2008; Blundell-Wignall et al., 2008; Ahrend, 2010; Bean et al., 2010; Pain and Röhn, 2011).

One might consider that the Supreme Court's ruling in *Marquette National Bank v. First of Omaha Service Corp*. in 1978 was the beginning of financial deregulation in the U.S. This decision allowed banks to export the usury laws of their home state nationwide, thus setting off a wave of deregulations that eventually resulted in the complete elimination of the interest rate ceilings in the states of South Dakota and Delaware, among others. Sherman (2009) provides an overview of the key events in the process of financial deregulation in the U.S up to March 2009. After a series of changes in the interpretation by the Federal Reserves (FED), the Glass-Stegall Act was finally replaced by the Gramm-Leach-Bliley Act in 1999 by which all restrictions against the combination of banking, securities and insurance operations within a single financial institution were removed. The very next year the Commodity Futures Modernisation Act was passed which prevented regulation of the over-the-counter (OTC) derivative contracts. In 2004 the mega banks created by the Gramm-Leach-Bliley Act, that created massive volumes of derivative contracts, were allowed to self-regulate under the Consolidated Supervised Entities program[19].

The most significant deregulatory issues were occurring in the period of low interest rates. Following the burst of the stock market boom in 1990s, the FED kept the interest rates low through 2004, which increased liquidity in the markets not only in the U.S., but globally. Given the widening current account deficit of the U.S. and its funding by significant cross-border flows of capital, the long-term yields decreased, fuelling even further the OTC derivatives transactions and mortgages business. The situation in Europe was similar, since the ECB was conducting a policy of low referent rates, which encouraged consumption and long-term mortgage lending, especially in the peripheral states.

According to Crotty (2009), the process of deregulation, accompanied by rapid financial innovation, stimulate powerful financial booms that ended in crises. Governments responded to the crisis with bailouts that allowed new expansions to begin. As a consequence, financial markets became even larger and a financial crisis more threatening to society. Given the high liquidity in international financial markets and increasing cross-border flow of funds, the issue of financial stability became increasingly global. Consequently, monitoring of financial stability, in addition to the stronger involvement of national regulators, resulted in an increasing formalization of arrangements involving multinational agencies and standard setters[20].

The Joint Forum was established in 1996 under the aegis of the BCBS, the IOSCO and the IAIS to deal with the issues common to the banking, securities and insurance sectors, including the regulation of financial conglomerates. The Joint Forum is

[19] Prior to 2004, the maximum debt to net equity ratio allowed for broker dealer activities was 15:1. Under the changed regulation, if an investment bank would agree to SEC consolidated oversight, the leverage ratio in some cases could be increased to 40:1.

[20] The list of the key standards, advocated by the Financial Stability Board (FSB), is provided in Table 1.8. The degree to which national legislators and regulators conform to these standards will differ. For example, as Illustrated in Section 1.4, the current regulatory environment in BH, significantly deviates from what is currently considered as the best practices in the area of financial regulation and supervision. In the case of the U.S., the existing practices of banking supervision are still not fully in compliance with Basel II and the pace at which it is implemented is much slower than in the cases of Europe or Asia (Dugan and Xi, 2011).

comprised of an equal number of senior bank, insurance and securities supervisors representing each supervisory constituency[21].

The Financial Stability Forum (FSF) was established in 1999 by the G7 Finance Ministers and Central Bank Governors with the goal of creating new structures for enhancing cooperation among the various national and international supervisory bodies and international financial institutions so as to promote stability in the international financial system. In November 2008, the leaders of the G20 countries called for a larger membership of the FSF. A broad consensus emerged in the following months towards placing the FSF on a stronger institutional footing with an expanded membership. It sought to strengthen its effectiveness as a mechanism for national authorities, standard setting bodies and international financial institutions to address the vulnerabilities and to develop and implement strong regulatory, supervisory and other policies in the interest of financial stability. The expanded FSF was re-established as the FSB with a broadened mandate to promote financial stability in April 2009[22].

A periodical assessment of financial stability is conducted by international financial organizations, such as the IMF, the WB, national regulators and even private sector and the findings are usually communicated to the public via a special report. The Financial Sector Assessment Program (FSAP) is a joint IMF-WB initiative launched in 1999 following the Asian financial crisis to provide member countries that request participation with a comprehensive assessment of their financial systems. Participation in the program is voluntary and periodical updates, albeit with possible differences in their scope, provide an opportunity to refresh the initial assessment.

Most Financial Stability Reports (FSR) published in the first five years of the FSAP were written by the central banks of the countries that have participated or volunteered to participate in the program (Čihàk, 2006b)[23]. By the end of 2005, according to Čihàk

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[21] The Joint Forum members are: Australia, Belgium, Canada, France, Germany, Italy, Japan, The Netherlands, Spain, Switzerland, U.K., U.S, BCBS, IOSCO, IAIS and the European Commission (EC) as an observer.

[22] The members of FSB are 64 institutions from 24 countries (Argentina, Australia, Brazil, Canada, China, France, Germany, Hong Kong SAR, India, Indonesia, Italy, Japan, Mexico, The Netherlands, Republic of Korea, Russia, Saudi Arabia, Singapore, South Africa, Spain, Switzerland Turkey, U.K., U.S.A.), international organizations (BIS, EC, ECB, IMF, OECD, WB) and the following international standard-setting bodies and groupings: BCBS, Committee on Global Financial System (CGFS), CPSS, IAIS, IASB and IOSCO.

[23] The first FSR was issued by The Bank of England, which issued its first *Financial Stability Review* in 1996, followed by the Sveriges Riksbank a year later.

(2006b), 47 central banks were issuing financial stability reports, however by November 2011, 86 countries were publishing financial stability reports (Čihàk et al., 2012). These publications aim to assess the risks for financial stability of an individual country and their usual frequency is semi-annual or annual. At a global level stability reports are also published by some international organizations, primarily by the IMF. The *Global Financial Stability Report* (GFSR) is the IMF's semi-annual publication launched in March 2002 aiming to provide a regular assessment of global financial markets with an attempt to identify potential systemic weaknesses that could lead to crises[24]. The importance of the GFSR is in its more general approach to financial stability than the country-specific FSR approach, addressing the global imbalances and risks arising from them. The importance of having a publication such as the GFSR is emphasized by the observation that neither China nor Japan issued a FSR before 2005; moreover, the United States first published such a report only in 2011 (Čihàk et al., 2012), and did not conduct a state-level stress testing exercise of their banking sector prior to spring 2009[25].

There are cases of financial stability reports being published by the private sector participants, such as the Counterparty Risk Management Policy Group (CRMPG)[26]. The CPRMG (2005) issued a list of recommendations and guiding principles urging the financial sector participants, among other things to: review their risk metrics and stress test methodologies together with the behavioural characteristics of models; continue to work to improve their understanding of their own portfolios; be alert to the potential for overall leverage in the system to increase; ensure that their risk measures and analyses comprehensively capture a full range of actual and contingent exposures; and implement robust credit pricing models. Besides these recommendations and the sale of complex products to retail investors being listed as one of the emerging issues that cannot be ignored, two years later the current financial crisis started to unfold with some of the CRMPG members having the leading roles.

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[24] Until March 2003 the frequency of the GFSR was quarterly.

[25] Not until spring 2007 (IMF, 2007a) was a warning issued concerning some market developments, primarily a deterioration in credit quality in the sub-prime segment of the housing market in the U.S., although the foundations for global stability were still judged at that time to be strong. The liquidity risks were not mentioned until the disruptions on the markets triggered a series of extraordinary liquidity injections by numerous central banks (IMF, 2007b).

[26] The CRMPG has issued three reports: in 1999, 2005 and 2008. The members of CRMPG can change but in 2005 they consisted of representatives of the following institutions: Goldman, Sachs & Co., Citigroup Inc., JPMorgan Chase & Co., Bear, Stearns Co. Inc., Deutsche Bank, TIAA-CREF, HSBC Holdings plc., Merrill Lynch & Co. Inc., Tudor Investment Corporation, General Motors Asset Management, Cleary Gottlieb Steen & Hamilton LLP, Lehman Brothers and Morgan Stanley.

With the exception, to a certain extent, of the BIS, the latest financial crisis was unanticipated by either international organizations or national authorities until it materialized. There were random warnings on deteriorating quality in segments of financial markets, but these were not credited with much attention. The sudden emergence of this financial crisis, and its strength that surpassed even the most pessimistic expectations, is a clear sign that there were problems in measuring financial stability and serious misperceptions of risk and linkages between the different parts of financial system.

2.3. What is understood by the term financial stability?

There is as yet no widely accepted definition of, or model or framework for assessing a financial system's stability. By definition, the financial system of a country consists of its currency, financial institutions and their supervising bodies, payment systems and financial markets, so the presence of financial instability implies that at least one of the main functions of the financial system is impaired. Depending on the focal point, definitions of financial stability are either information based or institutionally oriented (Bårdsen et al., 2008). The former category of definitions considers the ability of the financial system to perform its main tasks, such as channelling funds (Mishkin, 1994), while the latter emphasizes the stability of key institutions and markets (Crockett, 1997).

The existing, broad definitions of financial stability encompass the same common elements: they explicitly focus on the system as a whole; underline the link with the real economy; and make explicit reference to financial instability. It is unlikely that a generally accepted narrow definition of financial stability would ever be appropriate for several reasons. Depending on the structure and the stage of the financial sector's development, the threshold after which the financial sector is considered to be unstable will differ. The risk preferences may vary across the countries as well, which might reflect either the particular development strategy of the country or the stage of its macroeconomic development.

The main premise in Bårdsen et al. (2008) is that financial stability analyses are complicated by the lack of a clear and consensus definition of 'financial stability' and that the operational definition of this term must be expected to vary across the alternative models. Similarly, Mohamed et al. (2012) conclude that the difficulties in defining financial stability hinder reaching a broad consensus regarding the objectives of financial stability and the instruments used. Borio and Drehmann (2009) point to three important characteristics that this definition should have: it must be pragmatic with its scope narrowed down to the performance of financial institutions; it must assume a certain level of fragility as the property of the financial system that occasionally may evolve into an episode of financial distress; and, finally, the shock as a consequence of which the risks materialize and the crisis emerges should not necessarily be extraordinary in size.

The analysis of financial stability assumes linking the balance sheet of the financial sector to the real economy. These links, from the BH perspective, will be addressed in more detail in the following section. In this sense, narrowing down the scope of the definition can relate to any of the following: analysis of the stability of the key institutions in all segments of the financial system; stability analysis of all institutions in the most important sector; or stability analysis of the key institutions in the most important sector. Given the structure of BH's financial system (Section 1.2), the analysis of all institutions in the most important sector would be an appropriate approach: the number of banks is small enough, they are all commercial banks and the banking sector dominates the financial sector in terms of the size of assets[27].

Every system is characterized by a certain level of instability (Minsky, 1982 and 1992; Borio and Drehman 2009). An unstable system can perform its key functions relatively efficiently for a long period of time before a shock causes a distress or a crisis. A notion that one should distinguish the episodes of elevated risk of systemic crisis from the acceptable level of risk indicates that that stability is not a specific stage or a point in business cycle to be reached. Different parties may interpret the risk differently depending on their risk preferences: policymakers are traditionally more risk averse than, say, investment bankers. It is also possible that the members of one interest group have different perceptions of risk, since an increase in one of the underlying risk factors might affect only a fraction of the interest group. An example of such a case would be

[27] The availability and the quality of the data are also limiting factors in inclusion of the non-bank sector in financial stability analyses. A significant share of the non-bank financial sector in BH, namely the MCOs and the leasing companies, were not supervised until 2008, so there is no single database that encompasses information on the individual non-bank intermediaries. In the case one would choose an option of direct contact with each individual intermediary in order to obtain the necessary data the lack of common reporting templates and of a unified regulatory framework would make the micro-level data incomparable.

the different perceptions of risk that banks may have with respect to exposure to various types of clients, industries or chosen models of financing.

Text box 2.1: The difference between a distress and a crisis

Not every episode of financial distress can be labelled as a financial crisis. Distinguishing a distress, a state in which the financial system is still functional despite the possible failures of individual institutions, from a crisis, a state in which the key institutions and markets are dysfunctional and funds are not efficiently channelled form the liquidity abundant to liquidity scarce sectors, will be of particular importance in the following chapter where measures of systemic risk for BH will be developed. Table 2.1 below indicates how the existing *ex post* approaches to identification of crises may issue a different signal as to whether and when a crisis actually occurred.

Table 2. 1: Some of the criteria for detecting a crisis

	Authors	Criteria used
Banking crisis	Caprio and Klingebiel (1996)	(1) Insolvencies of 'important' banks
	Demirgüç-Kunt and Detragiache (1998)	(1) A sharp deterioration in the quality of assets (2) The involvement of the government - large scale nationalization of banks - high cost of the rescue packages - the emergency measures enacted due to an extensive bank run
	Laeven and Valencia (2008)	(1) Deposit runs represented by a monthly percentage decline in deposits in excess of 5% (2) Introduction of a deposit freeze or blanket guarantee (3) An extensive liquidity support or bank interventions defined as an extensive liquidity support involving claims from monetary authorities on deposit money banks to total deposits of at least 5% and at least double the ratio compared to the previous year

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Currency crisis	Frankel and Rose (1996)	(1) A nominal exchange rate depreciation of at least 25% that also exceeds the previous year's change in the exchange rate by at least 10 percent
	Kaminsky et al. (1997)	(1) Constructed index of "exchange market pressure" exceeding its mean by more than three standard deviations
	Andreou et al. (2007)	(1) Following Kaminsky et al. (1997) approach for identification of the country-specific crisis thresholds
Sovereign crisis	Manasse et al. (2003)	(1) A country classified as being in default by Standard & Poor's (2) It receives a large non-concessional IMF loan defined in excess of 100 percent of quota
	Laeven and Valencia (2008)	(1) Sovereign defaults to private lending (2) Debt rescheduling

All these definitions have in common that they are constructed to isolate sporadic events, i.e. something that usually does not occur in every business cycle. For example, it is considered that a country is experiencing a sovereign crisis if the government defaults on its obligations, reschedules its debt repayment or seeks financial assistance from the international financial organizations. Note that all these, just like the significant exchange rate depreciations, are rare events regardless of the stage of financial system development.

The identification of a banking crisis is a bit more complex since a crisis may be a consequence of both illiquidity and insolvency. In the case of illiquidity, a shock is usually on the liabilities side of the banking system balance sheet which affects the banking sector's ability to channel funds. Laeven and Valencia (2008), as indicated in Table 2.1, use this approach. In the case of insolvency, a shock is usually on the assets side of the banking system balance sheet and changes in the level of capital reflect changes in the value of assets. Caprio and Klingebiel (1996) and Demirgüç-Kunt and Detragiache (1998) in Table 2.1 use this approach. This distinction between

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the points of origin of banking crisis may be relevant from the perspective of crisis dating, or the choice of the appropriate policy action, but not so much from the perspective of the final effects. In other words, while it is easier to date the crisis if it is a consequence of a bank run, rather than a deterioration in the quality of assets, the consequence in both cases is a dysfunctional banking system that either does not channel funds from the liquidity abundant to liquidity constrained segments of the economy, or it caves in as a consequence of inappropriate business policies.

Clearly there must be something in the characteristics of the financial system that make it more or less prone to crises since there is a negligible probability that financial system is riskless at any point in time. The approach of Allen and Carletti (2008) can be used to explain the distinction between fragility and crisis. They argue that the key issue that determines whether the financial system is a shock absorber (i.e. more or less fragile, but functional) or amplifier (i.e. tends to become dysfunctional) is whether there is a market failure of some type, be it vulnerabilities, contagion or asset price bubbles. Without a market failure, the financial system is a shock absorber. With it, the financial system is an amplifier and the crises have a higher chance of occurrence. Note that a functional system does not imply the absence of failure in individual institutions. Furthermore, it does not imply a constant level of risk.

As an illustration, consider a system that enables an unconstrained flow of funds between various segments of economy. In such an environment there may be sporadic cases of institutional failures, but the system as a whole is functional. As economic activity increases, the demand for liquid assets increases and financial systems begin to expand faster in the area of complexity than in capacity. This trend is a consequence of the main role of financial institutions, primarily banks, namely the liquidity transformation. At a certain stage of a business cycle, demand for

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liquidity will surpass the available sources of liquidity. In the simplest case it would mean that the available deposits used to finance credit activity in a bank will not be sufficient. The bank, aiming to, at least, maintain its market share, has two options: expand its capacities by additional capitalization, or become more complex by involving in a process of liquidity creation. As will be discussed in more detail in chapter 3 the latter option is usually favoured for at least two reasons: an increase in an increase in equity may not be feasible in the short-run and liquidity creation will, eventually, increase bank's capital since the value of assets, at least for a certain period of time, will exceed the value of liabilities. In such an environment market failures, as Allen and Carletti (2008) refer to them, tend to amplify the effect of any shock. For example, a failure of a single client is not anymore only affecting a small fraction of a bank's portfolio, but also the other assets of the same bank and other banks via inter-bank exposures.

This phenomenon will be investigated in more detail in Chapters 3 and 5. In this textbox it is only used as an illustration how a financial system becomes more crises prone. Any system has a certain level of fragility. Even in a hypothetical case when the only assets of a bank are reserves with the central bank, there is a small risk of the central bank defaulting. A crisis occurs when either a shock of significant magnitude occurs, which is not that likely in recent periods, or the market failures of any type result in amplified, non-linear effects.

The criteria that a shock to the financial system must not be extraordinary in size means that the stability of the system would be overestimated if the resilience of the system was judged exclusively by the immediate effect of large shocks. Exposing the system to large shocks gives little or no information on the underlying relationships; it largely indicates a known fact that any system would break given a shock of sufficient magnitude. On the other hand, a small or a normal-sized shock can be significantly magnified through the amplifying mechanisms in the system (Allen and Carletti, 2008 and Blanchard, 2009). As mentioned previously, Blanchard (2009) uses two examples to illustrate this phenomenon: the subprime loan crisis and a large increase in the oil prices. A relatively limited and localized event, such as the subprime loan crisis in the U.S., with estimated losses in October 2007 at about USD 250 billion resulted in a decrease in stock market capitalization over all markets from July 2007 to November 2008 equal to about USD 26,400 billion. On the other hand, the very large increase in oil prices until mid-2008 had only a small apparent impact on economic activity, which might be interpreted as the economy being less fragile in some and more in other dimensions.

Given the arguments above, one may claim that any measure of financial stability should have the following elements clearly stated: the perspective of measurement, i.e. what type of risk is measured; the inclusiveness i.e. which institutions and macroeconomic segments are encompassed; the current level of system stability and quantitative comparison to the previous periods i.e. the ability to evaluate the system as more or less fragile; the current risks and most likely channels of transmission i.e. how significant is the effect of market failures; and the most likely level of system fragility n-periods ahead given the current and past developments in both the financial sector and the real economy. Such a measure of financial stability, or more accurately, financial fragility of BH financial system will be developed in Chapter 3. The chosen approach will require isolation of the breaking point that indicates a collapse of the financial system either, in the context of BH, in the form of the abandonment of the currency board regime or in the form of the banking system's capital being depleted and estimating the size of a shock that would collapse the system. Chapters 4 and 5 will investigate in more detail what causes changes in these risks of financial fragility.

2.4. What are the linkages between financial stability and the real economy?

The main difficulty in assessing the level of financial stability are the numerous and complex relationships between the financial sector and the real economy. As concluded in BCBS (2011), understanding the transmission channels that exist between the financial and real sectors of the economy is critically important when assessing financial stability. A body within the BCBS, the Research Task Force working group on the transmission channels between the financial and real sectors has identified three transmission channels (BCBS, 2011): the borrower balance sheet channel; the bank balance sheet channel; and the liquidity channel[28]. The borrower balance sheet transmission channel applies to both firms and households and it is caused by the inability of lenders to adequately assess the counterparty risk. The borrower balance sheet models are financial accelerator models that define the transmission channels between the financial and real sectors via changes in the net worth of borrowers (Bernanke and Gertler, 1989 and Carlstrom and Fuerst, 1997) or the value of collateral used as a form of securing the debt repayment (Kiyotaki and Moore, 1997).The bank balance sheet channel concerns the contraction of the banking sector lending activities as a consequence of an adverse shock to banks' balance sheets. The liquidity channel is caused by developments and innovations in financial markets in recent years that affected the bank balance sheet channel in a sense that the liquidity composition of assets was changed. An intensified use of securitization and market funding as a consequence of expansionary monetary policies resulted in high leverage ratios, maturity mismatches between assets and liabilities and sensitivity to mark to market accounting. Mark to market accounting (an accounting act of recording the fair value of assets and liabilities that can change over time) will affect the value of banks' balance sheets in a sense that the value of assets will decline in the periods of unfavourable economic conditions and depressed asset prices. This may result in illiquidity or insolvency of the banking sector. In short, BCBS (2011) lists the counterparty risk, the risk of dried up sources of financing and an increase in share of derivatives in the balance sheets of banks as the key issues that one must account for when assessing financial stability. The aim of this section will be to, using BH's end of 2010 data, illustrate why is it so difficult to model relationships between the financial and real sectors of the economy.

One of the simplest ways to describe the complexity of the relationships between various sectors of the economy and their influence on the stability of the financial system to an ordinary person is by referring to contingent claims analysis. A contingent

[28] The members are the representatives of: the Bank of England, Financial Supervisory Authority (U.K.), European Central Bank, Bank of Canada, French Prudential supervisory Authority, FED Board of Governors, Deutsche Bundesbank, Bank of Japan, Bank of Spain, Swiss National Bank, Office of Thrift Supervision (U.S.A), The Netherlands Bank, Bank of France, Bank of Italy, Office of the Comptroller of the Currency (U.S.A.), Federal Deposit Insurance Corporation, (U.S.A.), Comisión Nacional Bancaria y de Valores (Mexico), Sveriges Riksbank, National Bank of Norway, and Secretariat of the Basel Committee on Banking Supervision (Bank for International Settlements).

claim is any asset whose future payoff depends on the value of another asset (Gray et al. 2007). Contingent claims analysis is a generalization of the option pricing theory pioneered by Black and Scholes (1973) and Merton (1973). The contingent claims approach is based on three principles: the value of liabilities are derived from assets meaning that changes in the value of assets will be reflected in changes in the value of capital and other liabilities; liabilities have different priorities and consist of senior debt, subordinated debt and junior debt (equity); and the value of assets follow a stochastic process. Default happens when assets cannot service debt payments. In Gray et al. (2007) an economy is viewed as a set of interrelated balance sheets with four types of aggregate sectors: corporate, financial, household and sovereign. Given the inter-linkages between the sectors, starting with a shock to one sector it is possible anticipate the whole chain reaction. The idea is that the four types of aggregate sectors are dependent on each other and that a shock to one must have an impact on all the others. Keeping in mind the assets and liabilities items of all sectors, one can map the possible channels of risk transmission.

Figure 2.1 below provides the simplified balance sheets of all four sectors for BH with the linkages analysed in more detail later in this section. Given the characteristics of BH's financial system and the issues of the size and quality of the non-bank financial sector data (Section 1.3), it is assumed that the financial sector is represented solely by the banking sector. The sovereign sector consists of the Central Bank and all levels of government.

Figure 2. 1: Balance sheets for the corporate, financial, household and sovereign sectors of BH, end of 2010

Source: CBBH.
Note: A question mark instead of value means that the data is not available. In case of pre 1992 local currency debt (liabilities side of the sovereign sector), the question mark is reported alongside with values indicating that the value might not be correct.

Sovereign sector

Assets	Liabilities
1. Net foreign currency reserves BAM 6,456.3 millions **2. Deposits** BAM 1,664.0 millions **3. Net fiscal assets** BAM -611.9 millions **4. Other public assets** *unknown*	**1. Reserve money** **BAM 5,899.7 millions** **2. Foreign currency debt** BAM 6,249.3 millions **3. Local currency debt** - to banks: BAM 452.6 millions - to other sectors: BAM 2,749.4 millions (?) **4. Net worth of sovereign sector** *unknown*

Corporate sector

Assets	Liabilities
1. Corporate assets: -deposits: BAM 4,370.5 millions -other asets: *unknown*	**1. Debt:** -to domestic banks: **BA**M 7,744.2 millions -to other domestic sectors: BAM 643.6 millions -to foreign sectors: BAM 8,441.2 millions **2. Equity** *unknown* **3. Net worth of corporate sector** *unknown*

Banking Sector

Assets	Liabilities
1. Foreign assets: BAM 2,816.6 millions **2. Accounts with the CBBH:** BAM 3,940.0 millions **3. Claims on:** -households: BAM 6,314.6 millions -enterprises: BAM 7,744.2 millions -sovereign: BAM 452.6 millions -financial sector: BAM 59.4 millions **4. Other assets:** BAM 1,166.3 millions	**1. Foreign liabilities:** -deposits of all non-residents: BAM 2,618.6 millions -claims of all non-residents: BAM 2,047.3 millions **2. Domestic liabilities:** -short-term deposits: BAM 6,231.9 millions -long-term deposits: BAM 6,293.1 millions **3. Other liabilities:** BAM 1,498.4 millions **4. Capital accounts:** BAM 3,694.4 millions

Households

Assets	Liabilities
1. Income: *unknown* **2. Deposits:** BAM 6,490.5 millions **3. Real estate assets:** *unknown* **4. Other assets:** *unknown*	**1. Claims on assets:** -by banking sector: BAM 6,314.6 millions -by other sectors: BAM 770.1 millions **2. Net worth of households** *unknown*

Before the three transmission channels identified in BCBS (2011) are interpreted from a BH perspective based on Figure 2.1, note that there are numerous items in all but the banking sector that have unknown or undetermined value. This is not an uncommon finding for any country and it illustrates that a full set of information is never available, which further complicates the analysis of financial stability. There are two reasons: data availability and mark to market accounting, In the case of BH there are no data available for the following items in Table 2.1: the local currency debt of the sovereign to non-banks; corporate sector equity; and households' income. The process of verification of the claims of domestic sectors from the government is not completed (CBBH, 2011), so there is no exact information on the level of internal public debt. Furthermore, the process of restitution of the private property expropriated by the socialist government following World War II has not even begun. There is no data on equity of the corporate sector since there is no unified register of companies in BH, many of which do not report their end of the year balance sheets because they are unlisted on the stock exchanges, either because they are organized as limited liability companies or simply choose not to be listed. As with the income of households, the official data is also unreliable because of the unregistered and grey economy.

The values of the following assets from Figure 2.1 are unknown because of both unavailability of reliable data and marking to market of the available items: other assets of the sovereign sector; other assets of the corporate sector; real estate assets of the sector of households; and other assets of households. The other assets of the sovereign sector in Figure 2.1 represent any non-cash asset of the government from shares in equity to natural resources. To our knowledge there is no estimate of the value of these assets in BH. Furthermore, as is also the case with the other assets of the corporate sector and real estate and other assets of the sector of households, given the shallow and inactive markets for movable and immovable collaterals and low volume of transactions in the capital markets, even in cases when there are values of individual items available, these are usually book values, rather than market values. The undetermined value of assets results in an undetermined value of net worth in the sovereign, corporate and households sector.

The banking sector is different in the sense that there are no unknown (the accuracy is not assumed) values of either assets or liabilities. Given the characteristics of BH's banking sector, primarily a small share of banking and trading book securities in the period covered by this research (Section 1.3), the book and market values of both assets and liabilities are likely to be almost identical. This assertion is in line with the conclusion of Macit and Topaloğlu (2012) that bank fundamentals play a significant role in explaining the differences in market value to book value ratios. These authors argue that banks with higher net loans to total assets ratios are expected to have lower market value to book value ratios, i.e. banks that are closer to traditional retail banking are expected to be less subject to changes in the value of their assets. This implies that marking to market is not a part of the liquidity channel of shock propagation between the financial and real sector in the case of BH, as financing banks' liabilities is not likely to be jeopardized by large swings in the value of banks' assets. Another form of the liquidity channel (BCBS, 2011), the relationship between the use of leverage by institutions and liquidity problems, is important from the BH perspective. As explained in Section 1.3, banks in BH were financing domestic lending activities from abroad. Gromb and Vajanos (2008) demonstrate that arbitrageurs, who depend on external financing and undertake leveraged transactions, provide liquidity to the markets, but also cause liquidity dry-ups. Furthermore, they show that liquidity dry-ups follow periods of low returns for arbitrageur's investment opportunities and that liquidity is correlated across the markets. The theory and empirical research on the effects of foreign induced shocks to the stability of the financial system will be addressed in more detail in Chapters 4 and 5 that investigate the forces behind changes in the risk of currency and banking crisis.

Banking sector distress can be caused by either a shock to its assets side, in which case there is a threat of insolvency, or by a shock to its liabilities side, in which case the direct threat is illiquidity. Insolvency in the banking sector occurs when an institution's financial liabilities exceed their financial assets by an amount larger than the institution's equity. In order for this to happen, bank's assets, that are the other sectors' liabilities, must reduce substantially[29]. In the case of a simple-structured banking system, like in BH, with negligible levels of trading assets and a small share of low-risk assets, such as the corresponding accounts abroad and the funds at the reserves accounts with the CBBH, this is most likely to occur through a default of bank's counterparties: households, enterprises, sovereign or financial sector (Figure 2.1). Central banks, in

[29]The net worth item in the case of banking sector is a part of capital accounts item in Figure 2.1 and it consists to a largest extent of retained and undistributed income or is included in equity (Table A1.5, p.333).

order to fulfil their financial stability monitoring role, typically focus on systemically important financial institutions, securities markets and payment systems in order to detect any early signs of distress (Bårdsen et al., 2008). Although less likely than in the case of households or enterprises, a default of a systemically important financial institution is not unheard of (LTCM in 1998, numerous investment banks in 2008 starting with Lehman Brothers Holdings Inc., etc.). This point of origin for banking system shocks in BH is not very likely given the balance sheet structure of the commercial banks (Section 1.3): a negligible fraction of the banks' assets are traded securities and domestic inter-bank exposures are minimal.

A sovereign default is also less likely when compared to a corporate or household default, but may occur (Laeven and Valencia, 2008). In the case of BH, in the period covered by this thesis, the government was not allowed by law to borrow long-term from the commercial banks and there were limitations in the form of balanced budget requirements, which kept the government's local currency debt to the banking sector at low levels (Figure 2.1). The local currency debt also includes the debt generated pre-1992 and any government securities issued to repay it[30]. During 2008 and the first half of 2009 bankruptcy of FBH, caused by the enormous cost of public administration and social payments, was a constant threat. If the pressure on the FBH government results in it issuing relatively short-term bonds to cover the pre-1992 debts that cannot be repaid on maturity, this part of BH would go bankrupt, which would have severe consequences for the state as a whole[31]. The only ways to avoid bankruptcy would be either a fire-sale of its sovereign assets in the midst of a financial crisis or cuts in other expenditures. The latter solution seems to be preferred by the IMF, since drastic cuts in the expenditures of both entities were one of the pre-requisites for the stand-by arrangement (SBA) granted to the country by the IMF in spring 2009[32]. The foreign currency debt in BH is mostly

[30] The RS has already issued bonds and started with the repayment process. The FBH still has not done so. There are still no state-level bonds, but municipality bonds are issued in RS.

[31] The claims up to BAM 1,000 were settled in cash, but the vast majority of debt is to be settled through the issue of long-term government bonds. The Parliament of FBH has still not adopted the law, so all verified claims are still recorded as an off-balance item.

[32] In 2011 the government did not meet the obligations specified by the Letter of Intent based on which the SBA with the IMF from 2009 was initiated. The SBA was frozen and it finally expired in April 2012. In July 2012 a new round of negotiations with the IMF on a new stand-by arrangement was initiated with the IMF. The Letter of Intent was sent by the BH government and was discussed by the IMF Board meeting in late September 2012. As a consequence of the deteriorating fiscal position following the freeze of the stand-by arrangement with the IMF, the BH government started issuing short-term debentures, treasury notes, in order to overcome liquidity problems, and the long-term debentures, treasury bills in order to avoid bankruptcy. A fraction of these debentures is in the balance sheets of banks. For that reason

to public creditors (international and regional organizations and governments and their agencies). Foreign debt, primarily to the IMF, has almost always been repaid particularly by the emerging market economies (Boz, 2009). This type of government debt is usually countercyclical. This argument might be extended to the other international public sectors, since those loans are granted either for investment and development projects or in periods of distress, in both cases under strict conditions and relatively favourable repayment terms.

On the assets side of the sovereign sector there are the foreign currency reserves of the country, net fiscal assets and other public assets (Figure 2.1). Under the assumption that the item other public assets consists of non-financial tangible assets and resources that do not vary in their value as much as financial assets, a reduction in the value of the sovereign's assets can occur either through a reduction in net fiscal assets or through a decrease in foreign currency reserves. A decrease in foreign currency reserves, conditional on the reserves management being conducted properly, can be caused by runs in the financial sector. Foreign currency reserves link the assets side of the sovereign sector and the liabilities side of the banking sector, i.e. a liquidity crisis caused by a reduction in foreign liabilities of the banking sector would result in a depletion of foreign currency reserves, which may jeopardize the sustainability of the prevailing monetary regime. Given the importance of the banking sector in BH, if a run was to occur, it would be a bank run. Compared to traditional bank runs in which depositors and investors withdrew their funds from the institutions, modern runs are rarely literally runs, but the effect is identical (Blanchard, 2009). Perceived as being at risk and faced with a decreased ability to borrow, these institutions have to sell assets. Most CESEE countries are heavily exposed to Western European banks, either through direct borrowing by their private sector or through their banking sectors increasing the vulnerability of, and cost of access to, external funding (Beneš et al., 2009). In the case of BH, the banking sector's foreign liabilities were the main source of funding of domestic credit expansion and the foreign currency denominated funds that entered the country through the banking sector were reflected in an increase in foreign currency reserves (Section 1.3). A withdrawal of foreign deposits (both of mother-banks and other non-residents) and a cut in wholesale funding from abroad (higher refinancing cost with the mother-bank or limited access to funding from both mother-banks and

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one of the conclusions of this research is that, besides the measures of systemic risks of currency and banking crisis, one will have to develop in BH a measure of sovereign risk as well.

other non-residents), both affecting the liabilities side of the banking sector, might trigger a liquidity crisis and a collapse of the currency board regime.

The net fiscal assets or the net budget balance of the sovereign sector can be reduced either by a decrease in tax receipts or by an increase in government expenditures, thus relating the assets side of the sovereign sector to disposable income and wealth of the households and the profits of the corporate sector. A slowdown in domestic economic activity would lead to a reduction in tax income and an increase in government expenditures in the form of additional social payments. A decrease in wages or an increase in unemployment would, besides reducing the tax income of the government, reduce households' assets, relating the assets side of the household sector to the liabilities of both the corporate and the banking sector. In the case of the banking sector's liabilities, a reduction in the wealth of households would be reflected in a decrease in banking sector deposits. Alternatively, an increase in household's cost of debt funding would increase claims on households' assets. This effect would depend on the currency of households' debt denomination, the existence of a natural hedge and the variability of the exchange rate. An increased pressure on the households' disposable income in turn would result in a higher frequency of default on loan repayments that would affect the banking sector's assets.

In the case of the corporate sector, a cut in wages or an increase in unemployment is, most probably, the result of an attempt to reduce their costs. The liabilities side of corporate sector consists of debt and equity (Figure 2.1). A reduction in the corporate sector assets that exceeds its equity would result in bankruptcy. If a slowdown in domestic economic activity or that of their main trading partners affects the marketability of the corporate assets, the liabilities side of the corporate sector would be affected through either of the following: a default in debt repayment, which would affect the banking sector assets; a default in compensating either employees or partner companies (affecting the disposable income of households and assets of the related companies); a further slowdown in economic activity and an increase in the redundancies (affecting the disposable income of the households, the sovereign sector's expenditures and tax income); or an inability to meet their tax payments which would affect the tax receipts of the sovereign sector.

This simplified version of the interactions between the banking and sectors of the real economy depicts the complexity of the relationships between the sectors and explains some of the channels of contagion. Although consisting of only four large sectors, the macro-economic system of a country is a complex network of inter-relations, both within and between the sectors. In any type of financial stability analysis one must take into account all of the following: the participants; interactions between them and both the causalities and possible feedback effects. Without inspection of all the main linkages between the sectors, one might omit an important channel of shock transmission, while ignoring the causalities and feedback mechanisms one might get too optimistic a view of the prospects for financial stability.

2.5. How is financial stability currently assessed?

There are several ways in which financial stability is currently assessed, but none of these techniques proved capable of anticipating the global financial crisis of 2007. A rising number of the critics have addressed the over-reliance on mathematical models that have a tendency to underestimate the likelihood of sudden large events and poorly capture inter-related systemic risks (Murphy, 2008; Benmelech and Dlugosz, 2009). Two more possible explanations for this failure are: the vast majority of models were tailored to explain the manifestations of previous crises, rather than their underlying causes; the main focus of the models was on the probability of a crisis, rather than the build-up of financial instability.

Although theory has recognized the common elements of each financial crisis (Borio 2007) and the key principles that need to be kept in mind when thinking of financial stability (Shinasi 2004), there are no fully satisfactory models of the economy as a whole linking balance sheets in the financial sector to macroeconomic variables. According to Borio (2007) each financial crisis has the following four elements in common: asymmetric information; positive feedback mechanisms within the financial system itself and between the financial system and the real economy; limitations in risk perceptions, i.e. the time dimension of risk is much harder to measure than the cross-section of risk; and limitations in incentives, i.e. individually rational and compelling actions may not result in desirable aggregate outcomes. Shinasi (2004) lists five key principles that need to be kept in mind when thinking of financial stability: the need for a systemic perspective, since a disturbance in one component can undermine overall stability; financial stability and monetary stability overlap to a large extent; both preventive and remedial dimensions need addressing; disturbances in individual markets or institutions should not be viewed as a threat to stability if they are not expected to damage economic activity at large; financial stability does not imply that each part of the financial system operates at peak performance. In order to analyse each of the currently available tools for measuring financial stability, Borio and Drehmann (2009) argue that one must address dimensions questions: How far do the models provide leading, as opposed to contemporaneous, measures of episodes of financial distress? How far do the tools take into account the behavioural interactions that underline episodes of financial distress? How far do the models actually "tell a story" about the transmission mechanism of financial distress? According to the same authors, there are currently four types of models for measuring financial stability: balance sheet and market price indicators; Early Warning Indicators (EWI); single module measures, Vector Autoregression (VAR) and multiple module measures or stress tests.

Balance sheet and market price indicators are the simplest measure of financial stability. The pure balance sheet approach, as used in the Financial Soundness Indicators (FSI) or the Macro-prudential indicators (MPI), relies on the approach that risk factors develop within the system. The use of the FSI or the MPI is similar to the use of rating agencies' reports. The approach is based on the use of an identical methodology to identify the differences in the balance sheet vulnerabilities for deposit takers and other institutions of a country over some period of time or to compare the balance sheets of financial intermediaries across the peer group of countries at a point in time. Since both the FSI and MPI are computed quarterly, conditional on the compliance with the existing regulatory frameworks, the three months period is assumed to be short enough to allow for the assumption that no sudden significant deterioration in the quality of balance sheets occurred. Agresti et al. (2008) compared the two and found that the differences are not negligible. The differences were both numerical (only 3 out of 25 observed indicators for deposit takers were directly comparable) and conceptual, in the sense that they have different objectives or there are differences in methodology and statistical practices. The biggest differences between these approaches is that the FSI approach is broader and covers all sectors of the economy, while the MPI approach is more closely aligned with existing accounting standards.

The indicators and indices generated by pooling together individual indicators of the system's stability tend to be backward-looking and cannot be used as leading indicators of financial distress (Borio and Drehmann, 2009). Although, they do provide a suitable tool for cross-country comparisons (Geršl and Heřmánek, 2006), their usefulness in measuring financial stability is conditional on their use as inputs in a richer analysis.

Similarly, financial soundness indices are compiled by combining balance sheet items with some other variables. Similar to Illing and Liu (2003), and based on the signal extracting approach by Demirgüç-Kunt and Detragiache (1998) and Kaminsky et al. (1998), Hanschel and Monnin (2005) used market price data, balance sheet data, data unavailable to wider public and other structural variables to construct an index for the Swiss banking sector 1987-2002. The main drawback of these indices is that they rely on market data that are of high frequency and leave too short a period for the policy response. High frequency data reflect instantaneous changes in the market participants' perception of the future risks. Changes in behaviour and preferences will result in changes in prices, triggering a chain reaction of the adjustments towards the new equilibria. Because of the recognition, decision-making and implementation lags associated with any policy action there are lengthy lags before the first results of the undertaken action are evident, by which time the perceptions of the risk might have changed again.

Ratings for individual borrowers are a variation of balance sheet and market price indicators. They are more forward looking and represent the estimates of the probability of default or expected loss. Empirical studies find a surprisingly low predictive power of credit ratings for both the currency and debt crisis (Manasse et al., 2003). One of the explanations for this failure could be that credit ratings are highly correlated with the present values of economic fundamentals and other variables. Given the reporting lag and time taken for analysis, it is likely that the rating agencies are reporting credit risk for past periods. Caporale et al. (2009) focused on individual international bank ratings and found that both quantitative models constructed by them based on the publicly available information and those of the rating agencies are likely to produce highly inaccurate predictions of ratings during periods of financial instability.

One of the possible explanations for their widespread use is that a common methodology applied to a large number of institutions provides comparable risk assessment across the institutions at a point in time. Neglecting the evolution of risk over time results in an increase in the deterministic component of risk (the benchmark is becoming more risky so all other institutions are revised upwards accordingly) and, what is often forgotten, the idiosyncratic component of risk also increases (it is impossible to tell how much the probability of default of an institution changed since the last revision). Parra (2008a, 2008b) differentiates between the risk perception of investors regarding the sovereign bond market, measured by the sovereign bond spread, and the risk perception of investment banks, measured by the underwriting fee. Studying sovereign debt crises during the period 1993-2006 through the prism of the primary sovereign bond market, he found that the investment banks priced higher sovereign default risk well before the crisis occurred and before investors detected the increased default risk. Between one and three years before the onset of a crisis the average sovereign default risk countries' payment to the investment banks in underwriting fees was 1.1% of the issued amount. This was almost double the amount charged to emerging countries for the same period. In contrast, just before the onset of the crisis the sovereign bond spread in the secondary markets was only slightly higher for the defaulting countries. Benmelech and Dlugosz (2009) argue that 'rating shopping' has played a prominent role in the current financial crisis, supporting it with the finding that tranches of structured financial products rated by only one rating agency were most likely to be downgraded. Rating shopping occurs when an issuer chooses the rating agency that has the most lax criteria and is most likely to assign the highest rating, thus increasing the spread between the securities purchased as assets and the liabilities that are issued. This phenomenon is usually related to securitization issues and primarily affects the institutions with large trading books. The other possible explanation for the highly inaccurate predictions is the low levels of assumed correlations between the pooled assets, i.e. zero correlation of the risk of default on securities of the companies in different industries. By assuming zero correlation, the portfolio of the securities that are used in securitization seemed to be highly diversified, implying lower risk and, thus, gained a higher rating.

EWI are another way of measuring financial stability. They were developed as an attempt to identify the leading indicators that signal the conditions of stress. EWI function on the following principle: whenever an explanatory variable crosses a certain threshold, that signal, based on historical observations, is interpreted as an increased probability of a financial crisis over some period in the future. The more explanatory variables that cross that threshold and cluster around a point in time, then the bigger the probability of a financial crisis. Kaminsky et al. (1997) constructed a specific early warning system to predict currency crises. Andreou et al. (2007) use a similar approach to construct market pressure indices for six central and eastern European countries. One of the main critiques of EWI is that it issues numerous "false positive" signals, since the future episodes of financial distress do not have to be manifest in the same fashion as the past ones. Berg and Patillo (1999) examined to what extent the models of Kaminsky et al. (1998), Frankel and Rose (1996) and Sachs et al. (1996) helped to predict the 1997 currency crises. Only the model employed by Kaminsky et al. (1997) achieved a measure of success.

VAR analysis can be used to measure financial stability in the absence of structural econometric models. It allows for dynamic interaction between a small number of variables with interaction driven by a set of exogenous shocks. Through simulations, a VAR analysis can generate a probability distribution of outcomes for the dependant variable, which can provide a measure of the probability of distress over the given horizon. The main shortfalls of this measure, according to Borio and Drehmann (2009), are: data limitations; VARs have very little to say about the dynamics of distress, and they are unable to incorporate boom-boost cycles. As will be discussed in more detail in Chapters 4 and 5, these criticisms are valid if one attempts to generate a single through-the-cycle model. However, from the financial stability perspective, as will be argued in the following chapter, it is more important to detect the interactions between the various macroeconomic sectors prior to crisis, since such an approach allows more time for a policy action that could either remove the threat of the crisis or significantly reduce its effects.

As indicated in BCBS (2011), various types of VAR are employed in studies of the transmission channels between the real and financial sectors: Stock and Watson (2001) discuss the reduced-form, recursive and structural VARs; factor-augmented VARs; non-linear threshold VARs; and global VARs[33]. A special type of VAR, the VECM, includes an error correction term. As will be discussed in more detail in Chapter 4, the VECMs can be used for testing for a long-term cointegrating relationship between the variables while allowing for feedback effects between the chosen set of endogenous variables.

[33] According to BCBS (2011) the following are the main characteristics of the VARs. A reduced-form VARs specifies each variable as a function of its own past values, past values of other variables considered and a serially uncorrelated error term. A recursive VAR addresses the problem of the correlation of the error term across the equations in VAR by including some contemporaneous values of the variables as the regressors. A structural VAR is usually regarded as a recursive VAR in which the variables are ordered by the assumed economic relationship between the variables. Factor-augmented VARs are those in which one or more of the model variables are factors drawn from a large set of data that reflect a similar macroeconomic variable or concept. Non-linear threshold VARs allow the coefficient and covariance matrix to vary endogenously according to the evolution of the model's threshold variable. Global VARs represent the world economy and are designed to model economic and financial relationship at the national and international levels.

Stress-tests can be used at the micro level for testing the resilience of individual institutions, or at the macro level in which case their goal is to estimate how the system as a whole would behave under low probability but high impact adverse circumstances, i.e. in response to negative shocks from the tail of the distribution (Borio and Drehmann, 2009). These are more a measure of potential loss given the shock, rather than a measure of financial stability.

Moretti et al. (2008) list some of the stress testing approaches:

I Stress tests may take the form of sensitivity tests addressing the impact of shocks on single risk factors in each test, possibly in a rather ad hoc and non-theoretical fashion, or they may be tests focusing on scenarios in which multiple risk factors change in a fashion that is intended to be internally consistent;

II Bottom up (run by an individual institution) or top down (run by an organization with a focus on the financial stability of the system as a whole). The terms are not universally defined and may also mean common scenario/inputs applied consistently across portfolios or business units or the tests carried out by the various business or risk management units and then aggregated at the central risk management level;

III Tests can be run either on the portfolio of individual financial institutions or at the aggregate level. In the latter case, some attempt also needs to be made to understand the nature of the dispersion underneath the aggregates and averages, since concentrations, exposures and vulnerabilities may be important.

Stress tests are helpful in tracing the propagation mechanism from shock to outcome (Borio and Drehmann, 2009), and to take into account both the differences in loss given default (LGD) in institutions and extreme situations (Čihàk, 2007). According to Borio and Drehmann (2009), given that unusually large shocks are needed to produce any action, the current generation of macro stress tests is missing essential elements of financial instability, such as the positive feedback mechanism between the segments of an economy. Focusing on extreme situations is also what Čihàk (2007) considers the major shortfall of stress tests, in addition to the methodology for stress tests being undecided and their sensitivity to different assumptions.

In addition, BCBS (2011) also lists micro-founded dynamic stochastic general equilibrium (DSGE) models for studying the transmission channels. DSGE models are complex, non-linear systems of equations. They are special since behaviour of each variable is explicitly derived from the economic theory and all these equations combined constitute the economy. On the other hand, none of the current DSGE models incorporates the financial sector above some rudimentary level.

None of the broad existing types of models proved capable of accurately assessing the level of financial stability. In a sense, they all complement each other, but none is sufficient on its own. Balance sheet and market price indicators would suggest where the risk factors in the system are, while the EWI indicate a set of variables that used to behave differently in the past in periods of elevated systemic risk. The various types of VAR link the transmission mechanisms between the real and financial sectors. Stress tests are used to test the resilience of individual institutions under the assumption of a rare adverse scenario of a great magnitude and the effects the event is expected to have on the real sector. As will be demonstrated in the following chapters, the analytical approach to measuring the level of systemic risk undertaken in this research combines the first three types of models. The balance sheet model approach is used to identify what is worth modelling. The proposed measures of systemic risk, namely the liquidity and solvency indices are a sort of the EWI, while their changes with respect to changes in a set of real and banking sector specific variables will be investigated using the VECM approach.

2.6. Conclusion

The aim of this chapter was to explain what is understood by the term financial stability and why measuring it is so difficult that none of the techniques currently available were able to anticipate the global financial crisis of 2007.

For several reasons it is unlikely that a generally accepted narrow definition of financial stability would ever be appropriate. Depending on the structure and the stage of the financial sector development, as well as of the sector that evaluates the stability of financial system, the threshold after which the financial sector is considered to be unstable will differ. The sudden emergence of this financial crisis, and its strength that surpassed even the most pessimistic expectations, is a clear sign that there were problems in measuring financial stability and serious misperceptions of risk and linkages between the different parts of financial system. The over-reliance on mathematical models that poorly captured inter-related systemic risks and their tailoring to better explain the manifestations of the previous crises, rather than their underlying causes usually focusing on the probability of a crisis biased the measures of financial stability towards overly optimistic predictions. The *post festum* wisdom is that models should have been constructed to capture the build-up of financial instability.

Keeping in mind the desirable properties of a definition of financial stability that would enable the quantification of the systemic risk and the characteristics of the financial system and the real economy of BH, the appropriate course of action in the following chapter is to generate a measure of financial system fragility specific to BH. This measure should provide information on the evolution of the system’s fragility by comparing the absolute size of shock sufficient to result in a collapse of BH’s financial system. In a sense, the dependant variable will be created in the following chapter, while possible causes of shocks, i.e. the inter-linkages between the sectors, will be addressed in Chapters 4 and 5.

Chapter 3: A measure of financial fragility

3.1. Introduction

The previous chapter investigated the concept of financial stability: what is currently understood under the term and what are the possible reasons for inefficiencies and bias towards overly optimistic predictions. It was concluded that defining financial stability in a fashion that would allow for development of a country specific measure, one that would accommodate for the characteristics of the financial system's structure and the stage of its development, would be an appropriate approach. As emphasized, financial stability is not a point to be reached, but a state in which the financial system, regardless of the presence of a certain level of embedded fragility, is still functional. The measures of the systemic fragility of the BH financial system will be developed in this chapter. Building upon the characteristics of the BH financial system illustrated in Sections 1.3 and 1.5, two measures of systemic fragility will be developed: a measure of the risk of a currency and of a banking crisis.

The inception point of the empirical work undertaken in this chapter is the notion that, regardless of the causes of the financial crises, financial systems are inherently fragile. The danger of a financial crisis lies in the possibility that a shock may propagate through the economic system causing damage that would far exceed the size of the original shock (Allen and Gale, 2002). Under what these authors refer to as an extrinsic uncertainty view of banking panic, the shocks are spontaneous events caused by mass hysteria and may have no relation to the fundamentals of the economy. In this case the impact of extrinsic uncertainty on the equilibrium of the economy is disproportionate to the original shock simply because it was unexpected. Under the intrinsic view of a banking panic, the shocks are stochastic fluctuations in the fundamentals of the economy. In this case financial fragility is interpreted as a situation in which very small shocks can tip the economy into a crisis. This intrinsic view of banking panic is in line with Minsky's (1992) financial instability hypothesis whereby financial instability is endogenous and thus predictable, in the absence of counter measures such as the policy reactions and interventions.

As argued in Section 2.3, in order to determine whether a system is stable or not, one needs some sort of a reference value. The reference value may be a tolerable level of risk, which is a highly subjective measure, or some distance from the point of the system's collapse. Since a financially fragile system need not collapse (Tsomocos, 2003), in estimating a system's ability to absorb shocks of the arbitrarily chosen size, one cannot tell whether the system has entered or it is leaving what is believed to be the zone of financial stability. The main hypothesis of this chapter is that determining the level of a system's fragility is more informative and feasible, than determining its level of stability. The approach employed in this research in a sense goes in reverse: the breaking point is determined and then the distance to it from the current point of the financial system is measured. An investigation of what determines changes in the perception of risk indicates whether the system is getting more or less stable due to changes in a set of macroeconomic and banking sector specific variables. The speed at which a gap between the current and breaking points can be closed, i.e. how much time is there left for the implementation of a new policy, depends on the complexity of relations between financial institutions and financial and other macroeconomic sectors.

The structure of this chapter is as follows. Section 3.2 assesses the financial stability of BH based on contemporary definitions of financial stability. Section 3.3 addresses the feasibility of a single measure of financial fragility. As will be demonstrated, there is a theoretical rationale for such an approach and it has been widely employed in the applied research. A measure of the risk of currency crisis is developed in Section 3.4. The section begins by illustrating how a shock to the foreign currency denominated liabilities may result in the collapse of the CBA. The next step involves defining a threshold level of the loss of foreign reserves that would result in the abandonment of the CBA and, consequently, the currency crisis. A measure of the risk of banking crisis is developed in Section 3.5. The section illustrates what needs to occur in order to deplete fatally the capital of the banking sector, thus generating a banking crisis. Neither of these two measures of the systemic risk attempt to predict a crisis, but rather focus on the manifestations of systemic fragility. Section 3.6 concludes.

3.2. Is BH currently financially stable?

One of the conclusions of the previous chapter is that a narrow, generic definition of financial stability is inappropriate for a variety of reasons. As emphasized, some of these reasons are the differences in the structure and the stage of the financial sector development and the differences in risk preferences both between the countries and between different segments of an economy. Before the research in this chapter moves towards the construction of a country specific measure of the systemic risk, in this section the level of financial stability in BH will be assessed based on the currently existing broad definitions of the phenomenon. A special emphasis will be placed on the complexity of this issue and conditions based on which the perception of stability depends.

Based on the broad definitions of financial stability, BH can be classified as a financially stable country, although it might have entered a zone of rising instability in the first half of 2009. Definitions of financial stability focus on either the ability of the financial system to perform its main tasks, such as channelling funds or focusing on the stability of key institutions and markets (Bårdsenet al., 2008). In line with such an understanding of financial stability are the CBBH's (2011, 2012) conclusions that even in the periods following the macroeconomic shocks in late 2008 and despite the increases in the systemic risks, the stability of the BH financial system was preserved: the currency board was not abandoned; the payment systems were operating smoothly and financial intermediaries did not experience any significant operational difficulties.

By examining the existing, broad definitions of financial stability, Schinasi (2004) combined their common elements into a generic definition of financial stability:

> A financial system is in a range of stability whenever it is capable of facilitating (rather than impeding) the performance of an economy, and of dissipating financial imbalances that arise endogenously or as a result of significant adverse and unanticipated events (p.8).

Although it seems intuitive, this definition leaves space for discussion. The first condition of financial stability in the definition above states that a financial system should create an environment that is beneficial for economic activity. As will be discussed in more detail in later chapters, the financial instability hypothesis introduced by Minsky (1992) clearly distinguishes four stages of a business cycle. The financial instability hypothesis suggests that over periods of prolonged prosperity the financial system tends to move away from the stable hedge financing stage where contractual obligations can be met by cash flows. As expectations of prosperity persist, speculative finance, characterised by the roll-over of the existing liabilities, gradually replaces hedge financing and the system becomes more unstable. The final stage before the crisis and the adjustment towards the new equilibrium is the Ponzi financing stage, characterised by a failure to meet obligations on both the principal and interest. A large number of Ponzi units operating in an inflationary environment will be forced to hold fire sales if the authorities attempt to fight inflation by monetary constraint. The collapse of asset values will end in a financial crisis and result in an adjustment to a new equilibrating level. In the three stages before the final adjustment stage the financial system facilitates the performance of an economy if there are no regulatory or other barriers to lending activity that would result in a credit crunch. Building upon the same argument, it is implied that the financial system is within the range of instability only during the adjustment phase. As demonstrated in the case of BH below, such a conclusion may not be fully correct given the feedback effects from the real to the banking sector.

The sample in this research covers the period 2003-2010. As will be argued later in this and in the following chapters, the BH financial system experienced the first three stages of the business cycle, as described by Minsky (1992) and following the macroeconomic shock at the end of 2008 entered the adjustment stage towards a new equilibrium. There is no evidence that the adjustment phase was over by the end of 2012. In the years before the GFC the annual growth rates of claims the banking sector from domestic sectors recorded each month were steadily increasing to the level of 30% per annum just before the macroeconomic shock at the end of 2008 (Table A1.4, p.332). The growth rates of real GDP changed in the same direction as the changes in total claims.

In the period immediately following the macroeconomic shock banks re-adjusted their clients' creditworthiness assessment models. However, weak domestic demand for loans in the post-shock periods was the main cause behind a rapid decline in annual growth rates of loans to domestic sectors (CBBH, 2012). Research such as Gambacorta and Marques-Ibanez (2011) provide some evidence that changes in the banks' business models and lending policies in the post-shock periods is more characteristic of banks with a more significant share of investment banking and other fee-based activities. More specifically, their findings suggest that banks' ability to supply new loans in periods of financial instability is significantly more constrained in the cases when short-term funding and additional funding via markets (such as securitization and bond financing) make up a significant share in banks debt composition. Given the structure of BH's banking sector and its dependence on foreign sources of financing, mainly through loans and deposits of non-residents (Section 1.3), it is more likely that the significant decline in annual growth rates of claims in 2009 and 2010 (Table A1.4, p.332) was, as suggested by CBBH (2012), caused by weak domestic demand for loans. Given the arguments above, there is no firm evidence that the banking sector developments in the periods of post-shock adjustment towards the new equilibrium impeded the performance of the BH economy. It is likely that the causality was the reverse. Returning to Schinasi's (2004) definition of financial stability, the case of BH illustrates that one cannot judge the level of a financial system's stability based on the effect it has on real sector developments. In countries like BH it is common to find that the domestic sector's consumption, primarily of households, was the driving force behind GDP growth. Consequently, parts of the services sector, such as retailing and financial intermediation, were expanding. Strictly speaking, economic activity, as measured by GDP was growing, but the production sectors were not driving it.

Its ability to dissipate financial imbalances depends on the shock-absorbing capacity of the financial system. Allen and Carletti (2008) differentiated between complete and incomplete contracts and markets, arguing that although welfare is higher in the case when contracts are complete, it is the completeness of the markets that determine whether the system is a shock absorber or shock amplifier. In the case when the markets are complete, i.e. when risks are borne efficiently by everyone, the system is a shock absorber. Otherwise, the system is a risk amplifier. Allen and Carletti (2008) argue that liquidity issues are at the core of the amplification mechanism in the financial system and distinguish between three cases of market failures: financial fragility; contagion; and asset price bubbles. According to them, the short-term inelasticity of supply and demand for liquidity may result in large fluctuations in asset prices if there is even a small change in aggregate uncertainty, thus making the system fragile. The level of contagion is determined by the pattern of interconnectedness generated by the cross-holdings of deposits and, occasionally, by information contagion. In the former case banks may encounter liquidity problems if their deposits are held with those institutions that have liquidity problems themselves, while in the latter case banks may experience liquidity 'dry ups' just because they are perceived as resembling an institution with liquidity problems. Finally, asset price bubbles are the consequences of financial liberalization coupled with risk-shifting behaviour that makes the value of assets volatile, while the value of obligations is fixed.

As in the case of Schinasi's (2004) first condition for financial stability, there is no simple answer to whether BH's financial system is a shock absorber or shock amplifier, i.e. whether it is capable of dissipating financial imbalances. Ignoring for the moment how financial stability is defined by Allen and Carletti (2008), it is useful to use the listed liquidity related issues that signal market incompleteness in order to assess the stability of BH's financial system from this perspective. Given the balance sheet structure of the commercial banks (Section 1.3), a negligible fraction of banks' assets in the form of available for sale or held to maturity securities and the absence of complex financial instruments minimized the probability of significant fluctuations in asset prices. From that perspective, the BH financial markets could be regarded as complete given the absence of financial instability as defined by Allen and Carletti. As for the question of contagion, the answer is not straight forward. Although domestic inter-bank exposures are minimal (Section 1.3), the bank run that occurred in October 2008 was a case of information contagion; domestic depositors panicked and triggered a run on several domestic banks which were subsidiaries of Western European banks which had been downgraded by the rating agencies. In that sense, one could claim that, although the systemic risk of a financial crisis was rather low, the liquidity of the system was jeopardized by a random event that resulted in over 18% of domestic deposits, mainly in foreign currency, being withdrawn from the system (Section 1.5). Yet, a financial, or more specifically, a currency crisis, as traditionally defined, did not occur. An underdeveloped insurance sector and the absence of large institutional investors, as will be elaborated in more detail in Chapter 5, are the main reasons why the credit risk in the mortgage lending is mitigated by a combination of mortgage and at least one of the other three options: debt guarantors, co-signings or deposited funds (CBBH, 2011). For that reason asset price and real estate bubbles in particular, should not be viewed as a consequence of risk-shifting behaviour of BH's financial sector. Given the above, the mechanisms within the BH financial systems were such that the system itself could be considered as a shock absorber, mainly due to its relatively simple form. The amplification of systemic risk was a consequence of an inadequate pricing of the credit risk by the banking sector.

Finally, Schinasi's (2004) definition addresses the nature of the causes of the macroeconomic imbalances, emphasizing that they may be both endogenous and exogenous. Although not impossible, exogenous shocks of severe magnitude are very rare. Arguably, it is more often the case that an external shock is a cause of instability when there are underlying internal imbalances. Using Jeanne (2000) as an analogy "sunspots", adverse events not necessarily caused by changes in the fundamentals but generated by the "animal spirits" of the market, occur when the system is in the "ripe for the attack" region. In the context of fragility of the financial system, strong interconnectedness between the institutions and segments of the financial system and / or high complexity of the financial instruments could represent the "ripe for the attack" region. The most recent example of damaging effect of the "animal spirits" is the consequence of the crash of the U.S. sub-prime market that resulted in the unprecedented market volatility and the liquidity freeze in the international financial markets in 2007. With respect to the market volatility that resulted in the GFC of 2007 Haldane (2009) states:

> Back in August 2007, the Chief Financial Officer of Goldman Sachs, David Viniar, commented to the Financial Times: "We are seeing things that were 25-standard deviation moves, several days in a row". To provide some context, assuming a normal distribution, a 7.26-*sigma* daily loss would be expected to occur once every 13.7 billion or so years. This is roughly the estimated age of the universe. A 25-*sigma* event would be expected to occur once every 6 X 10^{124} lives of the universe (p.2).

The *vega* of portfolio of derivatives is the rate of change of the value of the portfolio with respect to the volatility of an underlying asset (Hull, 2000). A high *sigma*, i.e. high standard deviation, in this context means that relatively small changes in the volatility of an underlying asset cause dramatic changes in the value of the whole portfolio. A portfolio with a significant share of derivatives that was characteristic of investment banks recorded extremely high *vega* because the *sigmas*, i.e. the volatility of the underlying assets, were unprecedented. Such significant changes in the value of the portfolio are amplified in the financially fragile environment. Gai et al. (2011) developed a network model of interbank lending by which it was demonstrated that greater complexity and concentration in the financial network may amplify fragility and cause a systemic distress. If one ignores the cases of random shocks of great magnitude, the endogenous imbalances, embedded in any system as suggested by Minsky (1992), are a necessary condition for financial crises. As the imbalances grow, the whole system enters the "ripe for the attack" region. In the absence of complexity and concentration in the financial network, these imbalances should be predictable and offset with countermeasures. In such an environment high fragility that evolves into crisis is a consequence of regulatory failure. One of the consequences of greater complexity and concentration is that shocks capable of a rapid increase in fragility of the system are becoming smaller in magnitude. Whether complexity and concentration is endogenous or domestic financial system is strongly connected to other financial systems, would determine the originating point of potentially fatal shock.

As emphasized earlier in this section, domestic inter-bank exposures in BH are minimal and there are no complex financial instruments suggesting that domestic amplification mechanism is not strong. On the other hand, there is significant potential for the cross-border contagion given the dependence of commercial banks on foreign sources of financing (Section 1.3). In that perspective, even the bank run that occurred in October 2008 could be viewed as triggered by an external shock. Following Schinasi's (2004) conclusion that it is more often the case that an external shock is a cause of instability when there are underlying internal imbalances, one could argue that internal imbalances, such as a level of consumption unjustified by the real sector developments, were significant in the case of BH.

Alternatively, Schinasi (2004) proposes a generic definition that does not require the specification of what constitutes a financial system:

> Financial stability is a condition in which an economy's mechanisms for pricing, allocating, and managing financial risks (credit, liquidity, counterparty, market, etc.) are functioning well enough to contribute to the performance of the economy (p.10).

As was the case with Schinasi's previous definition, although it seems intuitive at least two reasons come to mind why it is hard to evaluate the level of financial stability as specified. The first reason is possible differences in perception of risk and incentives between home and host supervisors in the cases of significant cross-border connections between the financial systems. Additionally, there may be cases when the external, post-hoc implemented agreements were more effective in safeguarding financial stability than the mechanisms within the individual economies. The European Bank Coordination "Vienna" Initiative (EBCI) was an example of such an agreement.

In open economies where financial institutions are operating across national borders it is found that home country and host country supervisors, in addition to the level of information sharing that is found appropriate by the supervisors (Herring, 2007), tend to have different views on the key issues that determine the stability of the financial institutions. The main frictions are in the area of balancing the capital and liquidity at the group level while maintaining adequate buffers that will be in the interest of the host country (Shoenmaker, 2012). Aiming to identify the instances in which misalignments in incentives between host and home supervisors occur, D'Hulster (2011) built upon the principal-agent framework. It was concluded that, in addition to the information asymmetry problems resulting in self-capture, industry capture and political capture at the purely domestic level and the effect of externalities from other jurisdictions, the factors that exacerbate the effective cross-border cooperation are conflicts arising from different mandates and different tolerances for failure[34]. National authorities typically aim for the least-cost solution for domestic taxpayers (Shoenmaker, 2012). For that reason, international banks are required to run on national lines, as host supervisors force stand alone subsidiaries (and this is the most common way that foreign banks are organized in the host countries, especially in the CESEE region) to maintain separate liquidity and capital buffers in each jurisdiction, which may prove to be inefficient at the group level. In addition, Beck et al. (2012) concluded that national regulators have biased incentives when dealing with cross-border banks: banks with higher shares of foreign capital were intervened relatively shortly after their soundness deteriorated as opposed to banks with high shares of foreign deposits and assets.

CBBH (2008) illustrates an imbalance between the dependence of the Austrian subsidiaries in BH on cross-border funding compared to their in the country. At the end of 2007, external debt of the BH banks to the Austrian mother-banks was 95.3% of their total external debt and as much as 59% of total foreign debt of all banks. On the other hand, the exposure of Austrian banks to BH was only 1.3% of their total cross-border exposure. At the same time, 60% of banking sector equity was owned by the Austrian banks. In such an environment it could easily be the case that home and host supervisors do not see the threats to financial stability equally. The need for an effective coordination between the home and host supervisors is also, among other issues, emphasized by Vienna 2.0, the extension of the EBCI launched in January 2009.

The Vienna initiative, originally launched to help maintain financial sector stability in the CESEE countries, is an example of the case when the general perception of systemic stability may be altered by some post-hoc implemented agreements despite the fact that

[34] Self-capture is the term used for the case where regulators act to protect their own careers or reputation by disguising poor performance by their agency (Goodhart, 1996; Mishkin, 2001; D'Hulster, 2011). Industry capture and political capture occur when the regulators are under the influence of banks, politicians or both (D'Hulster, 2011).

vulnerabilities remain. The unfolding of the GFC caused significant shocks in the European banking system. The public and private sector's stakeholders of EU-based cross-border bank groups present in the emerging Europe region[35] recognized that strong de-leveraging of the western European banks from the CESEE countries could have significant adverse effects on the region, especially in countries where IMF/ European Commission (EC) macroeconomic support programmes had become necessary (EBRD, 2012). In addition to potential balance of payments problems, it was acknowledged that a large-scale and uncoordinated withdrawal of the cross-border bank groups from the region, referred to by Blanchard (2009) as the 'modern type' of bank run, could have triggered systemic banking crises both in individual countries and across the region (EBRD, 2012).

The EBCI contained two key points: a coordinated commitment of the banking groups to maintain their exposures to the CESEE countries conditional on the orderly implementation of the international support packages and on the consent of the home authorities; and a pledge to recapitalize their subsidiaries, if necessary, based on stress tests by host national banks (Nitsche, 2010). In addition, all banks committed their readiness to enter into bilateral commitments with the host national banks. In general, the duration of the commitments as specified in the Concluding Statements by Participating Banks for each individual country was not stated explicitly, but to be effective within the framework of the multilateral support programs. From the BH perspective, the EBCI meant that eight cross-border banking groups committed to maintain their individual overall exposures to BH at least at the December 31st 2008 levels during the period that the IMF's three-year SBA (2009-2012) remains in effect[36]. Furthermore, banks stated that should the subsidiary's CAR fall below the prescribed minimum the banking group will consider options for a pre-emptive recapitalization.

In their analysis of the determinants of credit growth during the 2008-2009 crisis in Emerging Europe, De Haas et al. (2012) conclude that the Vienna Initiative, an ad hoc

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[35] The stakeholders were the representatives of: international financial institutions (IMF, the European bank for Reconstruction and Development- EBRD, European Investment Bank- EIB and the World Bank-WB); European institutions (EC and the ECB as the observer); home and host country regulatory and fiscal authorities of large cross-border bank groups; and the largest banking groups operating in the EBRD region.

[36] The following cross-border banking groups signed the Concluding Statement by Participating Banks on June 22nd 2009 in Vienna, followed by individual Commitment Letters with BH: Raiffeisen International, Hypo Alpe Adria Bank International, UniCredit Bank Austria, Intesa Sanpaolo Bank, Volksbank International, NLB Group, Turkish Ziraat Bank and Erste Group Bank.

coordination mechanism where public funds were complemented by a coordinated bail-in of private sector lenders, not only helped the CESEE countries to close their external funding gaps at the macroeconomic level, but also to prevent an uncoordinated "rush to exit" of foreign capital. Although not legally binding, this, in essence, gentlemen's agreement prevented the 'modern type' of bank run and currency crises across the region during the period of deteriorating macroeconomic conditions. As the SBAs with the IMF in most participating CESEE countries ended in late 2011 and early 2012, banks started again to deleverage from the region. Weak demand for long-term loans in host countries and accumulated NPL on one, and funding constraints in home countries on the other side, called for a Vienna 2.0 in order to avoid an uncoordinated and excessive decline in bank lending across the CESEE region. Although multilateral working groups were created, primarily on the NPL resolution and effective cross-border supervision coordination, by the end of 2012 Vienna 2.0 had produced no specific commitments.

The aim of this section was to evaluate stability of the BH financial system in the context of some existing broad definitions. It was demonstrated that the process is not straight forward and that the assessment is conditional on numerous country specifics. These specifics will be used to refine the measures of systemic risks in BH that will be developed in the following sections based on the relationships between the banking sector and the real economy outlined in Section 2.3. Before that discussion proceeds towards constructing the country specific measures of the risk of currency and banking crises, the following section will briefly examine the relationship between them. Understanding how the two are theoretically linked will be useful in the later stages of this research when deciding whether it is more appropriate to observe them separately, or jointly either allowing for mutual influence or combining them into a single measure of financial fragility.

3.3. The feasibility of a single measure of financial fragility

Very often banking and currency crises have been found to precede one another or even coincide (Laeven and Valencia, 2008). The measures of risks of currency and banking crises that will be constructed in this chapter, given their mutual influence (Section 2.3) could theoretically be merged into a single measure of systemic risk. As will be discussed in more detail in the following chapter, these two types of risk are linked theoretically in the third-generation of the currency crisis models. These models emphasize the importance of the balance sheet effects of the various sectors of the economy associated with devaluations that are at the core of each currency crisis. The cause of the currency crisis in this generation of models is always sought in the activities of the banking sector, be it moral-hazard-driven lending and international over-borrowing (McKinnon and Pill, 1999, 2001; Burnside et al., 2003), bank runs (Diamond and Dybvig, 1983 and Chang and Velasco, 2000), or a currency or a maturity mismatches in banks' balances (Eichengreen and Hausmann, 1999).

A single measure would be preferred for the sake of simplicity, and that was a generally taken path in the applied research in the pre-GFC years. The earliest attempts to quantify the level of financial stability consisted of combining various indicators derived from the balance sheets into a single number. The following stage was the development of the early warning systems (Frankel and Rose, 1996; Sachs et al., 1996; Eichengreen and Rose, 1998; Kaminsky and Reinhart, 1999; Goldstein et al., 2000; Andreou et al., 2007). The first continuous measures of financial distress were the indices developed by Illing and Liu (2003) and Hanschel and Monnin (2005). These indices were better measures of financial distress than the early warning systems, since they had continuity, but they merely compared the symptoms of a crisis drawn from the subjective identifications of the previous crisis episodes. Illing and Liu (2003) used the variables that represent developments in the banking sector and foreign exchange, debt and equity markets to construct an index of financial stress that is then compared to the events widely perceived to be stressful. The events were considered stressful if they were explicitly identified in either the Bank of Canada's Annual Report (since 1977) or in its Monetary Policy Report (since 1995) as having had a significant impact on Canadian markets[37]. Hanschel and Monnin (2005) used a similar technique, but their variables include market price data, balance sheet items, non-public data, in the form of a list of the banks under special scrutiny maintained by the supervising authority, and other structural variables.

The most commonly used measures of systemic risk in the post-GFC years, whose performances were analysed by Rodriguez-Moreno and Peña (2011), are also single

[37] Nine events were Canadian in origin including mid-eighties bank failures and the early nineties real estate collapse. Twelve events were largely American in origin and included, among others: October 1987 stock market crash; the high tech collapse of 2000; the Savings and Loans crisis; the Long-Term Capital Management (LTCM) failure; and September 11 attacks. Thirteen events originated outside North America and some of the events included are: the first and second less-developed countries (LDC) crises in the early eighties: the Nikkei crash; the Scandinavian and ERM crises: and the Mexican, Asian, Russian, Argentinean and Turkish crises.

measures. These authors distinguish between two conceptually different types of measures of systemic risk: those that indicate the overall tension in the market and those that are related to the contributions of individual institutions to systemic risk. The former group of measures are based on LIBOR or Credit Default Swap (CDS) spreads. LIBOR spreads (usually the difference between the 3-month LIBOR rate and the 3-month Overnight Interest Swap or the 3-month LIBOR rate and the 3-month Treasury bills) indicate liquidity and default risk of banks with at least AA rating over the following months. CDS spreads are used in two ways to construct a measure of systemic risk: by performing a Principal Component Analysis (PCA) on a pool of the CDS spreads and by employing a linearized three-jump model to CDS indexes and their tranches. The PCA approach converts a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The first principal component has the largest possible variance, while each succeeding component is uncorrelated with the preceding components. A linearized three-jump model is used to determine what fraction of the portfolio that realized losses is a consequence of each of the three possible shocks: idiosyncratic, sector-wide and economy-wide.

The current measures of systemic risk that are related to the contributions of individual institutions to systemic risk are: risk indicators that are based on structural models, multivariate densities and aggregates of co-risk management measures. The first of the three measures is based on the contingent claims analysis as in Grey et al. (2009) and represents the probabilities of default that are the consequences of the relationships between banks' assets and liabilities. The multivariate densities approach is based on the work of Segoviano and Goodhart (2009) and it defines the banking system as a portfolio of banks. For each of the banks from this portfolio, empirical measurements of probabilities of default (PoD) are derived. Individual PoDs are used to derive the banking system's multivariate density based on which the banking stability measures are estimated. The most commonly used banking stability measures constructed in this fashion are joint probability of default (JPoD) and banking stability index (BSI). The former measure represents the probability of all banks in the portfolio becoming distressed, while the latter represents the expected number of banks to become distressed, conditioned on the fact that at least one bank has become distressed. The aggregate of co-risk management is a measure based on Adrian and Brunnermeier (2008). Under this approach one estimates CoVaR, the value at risk (VaR) of individual institutions conditional on other institutions' being in distress. Then an institution's marginal contribution to systemic risk is derived as the difference between CoVaR and the unconditional VaR of the whole portfolio. The sum of these differences for each individual institution indicates the level of the aggregate systemic risk.

The prevailing sentiment in the post-GFC years is that a single measure of systemic risk will not suffice given the complexity of the global financial system (Billio et al., 2010). With that in mind, it is important to note that these conceptually different types of recent measures of systemic risk primarily focus on the risk of banking crisis. Therefore, the conclusion of Billio et al. (2010) implies that there is no single model that can efficiently explain changes in the level of risk of banking crisis that arise from both changes in the exogenous sources of risk, the macroeconomic environment and conditions in financial markets, and the endogenous sources of risk, i.e. the inter-connectedness of the banking sector. As emphasized earlier, the lack of an interbank market and the simple structure of banking sector balance sheets in BH imply that a single measure of risk of banking crisis could be appropriate for this research. However, by using the research of Khandani et al. (2009) as an illustration, Billio et al. (2010) demonstrated how individually benign events often considered harbingering economic growth, such as rising house prices, falling interest rates and increasing efficiency and availability of refinancing opportunities, may increase systemic risk. In other words, an increase in households' wealth, high liquidity in the markets and bigger diversity of banking products, or softer lending, if occurring simultaneously, may increase systemic risk. This interpretation, when observed in the context of this research and the specifics of the BH financial system, may suggest that measures of the currency and banking crises risks in BH should be modelled separately, but be allowed to interact with each other.

Both proposed measures of systemic risk should aim to determine the size of the shock sufficient to cause either insolvency of the banking system that would result in the collapse of the country's monetary system, or, independently, the collapse of the CBA that would trigger a banking crisis. They will be referred to as the liquidity and solvency indices respectively. As argued in Section 2.3, in the case of a CBA, the abandonment of the fixed exchange rate would be interpreted as a currency crisis, which would spill-over to the banking sector. This way, the liabilities side of the banking sector would be affected taking into account the liquidity risk, since there is a direct link between the foreign currency reserves on the one side and foreign liabilities in the form of deposits and loans from non-residents and foreign currency deposits of domestic sectors on the other side. The other possible breaking point is related to the issue of insolvency and assumes the depletion of the banks' capital due to losses in value of banks' assets caused by the large write offs or a sharp deterioration in their quality. In either case, the distance from the breaking point is a measure of the system's fragility. For the sole purpose of constructing a measure of fragility, one does not need to know which events may trigger the depletion in the foreign reserves or losses in the value of the banks' assets. If the size of the gap between the current situation and the breaking point is smaller than in the previous period, this can be interpreted as an increase in the system's fragility since the size of shock capable of causing crisis is smaller.

In the case of a liquidity shock, the distance to breaking point could be expressed in two ways. The first option of measurement assumes the estimation of foreign liabilities withdrawal sufficient to cause the abandonment of the CBA as a share of total foreign liabilities of the period. The second measure is expressed in terms of the withdrawal of foreign currency deposits of domestic sectors as a share of the total for the corresponding category for the period under observation. In the case of insolvency, the distance to breaking point will be expressed in terms of both the reduction in assets (due to loans not renewed or large-scale write-offs in loans caused by a sharp deterioration in their quality) and increase in costs in the form of an increase in provisioning for existing loans equal to the amount of capital.

The continuous measures of financial fragility will be constructed in the following two sections. Changes in the single measures of the currency and banking crises with respect to changes in selected macroeconomic and banking sector specific variables will be investigated in Chapters 4 and 5 respectively. The relationships established in these chapters should answer what causes the majority of changes in the perceived levels of systemic risk: the trend component, i.e. is an increase in fragility a self-fuelling process; or the set of selected variables in which case it would be safe to assume that financial crises are random events? If the former is correct, then financial fragility is, indeed, imbedded in financial systems, which is in line with Minsky's financial instability hypothesis. If the case the latter is correct, it would imply that crises are usually the consequences of the regulatory failures. The possible interaction between these two measures of systemic risk in BH will be investigated in Chapter 6. Based on the arguments presented in this section, it is hypothesised that the two measures of systemic risk cannot be merged, but they should be allowed to interact with each other.

3.4. The measure of the risk of a currency crisis: the liquidity index

This research has so far introduced the BH financial system, its main components, the relationships between them and the main specifics (Sections 1.3, 1.5 and 2.4). It was also acknowledged that currently there is no measure of systemic risk for BH (Sections 2.3 and 3.2). The absence of historical episodes of financial crisis, as traditionally defined, since the CBBH was established in 1997 encumbered the evaluation of the level of systemic fragility since there was no benchmark of any kind that would indicate increased likelihood of a systemic crisis. It was also demonstrated that country specifics must be accounted for, which implies that an exact replica of a successful approach in one country need not be the best approach in another country (Sections 2.3 and 3.2).

This section continues with an explanation of the accounts of the currency board and an illustration of the relationships between the banking sector and Central Bank balance sheets. All illustrations used actual data for BH as of December 31st 2010, the end date of the sample that is used in this research. The aim was to inform from the BH perspective on the possible channels of shock propagation that may result in the abandonment of the CBA. The section continues by presenting the proposed way to construct a continuous measure of the risk of currency crisis. Finally, the measure of the risk of a currency crisis, or the liquidity index (LI), is presented and the results are interpreted.

According to law, the CBBH is responsible for establishing and maintaining an adequate level of foreign exchange reserves. The rule for issuing currency under the CBA is that the aggregate monetary liabilities (the sum of currency in circulation and the credit balances of residents) must be lower than the net foreign exchange reserves (the difference between the fair market value of the foreign assets and liabilities to non-residents). The difference between the two is the net free reserves (Table 3.1).

Table 3. 1: The accounts of the currency board, December 2010

Source: CBBH.
Note: Net foreign exchange reserves are reported in BAM in balance sheets, but they are held in foreign currency.

in millions of BAM

A: Net foreign exchange reserves (I) - (II):	**6,456.3**	**B: Aggregate monetary liabilities (III) + (IV):**	**5,969.6**
(I) Assets (a) + (b) + (c):	6,457.7	III: Currency in circulation:	2,497.5
(a) Foreign currency placements:	*3,003.5*	IV: Credit balances of residents (e) + (f):	3,472.1
(b) Investment in foreign securities:	*3,285.1*	*(e) Deposit money banks, required and liquidity reserves:*	*3,273.3*
(c) Other:	*169.2*	*(f) Other:*	*198.8*
(II) Liabilities to non-residents:	1.4	**C: Net Free Reserves:**	**486.8**

Given the conservative nature of the central bank in their conduct of business and investment policies, let us assume that the CBA can be shocked only on the liabilities side. Given that the CBBH does not have the role of the LOLR, nor it is allowed to conduct any open market operations (OMO), it is unlikely that a shock to the CBBH assets could originate in the currency in circulation. A strong depletion of net foreign exchange reserves (forex reserves from this point on) and, consequently, the currency in circulation could be categorised as a bank-run either in a traditional sense (caused by a withdrawal of deposits of residents) or as a modern type of a bank run caused by a flight of foreign investors as pointed out by Blanchard (2009). A classic bank run occurred in BH in October 2008 when total deposits, primarily those of the households regardless of the maturity, decreased by 6.4% with respect to the previous month. The quarterly reduction in the consolidated claims of the BIS reporting banks exceeded 5% in the third quarter of 2008 signalling a withdrawal of foreign investors[38]. According to the same source, in 2008 total international claims of BIS reporting banks from BH decreased by USD 1.37 billion (22.5%), most of it being claims with the remaining maturity exceeding two years. The repercussions of such an event were evident as soon as the following quarter when the annual growth of the long-term claims slowed down significantly.

[38] Source: BIS, Table 9A: Consolidated claims of reporting banks - immediate borrower basis

The credit balances of residents (Table 3.1) primarily consist of the reserve accounts of the commercial banks' with the CBBH. The level of credit balances of commercial banks depend on: the base for calculation of required reserves, the rate of required reserves, and the banks' assessment of the needs for liquidity often referred to as their "excess reserves" (Table 3.2).

Table 3. 2: Banks' reserves with the Central Bank, December 2010

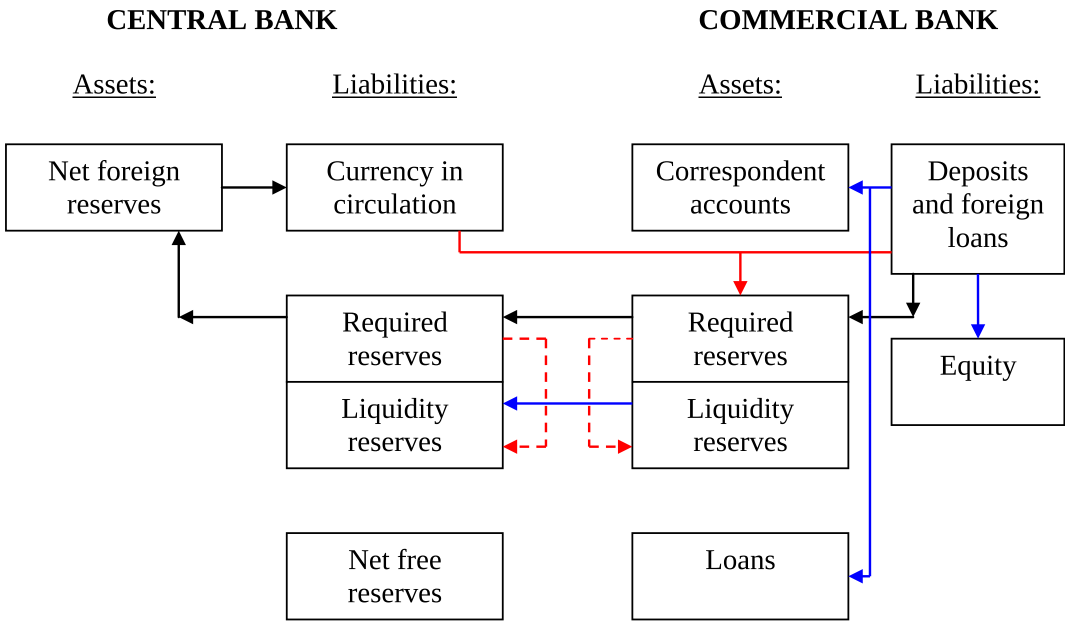
Source: CBBH.
Notes: Short-term loans and deposits and demand deposits have remaining maturity up to one year. Long-term loans and deposits and time and savings deposits have remaining maturity of more than one year.
Distinction between foreign and domestic commercial banks' liabilities is based on the residency and

in millions of BAM

A: Credit balances of commercial banks (I) + (II):	**3,328.0**	**B: Required reserves base (III) + (IV):**	**16,724.2**	**Applicable rate**
(I) Required reserves:	1,616.7	III: Foreign liabilities (a) + (b):	4,782.1	
(II) Liquidity (or excess) reserves:	1,711.3	(a) Short-term loans from and deposits of non-residents, of which:	692.3	14%
		short-term deposits:	*580.0*	
		short-term loans:	*90.8*	
		correspondent accounts and other:	*21.5*	
		(b) Long-term loans from and deposits of non-residents, of which:	4,089.8	7%
		long-term deposits:	*2,029.7*	
		long-term loans:	*2,060.0*	
		IV: Domestic liabilities (c) + (d):	11,942.2	
		(c) Demand deposits of non-bank residents:	6,078.0	14%
		(d) Time and savings deposits of non-bank residents:	5,864.2	7%

Regardless of the origin of the foreign exchange components of the required reserves base (banks' liabilities), the link between an increased demand for foreign currency and the changes in the level of net forex reserves (the Central Bank's assets) is straight forward. The adjustments to the liabilities side of the Central Bank's balance sheet that might follow are a bit less obvious. Figure 3.1a illustrates the adjustments in commercial bank's and Central Bank's balance sheet caused by an increased demand for foreign currency. The adjustment process is represented by a series of steps that take place through time, so each of them is represented by a different line in Figure 3.1a. As will be explained in more detail, the process starts with a shock to bank's liabilities and propagates along the black line to the CBBH's liabilities, ending in adjustments in banks' assets represented by the red and blue lines. A separate, detailed figure for each of these steps is provided in the text when the specific step is discussed.

Figure 3. 1a: The effect of an increase in demand for foreign currency

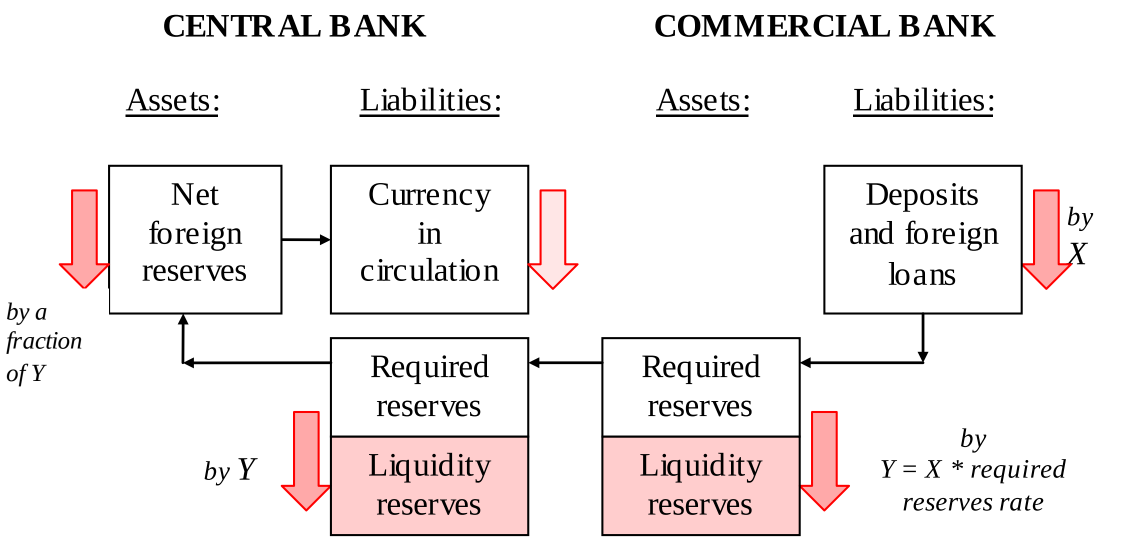


Let us assume that there is an increased demand for foreign currency in BH. Given the regulations on liquidity management, the banks face the following payment options: using foreign currency in their vault; using the funds from their correspondent accounts (also called *nostro accounts*) and other short-term accounts abroad; or by using the funds from their reserve accounts with the Central Bank[39]. The banks would most likely opt for the reserves with the CBBH for the following reasons: the funds in vaults are generally small since by minimizing them the commercial banks are minimizing their idle funds that do not earn any return, whilst funds from the accounts abroad are not available on demand. Therefore, in the case of an unusually large or persistent demand for the foreign currency (a reduction in deposits and foreign loans on the liabilities side of the commercial bank's balance sheet), the commercial banks will withdraw domestic currency from circulation, transfer it to its accounts and use it to purchase foreign currency. This purchase will be most likely financed by the funds from the reserves accounts with the CBBH (primarily the liquidity reserves). The reserves accounts are

[39] The banks are required to maintain an average ten calendar day minimum liquidity in cash funds up to at least 20% of short-term funds sources according to the book value at the last day of the previous month, taking into account that the level of cash funds cannot be less than 10% on any day. Banks' short-term funds sources include the following items from the liabilities side of bank's balance sheet: demand deposits; short-term liabilities based on time and savings deposits, money market funds or bonds; and limited deposits. A certain amount of foreign reserves is kept in their vaults to meet foreign exchange risk management requirements.

reduced by the same amount on both the assets side of the commercial bank and the liabilities side of the CBBH. This purchase of foreign currency will result in a reduction in the net forex reserves of the CBBH. As demand for foreign currency increases in the commercial banks, the balances on their reserves accounts with the CBBH are being reduced. Once they are exhausted, the level of currency in circulation will have to be reduced in order to meet the requirements of the CBA. This reduction in the currency in circulation would result in an increase in domestic interest rates. This mechanism is represented by the black arrows on the Figure 3.1a and in more detail on the Figure 3.1b.

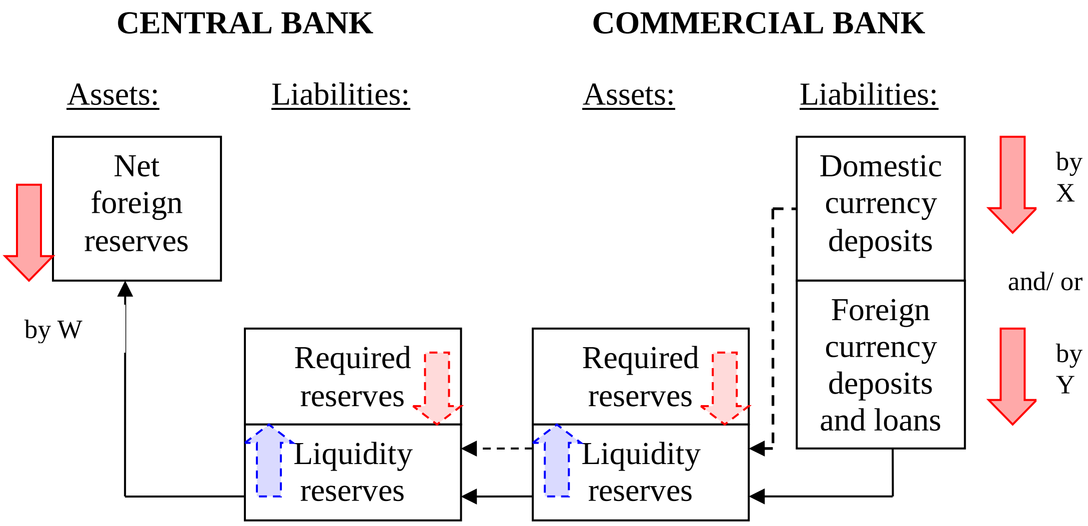
Figure 3. 1b: The link between a commercial bank's and the Central Bank's liabilities



Facing potential liquidity problems, the CBBH may choose to reduce the rate of required reserves, since, besides the reduced level of money in circulation, the banks' reserves with the Central Bank are also reduced due to the contraction in their deposit base. This mechanism is represented by the red line and arrow in Figure 3.1a and by the dashed semi-transparent blue and red arrows in the reserves boxes in Figure 3.1c below. Given that there are three required reserves maintenance periods each month in BH, it is possible that the effect will be evident in the balance sheets of commercial banks at the end of the same month. However, this tool is of limited effectiveness since regulating the level of liquidity is not its primary aim. This tool may be helpful in the case when a reduction in the forex reserves triggers a loss of confidence in the domestic currency.

Then, at least in the initial period, there would be just a reclassification of funds between the items on the liabilities side of the Central Bank's balance sheet (Table 3.1 and represented by the dashed red line in Figure 3.1a). If there is no panic amongst residents, and hence no sizeable withdrawals of domestic currency denominated deposits, a reduction in the rate of required reserves is futile if the reserves accounts are maintained in domestic currency (the dashed line in Figure 3.1c originating at domestic currency denominated deposits and terminating at liquidity reserves). In this case if there is a withdrawal of deposits in foreign currency, whatever the CBBH does with the rate of required reserves it will not ease the pressure on the forex reserves. Its impact on improving the liquidity of the system is also ambiguous since it may be the case that there is no increase in demand for the domestic currency given the higher interest rates.

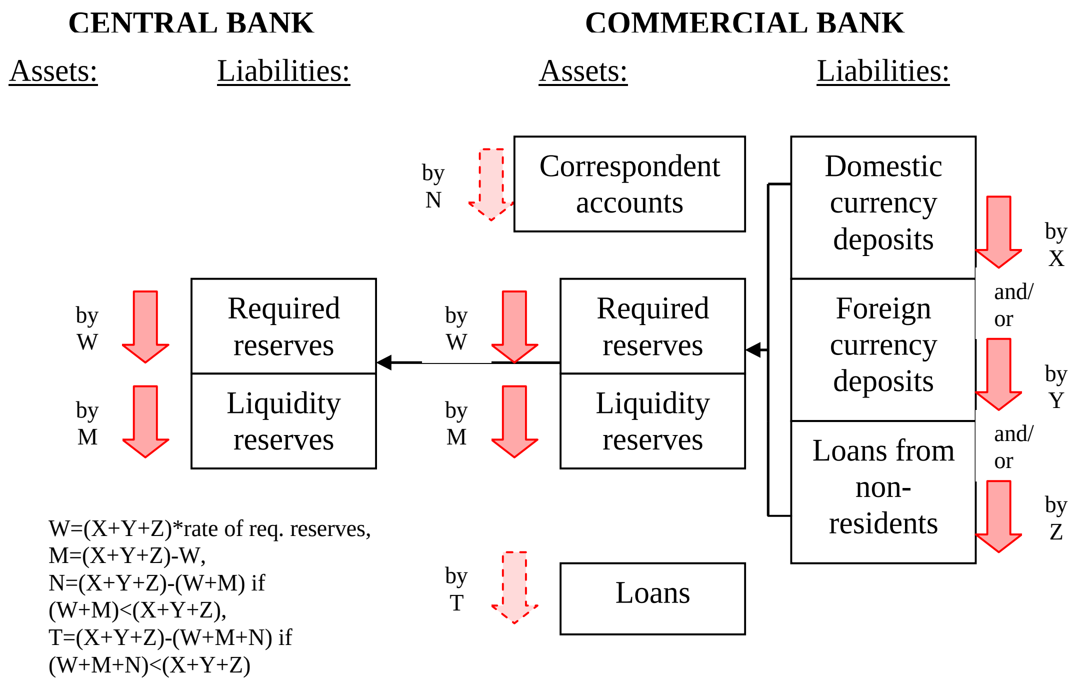
Figure 3. 1c: The effect of a change in the rate of required reserves



In Figure 3.1c the liquidity reserves fall by Z=X *rate of required reserves and W=Y*rate of required reserves. The sum of Z and W on this Figure corresponds to the value of Y in Figure 3.1b.

A reduction on the liabilities side of the banks' balance sheets would lead to a reduction on its assets side as well (Figure 3.1d). Required reserves would reduce by the amount of the withdrawal multiplied by the rate of required reserves (represented by the full red line in Figure 3.1a). The remaining part would be compensated by the reduction in the excess reserves of the commercial banks (represented by the blue line in Figure 3.1a). If the balances of the liquidity reserves with the Central Bank are insufficient, the correspondent accounts and, finally, the loans would be reduced by the remaining amount. The reduction in the reserves with the Central Bank would result in a reduction in the monetary liabilities of the Central Bank (Table 3.1). The cycle would end here since there would be no further reduction in the forex reserves. The net capital of the banking sector would also be reduced by the amount of the reduction in the subordinated debt since it is a part of the foreign currency denominated liabilities (Section 1.3 and Table A1.4, p.332). Although the reduction might not be substantial, it could result in further reductions on the assets side of the bank's balance sheet given the regulatory requirements on capital adequacy.

Figure 3. 1d: The adjustment through a commercial bank's balance sheet



The above illustration of the propagation of the shock to the banking sector liabilities and its effect on the level of forex reserves demonstrated that a bank run would result in a collapse of the CBA only if a substantial level of foreign currency denominated liabilities would be withdrawn from the system. However, there is no common ground on what is considered to be "a substantial level". The first-generation currency crises models (Krugman, 1999; Flood and Garber, 1984) assume that the central bank will abandon a fixed exchange rate when foreign reserves reach a pre-specified critical lower bound. However, it is never indicated what the lower bound might be. Rebelo and Vegh (2002) argue that in response to a sufficiently large fiscal shock it is always optimal to abandon the fixed exchange rate immediately, regardless of the level of foreign reserves. In a later version of the same paper, in line with Jeanne (2000), Rebelo and Vegh (2007) state that the historical evidence suggests that the monetary authorities choose to devalue as opposed to being forced to devalue. They find that in 38 out of the

51 crisis episodes in their sample the reserve losses over the 12 month prior to the crisis were less than 40% of the original level. This research will also assume that the authorities will abandon the CBA before all forex reserves are depleted, but the one year window, as suggested by Rebelo and Vegh (2007), was not considered appropriate for a couple of reasons. Primarily, a one year period might be far too long when it comes to the financial sector and the aggregate loss of foreign reserves might be significantly reduced by the interventions of the monetary authorities. Secondly, a country may face a currency crisis after only one speculative attack. Given the above-mentioned, in order to find a measure of the loss in foreign reserves that would lead to the abandonment of the currency board regime, a monthly decline in foreign reserves is chosen.

In order to estimate the level of critical loss in foreign reserves that will be used in the construction of the liquidity index, 90 episodes of currency crises recorded in 76 countries in the period 1990-2008 identified in Laeven and Valencia (2008) were examined. The IMF International Financial Statistics (IFS) data were used to measure the loss of the forex reserves during every crisis episode recorded by Laeven and Valencia (2008) and it was found that the average highest monthly decline in foreign reserves in the crisis year was 23.32% across the whole sample of 90 crisis episodes. Although Laeven and Valencia's database covers a longer period of time, economies from the previous decades of the past century are not directly comparable to modern economies, so the sample had to be reduced. In addition, the currency crisis episodes for which there were not data in the IFS were also excluded from the sample[40]. Based on the chosen sub-sample, the average monthly decline (the black solid line in Figure 3.2) is calculated as the absolute value of the sum of the weighted averages of the maximum monthly declines in foreign reserves in the crisis year for each of the recorded currency crises (the dots in Figure 3.2) where the size of the corresponding decline is used as a weight, i.e.

Key:
min denotes minimum.
Δ denotes change.
FOREX stands for the foreign reserves.
n ranges from 1 to 90, i.e. the number of the crises episodes from the sample.

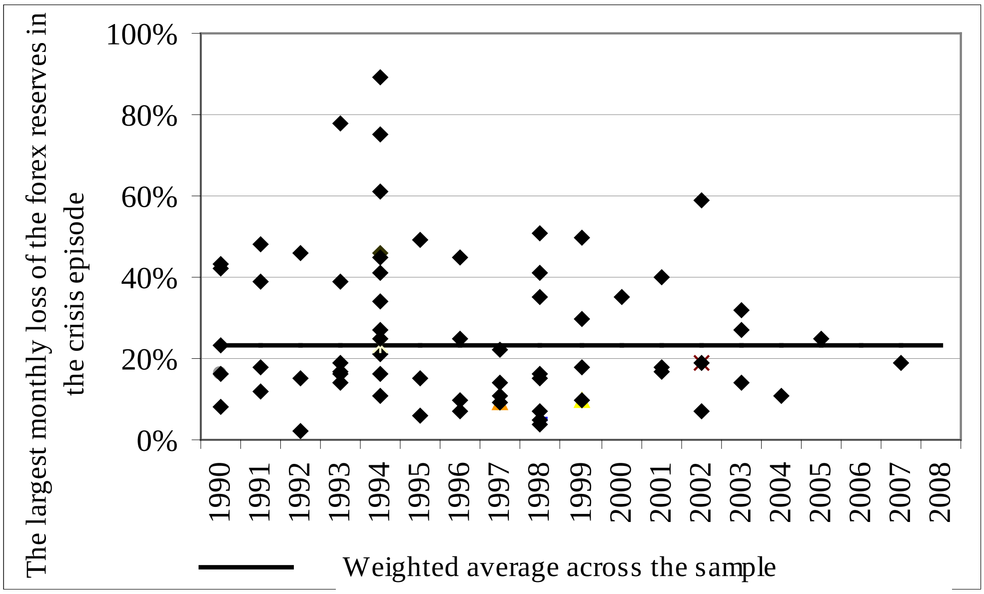
[40] No data for IR all periods, AO 1991, AZ 1994, BY 1994, KH 1992, KM 1994, CD 1999, GE 1992, LV 1992, LT 1992, MN 1990, NI 1990, ST 1992, RS 2000, ZW 2003. KR 1998 is omitted since there was no drop in foreign exchange in the crisis year. MM 2007 data is available only for the first half of the year.

$$Average = \left|\sum_{crisis=1}^{n}\left[\min\left(\frac{FOREX_{n,t}^{crisis}}{FOREX_{n,t-1}^{crisis}} * 100 - 100\right) * \frac{\Delta FOREX_{n,t}^{crisis}}{\sum_{crisis=1}^{n}\Delta FOREX_{n,t}^{crisis}}\right]\right| \qquad (3.1)$$

The first part of the equation, following the summation sign, $\min(\frac{FOREXR_{n,t}^{crisis}}{FOREXR_{n,t-1}^{crisis}} * 100 - 100)$, represents the percentage point change in foreign reserves in the crisis month (t) with respect to the previous month (t-1) for each crisis episode (n). Note that these values will be negative, therefore *min.* The numerator of the last term in the parentheses is the USD amount of loss of the foreign reserves in the crisis month for the crisis episode in question. The denominator is the total loss of foreign reserves (in USD) across the sample.

Figure 3. 2: The average monthly decline in foreign reserves in the crisis years

Source: IMF IFS, own calculations



The following text box will use the actual values in order to demonstrate how the dots in Figure 3.2 are calculated and how Equation 3.1 works, i.e. what is the purpose of the weighting.

Text box 3.1: Calculating the point at which the CBA is assumed to be abandoned

Each of the dots in Figure 3.2 represents a currency crisis episode during the period 1990-2008 identified by Laeven and Valencia (2008). The later studies of the same authors on similar topics cover the periods after 2008, but the crises episodes were only counted without naming the countries. For that reason the sample in this exercise could not be expanded to cover the periods after the GFC.

Let us randomly pick a crisis episode in Figure 3.2 and let it be the dot in the year 2002 that represents a monthly loss of some 60% of the country's forex reserves. The point represents Uruguay that, according to Laeven and Valencia (2008), experienced a currency crisis in that year. According to the IFS data, the biggest recorded monthly loss of the Uruguay's forex reserves occurred in July 2002 and it amounted to USD 822 million. At that time that amount represented almost 60% of the forex reserves of Uruguay. All other dots in Figure 3.2 were calculated in the same fashion: based on the IFS data it was calculated when in the crisis episode identified by Laeven and Valencia (2008) the biggest monthly reduction in country's forex reserves occurred.

The loss of similar magnitude occurred in one of twenty currency crises recorded in 1994 (Figure 3.2). In September 1994 Côte d'Ivoire lost 59% of its forex reserves when compared to the previous month. In absolute terms, the monthly loss was USD 1.2 million. This example indicates that one has to take into account the initial level of forex reserves (that reflects the stage of country's development) when calculating the average loss that presumably would result in the currency crisis.

Furthermore, it is also likely that the loss of forex reserves sufficient to cause the currency crisis would depend on the underlying macroeconomic conditions around the crisis episode. A set of Figures A3.1 (p.313) illustrate the changes in the forex reserves for countries from the sample drawn from Laeven and Valencia's database

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with the largest monthly change in the forex reserves in the crisis year over the observed period. In the case of Egypt, Mexico, Uruguay and Indonesia, the spikes on the graphs representing the monthly changes in forex reserves in the year of the crisis were very distinct when compared to the calm years. In other cases (Argentina, Brazil, Russia, Sweden, Turkey or Venezuela), the spikes are noticeable, but the graph indicates strong volatility in the monthly changes in forex reserves throughout the period 1990-2008. The presence of volatility in the level of forex reserves over the prolonged period of time signals fundamental weakness of the system. In such an environment, the average monthly change could be much lower when compared to a speculative attack, but the cumulative effect of the twelve months of forex reserves depletion before the fixed exchange rate is finally abandoned would be substantial. Rebelo and Vegh (2007) estimate that depletion to be significant, but lower than 40%. In the case of a speculative attack, the average monthly change would be much higher and it would not last too long. Given the above argument regarding the initial level of the forex reserves, one would expect to find more significant losses, expressed as the percentages of total forex reserves, at lower initial levels of reserves. Some of those countries from the Laeven and Valencia (2008) sample lost almost all their forex reserves in a single month.

The above arguments indicate that the monthly change assumed sufficient to cause a crisis should be high enough to have the government weighing the option of abandoning the fixed exchange in the case of a speculative attack, but low enough that the accumulated losses over a year would be less than 40% as estimated by Rebelo and Vegh (2007) in the case of weak macroeconomic fundamentals.

Ideally, one would apply the losses of the forex reserves in another transitional CEE economy to BH’s forex reserves. However, as indicated in footnote 8, there is no IFS data for the crisis episodes for countries from the sample that fall into this category,

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such as Serbia or Lithuania. The crisis that could, to a certain extent, be used as a reference value in the case of BH is the Bulgarian currency crisis of 1996, especially given that it also operates under a CBA. The biggest monthly change in Bulgarian forex reserves in 1996 was 27%. However, this value cannot be used as anything but a general guideline since the currency crisis coincided with a banking crisis that same year and it was preceded by 1991-1994 and 1995 banking crises, all rooted in weak macroeconomic fundamentals and delayed structural reforms.

In order to calculate the point at which the CBA is assumed to be abandoned a weighted average loss of the forex reserves in all currency crisis episodes identified by Laeven and Valencia (2008) over the period 1990-2008 is the approach that is proposed in this research. Assigning the crisis episodes with higher monthly losses of the forex reserves expressed in USD bigger weights takes into account both the differences in initial level of the forex reserves and the nature of the shock that triggered the forex loss.

Equation 3.1 generates the weighted average of the forex lost expected to result in a currency crisis based on the estimated monthly changes from the beginning of this text box. Over the sample period the maximum number of the currency crises per country was three. For each of those episodes both the maximum monthly change in USD in the crisis year was calculated as well as the corresponding percentage change in the forex reserves. All these changes in absolute terms were summed up. Then for each individual crisis episode the absolute change was divided by the sum of all changes over the sample in order to calculate the relative size of the forex loss per crisis episode. This relative size is then multiplied by the corresponding change in the forex reserves. This step ensured that both change in USD in the forex reserves and its significance from the perspective of the initial level of forex reserves are accounted for. Summing all these values up across the crises episodes essentially tells

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by how many percentage points the forex reserves of all countries from the sample that experienced currency crisis over the sample changed with respect to the pre-crisis month. The absolute value in Equation 3.1 is crises episodes essentially tells by how many percentage points the forex reserves of all countries from the sample that experienced currency crisis over the sample changed with respect to the pre-crisis month. The absolute value in Equation 3.1 is there to ensure a positive value.

Let us use Uruguay from the beginning of this text box as an illustration. Over the observed period two crises were recorded. The first crisis occurred in 1990 with the highest monthly forex loss of USD 33 million or 8% recorded in April. The second crisis occurred in 2002 with the highest monthly forex loss of USD 822 million or 59% recorded in July. The sum of all highest monthly declines in the forex reserves over the sample was USD 45.93 billion. Therefore, based on Equation 3.2 below the currency crises of Uruguay accounted for 1.06 percentage points of monthly forex losses across the sample used in this research.

$$\text{Uruguay} = \left|(-33)/(-45{,}930)*(-8)+(-822)/(-45{,}930)*(-59)\right| = 1.06 \tag{3.2}$$

Summing the values obtained for all crises episodes, one reaches 23.32. In other words, it is estimated that, all currency crises episodes from the sample resulted in a maximum monthly decline of forex reserves of 23.32%.

An average monthly decline in forex reserves of 23.32% seems like a plausible cut-off value in case of both a loss of reserves due to fundamental weaknesses of the system or a sudden speculative attack. From the perspective of fundamental weaknesses this value is acceptable since it is not too high to build up over a year to a loss that exceeds, say 40% of the pre-crisis level of forex reserves as suggested by Rebelo and Vegh (2007). Furthermore, it is lower than the decline in the case of Bulgarian currency crisis of 1996, which was to be expected since that currency crisis coincided with a banking crisis. At the same time, the effects of the bank-run that occurred in BH in October 2008 (Section 1.3), but did not end in a currency crisis, were lower. The chosen level is high enough to be considered a rare, but possible event. Most likely, once this amount of the forex reserves is lost due to a speculative attack, and usually in the matter of days, the number of speculators betting against the domestic currency would rise and the size of their bets increase exerting additional pressure on the government to devalue.

Based on the average monthly decline in forex reserves during the crisis period, one can calculate the withdrawal of the foreign currency denominated liabilities of the commercial banks (foreign currency loans from the non-residents and deposits from both residents and non-residents) sufficient to result in a collapse in the CBA. The Figures 3.1b-3.1d illustrate how a bank run propagates from a commercial bank's liabilities to the Central Bank's assets. Aggregated data on all the variables in question are available on a monthly basis as of August 1997, when the CBBH was established. However, due to a large number of structural breaks (Figure 1.1), the availability of the banks' balance sheets and bank-level data on flows of foreign investment to banking sector, the LI will be constructed starting from the first quarter of 2003. The procedure for constructing the liquidity index and all its components consists of several steps described below.

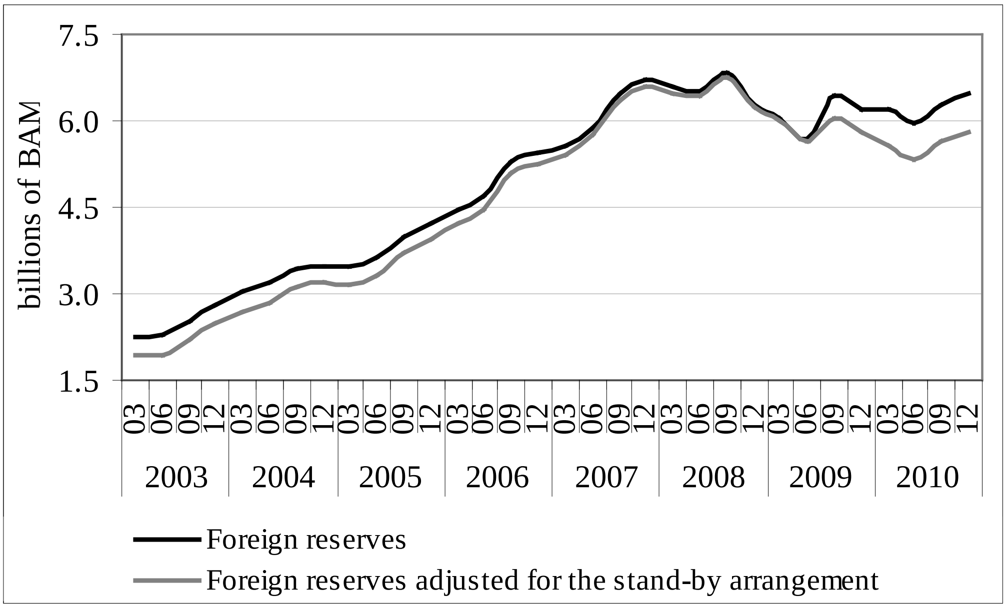
Step 1:

Based on the monthly data, one first calculates the loss of foreign currency reserves that would collapse the CBA. In our case this value is taken as 23.32% of stock forex reserves at the end of each month.

The stock of forex reserves is determined by numerous factors. In the case of BH it is a consequence of all of the following: the initial level at the moment when the CBBH was established; privatization and capital investment related inflows; public debt related inflows (including the SBAs with the IMF); public debt servicing outflows; financial and real sector activities; and, to a lesser extent, the investment policy of the CBBH (CBBH, 2012). Unlike other items that permanently shift the level of forex reserves, an increase in private and public debt only temporarily raises the level of forex reserves since those obligations must be serviced at maturity. The stand-by arrangement related inflows are the best example of inflows that have only temporarily effect on the level of reserves as their primary objective is a quick response to countries' external financing needs and stabilization of the balance of payments. As indicated in Section 2.4, BH entered several stand-by arrangements with the IMF, all of which altered the perception of the risk of currency crisis in a sense that the financial system seemed more robust with each SBA-related inflow. A detailed history of the BH SBA with the IMF can be found in Appendix 3.2 (p.337). In this research it is proposed that the effect of the SBA-related inflows of funds should be accounted for. Otherwise, as Figure 3.3 below indicates, one might conclude that the forex reserves were relatively stable in post 2008, the periods when the macroeconomic fundamentals were deteriorating. At the end of 2010 the official foreign reserves were 11.6% higher because of the SBA related inflows. Appendix 3.2 also provides a detailed explanation of how the original forex series was adjusted for the effects of the SBA.

Figure 3. 3: The effect of the stand-by arrangement on foreign reserves

Source: CBBH, IMF, own calculations.
Similar Figure with slightly different purpose was constructed for CBBH (2012).



Step 2:

The value from Step 1 is then expressed as the shares of each of the three types of commercial banks' liabilities in foreign currency, i.e. deposits of domestic sectors in foreign currency, deposits of non-residents and loans from non-residents. The percentage reduction in any particular type required to collapse the CBA depends on the size and variability of the particular type in total foreign liabilities. This calculation is made for each category in each period.

Step 3:

Each value from step 2 is subtracted from 100. This step ensures that, in the case of all three components, the value of 100 represents the collapse of the CBA, i.e. the lower the value recorded, the smaller the pressure on foreign reserves. Assumed monthly decrease in all three components sufficient to collapse the CBA can be found in Table A3.1 (p.341).

Step 4:

Each value from each component from Step 3 is expressed as a percentile of the values obtained in Step 3 for each of the three series. In other words, once the minimum and maximum values of each component are determined, every numerical observation of that component is transformed to represent the percentile rank thus forcing the measure of systemic risk to fall between zero and 1.

As an example, let us consider deposits of non-residents after Step 3. The lowest value of 24.58 is recorded in January 2003. As specified in Step 3, that is the period when the risk of a currency crisis caused by a bank run of non-residents' deposits was the lowest, since it implied that it would take an outflow of almost 2/3 of deposits of non-residents to collapse the CBA. Note that had all the deposits of non-residents been in foreign currency, at the lowest level of risk it would take around 75% (100-24.58) of this type of deposits withdrawn to cause the collapse of the CBA. The slightly lower percentage of total deposits of non-residents (around 66%) indicates that a fraction of them are in BAM. The highest value of 61.37 was recorded in June 2009. As this step ensures that all other monthly values from Step 3 are ranked within that sample, January 2003 in the case of deposits of non-residents is assigned a value of zero, while June 2009 is assigned a value of 1. The second smallest recorded value was 27.28 and it lays within the first percentile. The second percentile was 28.07 and so on towards the maximum value, i.e. the 100th percentile.

This step ensures that the value cannot exceed 100 and that all values are ranked with respect to the values from the sample. This is an important property since it allows for detection of extreme events even in the case of a relatively large number of high risk episodes falling into a rather small range.

Step 5:

Step 5 is a recalculation of monthly values into quarterly approximations. In this step the monthly values for each component, namely foreign deposits of domestic sectors, and deposits of and loans from the non-residents, from Step 4 are transformed into quarterly values by averaging of the values recorded in the months constituting the quarter in question. The quarterly values are approximates because the 3-month averages cannot, by definition, equal zero or 100. The quarterly approximation is nevertheless necessary to match the quarterly frequency of the rest of our data.

Step 6:

LI is generated as a geometric mean of the quarterly values of foreign currency deposits of domestic sectors, deposits of the non-residents and loans from the non-residents. Combining these three components into a single index was the most difficult aspect of the process. The calculated values for each type of foreign currency liabilities will change together, although not in a predictable manner; co-movements could reinforce, but also offset one another. Hence, the assumption was made that each of the types of series should have equal weight. Accordingly, for each period the values calculated in Step 5 are combined, giving rise to a simple time series.

There are numerous weighting techniques and the choice depends on the properties and behaviour of the components and the purpose of the index. Hanschel and Monnin (2005) used a variance-equal weight method for constructing their stress index. This method was chosen because of its widespread use in the literature and because they were unable to find another weighting scheme that would fit the context of their index. Illing and Liu (2003) preferred a credit aggregate weighting technique because it made the index easy to interpret and had the lowest Type I and Type II errors when tested on historical data. Given that the purpose of both indices was to signal episodes of financial distress, there was no alternative weighting technique that minimized the probabilities of both failing to report a high-stress event (Type I error) and falsely reporting a high-stress event (Type II error). The difficulty with such an approach, besides the subjectivity in dating of a crisis, is that it is greatly dependent on the combination of the variables that constitute the index. If a certain set of variables was favoured over another since it correctly signalled a number of stress periods without issuing a significant number of false alarms in the past, this is not a guarantee that the same variables would detect a future crisis.

The factor analysis technique was ruled out at the beginning, since the variables that are chosen to constitute the LI do not necessarily move in the same direction. Besides the geometric mean approach, the variables are also combined by using the following approaches: variance-equal weights: credit weights (the share of each of the three components in total foreign currency liabilities of the system); and simple averaging (the unweighted method). The liquidity indices created in these ways can be found in the following table.

Table 3. 3: The liquidity index based on different weighting approaches

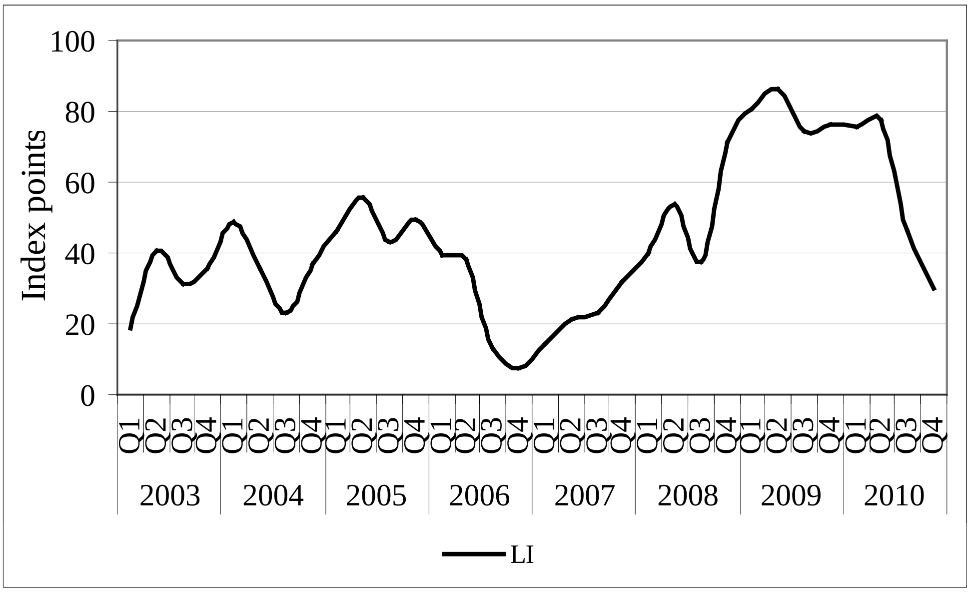
Source: Own calculations.

Year	Quarter	Geometric mean approach	Unweighted average approach	Credit weights approach	Variance-equal weights approach
2003	Q1	18.81	54.70	63.18	21.99
	Q2	40.36	57.91	64.54	82.27
	Q3	31.54	57.26	63.35	53.42
	Q4	35.90	56.67	61.14	11.00
2004	Q1	48.59	58.65	61.46	36.01
	Q2	35.86	55.24	58.83	-30.83
	Q3	23.31	50.58	55.72	-119.81
	Q4	36.64	52.04	57.35	-75.88
2005	Q1	46.13	53.46	58.70	-38.59
	Q2	55.76	55.30	59.94	-0.38

The unweighted method and the use of credit weights both reported rather low values of the index and provided insufficient variation as all values fall between 50 and 70. The geometric mean approach and variance-equal weights approach both resulted in indices of similar shape, only different levels. The reason why the geometric mean approach was chosen over the latter is that it has a simpler interpretation since the variance-equal weights approach yields negative values in half of the sample in the latter case. Since one cannot claim that the series that constitute the index are not interdependent, the logical step would be the use of the geometric over the arithmetic mean to combine the values for each period. The negative values would not pose a difficulty if one was interested only in the extremely high values of the sample, but the aim of the LI is to measure the level of fragility and not only to record the episodes of significant distress. The plot of the LI based on the geometric mean approach is illustrated in Figure 3.4.

Figure 3. 4: The liquidity index

Source: Own calculations



The LI seems to capture the changes in the general perception of the systemic risk of currency crisis rather well. With the exception of three sharp dips in the LI in mid-2004 and 2006 and Q3 2008, Figure 3.4 indicates a steady increase in the liquidity risk from the beginning of the sample through to mid-2009. Given the way the LI is constructed, and since the foreign currency liabilities of banking sector did not decrease in these two periods, such sharp declines in the perception systemic risk were caused by the significant increases in the level of forex reserves. Given that the level of forex reserves is adjusted for the effect of the SBA, this extraordinary increase in the forex reserves, as suggested by CBBH (2005) and CBBH (2007), is caused by an inflow of foreign investment, primarily to the banking sector. This assertion is, to a certain extent, supported by Table A3.1 (p.341). In 2006 a loss sufficient to collapse the CBA, measured in percentage points of stock of both deposits and loans from non-residents, increased substantially in July when compared to the previous month. In other words, it would take a ‘modern type’ of a bank run of a larger magnitude to cause the currency crisis. This is only possible if the stock of foreign currency liabilities of the banking sector towards non-residents has increased. As a consequence of stronger sources of funding, the loans to private sector ratio in 2007 increased significantly (Figure 1.2). From that perspective, one may argue that, at least in the initial periods, the pre-requisite for the stronger lending activity of banking sector made the BH financial system more robust to the risk of currency crisis.

The relationship between foreign investment in the banking sector and an increase in the forex reserves is less obvious in 2004. Table A3.1 (p.341) does not suggest any significant increase in the liabilities of the banking sector towards non-residents. In other words, the inflows of foreign investments to banking sector in 2004 were not strongly related to stronger lending activity. However, Table 1.4 indicates that a significant change in the structure of ownership of the banking sector assets occurred in 2004. This information suggests that the inflows of foreign investments were, most likely, related to privatization or mergers and acquisitions of banks. From that perspective, one might argue that capital-related inflows reduce the risk of currency crisis without, at least initially, resulting in stronger lending activities of banks.

Fragility increased noticeably from the fourth quarter of 2006 with a peak in the second quarter of 2009, when a withdrawal of 12% of the foreign currency liabilities of the banking sector was sufficient to result in a currency crisis. The main reasons for such a perception of increased systemic risk in the observed period are increased foreign liabilities of commercial banks (illustrated by significant increase in deposits of and loans from the non-residents) and the events following the bank-run in October 2008. The effect of international overborrowing of the banking sector, one of the main causes of the currency crises according to McKinnon and Pill (1999, 2001), can be best illustrated graphically. Figures 3.5a and 3.5b below illustrate the relationships between the stock of foreign liabilities of banking sector and the forex reserves (adjusted for the SBA effects) and the corresponding annual growth rates of these series. Figure 3.5a illustrates that the stock of BH forex reserves is mainly determined by the foreign liabilities of banks that promote domestic lending activities. This link is illustrated in Figures 3.1a and 3.1b.

Figure 3. 5a: Foreign liabilities of banks and the forex reserves, stock

Source: Own calculations

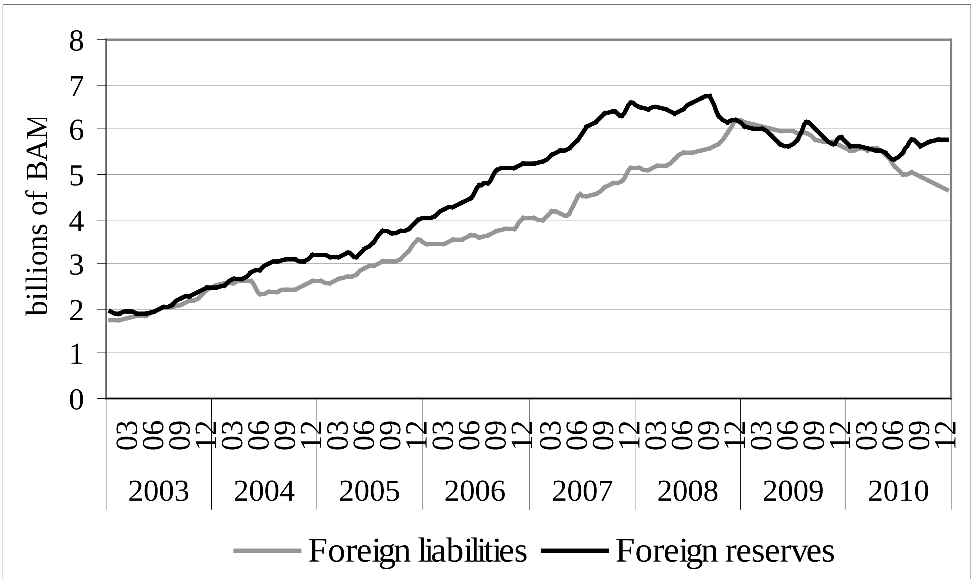
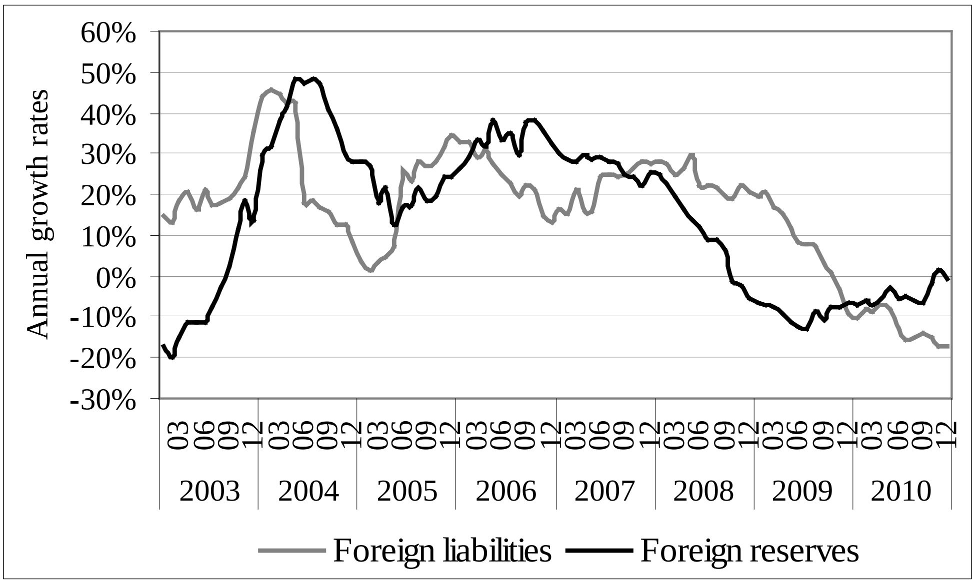


Figure 3.5b suggests that, at certain point (the end of 2007 in this specific case), the foreign liabilities begin to grow at faster pace when compared to the forex reserves. Returning to the financial instability hypothesis (Minsky, 1992), this is the stage where speculative finance gradually replaces hedge financing and the system becomes more unstable. The Figure below indicates that in the case of BH this started in 2007. Note that the slowdown in growth of forex reserves in 2007 would be even more pronounced had the privatization of one of the telecom operators not occurred (Figure 1.1).

Figure 3. 5b: Foreign liabilities of banks and the forex reserves, growth

Source: Own calculations.



The bank-run that occurred in October 2008 (Section 1.3), following a short dip in the LI in the third quarter of 2008, additionally altered the perception of the systemic risk upwards. This is represented by a steep increase in the level of LI between the third and the fourth quarter of 2008 in Figure 3.4. However, as explained in Section 1.3, the bank-run itself did not cause an increase in the risk of a currency crisis since the deposits were returned to banks within a fortnight so the event was not evident from the balance sheets. Changes in the macroeconomic environment, primarily downgrading of some foreign mother-banks caused by the liquidity dry-up in international financial markets and deteriorating fundamentals, resulted in changes in the lending policies of BH banks. Immediately following the macroeconomic shock at the end of 2008 (Figure 1.1.), banks' lending activities were brought to a halt since banks were trying to re-evaluate the risks in their balance sheets. In the following quarters domestic demand for loans banks started to weaken and the process of deleveraging started. As Table A3.1 (p.341) indicates, a significant reduction was recorded in the potential of foreign liabilities to cause the currency crisis which suggests that the stocks of both deposits of and loans from non-residents fell. The beginning of 2009 is identified by the LI as historically the most vulnerable point from the perspective of the risk of a currency crisis.

As the lending activity of banks decreased as a consequence of the re-assessment of credit risk in the periods immediately following the macroeconomic shock and weak domestic demand for the long-term loans that lasted through the end of 2012 (CBBH, 2011; 2012), adjustments on the liabilities side of the bank's balance sheets occurred as well. Weak demand for long-term loans, primarily to households, reduced the need for foreign liabilities of longer maturity and the existing loans and deposits of the non-residents were repaid as they matured. The decline in the growth of forex reserves stopped in mid-2009 (Figure 3.5b), mainly as a consequence of increased government borrowing through the activation of previously approved credit lines with the international financial organizations (CBBH, 2012). As the foreign liabilities of banks continued to decline, the share sufficient to collapse the CBA started to increase, thus lowering the LI through to the end of our sample.

3.5. The measure of the risk of banking crisis: the solvency index

In the previous section, in which a measure of the risk of currency crisis was constructed, the banking sector was an intermediary, a vehicle that related changes in the foreign currency denominated holdings of both residents and non-residents to the Central Bank accounts. In this section the banking sector has a pivotal role since the solvency index (SI) that will be constructed here, in essence, measures the shock absorption capacity of the banking sector capital. The aim of this section is to construct the measure of the systemic risk that would indicate how far the system is from the point where capital, most likely, would be fatally depleted. As in the case of the LI, only the measure of the systemic risk will be constructed. The relationship between the SI and a set of macroeconomic and banking sector specific variables will be investigated in Chapter 5. The section continues by listing the conditions under which the banking sector capital would be fatally depleted, followed by the proposed way to construct a continuous measure of such risk for BH. Finally, the SI is presented and the results are interpreted.

The banking sector capital acts as a buffer between the change in the value of bank's assets and its liabilities. Unlike the case of illiquidity, when bank cannot service its due short-term liabilities as they mature, in the case of insolvency bank has no remaining funds to service any of its obligations. In other words, bank has exhausted its capital and its liabilities surpass the value of its assets. Insolvency occurs when there is a significant change in the value of bank's assets. Given the nature of bank's regulatory capital, the absorption cushion, any deterioration in the quality of bank's assets will reduce the net/ regulatory capital of bank in two ways: via the reduction in general reserves for losses on loans classified as category A (an item in the supplementary capital, Table A1.5, p.333), or, ultimately, via the offsetting items from bank's core capital, losses from the current year and uncovered losses from previous periods (Table A1.5, p.333). In the case when bank's assets would deteriorate to the extent where net capital would be fatally depleted, the bank would declare insolvency.

Due to country specifics, this research opted for the use of net capital as a measure of the capital buffer. There are arguments in favour of using equity instead, moreover since Basel III framework requires banks to use more equity capital to finance their assets. In their study of the long-run costs and benefits of having banks finance more of their assets with loss-absorbing capital, i.e. equity, Miles et al. (2011) conclude that the amount of equity funding that is likely to be desirable far exceeds the amount banks have had in recent years. It is even higher than minimum targets agreed under the Basel III framework. Their finding suggests that a larger buffer that reduces the chance of banking crises is less costly than potentially higher cost of intermediation of saving through the banking system. In other words, it is suggested that the potential for substantial economic cost of crisis exceeds potentially lower level investment and slower economic activity.

As argued in Section 1.3, BH banks maintained the prescribed capital adequacy ratios in the pre-crisis years mainly through changes in supplementary capital while the core capital items, equity included, did not change fast. Moreover, the analysis based on the DuPont identity (Section 1.3) indicated that the increase in return on equity was mainly caused by the financial leverage. For period under observation in this research it was the case that banks maintained equity as low as possible in order to maximize the return to their shareholders. For that reason, as illustrated in Text box 3.2, the use of equity as a measure of capital buffer against a banking crisis in this research would exhibit a strong seasonal pattern of the constructed measure of systemic risk (mainly due to a seasonal pattern in current year profits), while the increase in equity in the post-shock periods due to the effect of additional capitalization would make the system appear more resilient than it actually was. For the abovementioned reasons, this research uses the regulatory capital in order to measure the resilience of banking sector to systemic crisis. With implementation of the Basel III framework, the appropriateness of use of equity instead should be evaluated.

An increasing risk of systemic banking crisis, i.e. the weakening of the absorption function of capital may arise for two reasons: a sharp reduction in the value of assets or a gradual increase in the cost of provisioning. In the case of BH, given dominance of claims in the structure of banking sector assets (Section 2.4), a sharp reduction in the value of assets, characteristic for a crisis period, would be a consequence of either sudden lending freeze or large-scale write-offs in loans due to a sharp deterioration in their quality. A gradual increase in the cost of provisioning, on the other hand, can be a sign of both stronger lending activity of banks since all loans, even the newly disbursed have to be provisioned for, and deterioration in the quality of loans since the cost of provisioning increase as the loan migrates to a lower quality category. One should note that the non-crisis period does not imply a non-increasing cost of provisioning, but the absence a non-linear increase. It should also be noted that an increasing cost of provisioning, whatever the underlying reason, indicates higher systemic risk of banking crisis if capital is not increasing as well. In the case of gradual increase in the cost of provisioning, a pick up in lending activity, unaccompanied by an increase in core capital, would imply a higher degree of financial leverage, which is one of the characteristics of the later, more crisis-prone stages of the Minsky cycle. The degree of financial leverage would also increase in the cases of deterioration in the quality of assets since higher costs of provisioning would reduce profit, or even cause losses thus reducing capital. Furthermore, an additional pressure on capital could arise from the liquidity mismatch between assets and liabilities that is a consequence of deteriorated quality of assets. A consequence of worsening in the quality of assets is their reduced marketability. As liabilities become due, any liquidity problems that bank may face would have to be financed from capital.

The effects of a lending freeze, regardless of whether it is a consequence of weak demand or, more commonly, a sudden shift in policies of banks (that are, according to Bebchuk and Goldstein, 2011, the consequence of the self-fulfilling beliefs that other banks are not going to lend) are difficult to measure due to limitations in data availability. Nevertheless, they would affect a bank's capital via the profit and loss accounts. Shrinkage in the value of assets would result in a reduced interest income, while the interest expenses (the interest paid to depositors or loans taken) would remain at the same level until the following re-pricing period. The consequence would be a lower net interest income, which would reduce a bank's profitability and affect a bank's capital. In order to exactly quantify these effects, one should have available a detailed breakdown of banks' assets and liabilities by the remaining maturity and the interest rates at which all items are priced. In general, such detailed data is unavailable even to the regulators since banks do not report individual costs. The reports on the maturity harmonization of the bank's assets and liabilities by banks are common regulatory requirement, but the cost at which each item is priced is never disclosed.

The above arguments are used to propose the measure of systemic risk for BH. The SI would depend on the level of banking sector net capital, or more specifically, its capacity to accommodate for either an expansionary lending policy or a deterioration in the quality of assets. As it will be elaborated in more detail, the SI measures the size of a shock sufficient to cause the insolvency of banking sector. In a sense, the SI employs the sensitivity analysis approach to calculate by how much the banking system's loan portfolio should deteriorate, assuming average provisioning rates for different classes of assets, in order to fatally deplete capital.

A bank's assets are categorized into one of the five categories, A through E. Different classified categories of assets are provisioned at different rates[41]. The applicable provisioning rates in BH are: 2% for category A (performing assets); 5%-15% for category B (special mention); 16%-40% for category C (substandard); 41%-60% for category D (doubtful); and 100% for category E (loss). This classification is made based on objective criteria (days of delay in repayment[42]) and subjective criteria (in regards to

[41] Only the categories of assets that constitute risk-weighted assets are provisioned for. Cash and cash equivalents, claims by the FBH, RS and BH governments and the central governments of the countries in the A zone are considered as riskless assets and are neither provisioned for, nor are part of the denominator in the capital adequacy ratio.

[42]Performing assets can have no more than 30 days of delay in the repayment of either the principal or the interest. Special mention assets cannot be delayed with repayment more than 90 days. Any asset that is

finances, economic and moral quality of the debtor). The average provisioning rates assumptions imply that the category A assets were provisioned at 2%, B at 10%, C at 28%, D at 50.5% and E at 100%. Based on the existing regulations, this categorisation is made primarily according to the number of days of delay. However, a bank can choose the rate of provisioning for the category and their decision is usually made based on the estimate of the value of the collateral; the better the collateral, the lower the provisioning rate for the category in question. If one applies the actual provisioning rates characteristic for each individual bank, it is possible that a bank that is more prone to risky behaviour (in a form of overestimating the value of the collateral so the cost of provisioning would be lower) is appearing to be more capitalized than actually is the case. For that reason, ideally one should use the weighted, rather than simple average provisioning rates. However, the individual bank's provisioning rates were not available for all observed periods. Until the fourth quarter of 2007 the CBBH did not have at its disposal either quarterly bank by bank data on loans by the classification categories or bank-by-bank provisioning by different categories. Therefore, the limitations in the availability of data were the determining factor for the average provisioning approach. The simple and weighted average provisioning rates did not differ significantly over the 2007-2010 sample, but periodical revisions are advised, especially if it occurs that the biggest banks report significant differences in provisioning.

Chan-Lau (2012) emphasizes the incentives of banks for under-reporting of provisions because of potentially different tax treatment of general and specific provisions and compensation schemes directly related to lending volumes and profits. General provisions are based on current conditions of debtor when the losses are known to occur. Hence, 2% provisioning rate for the new loans to clients with good credit history and these reserves are counted towards regulatory capital (Table A1.5, p.333). Specific provisions are set against expected losses and these affect capital exclusively via the profit and loss account. These specific provisions are found to be under-reported partially due to choice of lower provisioning rates for individual classification categories as argued above, and partially because of the overvalued collateral or some other form of guarantee. It is the unexpected losses incurred by banks when the macroeconomic fundamentals deteriorate that cause substantial capital losses and

delayed with repayment over 90 and less than 180 days is classified as substandard, over 180 and less than 270 days as doubtful and over 270 days as loss.

insolvencies. The proposed SI ultimately measures the size of the unexpected losses that would fatally deplete the banking sector capital.

The under-reporting of provisions is found to contribute to procyclicality (Brunenrmeier et al., 2009 and Burroni et al., 2009) since it raises net income and bank capital during good times thus enabling an acceleration in banks' lending activity (Chan-Lau, 2012). At the early stages of an expansion phase of the business cycle there is an increased demand for loans. As will be elaborated in more detail in Chapter 5, the clients' creditworthiness is usually higher closer to the loan approval date with higher probability of default associated with longer maturity. Consequently, a bank will only set aside general provisions for such loans. Given the treatment general of provisions (Table A1.5, p.333), they, as the empirical research suggest, promote stronger lending activity. General provisions effectively represent no cost for bank: the cost of the provisioning that reduces accrued income for current year will be offset by an increase in general reserves for performing assets therefore causing no change in bank's supplementary capital. As the economic activity picks up, banks increasingly use leverage in order to finance growing assets. The capital adequacy ratio requires that only a fraction of total weighted risk is covered by bank's net capital (Section 1.3). Therefore, as banks move from the hedge towards speculative financing stage of business cycle, that is characterised by a higher degree of leverage according to Minsky (1992), the unexpected loss sufficient to fatally deplete capital decreases. In other words, the system becomes more fragile.

As the individual clients' creditworthiness deteriorates for whatever reason the fragility of the system increases further since the cost of provisioning increases as specific provisions are set aside. These reduce the profitability of the bank without increasing reserves in the bank's supplementary capital thus reducing the shock absorption capacity of the bank. In such an environment the unexpected loss sufficient to fatally deplete capital decreases further thus increasing fragility. Finally, once the unexpected losses start to emerge the cost of provisioning rapidly increases threatening bank's solvency.

Ideally, one would have the exact migration pattern of the quality of each loan during the cycle of that loan. However, that information is generally not available as even the CRC in the period covered by this research would report only the current loan classification at the end of the reporting period, but not when the change occurred. In this research a parallel shift of part of the loans to the next lower category, all the way to category E, sufficient to deplete fatally capital was proposed as a measure of the unexpected loss. A parallel shift across all categories assumes that a fraction of loans originally classified as A would appear not only in category B, but also in categories C, D or E (equation 3.3a below). This assumption of a small fraction of high quality borrowers being reclassified to a category below the immediate lower one is plausible, especially in the periods of a sharp deterioration in macroeconomic conditions. However, from historical evidence, it is assumed that the vast majority of loans deteriorate to the next lower category. Note also that only a downwards shift in the quality of assets is assumed. This assumption was based on the historical evidence for the BH banking sector. The most plausible explanation for this would be the reluctance of banks to move the loan to a lower category (largely due to the reliance on the institution of guarantors) as, according to the existing regulations, a loan can be returned to a higher category (which would reduce the bank's cost of provisioning) after it has been serviced without any delay for at least six months.

As the absorption function of capital decreases due to rapid credit expansion in the early stages of business cycle, and an increase in the cost of provisioning as the clients' creditworthiness decrease, it would take a smaller fraction of the existing portfolio to unexpectedly deteriorate in quality and, at average provisioning rates, fatally deplete capital. Let us denote X a fraction of loans that is reclassified into a lower category. A through E stands for the stock of loans in the observed category. The amounts of loans being reclassified to the lower categories are:

A to B: $A * X$

New B to C: $(A * X + B) * X = A * X^2 + B * X$ (3.3a)

New C to D: $(\mathrm{A} * \mathrm{X}^2 + \mathrm{B} * \mathrm{X} + \mathrm{C}) * \mathrm{X} = \mathrm{A} * \mathrm{X}^3 + \mathrm{B} * \mathrm{X}^2 + \mathrm{C} * \mathrm{X}$

New D to E: $(A * X^3 + B * X^2 + C * X + D) * X = A * X^4 + B * X^3 + C * X^2 + D * X$

Note that loan migration in the set of equations (3.3a) above leaves category A reduced by some fraction X. As explained earlier, the vast majority of deteriorated loans will stay in category B, but some will move to C, D and E as well. The new stock of B will become the original stock of loans classified as B plus the amount that migrated from category A. A fraction of this new category B will migrate to categories C, D and E by the same fraction X. The same migration pattern that occurred in category B will occur in categories C and D. The migration of loans to lower category ends with category E that only increases. Note that these assumptions ensure that small fractions of what were originally A quality loans deteriorate to C, D and E as well. Similarly, a small fraction of what were originally B category loans will deteriorate to D and E as well, while a fraction of what were originally C category loans will appear in category E. This way the earlier mentioned assumption of significant deterioration (more than a category downgrade) in the quality of small fraction of loans is met.

Once all the reductions in the stock of loans in each category are put together and the average provisioning rates have been plugged in, after the rearrangement a polynomial of the fourth order for each quarter of the following form is reached:

$$0 = (0.1-0.02)*(A*X)+(0.28-0.02)*(A*X^2)+(0.28-0.1)*(B*X)+$$

$$+(0.505-0.02)*(\mathrm{A}*\mathrm{X}^3)+(0.505-0.1)*(\mathrm{B}*\mathrm{X}^2)+ \tag{3.3b}$$

$$+(0.505-0.28)*(\mathrm{C}*\mathrm{X})+(1-0.02)*(\mathrm{A}*\mathrm{X}^4)+(1-0.1)*(\mathrm{B}*\mathrm{X}^3)+$$

$$+(1-0.28)*(\mathrm{C}*\mathrm{X}^2)+(1-0.505)*(\mathrm{D}*\mathrm{X})-\mathrm{Capital}$$

After grouping the coefficients next to X, X^2, X^3 and X^4 a polynomial of degree four is reached

$$\mathrm{m}*\mathrm{X}^4+\mathrm{n}*\mathrm{X}^3+\mathrm{k}*\mathrm{X}^2+\mathrm{p}*\mathrm{X}-\mathrm{Capital}=0 \tag{3.3c}$$

m, n, k and p are constants where m is nonzero by definition.

The solutions for the fourth order polynomials were found by using the Quartic Equation Solver[43]. The solutions that are positive real numbers represent the fraction of the performing loans that need to be reclassified into the lower categories in each period in order to cause the insolvency of the banking sector. Table 3.4 below reports the values of the SI in the far right column of the table. The values were constructed based on the estimated values of X (the solutions for the fourth order polynomials for each period under observations) that were ranked with respect to the lowest and highest

[43]The solver is available free of charge at http://www.1728.com/quartic.htm. It was tested for accuracy by comparing the results obtained by solving a quartic equation by hand and by Solver.

values of *X* in the sample. This constructed measure of the risk of banking crisis is plotted in Figure 3.6 in Text box 3.2 that follows the table. The text box illustrates the necessity of taking into account the effects of the existing accounting standards and regulatory framework on the perception of systemic risk that were highlighted at the beginning of this section.

Table 3. 4: The solvency index

Source: CBBH, own calculations.
Notes: E category includes off-balance.
Net capital is adjusted for the effect of the accounting standards.

Year	Quarter	Classified assets by categories, millions of BAM					Capital, millions of BAM	Share of loans reclassified, X	Solvency index
		A	B	C	D	E			
2003	Q1	2,613	427	175	176	455	900	0.32	0.00
	Q2	2,786	446	173	176	457	944	0.32	0.03
	Q3	3,915	615	200	178	471	995	0.28	0.10
	Q4	4,022	627	187	178	494	1,038	0.28	0.06
2004	Q1	4,819	729	191	171	504	1,111	0.27	0.19
	Q2	5,124	748	183	172	493	1,154	0.27	0.26
	Q3	5,589	852	206	190	509	1,169	0.26	0.71
	Q4	5,860	860	165	188	484	1,209	0.26	0.68
2005	Q1	6,138	906	165	183	506	1,310	0.26	0.55
	Q2	6,508	958	169	181	521	1,384	0.26	0.58
	Q3	6,877	995	182	187	527	1,408	0.26	0.65
	Q4	7,247	1,073	209	179	538	1,443	0.25	0.77
2006	Q1	7,645	1,172	192	180	538	1,558	0.26	0.74
	Q2	8,163	1,245	219	176	543	1,606	0.25	0.84
	Q3	8,539	1,297	228	186	562	1,648	0.25	0.97
	Q4	9,271	1,353	197	169	575	1,777	0.25	0.90
2007	Q1	9,878	1,457	203	171	569	1,925	0.25	0.81
	Q2	10,704	1,580	191	162	573	2,029	0.25	0.94
	Q3	11,626	1,611	214	148	590	2,189	0.25	0.87
	Q4	12,238	1,811	202	159	593	2,253	0.25	1.00
2008	Q1	12,368	1,548	205	176	587	2,421	0.26	0.61
	Q2	11,527	1,569	215	184	590	2,532	0.27	0.13
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

In order to obtain the fractions of performing loans sufficient to fatally deplete regulatory capital should they unexpectedly sharply deteriorate in quality (the second to last column in Table 3.4), the values of classified assets (the third through the sixth column) and regulatory capital (the eighth column) are plugged into Equation (3.3b). In the case of the first period, Q1 2003, after re-arrangements, the following quartic equation is obtained.

$$
\begin{aligned}
0 = {} & (0.1-0.02)*2{,}613*X+(0.28-0.02)*2{,}613*X^{2}+(0.28-0.1)*427*X+ \\
& +(0.505-0.02)*2{,}613*X^{3}+(0.505-0.1)*427*X^{2}+ \\
& +(0.505-0.28)*175*X+(1-0.02)*2613*X^{4}+(1-0.1)*427*X^{3}+ \\
& +(1-0.28)*175*X^{2}+(1-0.505)*176*X-900
\end{aligned}
\tag{3.4a}
$$

Or, after re-arranging:

$$2{,}561.2*\mathrm{X}^{4}+1{,}651.9*\mathrm{X}^{3}+978.4*\mathrm{X}^{2}+412.5*\mathrm{X}-900.2=0 \tag{3.4b}$$

The Quartic Equation Solver offers the following solutions: 0.32124 + 0.62i; 0.32124 - 0.62i; -0.64372 + 0.56i; -0.64372 - 0.56i. All four solutions are complex numbers that include both real numbers (0.32124 and – 064372) and imaginary numbers (0.62i and 0.56i). A positive real number was chosen as a solution for our X in Equation (3.3c) since it is more intuitive for interpretation.[44]. The use of ranking ensures that all observations are ranked within the sample with respect to historically the least and most fragile points. Based on the results, the BH banking system was the least prone to a crisis at the beginning of the period studied as it would take a deterioration of 32% of the existing loan portfolio to fatally deplete the capital. Conversely, the system was the most fragile at the peak of the lending expansion, Q4 2007, as it would take

[44] When one squares each of the offered four solutions, the following values are obtained respectively: -0.2812, 0.4875, 0.7279 and 0.1007. The square roots for all, but the first (negative) values are: 0.6982, 0.8532 and 0.3174. Therefore, as a consistency check, the SI was constructed based on the negative real number from the offered four solutions to the polynomial of the fourth order. There were no differences in the SI, but an interpretation of a negative value of X is not intuitive.

deterioration of around a quarter of the existing loan portfolio to fatally deplete the level of a banking sector's capital at that time.

Text box 3.2: The effect of the accounting standards on the perception of the systemic risk

The aim of this text box is to illustrate how the existing accounting standards and regulatory framework may distort the perception of risk of banking crisis and explain how the official data may be adjusted in order to capture these effects.

The level of bank's regulatory capital is to a large extent determined by its profitability; retained (undistributed) profit from the previous years is a part of bank's core capital, while the current year's profit, confirmed by an external auditor, is a part of bank's supplementary capital (Table A1.5, p.312). According to the existing regulations in BH, that in this specific case mirror current international accounting and regulatory standards and best practices, the current year profit cannot be counted towards banks' capital unless it is confirmed by the independent external audit. In the case of BH it is mandatory for banks to have an external audit at least once a year, at the end of the fiscal year. The current year loss, on the other hand, is counted against bank's capital in the period when it is recognized in the profit and loss accounts. This means that in the periods of favourable macroeconomic conditions and lending expansion, i.e. when profitability is high, there will be significant seasonality in the level of bank's capital. In order to count their profit towards capital, banks usually complete the external revision process within the first quarter and that is why one normally sees significant increases in the level of regulatory capital in the first quarter of the year. Given that the SI measures the distance from the point where the banking sector capital would be fatally depleted, such pattern in the regulatory capital would signal a decrease in the perception of risk in each first quarter during the period of favourable macroeconomic conditions.

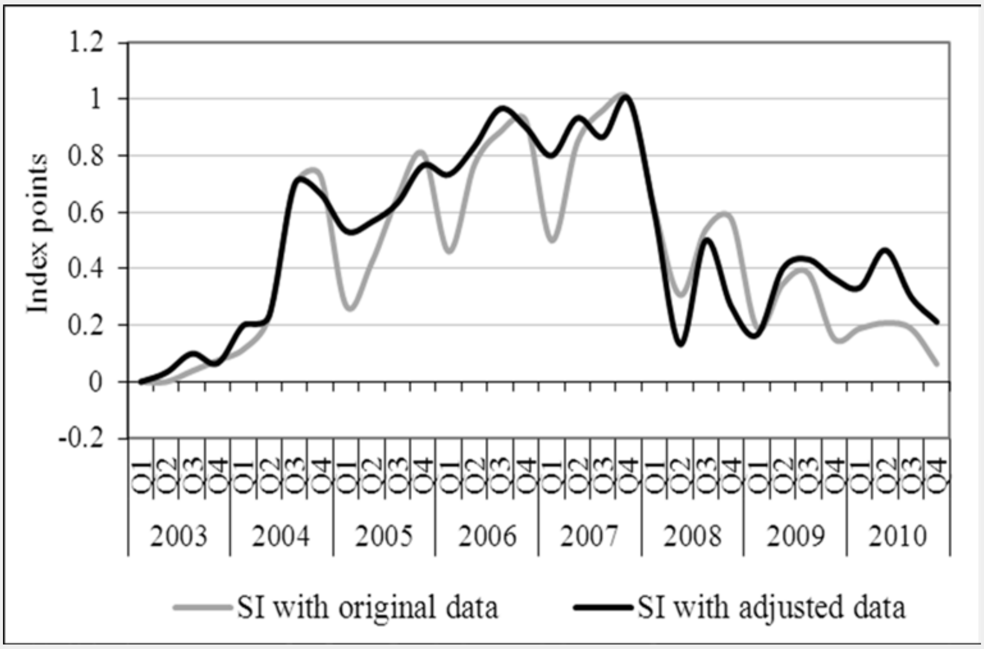
In this research, gross income is used to distribute the end of year value of profit over the quarters of the corresponding year. One first calculates a share of each quarter in

CONTINUED FROM THE PREVIOUS PAGE

total gross income in the corresponding year and then applies the same shares to annual profit. This way of annual profit distribution is most suitable for the years when all banks are profitable, which are the years 2004 through 2007 of the sample. Once the annual profit is distributed over the quarters, the amounts are subtracted from the official regulatory capital data.

Figure 3.6 below illustrates the difference in the perception of risk when no adjustments were made to official data and after the adjustments.

Figure 3. 6: The difference in the SI based on the original and adjusted data



Source: CBBH, own calculations.

The SI is constructed to capture two sources of banking sector vulnerabilities: the expansionary lending policy in the periods of economic upturn (the stock of loans was growing rapidly relative to capital, as reported in Table 3.4, which resulted in a reduction in the fraction of loans deteriorating that was necessary to deplete banking sector capital); and a sharp deterioration in the quality of assets, loans primarily in the case of BH, in the periods of economic downturn. Note that it is assumed that loans cannot deteriorate in quality due to the non-hedged exchange rate exposure of the banks' clients. Although some 70% of loans are classified as foreign currency and indexed, the vast majority of them (about 90%) are indexed to the EUR, the anchor currency in BH, as a consequence of the regulation regarding the net open position of banks (Section 1.5). Therefore, in the current environment, as long as the CBA arrangement holds, this potential channel of crisis propagation does not need to be modelled within the thesis. Figure 3.6 clearly indicates the difference in the general perception of the systemic risk of banking crisis before and after the macroeconomic shock in mid-2008. In the earlier periods, there is a pronounced trend of raising systemic risk of banking crisis, while the risk of banking crisis towards the end of the sample seems to be relatively low and fluctuating around a rather flat trend. Table 3.5 reports the mean and standard deviation of X reported in Table 3.4 for the sample as a whole, as well as the pre- and post-2007 sub-samples. The reported values indicate the following: overall, the unexpected loss sufficient to collapse the banking system is fairly constant across the sample; it is likely that the under-reporting of provisions enabled the acceleration in banks' lending; the macroeconomic shock unveiled these under-reporting practices. Consequently, following the macroeconomic shock, the source of systemic risk shifted from the balance sheet-expansion and raising financial leverage towards the accuracy of the estimated probability of default of individual clients.

Table 3. 5: The characteristics of the estimated values of potentially fatal unexpected losses

Source: Own calculations.

	Whole sample	Sub-sample	
		Q1 2003 - Q4 2007	Q1 2008 - Q4 2010
Mean	0.266	0.265	0.267
Standard deviation	0.017	0.022	0.004

Table 3.5 reports that, on average, it would take an unexpected loss of the approximate size of 27% of performing assets to cause the insolvency of the banking sector. It is possible that this percentage is a bit over-stated since the set of Equations (3.3a-3.3c)

does not take into account that regulatory capital will be reduced by the reduction in performing assets (via reserves for performing assets). At the same time, regardless of the shape of the SI, the estimated values of X do not differ significantly across the sample. In other words, the estimated fraction of the performing assets that could fatally deplete capital is not conditional on the size of the banking sector assets. Note, however, that the SI is much steeper in the pre-macroeconomic shock periods indicating that the risk of systemic banking crisis is increasing faster in the periods of credit expansion. These periods are characterised by a gradual increase of financial leverage in banks (Section 1.3), which is, according to Minsky (1992), an indication of departure from the hedge financing towards more risky speculative financing stage of the business cycle.

The SI reaches the highest value at the end of 2007, at the peak of lending activity of the banking sector. However, the sharp decline in the perception of risk in the first half of 2008 has nothing to do with the macroeconomic shock. As will be elaborated in more detail in Chapter 5, the fragility of the banking system decreased, at least temporarily, as a consequence of a significant inflow of the loans from non-residents (Section 1.3). These liabilities, used to finance lending activities in BH, if originating from the mother-banks, are part of the subordinated debt and, as such, counted towards regulatory capital (Table A1.5, p.333). Therefore, as a consequence of the existing accounting and regulatory practices, it is possible that the systemic risk is temporarily perceived as diminishing with a significant increase of financial leverage.

In the post macroeconomic shock periods, the risk of systemic banking crisis seems to be much lower when compared to the periods of credit expansion from the beginning of the sample. More importantly, it does not seem to increase. This conclusion may be wrong since the unexpected losses may have been covered by additional capitalizations. As concluded in Section 1.3, the changes in the structure of regulatory capital in BH in 2009 and 2010 indicate that losses were met by capital injections. In the cases when specific provisions or unexpected losses reduce the banking sector capital via the profit and loss account, it is possible that the reduction is offset by an increase in other items. This is especially true if the capital adequacy ratio falls below the prescribed minimum as a consequence of these losses in which case the regulator will order additional capitalization. Given almost unchanged levels of regulatory capital towards the end of the sample (Section 1.3) and almost flat SI, it is likely that this was the case in BH. This post-shock adjustment process in banks' balance sheets will be addressed in more detail in Chapter 5. It will be illustrated that, should the additional capitalizations not have occurred, the raise in the SI would be almost as steep in the post-macroeconomic shock periods when compared to the periods of credit expansion.

Finally, it is worth accenting that a significant increase in the concentration on the market for loans tends to shift the measure of risk upwards. This is evident from a significant increase in the SI between Q2 and Q3 2004. In that period the merger between the second and the third largest banks in the system occurred. Before the merger was officially approved, both banks were conducting an aggressive lending policy aiming to increase their market shares, which resulted in the raise of the SI.

3.6. Conclusion

Two measures of the systemic risk were developed in this chapter: the liquidity index (LI) that indicates the risk of the currency crisis and the solvency index (SI) that indicates the risk of the banking crisis. Both these indices will be used in the following chapters to investigate which macroeconomic and banking sector specific developments were increasing the fragility of the BH financial system and what is the relationship between these two measures of the systemic risk.

At the core of the LI is the estimation of the point at which the CBA would, most likely be abandoned. In the case of BH, it is argued that international borrowing of domestic banks poses the largest threat to stability of domestic currency. Furthermore, these foreign liabilities of commercial banks, especially when in the form of subordinated debt, were found to make the system more prone to banking crisis because of their role in emphasizing the problem of pro-cyclical nature of under-provisioning.

The macroeconomic-shock was found to be a sort of deflator of the overall systemic risk. The process of cooling off in the real economy reduced the need for foreign liabilities, which, in turn, reduced the risk of the currency crisis. Granted, the absence of the modern-type of bank run was a favourable development since the foreign reserves were decreasing gradually. Similarly, the macroeconomic shock put a stop to rapid credit expansion of banks and triggered the re-assessment of the creditworthiness of individual clients. Another favourable development in the case of BH was that banks who suffered significant unexpected deterioration in the quality of their loan portfolios chose to additionally capitalize when needed, rather than declaring insolvency. These information, however, indicate that the relationships between the real economy and financial sector change following the shock and that the events in the post-shock periods are largely determined by the reactions of banks.

Finally, it was demonstrated that one needs to account for the country specifics and the effects of the accounting and supervisory practices when constructing custom made measures of systemic risks. In the case of BH it was demonstrated that accounting for the effect of the SBA with the IMF significantly alters the perception of the risk of the currency crisis upwards. Similarly, accounting for the influence of the retained earnings on capital reduced the volatility of the perception of risk of banking crisis.

The following chapter will investigate which macroeconomic and banking sector specific variables cause changes in the perception of risk of the currency crisis in the case of BH.

Chapter 4: Causes of changes in the perception of risk of a currency crisis in Bosnia and Herzegovina

4.1. Introduction

As discussed in Section 3.3, a single measure of the systemic risk of a financial crisis is not likely to be feasible in any financial system, regardless of its complexity. It was concluded that, given the specifics of the BH financial system, one should model the measures of the currency and banking crises risks in BH separately, but allow for mutual interaction between these two measures. The aim of this chapter is to determine how a set of macroeconomic and banking sector specific variables, by influencing the liabilities of the banking sector, affect the perception of systemic risk of a currency crisis constructed in Section 3.4.

The following section grounds changes in the risk of a currency crisis in the case of BH, the liquidity index (LI), in the existing theoretical framework and empirical research. Section 4.2 begins with an overview of the theoretical framework, represented through three generations of currency crisis models. As will be discussed in more detail, the third generation of the currency crisis models are of special interest since it relates the risk of a currency crisis with the banking sector developments, most importantly moral-hazard-driven lending and international over-borrowing (McKinnon and Pill, 1999; 2001), maturity transformation (Chang and Velasco, 2000) and maturity and currency mismatch (Eichengreen and Hausmann, 1999). The section proceeds by examining some of the more recent research at whose core is the networks analysis between the banking sector's assets and liabilities. Given that banks' assets and liabilities may exhibit core-periphery structures and tiering (Section 4.2.1), which in the case of BH means that a significant number of banks have the same foreign lender or a group of lenders from the same country, the third generation models are linked to the sudden stop type of crisis, as referred to by Reinhart and Rogoff (2009).

Models with sudden stops associate currency crises with disruptions in the supply of external financing. Given the country specifics, more specifically the reliance of BH banks on foreign sources of financing (Section 1.3), and the relationships between the banking sector and central bank balance sheets (Section 3.4), findings of the empirical research on the causes of the perception of increased risk of currency crisis are used to identify the variables that would explain the changes in the liquidity index.

The list of potential explanatory variables identified in Section 4.2 will be narrowed down to a list of variables of interest and applicable in the case of BH in Section 4.3. These variables of interest in the case of BH are treated in a separate section for two reasons. Given the relative shortness and availability of time series in BH one may have to use proxies for the variables commonly used in empirical research. More importantly, some of the variables used in similar empirical research may not be applicable in the case of BH given the country specifics. Dedicating a whole section to the choice of explanatory variables was chosen since a series of cross-referencing to the chosen variables will occur in Chapters 4 and 5. Given the theoretical linkages between the currency and banking crisis models, it is likely that the same variables will be included when measuring risks of currency and banking crises.

Section 4.4 presents the model that relates the perception of systemic risk of currency crisis to the chosen explanatory variables. The VECM is chosen as the suitable model for capturing expected changes in the perception of systemic risk over time. This section also interprets the established long-run relationships between the risk of a currency crisis, macroeconomic activity and activities of the banking sector. Furthermore, it will be demonstrated that a certain level of risk of a currency crisis is embedded even in the financial systems of relatively simple structure, as suggested by Minsky (1975, 1982) and that the risk has a tendency to increase over time eventually ending in a crisis. These runs, as Gorton (2012) suggests, are rational events, tending to occur when there is information on potential problems and thus represent a rational reaction to available information. The findings of the model are in line with those of Haldane (2009) that disaster myopia, or what Claessens and Kose (2013) term "this time is different syndrome", are the main reasons why financial crises re-occur. Section 4.5 concludes.

4.2. The determinants of changes in the liquidity index

The LI constructed in Section 3.4 was introduced as a way to measure how far the BH financial system is from the onset of a currency crisis that would result in the abandonment of the CBA. Comparing the size of either the traditional or modern type bank run, as described by Blanchard (2009), sufficient to push the system over the brink provides an idea of the fragility of the system with respect to past periods. An increase in fragility occurs when a smaller fraction of foreign currency denominated liabilities is sufficient to deplete the foreign currency reserves to the point that would result in the abandonment of the CBA. The aim of this section is to determine the drivers behind changes in the LI.

4.2.1. The theoretical framework

Regardless of the type of the financial crisis or its causes, one of the consequences is a downward pressure on the value of the domestic currency (Liu, 2009). Eichengreen (2003) used the 1931, 1949 and 1967 sterling crises to illustrate how the literature on currency crises evolved after Krugman (1979) published his theory of balance of payment crises, classifying the resulting models into three generations. Currency crisis models are still categorised this way.

The first generation of these models is represented by the speculative attack models developed by Krugman (1979) and Flood and Garber (1984). Here runs on foreign reserves are viewed as provoked by a fiscal policy that is inconsistent with the fixed currency peg. The main assumption is that the government runs a persistent primary deficit. Since it is not feasible to indefinitely finance the deficit, either by depleting assets such as foreign reserves, or by borrowing, in the absence of fiscal reforms the government can only print money which is inconsistent with keeping the exchange rate fixed (Burnside et al., 2007). The main contribution of the speculative attack models is in explaining how a run is not the result of the irrationality of the market participants, but rather the very rationality of their expectations. By efficiently using all of the available information, the speculators correctly foresee that the government is running an excessive deficit and anticipate the abandonment of the fixed exchange rate that results in an increase in demand for foreign currency. On the other hand, the abandonment of the fixed exchange rate is deterministic; the government's objectives are not spelled out explicitly though "they follow rigid policy rules mechanically issuing domestic-currency-denominated debt to finance constant budget deficits while mindlessly intervening to support the currency" (Eichengreen, 2003, p.2). In explaining the 1931 sterling crisis in the light of such government behaviour, Eichengreen (2003) demonstrates that the political context was a key element in the crisis. Fearing the political consequences, the government was unwilling to raise taxes or cut their expenditure since by the time the currency pressure was felt, unemployment had already reached 20 per cent of the labour force.

While the first generation models explained how the currency panics in Latin American countries in the 1970s and 1980s were a consequence of monetary and fiscal policies that were inconsistent with the exchange rate objectives, they were unable to explain fully the EMS crisis of 1992-1993 (Jeanne, 2000). The second generation of the currency crisis models, or the escape-clause models as Jeanne (2000) calls them, allows for the government to abandon a fixed exchange rate before all reserves are lost, self-fulfilling speculation and the existence of multiple equilibria. Obstfeld (1994, 1996) adds more rationality to the model in the form of the government's choice to abandon the fixed exchange rate. Changes in the exchange rate regime are viewed in the light of the government's response to expectations of the public. In choosing its response, the government is minimizing a quadratic loss function. The latter depends on the costs of expected future depreciation and loss of the potential gains from an expansionary monetary policy in the case that the government chooses to maintain the fixed exchange rate and the costs of expected future depreciation and the loss of credibility in the case of floating. The properties of the quadratic function allow the classification of possible shocks into three regions. Firstly, a stable region in which the size of the shock is below the lower bound (the lower value solution of the quadratic equation). Secondly, an unstable region in which the size of the shock is above the upper bound (the higher value solution of the quadratic function). Thirdly, a "ripe for the attack" region when the shock is in the range between the two solutions (Disyatat, 2001; Liu, 2009). Given the cost of abandoning the peg, i.e. the expected future depreciation (and, consequently, higher inflation and higher interest rates) and the loss of credibility, the government will keep the peg in the case of the stable region and abandon it in the unstable region. In the case when the attack falls in the range between the two solutions, the size of the attack determines whether the government will defend the fixed exchange rate.

The zone in which devaluation is possible but not certain is characterised by a multiplicity of equilibria, since expectations of devaluation exert an additional pressure on the government, in the form of an increase in unemployment, to abandon the fixed exchange rate. Jeanne (2000) explains this by the loss function of the government being convex in the unemployment rate, which increases the temptation to devalue with a rise in the unemployment (caused by devaluation expectations that raise the wage level). Additionally, Jeanne (2000) points out that in the case of the intermediate range the crisis is not necessarily caused by changes in the fundamentals (it can occur while they remain the same), but it is generated by the "animal spirits" of the market, often referred to as "sunspots". If the fundamentals are in the "ripe for the attack" region, the probability of the government devaluing increases with the size of the attack, that is, the number of the speculators that bet against the fixed exchange rate and the size of their bets. Widespread expectations of devaluation would result, eventually, in devaluation.

Eichengreen (2003) argues that although the 1931 sterling devaluation is explicable by the second-generation model of balance-of-payment crises, the 1949 sterling devaluation demonstrates the relevance of the third generation of models that were developed in response to the Asian crisis. Until the beginning of 1997, conventional fiscal measures signalled no signs of distress in the afflicted Asian economies, nor was there any evidence of a clear trade-off between unemployment and exchange rate stability as during the 1992 sterling crisis (Krugman, 1999). The third-generation models emphasize the importance of the balance sheet effects of the various sectors of the economy associated with devaluations. The earlier generations of models evolved vertically, building up on top of each other and focusing on the characteristics of the macro environment in which the speculative attacks occur. The third-generation models developed horizontally, i.e. the focus of the research is on a part of the financial system, usually at the micro level, the interactions between the segments of the economy and their joint impact on the macro level. The common thing in all types of financial systems in the world is the existence of a banking sector. The availability of data and the fact that every transaction and every shock, regardless of the origin, must be recorded somewhere in the system made the analysis of the banking sector a natural starting point.

One strand of these models, represented by McKinnon and Pill (1999, 2001), puts the weight on moral-hazard-driven lending and international over-borrowing. Their argument is that the banks tend to increase their foreign liabilities if either of the following occurs: government issuing explicit guarantees; or domestic interest rates including a "super risk premium"[45]. In the case of BH, government guarantees, such as

45 The super risk premium represents the margin of temptation for banks to over-borrow in foreign exchange beyond what they might do if forced to hedge (McKinnon and Pill, 1999). The super risk premium consists of the currency risk premium and the possibility that the regime could change through a discrete devaluation as a consequence of upward pressure on the interest rate on assets (so called "the peso problem"). As the latter mirrors the credibility of the policymakers, countries with the less trustworthy governments will have higher risk premiums. If banks are not required to fully hedge, higher super risk premiums will encourage banks to increase exposure to these countries, while their liabilities in

deposit insurance, played no significant role in fostering increasing foreign indebtedness, both because the insured limit was very low until 2009 and not all the banks belong to the deposit insurance scheme. On the other hand, the absence of capital controls and a large difference between domestic and foreign interest rates increased the magnitude of international over-borrowing. As illustrated in Section 1.3, although the gap between domestic and foreign interest rates could not be considered as a “super risk premium”, it was an incentive for the international over-borrowing of banks.

As argued by Burnside et al. (2003), it is not only the presence of government guarantees to the banks’ foreign creditors that encourages borrowing from abroad, but also private guarantees, such as the institution of the guarantor in lending to households, and the ability of the banks to pass the exchange rate risk to the debtor. By extending the loans insured by the guarantors or the co-debtors, the banks were hedging against the clients’ default thus largely covering their external exposures. Similarly, the currency harmonization between their foreign liabilities and domestically-placed loans was maintained by issuing foreign currency denominated or indexed loans. This way the market risk was transformed into credit risk, which was insured by the guarantors.

Finally, on maturity transformation (Chang and Velasco, 2000) and maturity and currency mismatch (Eichengreen and Hausmann, 1999) one should note that although the foreign exchange risk was mostly passed to the banks’ clients and the maturity harmonization between assets and liabilities was significantly improved by international borrowing, a problem of over-reliance on international “soft” funding emerged. Deposits of mother-banks and other non-residents, the core-periphery structures, and tiering have increased the problem of over-reliance on a single (foreign) source. This issue of contagion in financial systems is also addressed in Gai and Kapadia (2010). These authors conclude that that while contagion rarely occurs, the effects can be widespread when problems do emerge and these effects are not limited exclusively to a country’s financial system or to a single country.

The linkages between financial institutions within a financial system may occur either through similarities in the portfolio of banks’ assets or the inter-linkages between claims

foreign currency will not be fully met by assets in foreign currency. However, McKinnon and Pill (1996 and 1997) argue that even in the cases when banks are required to fully hedge, international over-borrowing could still occur because banks with moral hazard assume too much domestic credit risk. In a sense, banks with moral hazard problems assume constant risk neutral position in their investments based on currently fully hedged forex position especially if the implicit government guarantees are present.

and obligations between banks. The former case will be investigated in more detail in the following chapter since default correlation and credit contagion among firms (Cossin and Schellhorn, 2007; Egloff et al., 2007) or significant exposure to a limited number of industries (manufacturing, trade, tourism etc.) or type (housing, general purpose, etc.), is more applicable to investigating the risk of a banking crisis. This does not imply that similarities in banks' assets are irrelevant from the perspective of the risk of currency crisis, only that the linkage is an indirect one. In the economic upswing, especially in the cases when a significant fraction of GDP is generated by a specific sector or industry, an increased demand for loans would result in an increase in the cross-border borrowing of banks thus increasing the external vulnerabilities of the system. In the periods of deteriorated macroeconomic conditions, significant default correlation between banks would shrink the value of the banking sector's assets, thus exerting pressure on the ability of banks to repay their liabilities. If banks' capital is perceived, or proved, to be insufficient to absorb this shock, a run may occur potentially threatening the level of foreign reserves.

The inter-linkages between claims and obligations can be illustrated by using the network structure approach employed by Allen and Gale (2000). They distinguish between the three most commonly found market structures: a complete market structure in which all banks are inter-connected; an incomplete market structures in which all banks are indirectly inter-connected; and a disconnected incomplete market structure in which only some banks are inter-connected. Guided by the rationale that a large number of connections between banks indicates a lower probability of a domino effect if any bank's liquidity or solvency is jeopardized, the authors conclude that when the network is "incomplete", i.e. when the banks have exposures to only a few counterparties, the system is more fragile. Note that this conclusion holds in the case of domestic financing, i.e. in the case of linkages between assets and liabilities between banks in a single banking system.

Figure 4. 1: Three types of inter-linkages between banks

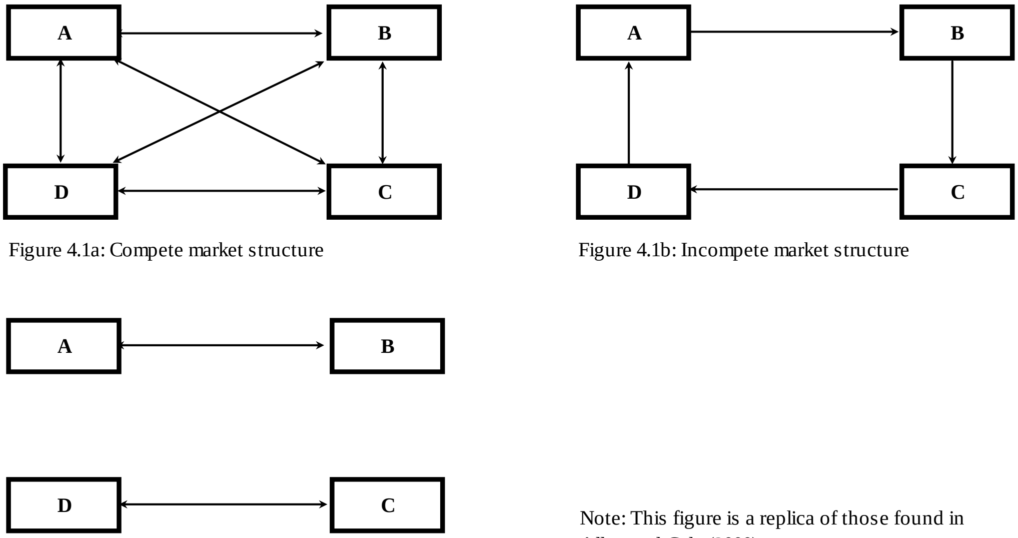


Figure 4.1a: Compete market structure

Figure 4.1b: Incompete market structure

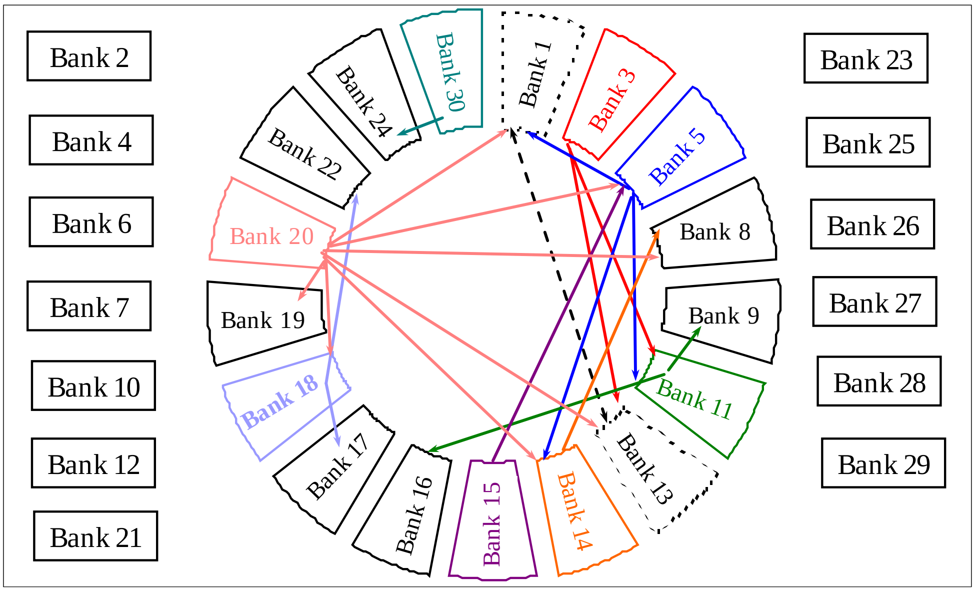
Figure 4.1c: Disconnected incompete market structure

Note: This figure is a replica of those found in Allen and Gale (2000)

The situation in BH resembles a disconnected incomplete market structure (Figure 4.1c above). In that sense, the BH banking system could be viewed as more prone to fragility since only 10 out of 30 banks at the end of 2010 had some type of exposures to other BH banks (Figure 4.2). However, domestic inter-bank deposits and loans in the BH banking sector are so low (0.36 percent of total deposits and 0.10 percent of total loans at the end of 2010) that they pose no significant threat of contagion since each bank is, largely, isolated from the rest of the system which significantly reduces systemic risk.

Figure 4. 2: Domestic inter-bank exposures

Figure 4.2 is generated by the author based on the CBBH data. Banks are labelled as Bank 1 through Bank 30 in order to maintain the confidentiality of data.
Key:
Banks outside the circle have no interbank exposures.
Within the circle, the directions of the arrows illustrate the flow of funds. The colours of the arrows correspond to the colours of depositing/ lending banks.
The arrows represent directions of the flows of funds.



The propagation of idiosyncratic shocks depends largely on the structure of the financial system. In systems where the banks play a dominant role it is suggested that contagion risk can be higher. While Furfine (2003) reports a relatively small chance of contagion in the U.S. banking system, Upper and Worms (2004) argue that this might not be the case in Germany. Recent history, while supporting the latter study, does not support the first part of this contention, but one also has to keep in mind that the U.S. commercial banks did not dominate the U.S. financial system in terms of the size of their assets in the pre-GFC period. The case of investment banks being acquired by commercial banks just added to the complexity of the issue, since the post-acquisition structure of the commercial banks' assets became very difficult to value. Of course, contagion dependent on interbank claims and obligations can be seriously reinforced by indirect contagion on the asset side of the balance sheets (Cifuentes et al., 2005; Shin, 2008), which was the case in the latest crisis. Given the absence of investment banks and complex financial instruments, as well as the negligible size of domestic interbank market, one may conclude that the linkages between claims and obligations between BH banks are weak.

However, another strand of the literature (Boss et al. 2004a; 2004b) emphasises that the networks between the banks' assets and liabilities may exhibit core-periphery structures and tiering. Figures 4.1 and 4.2 illustrated a case where the banks are connected via a common domestic institutional debtor. Bank 1 in Figure 4.2, for example, has liabilities towards Banks 5, 13 and 20. Should Bank 1 experience liquidity problems, it is possible that these three lending/depositing banks would encounter liquidity problems as well. In the case of tiering, banks depend on a single or a small number of lenders. The core-periphery structure in this context could be interpreted as a significant number of banks in a single country or a number of countries having the same foreign lender. The banks in BH, although free of any significant domestic inter-linkages, gravitate towards, and are linked to, their mother-banks in Western European countries, primarily Austria (Figure 4.3).

Figure 4. 3: Foreign exposures of BH banks, December 2010

Source: CBBH, own calculations.

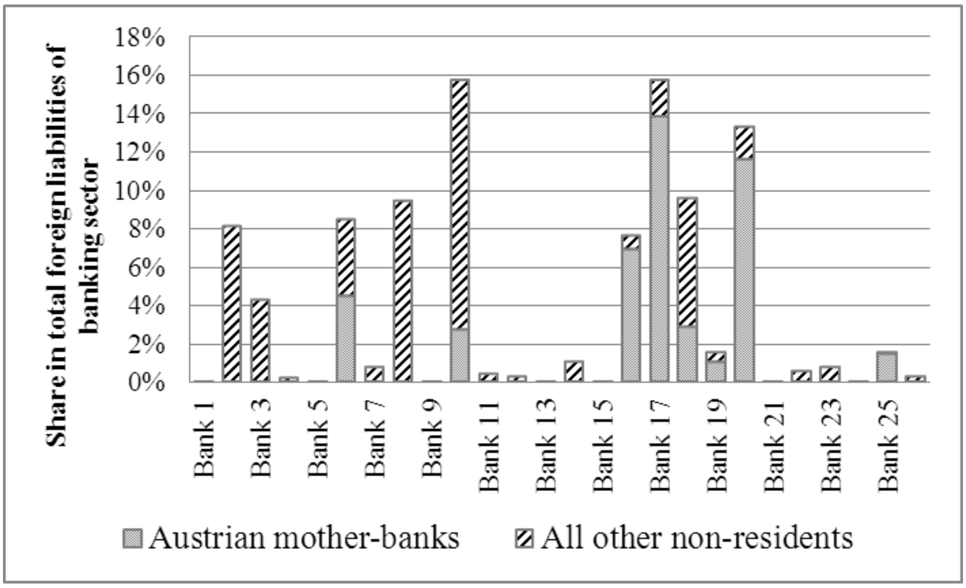


Figure 4.3 illustrates the foreign liabilities of BH banks by the origin of their owners. The solid grey bars represent funds provided by Austrian mother-banks, while the stripe bars represent the funds provided by all other non-residents, both the mother-banks and other investors. All points are expressed as a percentage of total non-capital related foreign investment in the BH banking sector at the end of 2010, meaning that all bars at the graph add up to 100. Twenty-six banks are represented on the axis since that number had foreign liabilities in their balance sheets at the end of 2010. In the cases of banks such as Bank 1, Bank 5, Bank 9, Bank 13, Bank 15, Bank 21 and Bank 24, their share in of total foreign liabilities was negligible, so their values appear like zeros on the graph.

Non-capital related means that equity, both originating from foreign direct and other investors, is not taken into account. The reason for exclusion of equity is that it is considered to behave as a buffer against the various risks, including credit risk. Because of the capital adequacy regulations, it is bound to rise with an increase in risk-weighted assets (Section 1.5). On the other hand, the remaining foreign liabilities that, in the case of BH, mainly consist of the mother-bank's deposits and loans and deposits of and loans from other non-residents (Section 1.3), are used to finance credit expansion. Although the latest financial crisis resulted in a change in the strategy of the mother-banks, in the sense that they have reduced their exposures in BH (Table A1.3, p.331), non-capital foreign investments of the Austrian mother-banks were still 45% of total foreign investments at the end of 2010. Figure 4.3 indicates the presence of tiering in the BH banking sector since some of the banks with the highest shares of foreign liabilities in the BH banking sector have the same mother-bank. These Austrian banks have significant exposures to the majority of the CEE countries. In a sense, the headquarters of large internationally active foreign banks behave as 'money-centre banks'[46].

The above overview of theoretical framework indicates that, in the case of BH, the driving factors behind the changes in the LI should be sought among the factors that affect the domestic demand for loans and the willingness of non-residents to invest.

4.2.2. The empirical framework

On the empirical side, there have been numerous attempts to predict the incidence of a crisis. Brüggemann and Linne (2002) emphasized two types of approaches in their empirical research on the currency crisis: the quantitative response and the signalling approaches. The quantitative response approach uses regression analysis, usually in the form of a probit or logit analysis, to estimate the relationships between different variables that are perceived as the indicators of a crisis and the occurrence of a currency crisis. The signalling approach is built around a comparative analysis of the behaviour of various indicators during crisis episodes and tranquil periods. The dependant variable in the models following this approach may be either a binary or a continuous one, constructed as an index of the speculative market pressures. In either case, the behaviour of explanatory variables is expected to differ in the crisis from the tranquil

[46]A money-centre bank is a banking institution that, besides its global presence, is characterized by heavy involvement in wholesale banking with clients comprising many retail banks and large multi-national corporations.

periods. Regardless of the choice of dependant variable and the techniques employed, all these models use a wide range of macroeconomic indicators to assess the probability of a crisis.

One of the earliest works that could be placed in the quantitative response approach group of studies was that of Frankel and Rose (1996). They used both an event study methodology and regression analysis in the form of probit models using maximum likelihood to single out the elements that might help in predicting a currency crash. In the event study methodology (in both cases their sample covered annual observations for 105 countries in the period 1971-1992), countries that experienced a crash were found to have: a high proportion of debt lent by the commercial banks; a high proportion of debt issued with variable interest rates; a high proportion of debt with short-term maturity and a low fraction of debt lent by multinational organizations. They also noticed that: foreign interest rates, represented by the weighted average of short-term interest rates for six developed countries, tend to be higher in the periods preceding the crisis[47]; the inflow of FDI would be relatively small with respect to an inflow of hot money; the debt burden was found to be high and rising; while international reserves were low and falling.

Frankel and Rose (1996) were surprised to find that the budget and current account deficits were found to be small and shrinking in those countries that experienced a crash. We believe that the most likely explanation for this finding lies in separating the cause of the crisis from the consequence of the crisis. From the national income accounting identity, it must be the case that the high and rising national debt is associated with the private sector. In this case, the current account deficit may be widened by an increase in private sector's consumption that is financed from abroad. If this was the case, then the current account deficit would peak just before the onset of the crisis and then rapidly shrink. The debt, however, would still remain high. A fall in consumption, that shrinks the current account deficit, would also result in a decline in GDP. A simultaneous decline in both the deficit and GDP may result in an almost unchanged ratio between the two variables. Under the scenario where the private consumption of imported goods is financed by domestic debt it is possible to find a

[47]The countries are: the United States, Germany, France, Japan, the United Kingdom and Switzerland. The weights are proportional to the fractions of total debt of all 105 countries from the sample denominated in the relevant currencies. On average, it was found that foreign interest rates tend to exceed tranquil period interest rates by over one percentage point.

small and shrinking deficit once the crisis unfolds, but if the deficit is expressed in percentages of GDP it may report an almost unchanged situation when compared to the pre-crisis periods.

One should also keep in mind that expressing the variables in terms of GDP was a necessity since Frankel and Rose's (1996) sample covered 105 countries and a direct comparison between nominal amounts of their deficits would be meaningless. A similar explanation applies to the budget deficit. Pro-cyclical government spending, fuelled by rising tax receipt, may peak just before the on-set of a crisis. Such pronounced domestic weakness may even attract a speculative attack on the currency. Once the crisis unfolds, the government cannot borrow anymore, its spending drastically reduces resulting in a decrease in GDP. Again, in nominal terms, the budget deficit may have shrunk, but not necessarily if expressed as a percentage of GDP.

Frankel and Rose's (1996) regression analysis indicate that crashes tend to occur when: FDI inflows dry up; reserves are low; domestic credit growth is high; foreign interest rates rise; and the real exchange rate has been over-valued. They also found that currency crashes tended to be associated with sharp recessions, though the causal linkages were unclear.

An identical foreign interest rates variable was used in Eichengreen and Rose (1998). Using probit analysis to measure the probability of a banking crisis, these authors found a highly significant correlation between changes in industrial countries' interest rates and banking crises in the emerging markets. This finding suggests that domestic developments do not tell the whole story, even though real exchange rate overvaluation and slow output growth may contribute to a crisis. Given the dominance of the banking sector in the BH financial system (Section 1.3) and a high concurrence of the twin crises (Section 2.2), the LI assumes that an increase in the risk of a currency crisis in the case of BH should be observed through developments in the banking sector balance sheet.

By analysing annual data on 26 emerging economies in the period 1981-1999 Kamin et al. (2001) found that, on average, domestic factors seem to contribute to many of the underlying vulnerabilities to currency crises of these countries, thereby increasing their average estimated probability of a crisis. However, it is adverse swings in external factors that may have been more important in pushing emerging market economies into crisis. As these authors themselves point out, if one works with a panel of countries it is sometimes hard to distinguish between domestic and external, exogenous, variables. For example, in the case of a large economy a variable such as the terms of trade might be endogenous with respect to its exchange rate. For a small open economy this same variable would be treated as an exogenous one. Kamin et al. (2001) conclude that, similar to Abaid (2003), the levels of significance of the explanatory variables vary across countries. Komulaien and Lukkarila (2003) employed a probit model to analyse a sample consisting of 31 emerging market countries in the period 1980-2001 and found that the variables that increase the probability of a currency crisis are: unemployment; inflation; private sector liabilities; and banking sector foreign liabilities. They also conclude that in emerging economies currency and banking crises coincide.

The study of Kaminsky and Reinhart (2000) uses a signalling approach in investigating the probability of currency crisis contagion controlling for the fundamentals. Based on a sample of 80 currency crises episodes for a number of industrial and developing countries in the period 1970-1998 they constructed three sets of the probabilities of a crisis: an unconditional probability; one set of probabilities controlling for the macroeconomic fundamentals; and another set of probabilities controlled for both the fundamentals and information on a crisis elsewhere. Their finding was that adding information on crisis occurrence elsewhere reduces the prediction error, even after accounting for differences in fundamentals. Following recognition that being aware of a crisis elsewhere helps predicting a crisis, these authors investigated the channels of crisis transmission. Four channels of cross-border risk transmission were considered. The first two channels dealt with financial linkages: namely, foreign bank lending; and globally diversified portfolios. The other two channels were focusing on trade related issues: trade in goods and services between the crisis and other countries; and competition in a common third market. They found that an exposure to a common creditor (banks) was a significant channel of contagion in Asia and Latin America. Their results also suggested that much of what has been attributed to trade actually had to do with financial sector linkages, since both the bilateral trade and competition in a common third market were found to be weaker channels of cross-border risk transmission than the financial sector links.

Caramazza et al. (2000) investigated the impact of external, domestic and financial weaknesses, through trade and financial linkages, on inducing a financial crisis in a sample of 61 emerging market and industrial economies. They argue that countries are sensitive to trade contagion when they exhibit external weakness as measured by their current account deficit. In another words, countries with sound external and domestic macroeconomic fundamentals are less prone to exchange rate vulnerabilities. Similarly to Kaminsky and Reinhart (1999) and Boss et al. (2004b), Caramazza et al. (2000) emphasize the importance of a common creditor in explaining the channels of financial crisis propagation.

Nitithanpapras and Willett (2000) offered an interesting explanation for the observation that a variable can appear significant in predicting a crisis in one country and irrelevant in another. They used a slope dummy regression to detect whether a combination of fundamental factors has more explanatory power in predicting a crisis than the factors observed individually[48]. A lending boom is a very significant variable in the majority of studies of currency crises and, when considered independently in the regressions, the real exchange rate, the current account deficit and FDI are significant only in some studies. When the three variables were included as separate independent variables they were significant in all of Nitithanpapras and Willett's (2000) regressions.

Given the loss of information that was a result of transforming a continuous variable into a binary one, an increasing number of studies focused on constructing a continuous measure of financial distress. The first such attempt was the Financial Stress Index developed by Illing and Liu (2003). However, changes in this index were never explained by changes in fundamentals but, rather, by their contemporary manifestations. The approach relied on trying to explain changes in the stress index for Canada using high frequency market data (Section 3.3). Such an approach, given its extremely short-term forecasting horizon, is more suitable for detecting "sunspots", since it reflects the expectations of the markets. Hanschel and Monnin (2005), on the other hand, attempted to forecast their stress index by using macroeconomic fundamentals. The following variables (with different lags) were found to be significant: GDP gap; GDP Europe gap; share prices index gap; housing prices index gap; credit ratio gap; and investment ratio gap. All 'gaps' were calculated as the difference between the actual series and its trend and then standardized in order to measure their relative size. In the case of all but GDP gaps, a positive gap is a priori expected to predict an increase in stress. In other words, an above-potential growth in share prices, housing prices, credit and investment was

[48] In the case of a slope dummy regression some of the independent variables are synthetically created so they capture the interaction of, usually, two variables. Whenever the two variables behave as "a crisis signal", that period is assigned 1 and 0 otherwise. A binary variable created in such fashion is then used as an independent variable.

assumed to signal potential distress. In the case of GDP ‘gaps’ a negative gap is expected to coincide with a crisis.

The signal extraction approach was also employed by Andreou et al. (2007), but they tailored their forewarning indicator of a crisis to the Central and Eastern European (CEE) countries. Given different levels of transition between the six countries observed, no common forewarning indicator of a financial crisis was extracted, but the real effective exchange rate was found to be significant in predicting the incidence of currency crisis in the majority of cases, supporting the hypothesis that banking and currency crises tend to be closely related. As for the other significant explanatory variables, the ones that were found most often to signal a crisis were: the M2 to GDP ratio; current account to GDP ratio; and deposits to GDP ratio. No explanatory power in the growth rate of GDP was found.

Abaid (2003) provided an extensive survey of the empirical literature on the currency crises modelled through the early-warning systems (EWS). Additionally, he suggested an alternative model, a Markov-switching EWS with time-varying transition probabilities that might help overcome the shortcomings of the two traditional approaches. The traditional approaches require a priori dating of the crisis episodes and, in some cases, transforming a continuous variable into a binary one. Markov-switching models start with the assumption that there are two periods: one tranquil; and the other a period under a speculative attack. These stages are not directly observable since the “crisis variable” is latent, but there are directly observable variables that behave differently depending on the value of the latent crisis variable. Given the current state, tranquil or crisis, the probability of moving from one state to another depends on the fundamentals.

One of the conclusions that Abaid (2003) reached was that since different indicators matter for different countries, the assumption of parameter constancy may have contributed to poor performance of the EWS up to that time. The latest financial crisis suggests that there have been few advances since then. Abaid’s (2003) argument was that if one cannot make a panel of similar countries in terms of macroeconomic characteristics and stage of development, then a better option would be utilising an individual country approach. Since the 1990s BH has not experienced a currency crisis or a speculative attack; a bank run did occur in October 2008 but the CBA was not abandoned (Section 3.2). For this reason, a binary approach was not feasible. The absence of a speculative attack made a Markov-switching approach unacceptable as well. However, the idea that changes in fundamentals may be used to determine whether there is an increased probability of a system entering a region where speculative attack may cause a crisis could be utilised in the case of BH.

The following table provides a summary of what was discussed in this sub-section. It is an overview of what the empirical research finds to either cause a currency crisis or increases the probability of its occurrence. The first column indicates the authors of the study, while the second states what was measured. Note that all but Eichengreen and Rose (1998) and Hanschel and Monin (2005) attempt to estimate the same thing[49]. The third column lists the explanations offered by the authors for the changes in the variable in the second column. Some of the indicators are found in more than one study to signal a forthcoming currency crisis, or at least, their presence increases the probability of a currency crisis. These signals range from the underlying imbalances (the deficits, real exchange rate overvaluation and expansionary monetary policy to list some) via crisis triggers (a hike in foreign interest rates, international illiquidity of the banking sector, an external shock amalgamated by strong financial and trade linkages with other countries) to crisis manifestations (a decline in domestic GDP). This, however, does not imply that different authors used the same variables but that the chosen variables represent the same phenomenon. For example, when constructing foreign interest rates variable, different countries may have been used or different weights, different types of interest rates, nominal or price adjusted levels, levels or some sort of differentials and so on. The fourth column explains why a variable found to matter in other empirical work is or is not relevant from the BH perspective.

[49] Eichengreen and Rose (1998) and Hanschel and Monin (2005) are both closely related to the currency crises models.

Table 4. 1: The indicators of a forthcoming crisis

Authors	Measuring	What was found to matter	Why/ why not relevant from the BH perspective
Frankel and Rose (1996)	Probability of a currency crash	- Drying up of FDI inflows	Foreign currency liabilities of banks and foreign currency reserves are used to construct our dependant variable, the LI.
		- Low reserves	
		- High domestic credit growth	The variable should not be used since it is believed that it causes foreign investment inflows. Instead, index of industrial production and a measure of unemployment will be used as the determinants of changes in domestic demand for loans.
		- A rise in foreign interest rates	The variable is assumed to influence foreign investment inflows. The difference between foreign and domestic interest rates will be used.
		- Real exchange rate overvaluation	The variable is assumed to affect the level of foreign currency reserves via foreign debt servicing, thus indirectly affecting the LI.
Eichengreen and Rose (1998)	Probability of a banking crisis	- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).
		-A rise in foreign interest rates	See discussion under Frankel and Rose (1996).
		-Recession in industrial countries	It is assumed that foreign investment inflows will be affected by developments in the EU countries thus affecting the LI. This effect will also be partially captured by changes in foreign interest rates.
		-A drop in domestic output	The variable is not taken into account directly. The authors associate domestic recession with an increase in loan defaults. In the case of BH it is assumed that domestic recession reduces demand for loans thus affecting foreign investment inflows. It is expected that index of industrial production and a measure of unemployment will pick up some of domestic recession effects.

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Kamin et. al (2001)	Probability of a currency crisis	- Rising budget deficit	The effect on the LI will be taken into account indirectly through nominal bilateral exchange rate. Since the government is not allowed to borrow long-term from the commercial banks in BH in the observed sample (2003-2010), the expected future increases in budget deficit would have to be financed by borrowing internationally. Under the assumptions of rather constant instalments of debt repayment and majority of it being issued in the US Dollars, it is expected that USD/EUR exchange rate will pick up the pressure that the weakening Euro is exerting on foreign reserves.
		- Expansionary monetary policy	The authors use it as a measure of excessive domestic credit creation. It is assumed that foreign investment inflows would account for this effect indirectly, thus affecting the LI, through rising demand for domestic loans and difference between domestic and foreign interest rates.
		- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).
		- Widening current account deficit	The effect is indirect. We assume that the current account deficit widens with credit expansion. See discussion under Frankel and Rose (1996).
		- Worsening in terms of trade	We assume that the index of industrial production would capture the change in the ratio of export to import prices. Variables such as USD/EUR and IRDIF might also pick up some of the effect.
		- Recession in industrial countries	See discussion under Eichengreen and Rose (1998).
Komulainen and Lukkarila (2003)	Probability of a currency crisis	- Rising public debt	Rising public debt may be a signal for the future widening of the budget deficit. See discussion under Kamin et. al (2001).
		- Rising private sector liabilities	It is assumed to be correlated to high domestic credit growth. See discussion under Frankel and Rose (1996).
		- Widening current account deficits	See discussion under Kamin et. al (2001).
		- Expansionary monetary policy	See discussion under Kamin et. al (2001).
		- An increase in foreign liabilities of banks	The variable directly affects the level of foreign liabilities thus affecting the LI.

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Komulainen and Lukkarila (2003)	Probability of a currency crisis	- Inflation	The variable will not be used since there is a structural break in the series (a switch from the retail price index as a measure of inflation to consumer price index in 2005) which further reduces the number of observations. It is expected that the effect will be partially accounted for via the difference between domestic and foreign interest rates.
		- Unemployment	The variable will be used. It is assumed to affect demand for households loans thus affecting the foreign investment inflows.
		- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).
Kaminsky and Reinhart (1999)	Signalling over 80% of the currency crises measured by the Index of currency market turbulence	- Real interest rate	The authors used domestic deposit rate deflated by the consumer prices. The variable will not be used since domestic inter-bank market is underdeveloped.
		- Expansionary monetary policy	See discussion under Kamin et. al (2001).
		- Exports	The authors argue that a large shock to exports may trigger a currency crisis. See discussion under Kamin et. al (2001).
		- Real interest rate differentials	The authors use the difference between real foreign and domestic deposit rates. The difference between domestic and foreign interest rates should pick up the effect.
Caramazza et. al (2000)	Probability of a currency crisis	- A drop in domestic output	See discussion under Eichengreen and Rose (1998).
		- The ability of banking sector to meet its short-term financial obligations	The variable will not be used since the authors used short-term debt to BIS reporting banks. In the case of BH, a fraction of mother banks are not the BIS reporting banks. However, this effect will be partially taken into account since all types of foreign currency denominated liabilities of the banking sector were used to construct the LI.
		- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).

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Caramazza et. al (2000)	Probability of a currency crisis	- Expansionary monetary policy	See discussion under Kamin et. al (2001).
		- Rising budget deficit	See discussion under Kamin et. al (2001).
		- Common creditor	This variable will not be used, but the effect will be partially accounted for since foreign liabilities of banks affect the LI and some of the existing BH banks are the subsidiaries of the foreign banking groups.
		- Trade contagion	This variable will not be used. BH had no currency crisis, so the effect of contagion through trade channels cannot be estimated. See discussion on worsening in terms of trade under Kamin et. al (2001).
Nitithanpapras and Willet (2000)	Vulnerability to a currency crisis when the variables interact	- The current account deficit that is not covered by the foreign direct investment (FDI) if REER appreciates by more than a pre-determined percentage	This variable will not be used since it is likely that a false signal may be sent given the structure of foreign investment (Section 1.3). If the majority of foreign investment was in the form of mother bank's loans that were used to finance rising private sector liabilities (caused by an expansionary monetary policy), then one could not argue that such way of financing of the current account deficit does not contribute to vulnerability to a currency crisis.
		- Rising private sector liabilities	See discussion under Komulainen and Lukkarila (2003).
		- Expansionary monetary policy	See discussion under Kamin et. al (2001).
Hanschel and Monin (2005)	Financial stress	- Recession in neighbouring developed countries	See discussion under Eichengreen and Rose (1998).
		- A drop in domestic output	See discussion under Eichengreen and Rose (1998).
		- Overshooting equity prices	This variable will not be used. BH is a bank-dominated financial system with dormant financial markets. In addition, the vast majority of enterprises are not publicly listed on the exchanges.
		- Overshooting housing prices	The variable will not be used since the length of the index of housing prices is too short (available as of the second quarter of 2003) to identify the episodes of overshooting prices. However, a measure of unemployment will capture the effect of this variable since the vast majority of loans to households are long-term and often related to the real estate purchases.

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Hanschel and Monin (2005)	Financial stress	- High domestic credit growth	See discussion under Eichengreen and Rose (1998).
		- Investment ratio	The variable will not be used. The authors did not explain what they used as the representative series. However, whatever it was, investment already enters our model through the LI.
Andreou et. al (2007)	Probability of a currency crisis	- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).
		- Expansionary monetary policy	See discussion under Kamin et. al (2001).
		- Widening current account deficit	See discussion under Kamin et. al (2001).
		- Low domestic funding base	This variable will not be used. A ratio of long-term loans to long-term deposits will be used instead since the aim is to investigate the changes in the LI that are influenced by the changes in foreign liabilities of the banking sector. The underlying rationale is that faster growth of domestic demand for long-term loans with respect to growth of long-term domestic deposits will increase international borrowing of domestic demand, thus affecting the LI.
Abaid (2003)	An increase in the probability of a currency crisis	- Real exchange rate overvaluation	See discussion under Frankel and Rose (1996).
		- Expansionary monetary policy	See discussion under Kamin et. al (2001).
		- A drop in domestic output	See discussion under Eichengreen and Rose (1998).
		- Rise in foreign interest rates rise	See discussion under Frankel and Rose (1996).

From the above overview of the empirical research on financial crises, one can conclude that, although there are some elements that are widely perceived to increase the risk of currency crisis, there is a need for a county-specific approach. Furthermore, the choice of variables depends on the definition of a crisis. The following section will introduce and examine the properties of the variables believed to be of significance in explaining changes in the perception of the risk of currency crisis in BH, as represented by the LI.

4.3. The variables of importance to BH

The liquidity index developed in Section 3.4 indicated that the closest BH has been to a currency crisis was in the second quarter of 2009. Judging by the elements listed in Frankel and Rose (1996) and other empirical research reviewed in the previous section, three to six months before the LI peaked BH exhibited the majority of the characteristics of a pre-crisis country (Figures 4.4a- 4.4d).

Figure 4. 4: The share of forex and indexed loans in BH was high

Source: CBBH

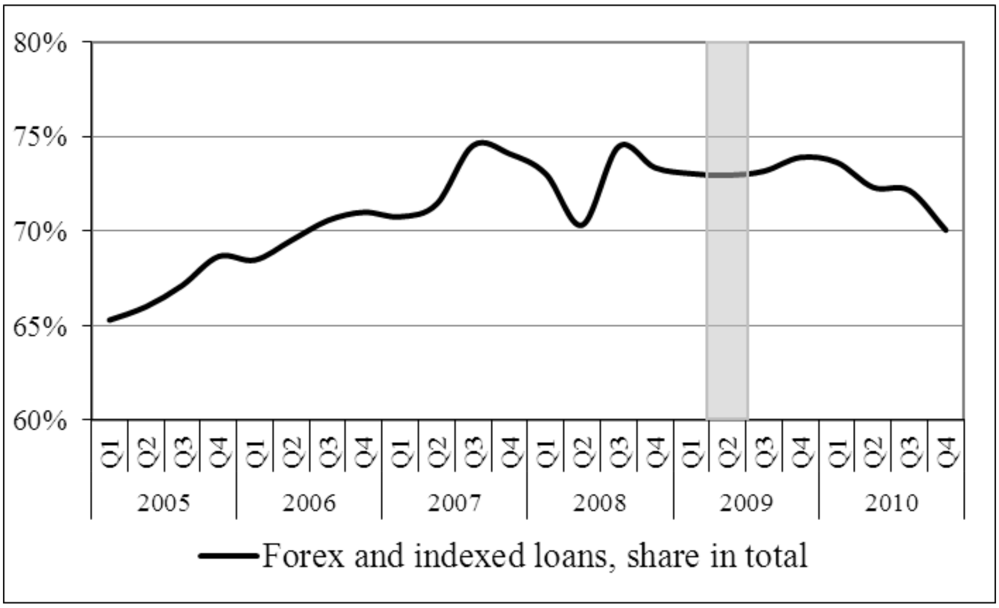


Figure 4. 4b: FDI inflows to BH were smaller than the inflows of hot money

Source: CBBH, own calculations

One should note that Frankel and Rose (1996) referred to total FDI when concluding that currency crashes tend to occur when FDI inflows dry up. Figure 4.4b represents the flow of foreign investment to BH banking sector. Hot money stands for foreign investment that can be easily withdrawn from an economy. These funds are recorded as portfolio and other investment in balance of payment statistics (Section 1.3).

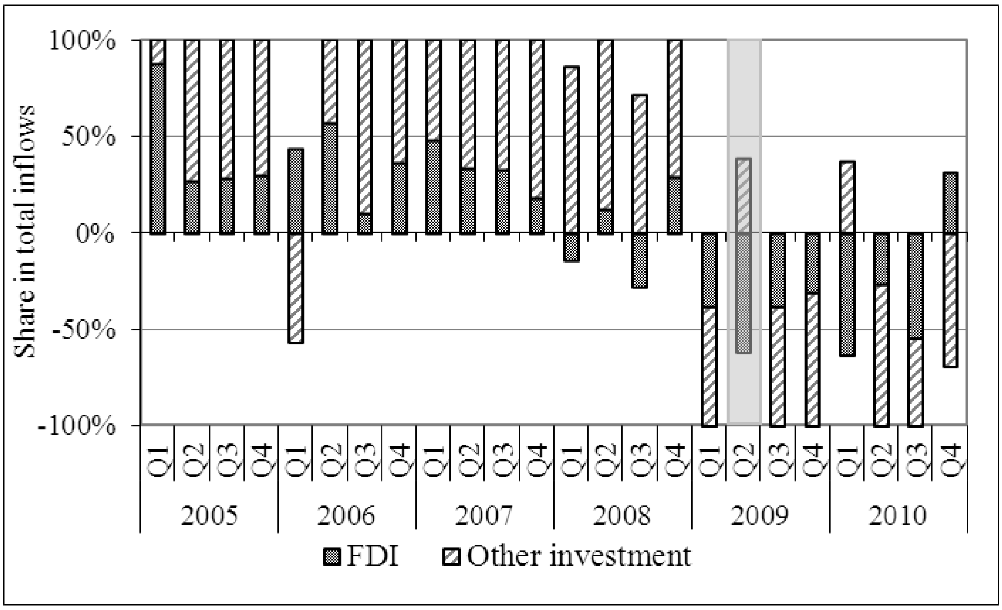


Figure 4. 4c: Domestic credit growth was high

Source: CBBH

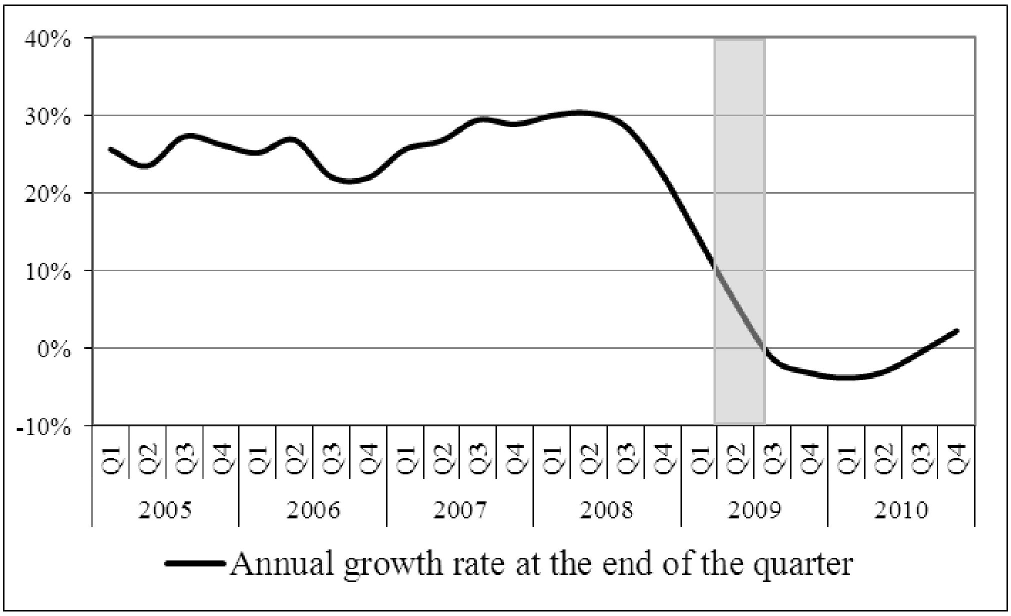
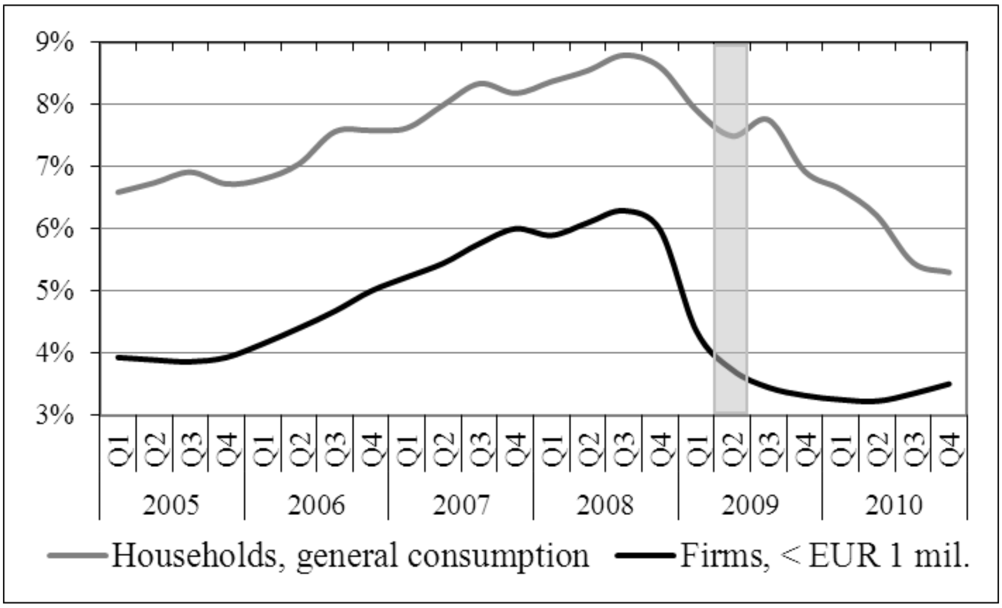


Figure 4. 4d: Foreign interest rates were rising in the periods prior to macroeconomic shock

Source: ECB

The series used are MFI interest rates (narrowly defined effective rate) on new business of loans by euro area: loans for consumption excluding revolving loans and overdrafts, convenience and extended credit card debt [A21-A2Z] with maturity up to one year in the case of households; and loans other than revolving loans and overdrafts, convenience and extended credit card debt [A20-A2Z], up to 1 year initial rate fixation and up to and including EUR 1 million amount in the case of non-financial corporations.



The LI developed in Section 3.4 indicates the size of a shock sufficient to cause the abandonment of the CBA. All values are re-scaled with respect to the highest value and are directly comparable. In other words, all points on the index are re-scaled with respect to the global maximum[50]. When deciding on the variables that will be used to explain the changes in the LI one needs to take into account that the value of the index depends directly on the changes in foreign reserves relative to the foreign currency denominated liabilities of the banks (domestic sector foreign currency denominated deposits, loans from and deposits of non-residents).

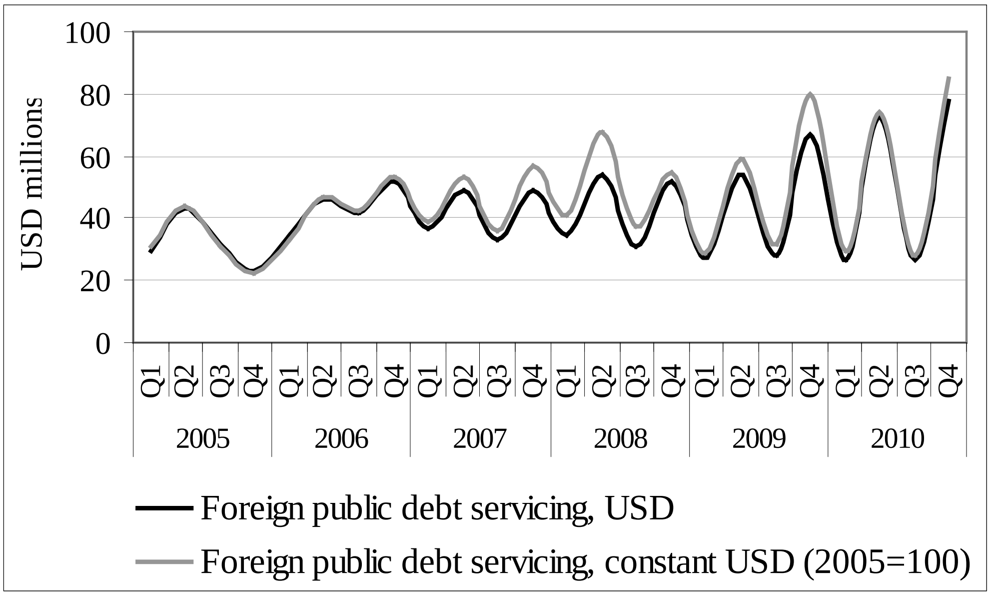
Given the conservative investment policy of central banks, it is unlikely that foreign reserves would be reduced because of their poor investment choices. The level of foreign reserves in the case of BH would be affected by the exchange rate between the EUR and the USD, since a weak EUR with respect to the USD would mean higher annuities in repayment of BH foreign debt, as explained below, and thus lower foreign reserves. The repayment schedule of government's foreign debt should not play a significant role in the changes in foreign reserves of the country since: the government cannot borrow long-term from the banks, which limits the expansion of its budget deficit[51]. In addition, there are legal limitations on the level of repayments when the budget deficit is financed by issuing debentures, while the annual repayment schedules have been kept fairly constant over the years (Figure 4.5). Note that this claim on repayment schedule of government's foreign debt holds for the sample of this research, but may not be true for periods after 2010 (Section 2.4).

Figure 4. 5: The repayment of foreign public debt

[50] The approach is similar to the use of a base index in a monotonically increasing function, only in this case the base is the global maximum instead of minimum. The shock sufficient to cause the abandonment of the CBA is calculated for every period under observation and the LI is constructed by comparing the sizes of these chocks across the sample and re-scaling them with respect to the highest value, i.e. the global maximum of the function.

[51] There is a possibility of applying for the credit tranches from the international financial institutions, such as the IMF or the World Bank, but the terms and conditions of those arrangements are rather strict and often involve policy shifts and/or restructuring.

Source: CBBH, own calculations



The repayment policy of BH's foreign public debt is such that the first and the third quarter's instalments are, in general, lower than those in the second and the fourth. Besides the repayment schedule, Figure 4.5 also indicates how much more BH repaid due to changes in the USD/EUR exchange rate. Every time the black line is below the grey one, the more costly is debt repayment expressed in BAM due to changes in the nominal exchange rate of the USD[52]. The vast majority of debt is repaid in either EUR or USD, with the latter component accounting for over 50% as of 2007 (MOFT, 2011).

[52] The foreign exchange rate is indirectly quoted.

As long as the CBBH operates under the CBA, the EUR component of its foreign public debt should not change its nominal value. However, given a significant increase in the funds borrowed from the IMF through four SBAs in 2009 and 2010, the component of BH's foreign debt exposed to an appreciation of USD with respect to EUR has increased[53]. At the end of 2010, the SDR component of the foreign debt was 38.6%, while "the pure" USD component of the BH foreign public debt (debt both issued and repaid in the USD) was 10.24%. 4.7% of the BH foreign debt at the end of 2010 was denominated in the Currency Poll Unit (CPU)[54].

Finally, foreign reserves are influenced by changes in the foreign currency denominated liabilities of the banking sector (Section 3.4, Figures 3.1a-c). These foreign currency denominated liabilities consist of: deposits of domestic sectors denominated in foreign currency; deposits of non-residents; and loans from non-residents. The latter two categories are also known as the foreign liabilities of the banking sector and they originate either from the mother-bank or from other non-residents.

One of the main causes of the foreign investment inflows to BH was a strong demand for loans (Section 1.3). In the immediate post-war years, given the very low deposit base, the lack of trust in the banking system and the weak institutional framework, credit activity was negligible. With the introduction of the Euro, the balance sheets of the commercial banks expanded significantly. Shortly after, the banking sector faced a maturity mismatch between its assets and liabilities. Demand for loans surpassed the lending capacity of the banks and majority foreign-owned banks that had already entered the market recognized an opportunity for an expansion of their business activities and seized a larger market-share by borrowing externally (Figure 4.6). This period coincided with excess liquidity and low interest rates in international financial markets and a fully liberalized BH capital account, so there were few constraints on credit expansion.

[53] The accounting unit of the IMF is the Special Drawing Rights (SDR). In 2009 its value was determined based on the following currencies: USD (44%); EUR (34%); JPY (11%); GBP (11%).

[54] The basket of currencies used by the World Bank and some other regional development banks for the calculation of the liabilities that are generally repaid in the USD.

Figure 4. 6: Banks' market shares for loans, 2005 and 2010

Source: CBBH, own calculations.
Key:
White diamonds represent the five largest banks in terms of assets at the end of years 2005 and 2010. The banks are the same in both years. Black diamond with coordinates (12,8) in 2005 was among the five largest banks in that year, but since it was later merged with another bank from the group, it was not regarded as one of the top five banks.
A diagonal line on both graphs represents the 45 degree line.

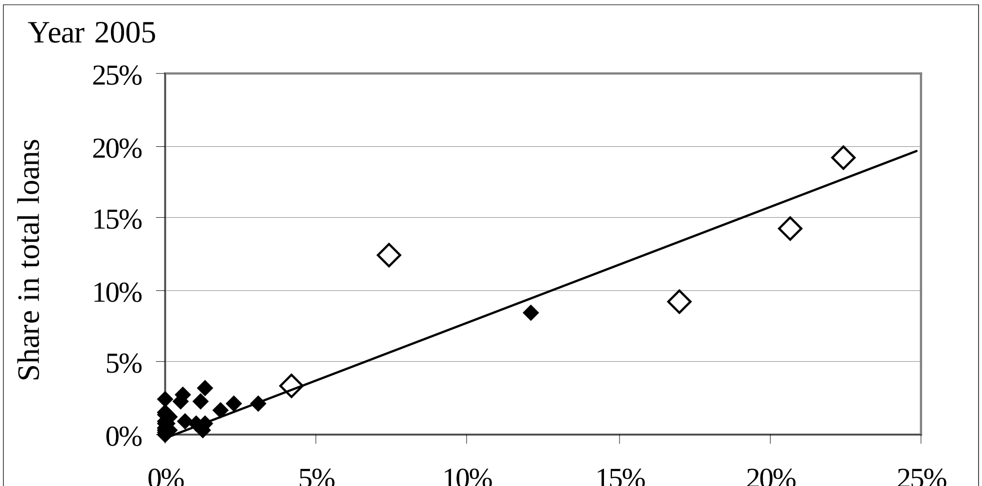


Figure 4.6 consists of two graphs illustrating the correlation between a market share for loans and a share of the corresponding bank in total foreign liabilities in years 2005 and 2010. The banks marked as white diamonds on both graphs represent the same foreign banks in both cases and in the same order[55]. These two figures suggest that banks initially increased their market share by financing their lending activities by borrowing from abroad and maintained those shares in the periods of credit expansion by following the same financing policy.

Cotarelli et al. (2005) list two macroeconomic forces that are likely to lead to a rapid growth of banking credit to the private sector (BCPS): crowding-in[56] and capital inflows. Crowding-in, i.e. a decline in bank credit to the government, in the case of BH occurred because the government was not allowed by law to run a deficit and it could borrow only short-term from the commercial banks. For the surge in capital inflows following the credit boom in the CEE countries and the Balkans in the late '90s and early 2000s these authors cited two reasons. Firstly, banks were mainly owned by banking groups in Euro area member countries, which facilitated access to external credit. Secondly, the nominal interest rate differentials, measured as the difference between deposit and T-bill rates, in CEE and Balkan countries and the corresponding interest rates in Germany, were still sizable. Similarly, Aydin (2008) concludes that high economic growth and much higher interest rates in the CEE countries when compared to the euro-area rates were the driving forces behind lending in the CEE markets. At the same time, declining interest margins in the home market were a motivation for the parent banks to increase credit in CEE countries. The amount of financial support that the mother-banks were allocating to their subsidiaries was positively correlated with higher interest margins and/or lower loan loss provisioning (De Haas and Van Lelyveld, 2006). The above studies suggest that the strong demand for loans in the CEE countries and shallow base of the banking sectors' liabilities, coupled with their inappropriate term structure, resulted in a surge in foreign investment in the region. Driven by the high profit margins, these foreign investment inflows tend to be the strongest in the early stages of the business cycle, or as was the case in the CEE countries, when new markets open. The reason is twofold: demand tends to be

[55] Bank's names or codes are not shown on the graphs because of data confidentiality issues.

[56] They also emphasize that credit to the government in the CEE countries from their sample is likely to decline over time as a consequence of the Euro-convergence process.

rather inelastic to interest rates, while the cost of provisioning is almost negligible at the early stages of the loan cycle.

On the other hand, a foreign bank's exit from the host country, usually in the form of deleveraging, illustrates the on-going reorganization of the mother-bank's operations with the purpose of increasing profitability at the group level (Hryckiewicz and Kowalewski, 2010). The occurrence of a crisis in one or more countries might induce investors to rebalance their portfolios for risk management, liquidity and other reasons (Caramazza et al. 2000). In other words, when demand for loans in the host countries weakens for any reason, the process reverses: banks tend to repay their foreign liabilities as they mature and the inflow of new funds from the non-residents, at best, dries up. The process of deleveraging not only pressures the level of foreign reserves thus affecting the LI, but also increases the liquidity risk in the banking sector as well (Maechler and Ong, 2009). Host countries and their banking systems over time become more at risk from a sudden withdrawal of short-term external funding since short-term direct cross-border claims by foreign banks represent an important source of liquidity risk for host countries[57].

So far, the following variables were identified as significant from the BH perceptive in explaining the level of risk of currency crisis: the exchange rate of the U.S. dollar with respect to the anchor currency, EUR, and the inflow of banking sector related foreign investment. The latter, being a manifestation of changes in domestic macroeconomic fundamentals, liquidity in international markets and business policies of banks, in the case of BH are a function of: the existing level and the appropriateness of domestic sources of funding, the difference between domestic and foreign interest rates, and domestic demand for loans. The business policies of banks determine the level of domestic interest rates, but also the level of concentration in the market for loans. Arguably, the market tends to get more concentrated when banks undertake a more aggressive lending policy, funded from abroad, in order to capture a larger market share in the host country.

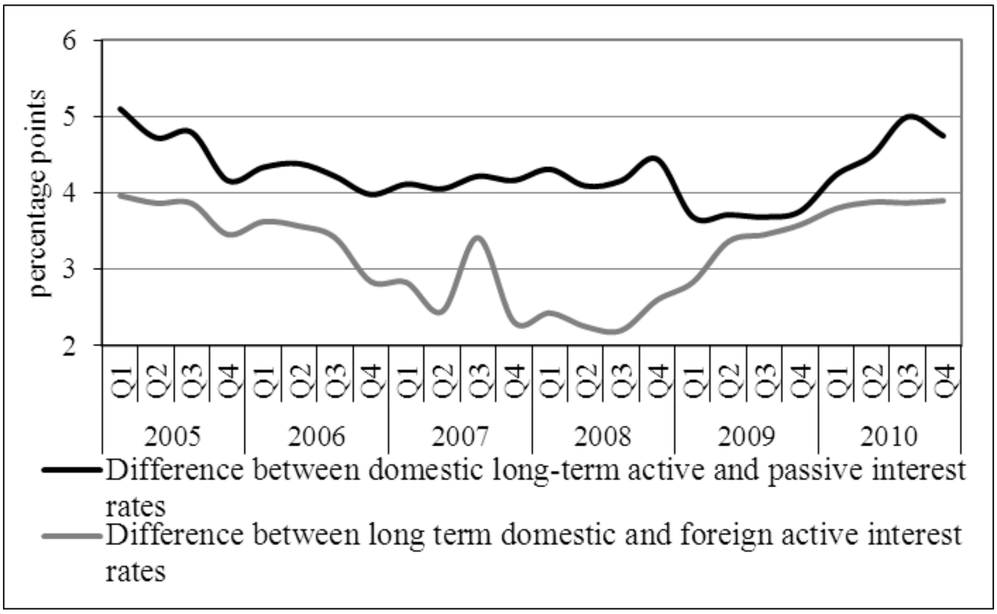
One should not expect that additional foreign liabilities will fund all credit expansion. In the case of BH (Section 1.3), banks started borrowing externally when they could not meet the regulations regarding the maturity harmonization between their assets and

[57] A fuller analysis of the theoretical framework and empirical research that address the risk of banking crisis can be found in the following chapter that focuses on the risk of a banking crisis in BH.

liabilities. With strong domestic demand for loans, dominant banking sector and no presence of large institutional investors, banks could keep interest rates on domestic deposits at low levels for a long time, thus reducing their interest expenses (Figure 4.7).

Figure 4. 7: The benefits of financing credit expansion domestically

Source: CBBH, ECB, own calculations



The solid black line in Figure 4.7 represents the difference between domestic long-term active and domestic long-term passive interest rates[58]. It can be interpreted as how much

[58] This footnote is a brief explanation of the terminology used. The term "active" refers to the interest that bank earns on its assets. Interest income consists of interest earned on: funds deposited with other financial institutions (either domestic or foreign); funds deposited with the central bank; loans extended; other assets (mainly securities). On the liabilities side, passive interest rates, i.e. interest expenses, consist of interest paid on: funds deposited with the bank (foreign or domestic); loans taken from other financial institutions; and other liabilities (securities issued and other debentures).

Therefore, if one refers to interest earned on assets and interest paid on liabilities, it is more appropriate to use the terms active and passive interest rates rather than lending and deposit rates.

net would a bank earn if the long-term domestic loans were funded by the long-term domestic deposits. The solid grey line represents the gap between domestic active and foreign active interest rates to enterprises[59]. It indicates how much net a bank would earn if borrowing foreign and placing domestically. Clearly, as long as the black line is above the grey one, banks will prefer financing domestically. However, banks have very limited domestic sources of long-term financing, since the domestic supply of long-term deposits is lower than domestic demand for long-term credits (Section 1.3). Banks will have an incentive to borrow internationally and will continue to do so as long as the grey line in Figure 4.7 is below the black one. Once the grey line reaches the black one, a bank breaks even when borrowing internationally and placing domestically. In this case, domestic active interest rates would have to increase in order to maintain the gap between domestic and foreign costs of funding. This development is likely, given the much lower sovereign rating of BH with respect to countries where the headquarters of BH foreign banks are placed.

Note three different trends in the cost of funding in Figure 4.7. At the early stages of credit expansion, until the end of 2006 in figure above, as the cost of external funding was decreasing, so was the difference between domestic active and passive interest rates. By the end of that stage banks have established their respective market shares that were largely to remain the same to the end of the sample. In the second stage, until Q3 2008, the gap between the domestic and foreign cost of financing was widening, with the exception of occasional privatization-related inflow of funds (Section 1.3, Figure 1.1). In this stage, characterised by rapid credit growth and an increase in market concentration, banks were compensating a decreasing net interest margin with an increase in the volume of disbursed loans (Section 1.3). Finally, following the liquidity freeze in international markets, the cost of borrowing internationally began to increase closing the gap between the two measures of the net interest margin. Developments in

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For the sake of simplicity, active interest rates to non-financial enterprises were used in both the cases of domestic and foreign interest rates. These interest rates are usually lower when compared to households, which makes them a better choice if one wishes to compare the costs of financing between countries. In the case of domestic passive interest rates, the weighted average of the long-term interest rates for non-financial enterprises and households is used. The argument is that it is irrelevant from the perspective of bank from which domestic sector the long-term deposits are coming from.

[59] Data source for the foreign interest rates is the ECB's Statistical Data Warehouse. The series used is: Euro area (changing composition), Annualized agreed rate (AAR) / Narrowly defined effective rate (NDER), Credit and other institutions (MFI except MMFs and central banks) reporting sector - Loans other than revolving loans and overdrafts, convenience and extended credit card debt [A20-A2Z], Over 1 year initial rate fixation, Up to and including EUR 1 million amount, New business coverage, Non-Financial corporations (S.11) sector, Euro

international financial markets caused a shift from foreign to domestic sources of financing, which resulted in a hike in interest rates on domestic time and savings deposits (Section 1.3). Domestic lending interest rates increased as well, but not proportionally, causing the difference between domestic active and passive interest rates to decrease at the end of 2008. As domestic client's creditworthiness deteriorate with worsening in the macroeconomic conditions, domestic active interest rates increased mirroring an increase in credit risk. Consequently, the gap between the domestic active and passive rates significantly increased in 2010.

This illustration of changes in interest rate margins indicates that the following variables should be useful in explaining changes in banking sector related inflows of foreign investment and, indirectly, the level of the LI: the difference between domestic and foreign interest rates, the ratio of domestic long-term deposits to long-term loans and a measure of concentration in the market for loans. In the case of the latter, the Herfindahl- Hirschman index (HHI) will be used.

Finally, banking sector related inflows of foreign investment depend on the strength of domestic demand for loans. As will be addressed in more detail in the following chapter, using the level of loans or deviations from its trend to estimate the level of the system's fragility, as suggested in some research, is not appropriate in the case of BH. A low base, capital account liberalization and a strong demand for loans, despite rather high nominal interest rates, resulted in extremely high annual growth rates of total loans. Between 2004 and mid-2008 the recorded annual growth rates of nominal loans at the end of each month were above 25%, only to fall below zero in less than a year where it hovered through to the end of 2010. The incidence of high growth rates of loans in real terms across the region was also a finding of Arvai et al. (2009). Depending on the point in the cycle, the trend value will differ substantially regardless of how one transforms the series. This will make the results highly dependent on the chosen time period and the conclusions would be applicable to a very limited period or a specific macroeconomic scenario. This research proposes using the level of industrial production and change in the rate of unemployment as the measures of domestic demand for loans.

The use of the index of industrial production instead of, more commonly, GDP in credit growth models will be discussed in more detail in the following chapter, but there is precedence for this choice (see Ègert et al., 2006). Changes in the index of industrial production should capture changes in the short-term loans to enterprises, especially given that the majority of short-term loans are to this sector of the economy and especially to industries that constitute the index of industrial production[60]. It is expected that the level of debt would increase with an increase in the index of industrial production in the current and the past periods.

BH has no data on household disposable income, so the change in the rate of unemployment is used to capture some of the variations in loans to households that are mostly long-term (Section 1.3). Statistical data on the rate of unemployment is also rather poor, but using the differences in the official rate of unemployment between two periods instead of the levels should lessen the problem[61]. The change in the rate of unemployment should also affect some of the changes in loans to the corporate sector. An increase in the rate of unemployment is likely to be caused by, and result in, lower demand for non-tradable goods and thus a lower demand for loans in the industries that produce the non-tradable goods.

Table A4.1 (p.344) provides an overview of the significant exposures in classical loans to legal entities by industry classification[62]. In the industry classification area G (Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods) the following three sub-areas make up for 15.6% of total loans to the area: wholesale trade of other products for households; retail sale in non-specialized stores with food, beverages or tobacco predominating; and other retail sale in non-specialized stores. The immediate effect of an increase in the rate of unemployment may not be evident in this category since the households may reduce their unused amounts on all types of debit and credit cards and fund the purchases for a certain period of time (CBBH, 2012). However, if unemployment rises for two or more consecutive periods, it is to be expected that loans to the legal entities in this industry classification area will decrease.

[60] The industries that constitute the index of industrial production are: C- Mining and quarrying; D- Manufacturing; and E- Electricity, gas and water supply. The three together made up for 30.5% of classical loans to legal entities at the end of 2010.

[61] There is a labour force survey, but that is an annual publication and there have been only six surveys conducted so far.

[62] The data source is the Central Register of Credit (CRC). Classical loans are the type of loans with a usual repayment plan characterized by: the date of activation; the date when it is due; the nominal amount of debt; the currency of debt denomination; and the interest rate. This type of loans made up for 70% of total claims from the legal entities.

Before proceeding towards constructing the model that explains changes in the LI, the following table summarizes the previous discussion on the selection of variables. The table also provides the information on data sources and potential adjustments to the original series.

Table 4. 2: The summary of chosen variables

USDEUR: The nominal USD/EUR exchange rate	
Aim:	Capturing the effect of changes in the USD/EUR exchange rate on the level of foreign reserves
Expected effect:	Negative. Given that the exchange rate is indirectly quoted, strenghtening of the home currency (EUR), and indirectly BAM, means that it is cheeper to service the foreign debt repayment which reduces the pressure on foreign reserves.
Source:	ECB: Reference exchange rate, US dollar/Euro
Adjustments made:	None.
LTDOMFUND: The ratio of long-term domestic deposits to long-term domestic loans.	
Aim:	Capturing the effect of the availability of domestic sources of financing on banking sector related flow of foreign investments
Expected effect:	Negative; the higher the ratio, the less foreign funds are needed to finance the credit activities in domestic market.
Source:	CBBH: Long term deposits of domestic sectors and long term
Adjustments made:	Monthly values were calculated as the ratio of long-term deposits to long-term loans to domestic sectors. Quarterly values are generated as the arithmetic average of the values recorded in the months that constitute the quarter.
IRDIF: The difference between the long-term active domestic and foreign interest rates for private non-financial enterprises	
Aim:	Capturing the effect of difference between domestic and foreign interest rates on banking sector related flow of foreign investments
Expected effect:	Positive; a larger difference between domestic and foreign interest rates in the period of credit expansion is expected to result in a higher inflow of foreign funds that are going to be used for the financing of credit activities.

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Expected effect:	The expected sign may be different in the crisis and adjustment periods since the nature of changes in interest rates is different. While the differences between domestic and foreign interest rates cause changes in foreign liabilities in the pre-crisis periods, once the crisis materializes, the difference between the interest rates is a consequence of the adjustment in business policies of banks.
Source:	CBBH: Interest rates on newly disbursed long-term loans to non-financial enterprises; ECB: Interest rates on newly disbursed loans to non-financial companies in the amount of up to and including EUR 1 million and initial rate fixation exceeding 1 year
Adjustments made:	Monthly values were generated by subtracting long-term foreign interest rates from long-term domestic interest rates. The quarterly values are generated as the arithmetic average of the values recorded in the months that constitute the quarter.
HHI : The Herfindahl-Hirshman index for concentration in market for loans	
Aim:	Capturing the effect of banks' lending policies on banking sector related flow of foreign investments
Expected effect:	Positive; more aggressive business policies of banks increase reliance on foreign funding to finance an increase of banks' share in the market for loans
Source:	CBBH: Loans by banks, stock
Adjustments made:	Monthly values of HHI were calculated as the sums of squares of the individual banks' shares in stock of loans for the observed month. Quarterly values are generated as the arithmetic average of the values recorded in the months that constitute the quarter.
IIP : The index of industrial production	
Aim:	Capturing the effect of changes in domestic demand for loans
Expected effect:	Positive; the higher the industrial production, the higher the demand for loans.
Source:	Agency for Statistics of Bosnia and Herzegovina

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Adjustments made:	The monthly base index (2005=100) is transformed into quarterly by averaging the values for the months that constitute the quarter.
UNEMP: The rate of unemployment	
Aim:	Capturing the effect of changes in domestic demand for loans
Expected effect:	Negative: more aggressive business policies of banks in the periods when the rate of unemployment is falling increase reliance on foreign funding to finance an increase of banks' share in the market for loans
Source:	Agency for Statistics of Bosnia and Herzegovina
Adjustments made:	There were two inexplicable linear increases in the number of employed persons for the period January through June 2008 and January through April 2009. The adjustments to the original series are explained in detail in Appendix 4.2. Quarterly values are generated as the arithmetic average of the values recorded in the months that constitute the quarter.

4.4. The model

The aim of this section is to model changes in the LI constructed in Section 3.4 using a set of macroeconomic and banking sector specific variables identified in the previous section. The current empirical approaches to modelling the risk of a currency crisis, the quantitative response and the signalling approaches (Section 4.2.2), are not applicable given the BH context since no currency crisis, as traditionally defined, has occurred since the CBBH was established in 1997. Based on the statistical characteristics of the variables, the VECM was estimated. As will be demonstrated later in this section, the VECM that allows for breaks in deterministic trend was chosen as the appropriate model for explaining changes in the perception of the risk of a currency crisis.

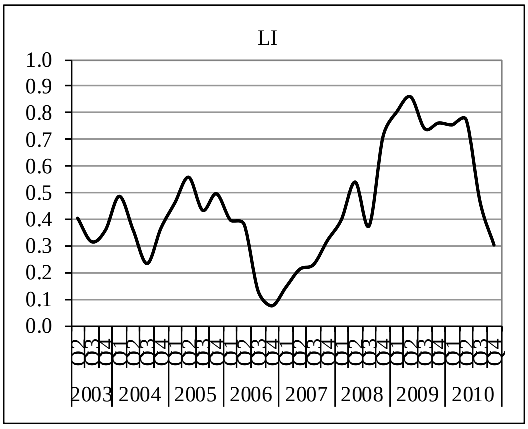
The following table provides descriptive statistics for all the variables. The sample consists of 32 quarterly observations in the period Q1 2003 through Q4 2010.

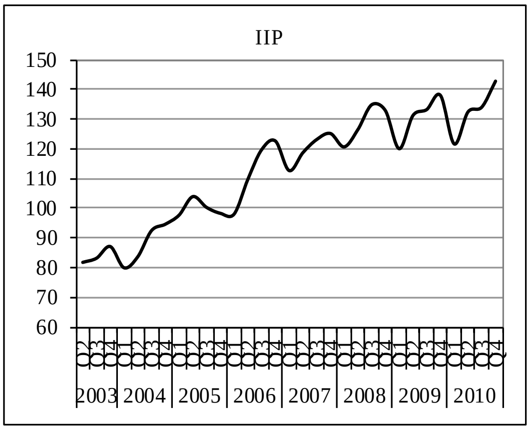
Table 4. 3: Descriptive statistics

	LI	USDEUR	LTDOMFUND	IRDIF	HHI	IIP	UNEMP
Mean	0.438	1.301	56.941	3.681	914.117	111.574	42.469
Median	0.397	1.291	55.360	3.787	933.453	119.153	42.825
Maximum	0.860	1.559	66.396	5.577	1082.445	142.733	44.944
Minimum	0.074	1.070	50.296	2.524	702.758	70.791	37.632
Std. Dev.	0.214	0.116	4.767	0.737	107.605	20.176	1.913
Skewness	0.406	0.288	0.410	0.264	-0.826	-0.346	-1.140
Kurtosis	2.272	2.689	1.932	2.904	2.767	1.888	3.686
Jarque-Bera	1.588	0.572	2.417	0.385	3.715	2.286	7.560
Probability	0.452	0.751	0.299	0.825	0.156	0.319	0.023
Sum	14.027	41.646	1,822.128	117.807	29,251.730	3,570.351	1,359.008
Sum Sq. Dev.	1.415	0.414	704.402	16.856	358,942.800	12,619.360	113.475
Observations	32	32	32	32	32	32	32

Before one starts with any type of regression analysis, testing each variable for a unit root is a pre-requisite. By using long historical time series for the U.S. in their research, Nelson and Plosser (1982) were unable to reject the hypothesis that macroeconomic series are better characterized as non-stationary stochastic processes with no tendency to return to a trend line. In line with this argument, a unit root is expected in our selected variables. Given that time series in the sample are short and characterized by transitional growth dynamics, the results of the conventional unit root tests may be unreliable (Lucke and Lütkepohl, 2003). The following set of graphs plots all variables in the model.

Figure 4. 8: All variables, levels





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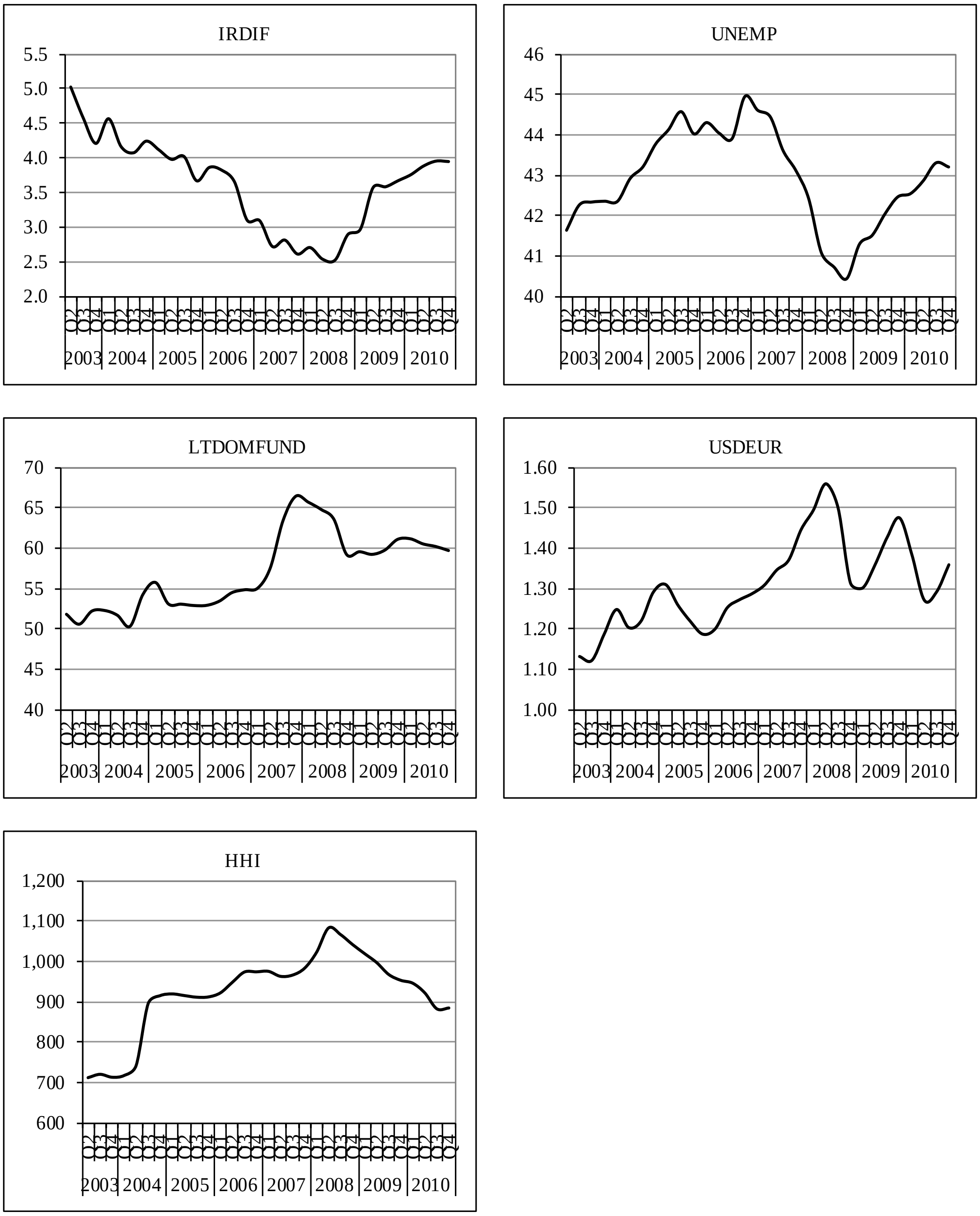

There are a few variables where a unit root is not suspected when inspecting the figures “by eye”: IRDIF, UNEMP and USDEUR. Table 4.4 below summarizes the results of the ADF and Phillips-Perron (PP) unit root tests respectively[63].

[63] For details see Dickey and Fuller (1979) and Phillips and Perron (1988).

Table 4. 4: Unit root tests

Key:
The values reported are t-statistics (ADF) and adjusted t-statistic (PP)
*** Larger than 1% test critical value in absolute terms
** Larger than 5% test critical value in absolute terms
* Larger than 10% test critical value in absolute terms
Lag length is selected automatically.
Appendix 4.3 (p.328) provides the results for the ADF unit root test in both the levels and first differences. Appendix 4.4 (p.332) provides the results for the PP unit root test in both the levels and first differences.

		Augmented Dickey-Fuller test		Phillips-Perron test	
Variable	Exogenous	Levels	Differences	Levels	Differences
LI	Constant, Trend	-1.714	-5.347***	-1.826	0.001***
IIP	Constant, Trend	1.230	-1.348	-3.803**	-11.205***
UNEMP	Constant, Trend	-2.411	-3.749**	-1.823	-3.8158**
IRDIF	Constant, Trend	-1.447	-6.256***	-1.468	-6.240***
LTDOMFUND	Constant, Trend	-2.422	-3.815**	-1.903	-3.734**
HHI	Constant, Trend	-1.192	-4.204**	-0.033	-4.896***
USDEUR	Constant, Trend	-3.642**	-5.418***	-1.925	-4.280**

For all but two variables, IIP and USDEUR, the ADF and PP tests indicate that one should not reject the null hypothesis of a unit root in levels. In the case of USDEUR, the ADF test indicates that one should reject the null hypothesis, while the PP test suggests a unit root process in USDEUR. This ambiguity of the tests may be a consequence of two breaks evident in the plot of USDEUR in Figure 4.8: the banking crisis in the Eurozone in Q4 2008 and the sovereign debt crisis in the Eurozone in Q2 2010. This variable, together with IIP and UNEMP, illustrate the argument of Lucke and Lütkepohl (2003) that unit root tests may be unreliable in small samples. The plot of IIP in Figure 4.8 indicates the presence of a unit root, while the tests are, at least, inconclusive. In order to test for a unit root under the assumption of the presence of a structural break in

IIP in 2008, Perron (1989) test for exogenous structural break in the ADF tests was used. The test (Table A4.4, p.358) indicate that IIP is characterized by a unit root process as suggested by Figure 4.8.

The case of UNEMP is a bit more complex since both tests indicate the presence of a unit root in levels, while the plot of UNEMP in Figure 4.8 is inconclusive. In addition to the standard tests for unit root in UNEMP in levels, three more were conducted: the Perron (1989) test for unit root under the assumption of single breaks in both Q1 2007 and Q4 2008, and the Lumsdaine and Papell (LP) (1997) test for multiple breaks in the two periods. The tests that assume a single break (Table A4.7, p.362 and Table A4.8, p.362) indicate that UNEMP is characterized by a unit root process, while the test that assumes two breaks rejects the assumption of a unit root in UNEMP (Table A4.9, p.363). Based on the results of these additional tests, the assumption of the unit root in UNEMP is rejected. The LP test is considered as more appropriate given that there is suspicion that a strong, non-linear trend in UNEMP in the periods after 2008 is a consequence of asymmetries in the adjustment process following a macroeconomic shock (see Appendix 4.5, p.357). The LP test was also used in the case of the USDEUR and it was concluded that the unit root process should not be assumed (Table A4.11, p.364).

Before one continues with the process of building the final model, one should emphasize that no severe multicolinearity was detected among the chosen explanatory variables, as measured by the variance inflation factor, VIF, (Appendix 4.6, p.365). There is a certain degree of multicolinearity detected in the cases of USDEUR and IRDIF, which was expected given the relationship between the exchange rates and interest rates. Furthermore, endogeneity is detected in IRDIF and IIP (Appendix 4.6, p.365). However, it is suspected that the endogeneity of IRDIF is a consequence of changing nature of IRDIF (in a sense that IRDIF fosters LI in the pre-shock periods, and is a consequence of changes in business policies of banks in the post-shock periods), while the endogeneity of IIP is a consequence of reverse causation between LI and IIP.

Given the limitations in the sample size, the appropriate model should be the one that represents a data generating process. The general approach is to handle the variables endogenously thus allowing for capturing rich dynamics within data. In the cases where some of the series have common stochastic trend, providing that they are cointegrated

(Granger, 1981 and Engle and Granger 1987), the VECM should be the favoured approach (Johansen, 1991).

The VECM is of the following general form:

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + ... + \Gamma_{\rho-1} \Delta y_{t-p+1} + u_t \qquad (4.1)$$

where Γ_js(j=1,…,p) are the short-term parameters and $\prod y_{t-1}$ is the long-run part.

$\Pi = \alpha\beta^{'}$ where the rank of $\prod$ is the cointegrating rank of the system, α is the loading matrix and β is the cointegration matrix.

In matrix format $\prod y_{t-1}$ in a system with two I(1) variables cointegrated of order 1 would be written as:

$$\Pi y_{t-1} = \alpha\beta^{'} y_{t-1} = \begin{bmatrix} \boldsymbol{\alpha}_{11} \\ \boldsymbol{\alpha}_{21} \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta}_{11} & \boldsymbol{\beta}_{21} \end{bmatrix} \begin{bmatrix} \mathbf{y}_{1,t-1} \\ \mathbf{y}_{2,t-1} \end{bmatrix} \qquad (4.2)$$

For a statistically significant adjustment factor or the weights to the eigenvector (α11 or α21 in the relationship above), whenever $\hat{\alpha}_{ij} > 0, \hat{\beta}_{ij} < 0$ and vice versa, the cointegration relation is equilibrium correcting in an equation. When $\hat{\alpha}_{ij}$ and $\hat{\beta}_{ij}$ are of the same sign it usually means that the cointegration relation describes overshooting behaviour in the equation (Juselius, 2006). Since the eigenvector is normalized, $\hat{\beta}_{ij}$ reports by how much the parameter that is set to unity has to change in order to restore equilibrium after a unit/percentage change in the endogenous variable. The corresponding adjustment coefficient reports the dynamics of the adjustment process towards equilibrium. Note that one would expect a statistically significant $\hat{\alpha}_{ij}$ with value less than one in a stable system.

The building blocks of the appropriate VECM are the following: defining the endogenous and exogenous variables; determining the autoregressive order; and specifying the cointegrating rank. Based on the results of the unit root tests, LI, IIP and LTDOMFUND are the candidates for the endogenous variables. Table 4.5 below indicates the classification of the variables as endogenous or exogenous and their expected signs. The table also provides information on deterministic variables that would account for the change in trend. The software used, JMulti, allows for breaks in the deterministic trend.

Table 4. 5: The classification of the variables

	Variable	Explanation
ENDOGENOUS	LI	The VECM is normalized on this variable.
	IIP	With an increasing economic activity, with an increase in IIP used as a proxy, the demand for loans in both firms and households will rise. If domestic long-term deposits are not rising as fast as domestic long-term loans, then an increase in economic activity would result in a credit expansion that will contribute to overall fragility of the system by fostering external borrowing. Credit expansion will, in turn, increase the volume of economic activity.
	LTDOMFUND	An inadequate maturity structure of domestic sources of financing will promote foreign borrowing thus affecting LI. With an inflow of banking-sector related funds, the fraction of loans financed domestically will reduce further.
EXOGENOUS	USDEUR	The bilateral USD/EUR exchange rate is exogenously determined.
	IRDIF	Foreign interest rates are exogenously determined. Given the reliance of lending activity in BH on foreign sources of financing, changes in domestic rates will depend on trend in foreign interest rates. In the periods of unfavourable macroeconomic conditions the difference between domestic and foreign interest rates may be shrinking, but foreign banks will still favour foreign financing of domestic lending activities thus adjusting domestic lending rates to foreign interest rates (Section 4.3).
	UNEMP	See Section 4.3.
	HHI	If the point estimate deviates from its long-term equilibrium level, assuming cointegration, one would expect the adjustment towards equilibrium to occur. In our case, if the level of fragility is above the long-term trend, one would expect the error correction mechanism of HHI to exert a downward pressure. In other words, if the system is getting more fragile, less competition would cool it off. This explanation may be valid if one assumes that either policy makers can impose restrictions on credit activity of banks or that the borrowers would ignore their needs, look at the bigger picture and borrow less when the economy is overheating. Under the existing BH regulations banks have no limitations on balance sheet expansion other than capital adequacy ratio and the rules on maturity harmonization between assets and liabilities. The arguments above imply that the level of concentration on the market for loans is determined outside the system, mainly by the business plans of the banks and borrowers' perception of the future macroeconomic conditions.

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DETERMINISTIC	INFLOW2006	Major inflow of the banking-sector related foreign investment in Q2 and Q3 of 2006 used to finance the activities in BH.
	PRIVATIZATION	Privatization of one of the telecom operaters in Q2 2007 that permanently increased the level of foreign reserves.
	INFLOW2008	Major inflow of the banking-sector related foreign investment in the third quarter of 2008 used to finance the activities in BH.
	BANKRUN	An external macroeconomic shock that coincides with a bankrun that ocured in BH in October 2008.
	SHOCKLEVEL	Change in the level of the LI in the post Q2 2009 periods.
	SHOCKTREND	Change in the slope of the LI in the post Q2 2009 periods.

As explained in Appendix 4.5, the brief fall in LI in Q3 2004 was not accounted for by any of the deterministic variables for two reasons: HHI is expected to pick up the effect of merger between two large banks and inflows related to that event; while there is no obvious explanation for an increase in foreign currency denominated deposits of domestic sectors, primarily private non-financial enterprises that occurred in that period.

Finally, one should mention the difference between using dummy variables in a Vector Auto Regression (VAR) model and in an OLS estimation as emphasized by Juselius (2006). She distinguishes between three types of dummy variables in VAR: the shift dummy that is restricted to lie in the cointegration space; the unrestricted blip dummy that represents a permanent shift; and the unrestricted transitory blip dummy that represents a transitory effect. INFLOW2006 and INFLOW2008 and are the transitory variables restricted to lie in the cointegration space, thus affecting the deterministic trend. BANKRUN, as demonstrated in Appendix 4.5 (p.357), represents an external macroeconomic shock that coincides with a bank run in BH. This shock affected the results of the tests for unit root under the assumption of structural breaks for majority of the variables for which the null hypothesis of unit root was rejected. As such, BANKRUN was considered an unrestricted variable. Therefore, the variable was transformed, as suggested by Juselius (2006), in a sense that the period following the shock (Q1 2009) was assigned the value of -1. Failure to do so, as Juselius (2006) argues, violates the independence assumption of the VAR model since the consequences of the occurrence of transitory shocks in the model, regardless of their size, produce negative autocorrelation in the errors.

Since the order of VECM is determined by the order of VAR with satisfactory diagnostics, the search for the appropriate VAR structure of the model for LI starts with VAR (2,0) specification. Should this specification be found satisfactory, conditional on the existence of the cointegrating relationship between the endogenous variables, the VECM (1,0) can be estimated, i.e. the VECM model with 1 lag of the first differences of the endogenous variables and deterministic variables and no lags in exogenous variables in levels. Table 4.6a below provides the diagnostics for several VAR specifications.

Table 4. 6a: The diagnostics of the VAR model with two endogenous and no exogenous lags assumed: VAR (2,0) model

Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

	VAR (2,0), intercept only	VAR (2,0), intercept and trend	VAR (2,0), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.2292	0.0797	0.1137
Doornik (1996), LMF test for autocorrelation, 2 lags	0.1210	0.0090	0.0474
Doornik (1996), LMF test for autocorrelation, 3 lags	0.1436	0.1977	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994),	0.3632	0.8654	0.9281

Table 4. 6b: The diagnostics of the VAR model with two endogenous and one exogenous lags assumed: VAR (2,1) model

Note is identical to that next to Table 4.6a.

	VAR (2,1), intercept only	VAR (2,1), intercept and trend	VAR (2,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.0516	0.0669	-
Doornik (1996), LMF test for autocorrelation, 2 lags	0.3019	-	-
Doornik (1996), LMF test for autocorrelation, 3 lags	-	-	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994), joint test for non-normality	0.0035	0.0067	0.8793
Lütkepohl (1993), joint test for non-normaility	0.7733	0.8282	0.8934
Jarque-Bera test, u1	0.5789	0.5204	0.5819
Jarque-Bera test, u2	0.8579	0.8174	0.6503
Jarque-Bera test, u3	0.0002	0.0006	0.9687
	(1): 0.1588 / (2): 0.0971	(1): 0.0875 / (2): 0.0304	(1): 0.0891 / (2): 0.0954

Tables 4.6a and 4.6b above do not clearly indicate the appropriate VAR specification. VAR (2,0) with intercept, trend and seasonal dummies is chosen for the following reasons. The maximum number of lags is set to 2 due to the limitations in the size of the sample. Choosing too small number of maximum endogenous lags, according to Lütkepohl and Krätzig (2004), should not matter too much since the specification tests of the final model would indicate whether the order chosen was too small. Since an inappropriately short endogenous lag would be indicated by a failure to reject the autocorrelation in the final model, a VAR (3,0) model was also estimated. The Doornik (1996) LMF test for autocorrelation (1 lag) when intercept and trend are included reports almost identical value as in the case of a VAR (2,0) model of the same structure. In other words, there is no evidence that estimating the VECM with two lags of endogenous variables instead of one should be preferred. Given that Figure 4.8 and the unit root tests suggest that trend in LI, IIP and LTDOMFUND should not be neglected. For that reason, the specifications with only intercept will not be considered. Out of the remaining four specifications, two in both Table 4.6a and 4.6b, the VAR (2,0) model with intercept, trend and seasonal dummies was chosen since the diagnostics, although not ideal, were better when compared to the VAR (2,0) and VAR (2,1) both with intercept and trend included. Due to limitations in the sample size, it was impossible to verify that the VAR (2,1) specification with intercept, trend and seasonal dummies was superior.

Table 4.7 below summarizes the results of the Johansen trace (1995) and Saikkonen and Lütkepohl (2000a; 2000b; 2000c) cointegration tests. Based on the chosen VAR specification, both the Johansen and Saikkonen and Lütkepohl tests were executed for the case of two lags with seasonal dummies included for all three options: constant, constant and trend and orthogonal trend. The tests suggest one cointegrating relationship between the endogenous variables.

Table 4. 7: The cointegration tests

Note:
Break date in Johansen Trace Test is set to Q1 2009. The break is assumed in levels and trend jointly and ignored in "orthogonal trend". INFLOW2006 and INFLOW2008 are restricted to long run, while BANKRUN is not.
Saikkonen and Lütkepohl test does not have an option to set the break dates. Instead, it allows for including series that will account for changes in deterministic trend. In this case, the variables included are: INFLOW2006, INFLOW2008, SHOCKLEVEL and SHOCKTREND.
Note that inclusion of SHOCKLEVEL and SHOCKTREND have the same effect as the introduction of the break in Q1 2009 in Johansen test.

Test	Included	Null hypothesis	Test value	p-value	Critical values		
					90%	95%	99%
Johansen Trace Test	- Constant	r = 0	45.73	0.02	38.91	41.69	47.25
		r = 1	20.00	0.21	22.83	25.09	29.73
	- Constant - Trend	r = 0	63.17	0.01	52.79	56.35	63.43
		r = 1	31.80	0.11	32.31	35.21	41.10
	- Orthogonal trend	r = 0	38.64	0.00	27.16	29.80	35.21
		r = 1	13.43	0.10	13.42	15.41	19.62
Saikkonen and Lütkepohl Test	- Constant	r = 0	31.04	0.01	21.76	24.16	29.11
		r = 1	8.73	0.19	10.47	12.26	16.10
	- Constant - Trend	r = 0	21.28	0.31	26.07	28.52	33.50
		r = 1	6.23	0.75	13.88	15.76	19.71
	- Orthogonal trend	r = 0	28.82	0.00	18.67	20.96	25.71
		r = 1	5.27	0.31	8.18	9.84	13.48

Based on the above information the VECM with one endogenous and zero exogenous lags was estimated. The estimation output for the unrestricted model is provided in the set of Tables A4.17a-e (p.370). It diagnostics are mainly satisfactory with the exception of the evidence of autocorrelation (Table A4.18, p.372). Edgerton and Shukur (1999) suggest that this test may be biased in small samples and suggest an alternative that accounts for the size of the sample. This test was reported in the cases of VAR models diagnostics (Tables 4.6a and 4.6b). However, JMulti does not have this option for the VECM, and re-writing VECM into an appropriate VAR format was not an option since JMulti does not allow for lags in deterministic variables in the cases of VAR (in which case none of the variables from the cointegrating vector, the endogenous variables excluded, could not be included). Based on the inspection of cross (Figure A4.5, p.372) and autocorrelation (Figures A4.6a-c, p.373-375) functions of the residuals from three equations from the unrestricted VECM, there is evidence of neither suggesting that relatively poor diagnostics were indeed a consequence of the small sample.

The final model was reached by restricting statistically insignificant coefficients of the lagged endogenous and exogenous variables. The final model, presented in the set of Tables 4.8a-e below is reached by the automatic search of restrictions in JMulti based on the Akaike Information Criterion. Its diagnostics are all satisfactory (Table 4.9 below).

Set of Tables 4. 8: The estimation output for the restricted VECM

VEC REPRESENTATION	
endogenous variables:	LI_log, IIP_log, LTDOMFUND
exogenous variables:	USDEUR_log, HHI_log, IRDIF, UNEMP
deterministic variables:	inflow2006, privatization, inflow2008, bankrun, shocklevel, shocktrend, CONST, S1, S2, S3, TREND
endogenous lags (diffs):	1
exogenous lags:	0
sample range: [2003 Q4, 2010 Q4], T = 29	
estimation procedure: Two stage. 1st=Johansen approach, 2nd=OLS	
{p value}	
[t statistics]	

Table 4. 8a: Loading coefficients

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
	0.141	-0.033	
ec1 (t-1)	{0.012}	{0.000}	---
	[2.518]	[-5.380]	

Table 4. 8b: Estimated cointegration relation(s)

	ec1 (t-1)
LI_log (t-1)	1 {0.000} [0.000]
IIP_log (t-1)	18.076 {0.000} [4.999]
LTDOMFUND (t-1)	0.066 {0.064} [1.850]
inflow2006 (t-1)	0.245 {0.718} [0.361]
inflow2008 (t-1)	2.090 {0.018} [2.375]
shocklevel (t-1)	-10.655 {0.000} [-4.558]
shocktrend (t-1)	0.456 {0.000} [4.812]
CONST	-79.996 {0.000} [-5.055]
S1 (t-1)	-1.023 {0.000} [-3.979]
S2 (t-1)	-1.073 {0.000} [-3.612]
S3 (t-1)	-1.773 {0.000} [-5.390]
TREND (t-1)	-0.523 {0.000} [-5.478]

Table 4. 8c: Lagged endogenous term

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
d(LI_log) (t-1)	---	---	---
d(IIP_log) (t-1)	-2.892 {0.010} [-2.591]	---	5.071 {0.294} [1.050]
d(LTDOMFUND) (t-1)	---	---	0.333 {0.022} [2.294]

Table 4. 8d: Current exogenous term

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
USDEUR_log (t)	0.598 {0.032} [2.143]	---	---
HHI_log (t)	---	---	-1.742 {0.141} [-1.472]
IRDIF (t)	---	---	---
UNEMP (t)			0.280 {0.137} [1.487]

Table 4. 8e: Deterministic term

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
privatization (t)	---	---	---
bankrun (t)	---	---	-2.941 {0.005} [-2.811]

Table 4. 9: The diagnostics of the restricted VECM

Note:
For Doornik (1996) p-value of LM statistics is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value of Chi^2 is reported.
For Multivariate ARCH-LM test p-value of Chi^2 is reported.
For ARCH-LM test p-value of F statistic is reported.

	1 lag	2 lags	3 lags	4 lags
Doornik (1996), LM test for autocorrelation	0.292	0.354	0.510	0.381
Doornik & Hansen (1994), joint test for non-normality	0.120	0.120	0.120	0.120
Lütkepohl (1993), joint test for non-normaility	0.536	0.536	0.536	0.536
Jarque-Bera test, u1	0.946	0.946	0.946	0.946
Jarque-Bera test, u2	0.949	0.949	0.949	0.949
Jarque-Bera test, u3	0.010	0.010	0.010	0.010
Multivariate ARCH-LM test	0.889	0.625	0.909	0.349
ARCH-LM test, u1	0.424	0.506	0.661	0.706
ARCH-LM test, u2	0.271	0.435	0.327	0.544
ARCH-LM test, u3	0.938	0.710	0.806	0.707

As the VECM was considered the baseline model in this research, the estimation output reported in the set of Tables 4.8 will be discussed in more detail in the following pages. However, given the estimates from the ARDL-ECM that were estimated as a consistency check on the VECM findings, all quantified VECM relationships should be taken with a grain of salt. It will be demonstrated later in this section that, overall, the relationships outlined by the VECM are supported by the ARDL-ECM, but the estimated coefficients differ. For reasons that will be discussed in more detail later in this section, the coefficients estimated by the ARDL-ECM cannot be regarded as accurate either given that it is very likely that an important explanatory variable is excluded from the model.

The interpretation of the results begins by investigating whether the relationship between the endogenous variables is equilibrating or not. The part of the estimation output represented in Tables 4.8a and 4.8b will be used. Both loading coefficients (Table 4.8a) are highly statistically significant indicating that variables tend to adjust when one of them changes. The process of adjustment, as indicated by the size of the loading coefficients, tends to be very slow. For example, the speed of adjustment in LI, the faster of the two, of 0.141 indicates that it would take 20 quarters for 95% of the initial shock to be absorbed. This finding indicates that in the case of BH the volume of economic activity was not the main cause of the increase in the risk of currency crisis in the period covered by this research. It is also likely that the level of economic activity in BH was not primarily determined by the rise in foreign reserves, i.e. the availability of the foreign sources of funding.

The signs of the loading coefficients and the signs of the coefficients in the estimated cointegrating relation signal potentially destabilizing relationships. This finding is rather peculiar at first sight given that, according to the Granger Representation Theorem, the presence of the cointegrating relationship (Table 4.7) suggests that there should be a mechanism by which these variables adjust in the long run when one changes. As will be demonstrated later in this Section, this finding is not a consequence of a potentially inadequately estimated relationship given the small sample. Similar findings in terms of the relationship between the variables in the ARDL-ECM approach (that, despite being less informative, is more appropriate for small samples), suggest that an equilibrating force was omitted from the model. In other words, there is something that affects the level of the risk of a currency crisis in a small open economy such as BH more than the level of economic activity.

Underspecification of the statistical model, in the context of an omitted variable issue, may affect the estimates. Pashourtidou (2003) argues that underspecification results in either a failure to detect a cointegrating relationship (in the case when the true cointegrating rank is smaller or equal to the number of omitted variables) or underestimation of the cointegrating rank (in the case when the true cointegrating rank is greater than the number of omitted variables). In the underspecified statistical model the estimator of the detected cointegrating vectors is shown to be consistent, but that is not the case for the estimators of the adjustment coefficient matrix. The simulations in this study demonstrated that although the analytical results are asymptotic, the theoretical findings also apply to small sample sizes.

The standard approach to dealing with an omitted variables problem is to use instrumental variables or proxies. However, to use them correctly, one must know what important variables are omitted and how to model their influence on the dependant variable via proxies. In the VECM estimated in this chapter we do not know which variable is omitted and, most importantly, we cannot tell whether its omission is of such consequence that the loading coefficient would completely switch the sign once the omitted variable is included or only the size of the coefficient would be affected. If any integrated variables that should be included are omitted from the cointegrating relationship, then the remaining variables will fail to cointegrate (Stern, 2011). In line with Pashourtidou (2003), and in the context of the VECM estimated in this chapter, this would imply no cointegrating relationship between LI and IIP. As the cointegrating relationship is detected by Johansen trace (1995) and Saikkonen and Lütkepohl (2000a; 2000b; 2000c) cointegration tests (Table 4.7), and supported by the ARDL-ECM approach (Appendix 4.8, p.376), the true cointegrating rank cannot be smaller or equal to the number of omitted variables. If the true cointegrating rank is larger than the number of omitted variables, the true rank of the VECM estimated is at least two. Note that this case does not invalidate the existing estimated cointegrating relationship between LI and IIP (Table 4.8b), but it might indicate that the estimated speed of adjustment is too slow or too fast. IIP might still be a potentially destabilizing force in the short-run, but the VECM normalized on LI might be equilibrating due to impact that IIP and omitted variable have on each other.

Theoretically, there is a possibility that the omitted variable is I(0), regardless whether it is a lagged endogenous variable or new exogenous variable. Again, the long-run relationship between LI and IIP would not be affected, but the loading coefficients might be as the unadjusted part of the relationship represented by the VECM from the previous period might differ significantly. Therefore, if one wishes to investigate determinants of changes in the risk of currency crisis alone, one should expand the system as the level of industrial production is not the only factor that determines it and vice versa. The VECM estimated in chapter 6 when both measures of the systemic risk are observed as a system, together with IIP and LTDOMFUND still indicate that the risk of a liquidity crisis and the level of industrial production are potentially destabilizing variables in the system. However, the magnitude of the attraction outweighs the repulsion once the banking sector capital becomes the part of the system via the risk of a banking crisis. Furthermore, in the shock propagation simulation in chapter 6 it will be demonstrated that the adjustment towards the equilibrium occurs via a damped cycle reflecting the impact of these potentially destabilizing forces in the system.

In addition to the omitted variable, other possible causes of the failure to detect the expected cointegration (or failure to detect the expected economic relations) between the variables are the tendency of standard unit root tests to suggest the presence of unit root in macroeconomic series and normalization on a “wrong” variable (Maddala, 1992). Fully aware of the questionable reliability of unit root tests in small samples that are, in addition, characterized by transitional growth dynamics (Section 4.4), after inspecting the series „by eye“, performing a set of conventional unit root tests, such as ADF and PP, and performing Perron’s (1989) test for unit root under the assumption of structural break in the case of IIP (Appendix 4.5, p.357), it was concluded that the hypothesis of unit root should not be rejected. Following the recommendation in Maddala (1992), a test with stationarity as the null and unit root as the alternative hypotheses was also conducted (Appendix 4.8, p.376). The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test (Kwiatkowski et al., 1992) suggested that one should reject the hypothesis of stationarity. Together these results strongly indicate that both LI and IIP are I(1).

The choice of normalizing variable should produce long-run relationships consistent with economic theory (Rossana, 2004). As the VECM specification assumes that all endogenous variables adjust towards the equilibrium when one of the changes, the Bounds test methodology was applied to test whether the correct variable as chosen as the normalizing variable in the VECM (Appendix 4.8, p.376). Table below summarizes the Bounds test run on all endogenous variables from the VECM. No cointegrating relationship was detected except in the case of the restricted VECM normalized on LI.

Table 4. 10: The results of the Bounds tests

Note:
The lower and upper bounds for the Narayan (2005) F-test statistic at the 10%, 5%, and 1% significance levels for 30 observations and k=1 are [6.01,6.78], [7.16,8.27] and [10.61,11.65] respectively.
The lower and upper bounds for the Narayan (2005) F-test statistic at the 10%, 5%, and 1% significance levels for 30 observations and k=2 are [4.58,5.60], [5.55,6.75] and [7.98,9.41] respectively.

Normalizing variable	Independent variables (endogenous in the VECM)	F-statistic	Result
LI	IIP	7.19	Cointegration
IIP	LI	4.26	No cointegration
LI	IIP, LTDOMFUND	2.92	No cointegration
IIP	LI, LTDOMFUND	2.77	No cointegration
LTDOMFUND	LI, IIP	4.32	No cointegration

Given all these considerations, one should assume a cointegrating relationship between LI and IIP in which real economic activity favours more stable financial systems. However, the speed at which both variables adjust to restore equilibrium may be incorrect in the VECM estimated in this chapter. There is no evidence that the sign of the loading coefficient next to IIP is wrong given that real economic activity also favours less banking crisis prone systems as well and that IIP is also potentially disequilibrating despite the fact that the system is, overall, equilibrating (Section 5.4). The following offers an illustration of the relationship between LI and IIP.

Table 4.11 below illustrates the forces within the cointegrating vector. If the risk of currency crisis was above some long-term equilibrium level in the previous period, the self-correcting mechanism, as indicated by a positive loading coefficient in Table 4.8a, would increase the change in the LI in the current period with respect to the previous period thus pushing the level of systemic risk even further away from the long-term equilibrium level. At the same time, too high a risk of currency crisis in the previous period tends to reduce IIP in the current period, as indicated by a negative loading coefficient in Table 4.8a, thus slowing down the volume of economic activity altogether. This reduction in the volume of economic activity, given a positive coefficient on IIP in Table 4.8b, would further destabilize the system by increasing the risk of currency crisis.

Table 4. 11: The long-term relationship within the system

If LI_{t-1} is too high, i.e EC > 0:	
→ dLI_t ↑	→ $dIIP_t$ ↓
→ LI_t ↑	→ IIP_t ↓
	- then positive sign on IIP in CV
BOTH DISEQUILIBRATING	

Based on the residual analysis (Table 4.9) indicating the correct specification and the plots of the error correction (EC) term with three different representations (Set of figures 4.9 below and Text box 4.1 below for explanation), it is concluded that the expectations of the BH market participants with respect to future economic activities were based on past trends in the volume of industrial production. The volume of industrial production, on the other hand, was not significantly directly affected by an increased risk of currency crisis. However, the indirect effect is evident from a flattening slope of IIP (set of Figures 4.8) in the periods following the macroeconomic shock and reduced risk of currency crisis caused by a strong deleveraging process in the banking sector (Section 4.3).

Text box 4.1: The EC term specifications in JMulti

JMulti allows for four possible representations of the estimated error correction term available (Lütkepohl and Krätzig, 2004), three of which are of interest for the current analysis.

In the first case it is assumed that the EC term depends on the levels of the endogenous variables in the cointegrating vector a period before and the corresponding beta coefficients.

$$EC = \beta^{*'}_{K} Y_{t-1} \tag{4.3}$$

where β^* is a set of coefficients on the endogenous variables, Y_{t-1}. This case is illustrated in Figure 4.9a below.

The second case assumes that the EC term depends on the levels of all variables in the cointegrating vector a period before and the corresponding beta coefficients.

$$EC = \beta^{*'} \begin{bmatrix} Y_{t-1} \\ D_{t-1}^{CO} \end{bmatrix} \tag{4.4}$$

where β^* is a set of coefficients on the endogenous variables, Y_{t-1}, and all other, D_{t-1}^{CO}, variables in the cointegrating vector. This case is illustrated in Figure 4.9b below.

Let us assume that the system is in equilibrium and a shock to one of the endogenous variables occurred. The representation in equation 4.4 assumes that the endogenous variables will adjust in the following periods in order to absorb this shock and, over time, restore equilibrium. These adjustments will take place at the speeds specified by the corresponding loading coefficients alone. In other words, it is assumed that the evolution of endogenous variables after the shock is determined exclusively by the long-term relationship between these variables.

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The third representation of the estimated EC term is the following.

$$EC = \beta^{*}{}' \begin{bmatrix} Y_{t-1} \\ D_{t-1}^{CO} \end{bmatrix} M \tag{4.5}$$

Multiplication with the matrix M defined as $M = I_T - X(X'X)^{-1}X'$ ensures that there are no short-term dynamics in the cointegrating vector. In other words, multiplication with the matrix M takes into the account the influences of the recent changes in the levels of the endogenous variables on their current levels. This case is illustrated in Figure 4.9c below.

Finally, the fourth representation of the estimated EC term, the one that is of no interest to this research, is the following.

$$EC = \beta^{*}{}'_{K} Y_{t-1} M \tag{4.6}$$

This specification assumes that the EC term depends on the levels of the endogenous variables in the cointegrating vector a period before and the corresponding beta coefficients adjusted for the short-term dynamics.

Figure 4. 9a: The EC term based on equation (4.3)

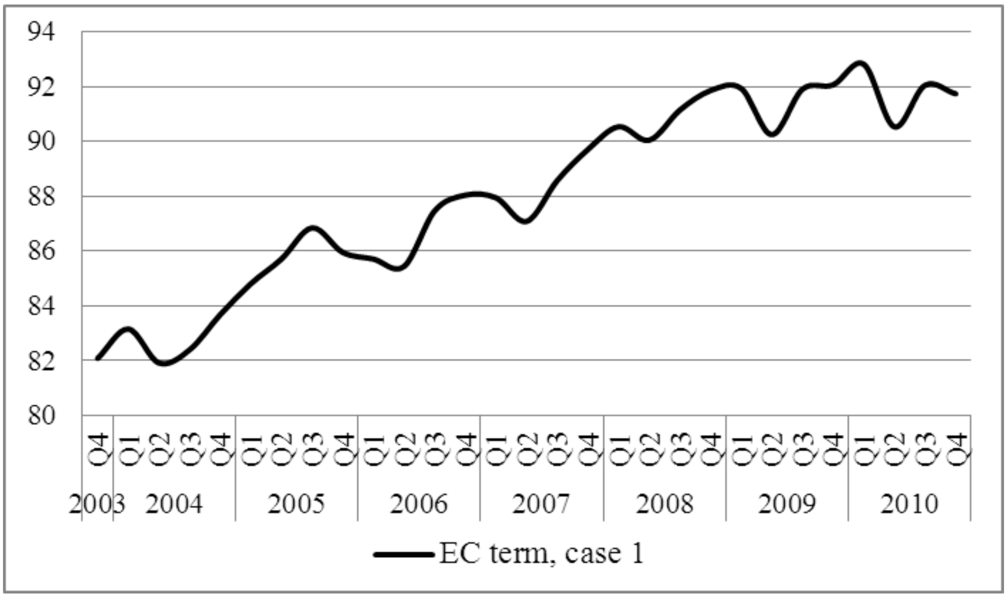


Figure 4. 9b: The EC term based on equation (4.4)

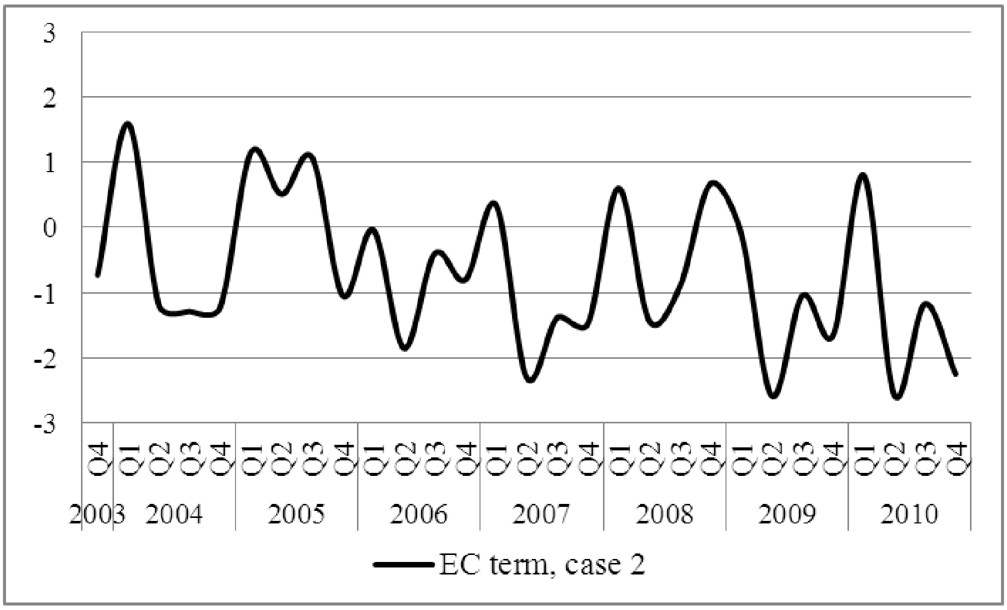
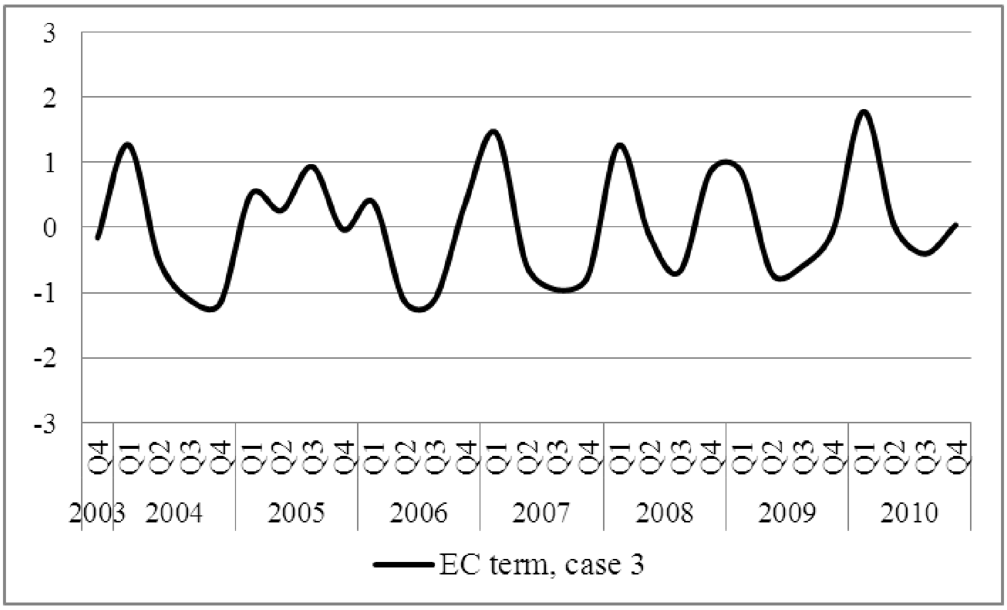


Figure 4. 9c: The EC term based on equation (4.5)



The difference in levels between the EC terms illustrated in Figures 4.9a and 4.9b represent the "black box" effect. Note that the plot in Figure 4.9a resembles the plot of IIP in Figure 4.8, which is understandable given that LI and IIP are the only remaining endogenous variables in the final model. Once all other remaining variables are accounted for, the value of the EC term moves close to zero with a mild downwards sloping trend (Figure 4.9b). Accounting for the short-term dynamics removes this trend (Figure 4.9c). The spikes in Q1 in post 2007 periods suggest that a variable with an effect on the level of foreign reserves, and thus the LI, may have been omitted.

A statistically significant and positive intercept (Table 4.8b) indicates that a certain level of the risk of currency crisis is embedded in the BH financial system[64]. A high intercept (80) is likely a consequence the main components of the foreign reserves. As indicated in Section 3.4, Figures 3.1a-d, only a fraction of banking sector related foreign investment becomes a part of foreign reserves. In a system where the level of foreign reserves is mainly a consequence of the banking sector activity, the system is more prone to crises simply because it becomes more inflated given the way the measure of the systemic risk is constructed. This finding is in line with the conclusions from previous empirical research that large inflows of hot money (and a significant fraction of banking sector related investment, as indicated in Section 1.3 was in the form of

[64] Since the VECM is normalized on LI, LI_log(t-1) in the EC term (Table 4.8b) is set to unity. All other variables switch the sign during the interpretation of the effects since they move to the right hand side of the equation.

deposits) signify a higher risk of a financial crisis (Korinek, 2011). These inflows, however, will reduce the perception of risk in the periods when they occur, as indicated by INFLOW2008 (Table 4.8b).

Over time, the perception of the risk of a currency crisis tends to increase at the rate of 0.52 percentage points per quarter (Table 4.8b). Given that LI is expressed in index points, an average increase of such magnitude does not seem to be much, but being statistically significant, it implies that the risk of currency crisis has steadily increased over time. The presence of a seasonal pattern is indicated by statistically significant seasonal dummies, S1, S2 and S3 (Table 4.8b).

The level of risk increases significantly once a macroeconomic shock occurs, as indicated by SHOCKLEVEL (Table 4.8b). In the case of BH, the external macroeconomic shock that occurred at the end of 2008 increased the level of risk of currency crisis by 10.7 percentage points when compared to the initial level in the pre-crisis period. Following the shock, the risks start to decline while the system adjusts towards the new equilibrium, which is suggested by a statistically significant SHOCKTREND (Table 4.8b). The speed at which the risk decreases over time (-0.46) indicates that in the case of BH the adjustment towards the new equilibrium level was gradual. This finding could be a consequence that in BH a currency crisis did not occur. Furthermore, a gradual reduction in the perception of systemic risk following the shock may have been caused by a weakening demand of domestic sectors for long-term funding, rather than of the modern type of bank run that resulted in gradual deleveraging of banks.

The short-term dynamics in the VECM indicate that a change in LI in the current period is caused by the changes in IIP in the previous period (Table 4.8c) and USDEUR in the current period (Table 4.8d). A percentage point raise in IIP in the previous quarter is found to reduce LI by 2.9 percentage points, suggesting that stability of the currency favours stronger economic activity. The nominal appreciation of EUR with respect to USD is found to simultaneously increase the level of LI. This finding suggests that the effect of USDEUR on LI via foreign debt servicing, as suggested in Table 4.2 is muted by another effect. The most likely explanation is that USDEUR captures the effect of economic developments in the Eurozone. Appreciation of EUR is driven by strong economic activity in the Eurozone. Favourable macroeconomic conditions resulted in high liquidity and narrowing yields in home markets for banking groups present in the

CESEE countries. Higher returns in host countries and their strong demand for loans resulted in raising the risk of currency crisis in these countries as a consequence of increased exposure to cross border flows of capital.

The fraction of long-term loans funded domestically is found to increase by 0.33 percentage points in the current period for each percentage point increase in the period before (Table 4.8c). The bank run from October 2008 was found to reduce LTDOMFUND by 2.9 percentage points (Table 4.8e).

As a robustness check of whether one might assume a cointegrating relationship between LI and IIP, a less complex model, more suitable for the cases of small number of the degrees of freedom, the ARDL Bounds Testing methodology of Pesaran and Shin (1999) and Pesaran et al. (2001) was estimated (see Appendix 4.8, p.376 for detailed explanation of this methodology and estimated results) based on the final restricted VECM represented by the set of Tables 4.8. An ARDL-ECM might be a simplified version of reality in the sense that allows for change in the dependant variable conditional on changes in variables that are cointegrated with it, but it tells nothing on the feedback effect for which the VECM allows. Nevertheless, it should indicate the following: whether it is safe to assume a cointegrating relationship; whether the relationship between the endogenous variables from the VECM holds (i.e. whether the VECM estimates are consistent given that there are only 29 observations and 14 variables in the VECM normalized on LI); what is the adjustment process in the dependent variable given the shock in the explanatory variable; and what are the short-term effects. This approach is implemented by an OLS estimation, which has known and good small sample properties. Hence, this analysis can provide a benchmark for assessing the efficiency of our VECM estimates.

The ARLD-ECM methodology (Appendix 4.8, p.376) suggests that the cointegrating relationship between LI and IIP was correctly detected by the VECM despite the limitations in the number of degrees of freedom. The simpler model, that we believe for the reasons mentioned above should be inferior to VECM in explaining the complexity of the underlying relationships between the risk of currency crisis and the real economy confirmed that in the long run stronger real economic activity promotes stability. Granted, the estimated coefficients are quantitatively different,-18.08 in the VECM compared to -4.96, but as already argued, they were not expected to be identical. The ARDL-ECM approach also indicates that there is a process of short-term adjustment towards the long-run equilibrium. The estimated coefficient (Table A4.24, a replica of which is reported below) indicates that 58.6% of any disequilibrium between IIP and LI is corrected within a single quarter via changes in LI alone.

A replica of Table A4.24: The restricted ECM estimation output

Dependent Variable: D(LOG(LI))
Sample (adjusted): 2003Q3 2010Q4
Included observations: 30 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.334	0.850	-0.393	0.698
D(LOG(LI(-1)))	-0.035	0.170	-0.208	0.837
D(LOG(IIP(-1)))	-1.863	1.052	-1.771	0.089
USDEUR	0.293	0.641	0.458	0.651
RES_LI(-1)	-0.586	0.258	-2.270	0.032
R-squared	0.262	Mean dependent var		-0.010
Adjusted R-squared	0.143	S.D. dependent var		0.381
S.E. of regression	0.352	Akaike info criterion		0.902
Sum squared resid	3.101	Schwarz criterion		1.135
Log likelihood	-8.524	Hannan-Quinn criter.		0.976
F-statistic	2.214	Durbin-Watson stat		1.844
Prob(F-statistic)	0.096			

Consider the case when the system is in equilibrium and there is a decrease in the volume of industrial production. This fall in economic activity will result in LI being too high. Note that this scenario mirrors the one described in Table 4.11 as it illustrates the forces within the cointegrating vector that starts with the assumption that LI_{t-1} is too high, i.e. EC term > 0. Based on the ARDL-ECM estimates (table above), LI will then increase to correct this disequilibrium with 58.6% of the remaining deviation corrected in each subsequent period thus increasing the level of LI. This is considerably faster compared to 0.14 estimated by the VECM (Table 4.8a). Again, quantitatively identical coefficients were not expected as the VECM is a system of equations that allows for the interaction between the variables. This is where the ARDL-ECM stops. Being a single equation model, it does not allow for the feedback effect, but it did isolate the long-run relationship between the level of economic activity and the measure of the systemic risk, as well as the short-run adjustments in LI necessary to restore the equilibrium once IIP changes. The VECM, however, suggests that IIP would decrease even further and additionally destabilize the whole system. A possible scenario would be an increase in the level of the risk of a banking crisis as a consequence of banks' deleveraging. Ultimately, the process of deleveraging (generally associated with deteriorating macroeconomic conditions) will result in more strict lending conditions that will affect industrial production.

Therefore, caution is recommended when interpreting the results of either the VECM or ARDL-ECM. The latter may be more appropriate for small samples, but it will miss the finesse of a more subtle model that allows for the interaction between the variables. The VECM, on the other hand, may fail to detect the mechanism of the short-term adjustment towards the long-term equilibrium in small samples, even in the absence of numerous structural breaks. Based on economic theory and the expected relationship between the variables, none of these models should be discarded. However, we do encourage running both the VECM and ARDL-ECM in small samples, where more merit to detecting a cointegrating relationship is given to the ARDL-ECM. If that model suggest a cointegrating relationship, then running the VECM might reveal some interactions between the variables that the ARDL-ECM cannot detect. In this particular research the ARDL-ECM suggested that there might be a long-term relationship between the level of real economic output and the level of systemic risk, which is in line with the Granger Representation Theorem. The VECM output, however, is consistent with Minsky's notion that real economic activity may endogenously generate instability on the path towards the long-term stability of the system.

The aim of this section was to build a model that captures changes in the perception of risk of currency crisis in BH. The chosen model is a VECM that captures the cointegrating relationship between the risk of currency crisis and economic activity. The main conclusions will be summarized in the final section of this chapter.

4.5. Conclusion

Building upon the measure of the risk of currency crisis (LI) developed in Section 4.3, this chapter aimed to identify the causes of changes in the perception of risk of currency crisis in BH. Based on the existing theoretical framework and previous empirical research a list of variables believed to have some explanatory power in the model built to explain changes in LI was identified. It was concluded that a VECM specification would be the most suitable model. Favourable diagnostics, despite the limitation in the size of the sample, confirmed its appropriateness.

Overall, the system was found to be sensitive to external shocks, while the relationship between the endogenous variables was found to be disequilibrating. In other words, higher economic activity will fuel the risk of currency crisis, while this increased level of risk, being a consequence of significant banking sector related cross border inflows of investments, will increase the level of economic activity via banking sector lending. Since there is no self-correcting mechanism, it takes a shock to deflate the risk of currency crisis. The size and the nature of the shock will determine whether the process of adjustment towards the new equilibrium will be gradual or rapid.

There is some evidence to suspect that the level of economic activity is the underlying, but not the main cause of the rising risk of a currency crisis in BH. The short-term dynamics suggest that an increase in the volume of industrial production in the previous period negatively affects the perception of risk in the current period. Yet, the cointegrating relationship between LI and IIP suggests that the two fuel each other in the long run. A likely explanation for this phenomenon is that the inflows of foreign funding were caused by the expectations of BH market participants of future economic activities that were extrapolated from the past trends in the volume of industrial production. Once the macroeconomic shock of significant magnitude occurred and the risk of currency crisis started to deflate, the slope of IIP was flattening, suggesting that the adjustment towards the new equilibrium was affecting the volume of economic activity indirectly. This potential relationship between the banking sector activity and the risk of currency crisis will be examined in Chapter 6.

Interestingly, some of the variables, like the level of unemployment or the difference between domestic and foreign interest rates were found to be uninformative. A possible implication of the former is that the moral hazard and the implicit guarantees in the lending process in BH were rather significant. In other words, there is evidence to suspect that banks undertook more risk and did not evaluate their clients as diligently as would be the case had the use of the institutions of guarantors and co-debtors not been used so extensively. This relationship between the level of underlying economic activity and the lending activities of banks will be investigated in more detail in Chapter 5. In the case of the latter, especially given the significance of the current change in USDEUR on the current change in LI, it is likely that domestic lending rates in the observed period were determined by the availability of foreign funding further underlying the sensitivity of the BH financial system to the shocks from abroad.

Chapter 5: Causes of changes in the perception of the risk of a banking crisis in BH

5.1. Introduction

The aim of the previous chapter was to determine how a set of macroeconomic and banking sector specific variables, by influencing the liabilities of the banking sector, affect the perception of the systemic risk of a currency crisis. The aim of this chapter is to investigate how the same groups of variables, by influencing the items on the assets side of individual banks' balance sheet items, affect the solvency index (SI) developed in Section 3.5.

The SI is constructed as a measure of the distance between where the system is currently at and the level at which banks' equity would be fatally depleted due to a worsening in the quality of the banks' assets. As the recorded value of the index approaches the ceiling of 100, the banking system is perceived to be closer to a banking crisis. The level of the SI is determined by the factors that directly influence the quality of the banking sector's assets, primarily loans, and the level of the banks' equity.

The structure of this chapter is as follows. Section 5.2 focuses on the theoretical background of a banking crisis, critically examining different approaches that stem from the seminal articles and highlight recent trends. The focus will be on the triggers of changes in the theoretical and analytical approach to banking crises and a general overview of the characteristics of the theoretical developments over the past couple of decades. The relevance of findings from the theoretical framework will then be evaluated in the light of BH's current conditions. Based on the analysis presented in Section 5.2, the theoretical linkages between the currency and banking crisis models and the conclusion from the previous chapter, Section 5.3 demonstrates that the variables used to explain changes in the perception of risk of a currency crisis should also be used in the case of SI. The only differences between the two should be the dates of breaks in the deterministic trend indicating that the risks coincide, but also cause changes in each other. The VECM was chosen as a suitable model capable of capturing the expected changes in the perception of the risk of currency crisis over time and the same analytical approach is employed in the case of SI in Section 5.4. Such an approach allows the investigation of the long-run relationships between the two measures of risk, macroeconomic activity and activities of banking sector in Chapter 6 and for testing whether the LI and SI should be merged into a single indicator of financial fragility. Section 5.5 concludes.

5.2. The theoretical framework

The starting premise of this chapter is that the effect of macroeconomic variables on the level of banks' capital will differ depending on a set of pre-conditions. These pre-conditions, as the theory suggests, span from excessive influence of government on the lending policies of the banking sector to imprudent lending policies of the banks themselves, especially pronounced in the periods of economic expansion. The vulnerabilities identified in this section will be linked to the results of empirical studies on signals of a forthcoming banking crisis in Section 5.3, thus providing a ground for our own empirical analysis in Section 5.4.

At the beginning of this section the emphasis is placed on the high incidence of banking crises since the 1970s and the various circumstances in which they have materialized. This section then proceeds towards identification of the main pre-conditions that make the banking system crisis-prone. Towards the end of this section a summary table groups the relevant studies around these banking crisis pre-conditions and comments on their relevance from the BH perspective. The branch of research that is based on network analysis will not be addressed in detail given the dominance of the banking sector in the BH financial system and weak inter-linkages between the BH banks (Section 4.2.1). Sensitivities to a common macroeconomic shock and the possible channels of contagion (Boss et al., 2004a and Pesola, 2008) will be accounted for via the causes of credit expansion of the BH banking sector. Lending and deposit-taking activities between the banks (Furfine, 2003; Iyer and Peydró-Alcalde, 2005) and the correlations between changes in prices of both individual and pooled assets (Segoviano et al., 2006, Nijskens and Wagner, 2008, Caporale et al., 2009, and Benmelech and Dlugosz, 2009) are irrelevant from the BH perspective at its stage of financial system development (Sections 1.2 and 4.2).

The high incidence of banking crises in the first half of the 1990s (Section 2.2) led to a significant rise in the number of studies examining their causes. Given that the vast majority of systemic banking crises occurred in developing and transition countries, the research, especially the empirical work, was skewed towards their specific macroeconomic conditions and the home-host issues in international banking. As an illustration, Laeven and Valencia (2008) attributed only 8 out of 124 systemic banking crises identified in their database to developed countries: the 1998 U.S banking crisis; the 1991 Nordic banking crisis in Finland, Norway and Sweden; the Asian crisis in 1997 in Korea and Japan; and the 2007 sub-prime crisis in the U.K. and the U.S. However, the recent wave of banking crises, such as those in Iceland, Ireland and Spain, occurred after the study undertaken by Laeven and Valencia (2008) and directly affected only developed countries. Although the incidence of crises in the observed sample is highest in Africa and the Americas, one can distinguish three types of crises: those in which the crises are isolated cases; those in which the crises are mainly regional; and those in which several regions simultaneously experienced crises. Given that the global financial crisis commencing in 2007 directly affected mainly developed countries, one might argue that there is a fourth type of "crises": one in which similar financial systems are affected, regardless of their geographical position. Here the term "similar financial systems" is primarily used as a synonym for developed economies, since there is no clear indication which of the two types of financial systems, namely the market-based and bank-based, are more prone to banking crises. This difference in banking crisis clustering suggests that, in order for a crisis to occur, there must be more than one, or a different combination of several pre-conditions. Consequently, there may be more than a single banking crisis trigger.

The reasons why banking crises are so unpredictable are numerous: they tend to occur under different macroeconomic environments; they can be systemic or random events; and different shocks may trigger them. In the case where a banking crisis is a consequence of a speculative attack on a currency there are certain macroeconomic factors that the speculators interpret as the favourable developments for the success of the attack (Jeanne 2000; Disyatat, 2001; Liu, 2009). Blanchard (2009) views a flight of foreign investors, or the modern type of a bank run, as predominantly the consequence of macroeconomic imbalances. Chang and Velasco (2000) establish a connection between a bank run and the imbalances in banks' balance sheets. Their model is an extension of the model introduced by Diamond and Dybvig (1983) in which a maturity transformation of liquid liabilities to illiquid assets may enhance welfare, but also leaves banks subject to self-fulfilling runs. Alternatively, hysteria induced bank runs may be a cause of a banking crisis, a currency crisis or both, but here there may not be any signs of the forthcoming crisis. In their effects and propagation channels they resemble a classic bank run, but they may occur when there are no obvious imbalances in either financial or macroeconomic system. According to the CBBH (2009), the bank run that occurred in BH in October 2008 was hysteria induced and a consequence of downgrading of some foreign mother-banks. These types of banking crises will not be the focus of this chapter because such random events cannot be modelled.

The early research on banking crises (Demirgüç-Kunt and Detragiache, 1998 and Kaminsky and Reinhart, 1999) focused on the state of the macroeconomic environment at the moment of the crisis, investigating which macroeconomic developments coincide with banking crisis. Based on Demirgüç-Kunt and Detragiache (1998) weak macroeconomic conditions, represented by sluggish growth, an inflationary environment and accompanied by vulnerabilities in the balance of payments, represent a fertile soil for banking crises. Similarly, Kaminsky and Reinhart (1999) argue that these crises typically occur as the economy enters a recession, following a prolonged boom in economic activity, in a system with an overvalued currency. This research adopts Honohan's (1997) classification of the preconditions for banking system failures, placing the theoretical framework and empirical research into one of the three broad categories. According to this approach, banking system failures are the consequence of one of the following: an endemic crisis in a government-permeated banking system; poor management and other microeconomic deficiencies including supervisory failures; or macroeconomic epidemics. Each of these preconditions will be evaluated in the context of BH and the conclusions will be used as the platform in the following section for the selection of variables for the empirical work.

5.2.1. Government-permeated banking systems

A government-permeated banking system is usually viewed as a cause of an endemic crisis. The main weakness of such a banking system is embodied in the strong influence of the government and its priorities. The planned economies' banking systems were a representative case of a government-permeated banking system, but any system that directly finances the government and/or whose lending decisions are influenced by the government can be qualified as such. In other words, any system in which the government has a significant influence on the banking sector's lending policies can be viewed as a government-permeated banking system. As argued later in this sub-section, even some regulatory measures, such as “excessive” compulsory deposits with the monetary authorities, may be characterized as introducing a strong government influence.

In the first half of the 1990s, an economically and socio-politically specific group of countries was experiencing a wave of banking crises. Based on the Laeven and Valencia (2008) database, almost every Central, Eastern and South-Eastern European (CESE) country and a significant number of the former Soviet states experienced a banking crisis in the 1990s. Banking crises in these countries occurred at a specific stage of their transformation from a centrally planned to a market oriented system (Tang et al., 2000; Enoch et al., 2002; Bonin and Wachtel, 2003; Barisitz, 2008). The initial establishment of the new banking sector occurred though two channels: the abandonment of the monobank system and the liberalization of banking laws in order to allow the entry of new banks. The commercial banks that were established out of the monobank were generally not in competition with each other, since they were all state owned and serviced a pre-specified sector of the economy (Enoch et al., 2002). The numerous private banks that were established in the era of lax licensing procedures operated under almost no supervision at all. A large number of those small private banks were established with a sole purpose of generating funds to lend to the owner’s other business interests (Enoch et al., 2002). With a significant accumulation of domestic and foreign debt, a considerable weakening in the performance of the large enterprises, that were the main clients of these banks, and huge external imbalances, typically non-performing loans (NPL) increased and, eventually, resulted in banking crises across the region. After the resolution and restructuring processes were completed at different cost and with different degrees of success (Tang et al., 2000), the entry of the foreign-owned banks occurred in the late 1990s through the privatization of the remaining state-owned banks or the buy-outs of the restructured domestically-owned banks.

The key signs of strong government interference in the banking sector are the following: a significant share of the government ownership of the banking system (Honohan, 1997; Tang et al., 2000; Enoch et al., 2002; Bonin and Wachtel, 2003; Barisitz, 2008); a significant presence of compulsory deposits or sectoral allocations (Honohan, 1997 and Enoch et al., 2002); high commercial banks’ borrowing from the central bank (Honohan, 1997) and explicit and implicit financial intermediation subsidies and taxation (Honohan, 1997 and Tang et al., 2000).

In the case of BH the share of the government ownership of the banking sector has decreased rapidly over time (Section 1.3). At the end of 2010 the share of state ownership in total banking sector equity was less than 2% (there were no majority state-owned banks) implying that this type of potential state interference is negligible. One form of compulsory deposits are the required reserves held at the Central Bank. The highest rate of required reserves was recorded just before the bank run in October 2008 when the banks' lending activity was at its peak. The banks had no difficulties meeting the prescribed rate of required reserves; none of them ever failed to meet the requirement, indeed their excess reserves were rather high in the observed period. According to Honohan (1997), a compulsory component above 25% would suggest a high degree of government involvement. Given that the highest rate of required reserves in BH was 18% and the banks still had excess liquidity suggests that this type of potential state interference was not risk-inducing. The most likely explanation for such finding is the maturity structure of the banks' assets and liabilities. Given that the funds in the reserves accounts represent highly liquid assets (their maturity is up to 10 days), they are usually financed by sight and other types of deposits with very short maturity (usually up to a month). High demand for the long-term loans, especially by households, could not be met by these short-term funds. For this reason, a high level of required reserves may be a misleading indicator of a high degree of government involvement.

The rules on sectoral allocations usually come in the form of a mandatory share of banking sector loans to specific industries. There are no rules on mandatory sectoral loan allocation in BH. Furthermore, the government is not allowed to borrow long-term from banks and the CBBH received the highest independence rating in the sample of 96 countries in the study of Crowe and Meade (2007). The CBBH has no LOLR function, so there is no possibility of Central Bank's lending to the commercial banks. There are neither explicit nor implicit financial intermediation subsidies nor sector-specific taxes. Based on the listed criteria and the characteristics of the BH economy, an endemic banking crisis caused by the strong interference of the government is not very likely.

5.2.2. Poor management and other microeconomic deficiencies

The second group of symptoms of a forthcoming banking crisis according to Honohan (1997) are poor management and other microeconomic deficiencies. Unlike the previous group, in which banking system distress is preconditioned on an exogenous factor, here the endogenous imbalances are viewed as the key risk factors. For that reason each of the three symptoms, poor management and other microeconomic deficiencies, namely fraudulent activities, reckless behaviour and herding, and poor managerial and lending decisions in the banks themselves, are potentially relevant from the BH perspective. These reflect operational risk and/or weak internal supervision issues that may explain both a single bank failure and high systemic risks. However, note that there may be significant differences between the operational and systemic risks from the supervisory point of view (Appendix 5.1, p.388).

Unfortunately, there is no meaningful way to measure any of the three symptoms of endogenous risk. As Honohan (1997) notices, if it is to be successful, fraud and reckless behaviour must be concealed. For that reason, this phenomenon is usually measured, with very limited success, indirectly by some market signals that aim to capture the investor' sentiment towards the bank itself (Honohan, 1997) or some regulatory indicators (Sheng, 1996 and Honohan, 1997). One of the country specifics in the case of BH is an underdeveloped interbank market (Section 1.3). In such an environment, market-based indicators are muted to the point that they provide little or no information on any deterioration in the creditworthiness of the banking system and cannot be used as a reliable signal of forthcoming turbulence. For all the above reasons, measures of fraudulent activities in the banking sector are no more than educated guesses and as such should not be used to explain the level of the SI.

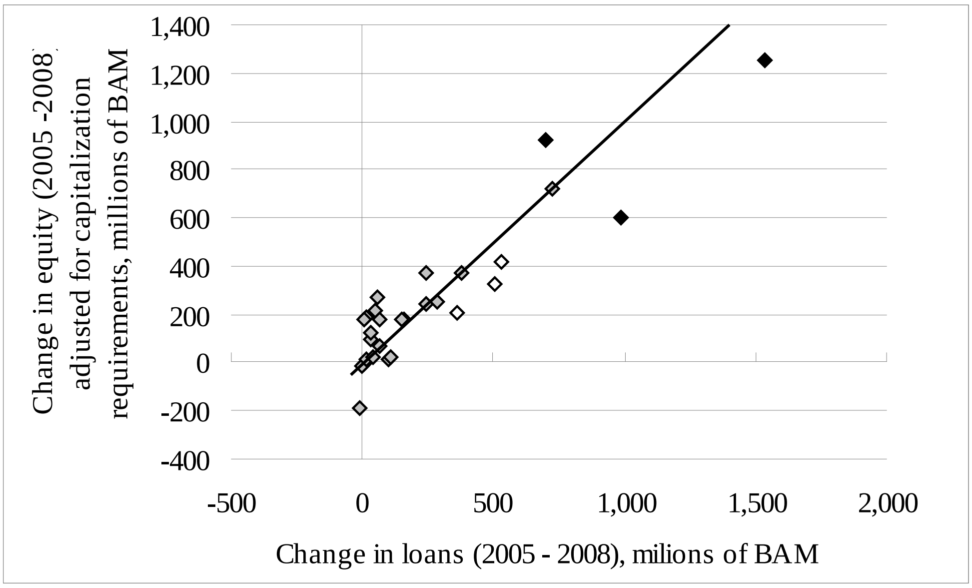
Although ‘herd behaviour’ may be a characteristic of banks’ depositors (Yorulmazer, 2003 and Gu, 2011), the term is also related to behaviour of financial intermediaries and recognized by the existing body of literature as one of the common elements of each financial crisis (Section 2.3). Banks tend to exhibit ‘herd behaviour’ (Kindelberger, 2000; Rötheli, 2001; Stever and Wilcox, 2007; Alves et al., 2008; Tamirisa and Igan, 2008). Their poor lending decisions may cause banking crises (Honohan, 1997; Boss et al., 2004a; Segoviano et al., 2006; Pesola, 2007; Caporale et al., 2009). These poor lending decisions are represented by the underestimation of risks and lowering of lending standards (Eichengreen and Hausmann, 1999; McKinnon and Pill, 1999, 2001; Borio et al., 2001; Dell'Ariccia and Marquez, 2006; Tamirisa and Igan, 2008; Dell'Ariccia et al. 2009). The excessive risk taking behaviour may be additionally amplified by the presence of explicit or implicit government guarantees (Corsetti et al., 1999; Burnside et al. 2003).

There are indications that the herding phenomenon is present in the BH banking sector. If one foreign bank in an unsaturated market undertook a more aggressive lending policy relying on mother-bank funds, then other foreign banks are likely to follow. Alves et al. (2008) also emphasize the link between a bank's expanding balance sheet and the incentives of the other banks to follow, resulting in a possible excessive credit expansion at the level of the system as a whole. Tamirisa and Igan (2008) suggest that during credit booms supervisors need to carefully monitor the soundness of rapidly expanding banks since, over time, weaker banks start to expand as fast as stronger ones. Based on these arguments, Figure 5.1 illustrates the relationship between the growth of loans of individual BH banks and their equity. In both cases the change was calculated as the difference between the end of 2008 and end of 2005 levels. This sample was chosen since it encompasses the years when credit activity was the strongest in BH and the effects of the latest crisis were not yet affecting the balance sheets of banks significantly. Equity is adjusted for the credit risk capital charges[65].

Figure 5. 1: Changes in credit growth and equity in the period 2005-2008

[65] Comparing the absolute changes in stock of loans and equity revealed little. However, by dividingthe change in equity by 0.12 (the capital adequacy ratio is set to 12%) one can tell whether a rise in loans was followed by an 'adequate' rise in equity.

Source: Banking agencies, own calculations



The most distant banks from the 45 degrees line (the black dots in Figure 5.1) are, assets wise, the biggest banks in the BH banking sector. They accounted for 44.7% of total loans at the end of 2010. Note that the one on the left hand side of the 45 degrees line has a higher increase in equity when compared to change in loans. This is a consequence of that bank's policy to increase equity by the amount of retained earnings rather than keeping them in a separate account within Tier 1 (Table A1.5, p.333). In addition to these three, the other banks that recorded significant increases in total loans when compared to equity (the three white dots on the right hand side of the 45 degrees line in Figure 5.1), accounted for only 15.5% of total loans in 2010. Although an overly rapid credit expansion that exceeds a bank's capabilities is taken as a sign of poor lending decisions, in this case it also indicates that smaller banks indeed adopted the more aggressive lending policies of the large banks. The structure of the loan portfolio of the smaller banks mirrors those of the large three banks, suggesting that the smaller banks relied on the large banks' assessments of the profitability of investing in certain industries[66].

The manifestations of poor lending decisions are in general represented by one of the following: an overoptimistic assessment of clients' creditworthiness or loss given default; undue concentration of lending or overly rapid credit expansion that exceeds a bank's capabilities. Figure 5.2a illustrates banks' B10 and B18 changes in their sectoral structure of total loans in the period 2008-2010. These two banks are the ones with the largest increase in total loans in the period 2005-2008 in Figure 5.1. Figure 5.2b illustrates these banks' change in the sectoral structure of non-performing loans in the same period. 2008 was chosen being the year when the credit activity in BH peaked and 2010 being the last year covered by this research, the period in between is characterized by balance sheet adjustments following the significant slowdown in economic activity.

[66] One should note that being on the right hand side of the 45 degrees line does not imply that the bank was undercapitalized, since regulatory capital that is used in the calculation of the capital adequacy ratio is a much broader concept than equity (Table A1.5, p.333). It does, however, imply the possibility that these smaller banks, just like the biggest three banks in the system, were making too optimistic an assessment of the quality of their loan portfolio during the economic expansion. This conclusion is based on the finding that the most significant item besides equity in their capital accounts was general reserves for losses on loans classified as category A.

Figure 5. 2a: Sectoral concentration of total loans in systemically important BH banks

Source: Banking agencies

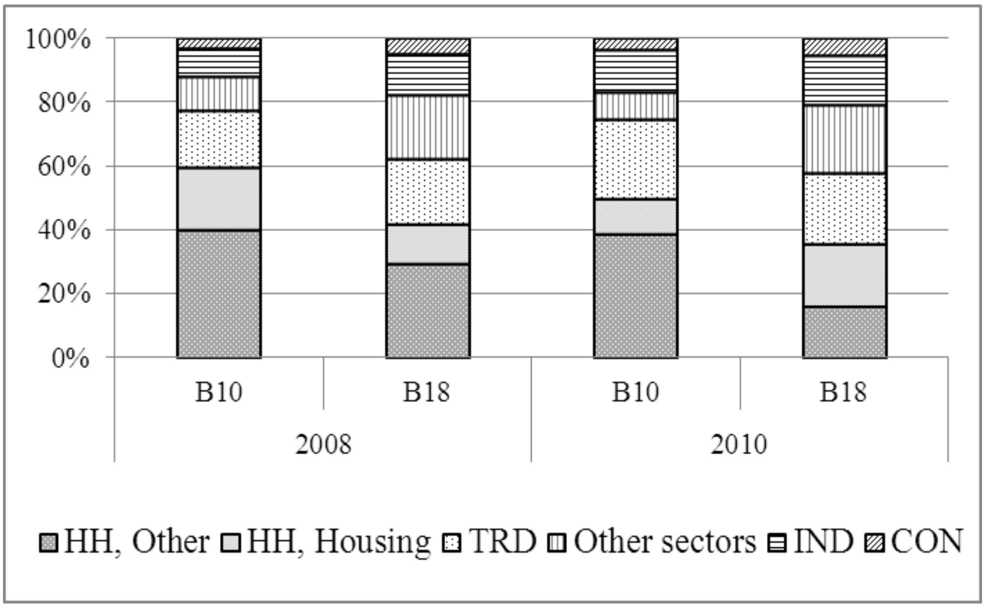
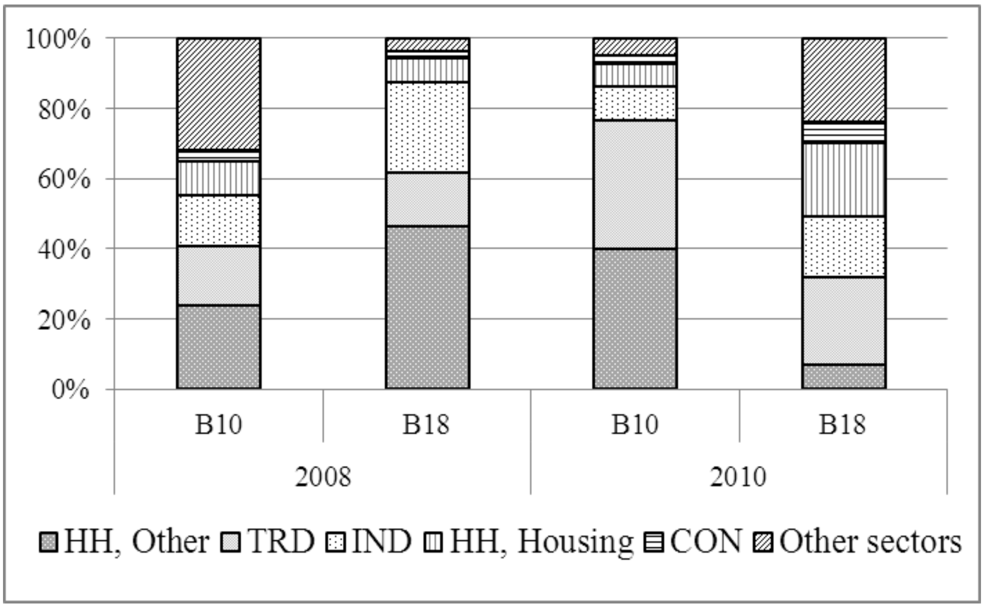


Figure 5. 2b: Sectoral concentration of non-performing loans in systemically important BH banks

Source: Banking agencies



Both banks had significant exposure to households, both in housing loans (HH, HOUSING) and other types of loans, mainly general purpose, to households (HH, Other). When it comes to legal entities, the loans were mainly concentrated in manufacturing (IND), trade (TRD) and construction (CON). These five sectors accounted for about 90% of total sectoral exposure of banks in both pre- and post-economic slowdown periods. According to the CBBH data, new loans recorded a significant decline in 2009 and 2010 when compared to the earlier years. Despite a decline in new loans, the sectoral distribution of total loans remained similar in post-crisis to the pre-crisis years. This suggests that the banks had no significant changes in preferences between different sectors in the pre- and post- crisis periods.

The exposure of BH banks to the different sectors of the economy remained almost unchanged in the period when total loans were recording negative annual growth rates after the prolonged period of growth rates exceeding 20%. At the same time, new loans were extended in modest amounts. Combining these two pieces of information one might argue that some of the banks' irrevocable obligations, that were previously recorded off-balance, were activated. When a loan is approved to a client it instantaneously enters the bank's balance sheet on the assets side and it is provisioned for at an applicable rate of provisioning depending on the classification category that it is placed into. Most loans are classified into category A when approved and they are currently in BH provisioned at 2%. Loans are considered risky assets and, arguably, their quality is closely monitored as the macroeconomic environment changes. Let us assume, for the sake of simplicity, that the bank's only potential irrevocable obligations are the credit and deferred payment cards issued to households. Banks are required to provision only for the fraction of debt that has been activated within the approved limit. On the other hand, banks have obliged themselves to extend credit up to the specified limit at any time for the duration of the contract. Concerned about the quality of their credit portfolio, when the real economy slows down banks extended fewer loans. This was the expected reaction given the procyclical nature of bank lending. However, facing stricter loan approval procedures in a period when their wealth was declining, households relied more on credit card financing. Previously unused limits on the credit cards now entered the balance sheets of banks and had to be provisioned for, thus increasing the costs of provisioning that finally resulted in unexpected losses. Banks then had to additionally capitalize and significantly reduce new lending.

During the economic upswing, in the pursuit of new, or in an attempt to keep the existing, clients the banks tend to neglect that these potential obligations accumulate thus increasing credit and liquidity risk (D'Hulster, 2009). In cases when structured credit products exist, banks may fund a growing amount of long-term assets with short-term liabilities in wholesale market. On a less complex level, this is what was happening in BH as well. The banks were increasing their client base and expanding their assets based on the expectations that the inflow of short-term funds, mainly in the transaction accounts, will not slow down. The final outcome is that, although it may seem that the banks follow a prudent policy reflected in a moderate growth of their potential obligations, their irrevocable obligations accumulated to the point when they became a threat to both banks' liquidity and solvency. In the periods of worsening macroeconomic environment, facing stricter loan approval procedures, both firms and households may increasingly rely on the unused parts of the approved limits (CBBH, 2009). This migration of items from the off-balance records to the banks' balance sheets increases the cost of provisioning and reduces capital adequacy. This finding may be an argument in support of claims that sometimes bank failures can be traced to poor lending decisions based on the over-optimistic assessment of credit worthiness of their clients and macroeconomic trends.

In support of this argument are the developments depicted in Figure 5.2b. While banks B10 and B18 had a similar structure of non-performing loans in 2008, the creditworthiness of their clients in different sectors deteriorated at different rates. The NPL ratio in both banks increased substantially, but its distribution across sectors differed. In the case of bank B10, the increase in NPL was mostly due to a sharp worsening in the quality of general purpose loans to households and loans extended to manufacturing companies. In the case of bank B18 mortgage lending to households and loans to other sectors (less significant in terms of the size in the pre-crisis years) deteriorated the most.

Finally, in this sub-section it is worth touching upon the issue of asset price bubbles. A crisis caused by a burst of asset price bubbles is rather unlikely in the case of BH. The financial markets are underdeveloped in terms of both the size and complexity of traded securities. Available for sale securities make up for less than 4% of banking sector assets and that ratio, recorded at the end of 2010, is more than threefold the pre 2008 level. The risk of lending long-term to households in BH is covered by mortgage, the guarantors, deposited funds and debt insurance. In most cases, bank's protection against credit risk in long-term lending to households is a combination of mortgage and at least one of the other three options. Unlike in developed financial systems, debt insurance is not common in BH, especially in the cases of long-term and high value loans. One of the possible explanations for this is an underdeveloped insurance sector. An inadequate regulatory framework and the absence of large institutional investors such as pension funds, as well as the rather low levels of disposable income make the mandatory insurance, such as the third-party liability insurance, the dominant category in total insurance premiums (CBBH, 2011). For this reason, banks usually, in addition to the mortgage, require debt guarantors, co-signings or deposited funds as the means of credit risk arbitrage. In such an environment, the size of banks' balance sheets does not vary significantly with changes in real estate prices. The mortgage is activated only in the cases when the alternatives for credit risk mitigation fail. In a shallow real estate market such as BH even a few dozen residential units could swamp the market, exerting a downward pressure on prices. Since banks should value their assets at current prices, the banks' balance sheets would have to contract. These extra layers of protection against the mortgage activation in the forms of guarantors or insurance reduce the probability of assets fire sales. There is a possibility that this relatively small number of transactions would exert an upwards pressure on the value of collateral, inflating the asset price bubble and potentially worsening the moral hazard problem. However, the low level of the households' disposable income in BH and historical trends still make housing demand the limiting factor for a strong hike in real estate prices (CBBH, 2011).

Based on the evidence, one might assume significant microeconomic deficiencies in the BH banking sector, primarily in the form of herd behaviour, an overoptimistic assessment of the clients' creditworthiness and an undue concentration of lending. However, given country specifics, the probability of a crisis solely caused by an asset price bubble is still rather low.

5.2.3. Macroeconomic epidemics

Recognizing that the degree to which financial systems can absorb macroeconomic shocks without systemic failure varies greatly across time and countries, Honohan (1997) emphasized the role of endogenous macroeconomic disturbances. The starting premise being that a system is likely to withstand a single macroeconomic shock and that it is a rarity to find a banking system concentrated to a degree that a single bank's failure would pose a systemic risk. Building upon this argument, he explained macroeconomic epidemics as a hybrid between an endogenous lending boom, microeconomic deficiencies in bank behaviour and errors in macroeconomic or monetary policies. An endogenous lending boom is viewed as a consequence of banks' over-optimistic lending decisions that tend to amplify the economic upturn, fostering lending based on unrealistic asset prices.

A credit boom is an episode in which lending is growing above some long-term country-specific trend. The theory of credit booms was developed from business cycle models that established a connection between credit booms and macroeconomic activity. These models incorporate “financial accelerators” by which the real economy effects of shocks to asset prices are amplified through balance sheet effects (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Bernanke et al., 1999). The drivers of the credit booms in these models are: herding behaviour by banks (Kindelberger, 2000; Rötheli, 2001); the underestimation of risks and lowering of lending standards (Eichengreen and Hausmann, 1999; McKinnon and Pill, 1999, 2001; Borio et al., 2001; Dell'Ariccia and Marquez, 2006; Tamirisa and Igan, 2008; Dell'Ariccia et al. 2009) and the presence of explicit or implicit government guarantees (Corsetti et al., 1999; Burnside et al. 2003).

Besides historical and macroeconomic determinants that affect the long-term level of credit, there are factors that tend to push the level of credit above its long-term trends in certain periods. These factors are typically indentified as poor management and the other microeconomic deficiencies identified in the previous sub-section. Strong lending activity in the mid 2000s in BH and neighbouring countries, measured by either the total loans to GDP ratio or annual growth rates of loans, was a common occurrence because of the low initial base and strong domestic demand. For example, in the period from the beginning of 2003 until the bank run in October 2008 total loans in BH were growing, on average, by 26.7% annually. The outstanding loans to GDP ratio grew from 37.2% in 2003 to 58.9% in 2008 with similar levels recorded in the years 2009 and 2010. The tools of monetary policy in BH were restricted by its currency board arrangement and fiscal policy was suffering from the constraints of the high level of unregistered economy, so nothing curbed this ‘excessive’ demand for loans. Only with the latest financial crisis did the BH economy complete a full economic cycle. For that reason, it is impossible to conclude whether the rapid credit growth in BH was based on overly-optimistic expectations of the future economic trends.

The approach of Gourinchas et al. (1999) and its modification used in Cotarrelli et al. (2003) and in Mendoza and Terrones (2008) was used to determine whether BH experienced a credit boom in the 2000s. Before one continues with an application of different credit boom-detecting techniques to BH data, it is necessary to investigate in more detail what is in the trend. As will be explained in more detail later in this section, all three of these studies describe a lending boom episode as a significant deviation of the ratio between an observed measure of lending activity and its trend. In all three cases, a country-specific deterministic trend was used, although Gourinchas et al. (1999)

define a lending boom episode as "a deviation of the ratio between nominal private credit to nominal GDP from a country-specific stochastic trend" (page 6). The validity of the conclusions regarding the existence of credit booms in BH depends on the assumptions made regarding the deterministic trend. For that reason the credit boom conditions from Gourinchas et al. (1999), Cotarelli et al. (2005) and Mendoza and Terrones (2008) will be tested for different assumptions regarding the structure of the deterministic trend in BH. The following text box provides an intuitive, rather than strictly theoretical, insight into the role of a trend in time series analysis. Text box 5.1 also explains how the deterministic trend is derived and these procedures will be applied later in the section when the presence of a credit boom in BH is considered.

Text box 5.1: What is in the trend?

In time series analysis the issue of a trend in data is a major one, since classical estimation methods are valid for stationary series only. There are two ways to ensure the stationarity of a non-stationary process: differencing and de-trending. While differencing the unit root variables is a common approach, it ignores information on the long-run equilibrium relationship implied by economic theory. An investigation of whether there was a credit boom episode in BH places the focus on deviations from the long-term trend and the process of de-trending.

The most common assumption that the economist makes is that if the series is subject to a shock then, after some departure from the trend, the variable will return to its long-term trend value. This assumption implies that shocks have no permanent effect on the long-term trend value: in other words, the series is assumed to have a deterministic trend. Under this assumption, knowing the initial value of a series is sufficient to forecast any future value.

A deterministic trend process can be represented as follows:

$$Y_t = C + \alpha * t + \varepsilon_t \qquad (5.1)$$

where C is an intercept, t is time and ε_t is a normally distributed error term.

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Equation 5.1 reads as follows: an observation in time t is the sum of the intercept, a cumulative growth over the period of time and some errors. A statistically significant coefficient attributed to the time trend is an indication of a non-stationary process that could be made stationary by de-trending. In other words, the series may be stationary around the trend.

The cyclical component, or the deviations of the series from the deterministic trends, is in focus of a credit boom analysis in Gourinchas et al. (1999), Cotarelli et al. (2005) and Mendoza and Terrones (2008). The periods in which the deviation crosses a pre-defined threshold are viewed as the credit boom episodes. A pure deterministic trend, as represented by equation (5.1) is a simplified view of reality. It assumes a constant growth rate over time, or more specifically, a mean that grows around a fixed trend which is constant and independent of time. An a priori assumption of the deterministic trend suggests that the cyclical component, that is equal to the error term from (5.1), is stationary. If the assumption is correct, than significant deviations in series from their deterministic trends may be valid indicators of the credit boom episodes.

An alternative is to assume a deterministic component in an otherwise stochastic process; i.e., a random walk with a drift process (5.2).

$$Y_t = Y_{t-1} + a_0 + \varepsilon_t \tag{5.2}$$

where α_0 is the constant drift.

The difference between equations (5.2) and (5.1) is that the value at time t is regressed on the value from the previous period, rather than on the time trend. Equation 5.2 reads as follows: an observation in time t can be explained by its past value, some constant drift in the series and some white noise in time t. In other words, the change

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in the series between the two consecutive periods is equal to the sum of the constant drift and some random events that occurred in the period underobservation, i.e. $\Delta Y_t = a_0 + \varepsilon_t$. Substituting into (5.2) and solving for the initial period, a random walk with a drift process can be re-written as:

$$Y_t = Y_0 + a_0 t + \sum_{i=1}^{t} \varepsilon_i \qquad (5.3)$$

The terms $a_0 t$ and $\sum_{i=1}^{t} \varepsilon_i$ are both non-stationary and represent the deterministic and stochastic trends respectively. Even under the assumption that the cumulative effects of a constant drift (α_0t in the equation 5.3) are identical to the cumulative growth in the series over time (αt in the equation 5.2), a removal of this deterministic component would not necessarily ensure the stationarity of the series. This may be the case if the random events (ε_t) are small in magnitude and not persistent or if the period for which the trend is estimated is fairly short (Harvey, 1997). Then $\sum_{i=1}^{t} \varepsilon_i$ from (5.3) would not be significantly different from (ε_t) in (5.1).

However, if the cumulative effect of these random events in time t ($\sum_{i=1}^{t} \varepsilon_i$ in equation 5.3) is wrongly assumed to be stationary, then representing the trend by a straight line would result in an overly amplified cycle component. The non-stationarity of the cyclical component indicates that the deviation of the series from its trend is picking up something that should be a part of the trend. From the perspective of the lending boom analysis, an incorrect assumption of stationarity of the cumulative random events would issue a false positive signal of significant deviations in a series from its long-term trend. By not taking into the account that the shocks may have altered the

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trend permanently one risks to wrongly identify deviations of the series from the trend.

A way to deal with the possible non-stationarity of the cyclical component was proposed by Perron (1989) and later advocated for empirical research (Rao, 2010). Acknowledging that a deterministic trend tends to be too restrictive and linear, and that the unobservable components tend to attribute too much of developments to trend rather than cycle, the proponents of this approach argue that the use of a deterministic trend that allows for major changes in the level and the slope should be satisfactory. In other words, the assumption is that the long-term trend in a series can be represented by the time trend adjusted for the effects of structural breaks. Following the approach of Box and Tiao (1975), Perron (1989) proposed separating "outlying" events from the noise function and modelling them as changes in the deterministic part of the general time series model. With this approach the underlying idea is that major changes in legislation and macroeconomic policies, or any outstanding macroeconomic shocks, are likely to be noticed. Each of these events would affect either one or both the shift and slope of the trend. By accounting for the effect of these significant events, and thus smoothing the deterministic trend, one might get a more accurate estimate of the cycle component. Perron (1989) distinguishes three cases of structural breaks in the deterministic trend: a change in the intercept of the trend function (equation 5.4); a change in the slope (5.5); and a sudden change in the level followed by a different growth path (5.6).

$$\tilde{Y}_t = \tilde{C} + \tilde{\alpha} DU_t + \tilde{\beta} t \qquad (5.4)$$

where the sign tilde marks the estimated values, C is the intercept and t is time. DU_t is an intercept change dummy that takes the value zero in the pre- and the structural break period and one otherwise.

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$$\tilde{Y}_t = \tilde{C} + \tilde{\beta}t + \tilde{\gamma}DT_t^* \tag{5.5}$$

DT_t^* is a slope change dummy that takes the value zero in the pre- and the structural break period and the value t-TB otherwise. TB is the order number of the period in which the structural break occurred.

$$\tilde{Y}_t = \tilde{C} + \tilde{\alpha}DU_t + \tilde{\beta}t + \tilde{\gamma}DT_t \tag{5.6}$$

where DT_t is a slope change dummy that takes the value zero in the pre- and the structural break period and the value t otherwise.

Note that each of these equations (5.4, 5.5 and 5.6) resemble equation 5.1; they all have the deterministic component represented by the intercept and the time trend. In addition, the deterministic trend in each is allowed to change due to significant events that are likely to affect the future values of the series. This implies that the trend will be smoother when compared to the pure deterministic trend generated by equation 5.1. From the perspective of the verification of the credit boom episodes, the use of the deterministic trend with structural breaks, if appropriate, would provide some information on the drivers of credit expansion in BH. Once the structural breaks are accounted for, small oscillations of the series around the trend might indicate a catching-up process in the early stages of the banking sector

As illustrated in Text box 5.1, the assumptions made regarding the deterministic trend may have an impact on the conclusion as to whether there was a lending boom in BH. An incorrect assumption of a pure deterministic trend may result in a false positive signal of the presence of a lending boom. A deterministic trend accounting for the structural breaks may be a more appropriate approach. This section will continue by examining whether there were evidences of a credit boom in BH by replicating the approaches of Gourinchas et al. (1999), Cotarelli et al. (2005) and Mendoza and Terrones (2008). In all three studies the Hodrick-Prescott (HP) filter, although with different smoothing parameters, was used to generate the deterministic trend. In addition, the lending boom conditions as proposed in those three studies will be tested under the assumption of structural breaks in the deterministic trend. The deterministic trend with structural breaks will be, based on the characteristics of the underlying series, generated by either equation 5.4, 5.5 or 5.6. Since all three variables used in Gourinchas et al.'s (1999), Cotarelli et al.'s (2005) and Mendoza and Terrones' (2008) approaches are measures of credit activity in a country, two breaks in common to all three series are suspected. The first structural break is accounting for the change in slope and it occurred in 2001. This structural break is associated with the second wave of privatization in 2000, the Euro changeover in 2001 and a removal of the limitations on the foreign borrowing of banks in 2002. Each of these events was crucial for an increase in lending activity (Sections 1.2 and 1.4). With foreign bank entry in the second wave of privatization, the lending activities intensified, which may have resulted in a shift of the trend. The Euro changeover resulted in a significant increase in the domestic deposit base that fostered long-term lending. Changes in the regulatory rules that were promoting the cross border activities of the banks may have altered the slope of the long-term trend. The second structural break occurred in 2008 when the macroeconomic shock resulted in a strong re-adjustment of both the banking sector's lending policies and the borrowers' expectations regarding the future outlook. In this case, the intercept changed.

Analysing a sample of 91 countries in the period 1960-1996 Gourinchas et al. (1999) defined a lending boom episode as a deviation of the ratio between nominal private credit to nominal GDP from the country-specific trend. Private credit is measured as credit from non-monetary institutions (banks and other intermediaries) to the non-banking private sector. In the case of BH, only credit from banks was used. To be counted as a lending boom episode, the deviation had to be larger than the 25% threshold for the relative (relative to the credit to GDP ratio) or 5% thresholds for the absolute (relative to GDP) deviations. Gourinchas et al. (1999) started their analysis with three different thresholds that yielded exactly 100, 80 and 60 cases of a credit boom for both the relative and absolute deviations. The chosen values of 25% and 5% correspond to thresholds that yield 100 cases. The numbers 60, 80 and 100 are interpreted as the probability of the year/country observation being a part of a boom episode. Because outstanding credit is a stock variable measured at the end of the year, the geometric average of GDP of year t and t+1 was used as the relevant measure of GDP in the ratio calculations. As previously mentioned, the original definition in Gourinchas et al. (1999) explains a lending boom episode as a deviation of the credit to GDP ratio from the country-specific stochastic trend. The trend was estimated using the

HP filter, which generates the deterministic trend. The HP filter extracts a time varying deterministic trend with the smoothing parameter lambda commonly set to 100 for annual data. The smoothing parameter in Gourinchas et al. (1999) was set to 1000. This choice of a higher lambda makes the trend more linear when compared to the smaller chosen values, thus detecting larger and more persistent deviations from the trend. The use of an “expanding trend” was justified by arguing that it reflects the credit information available to the policy makers at time t. In later studies, such as Mendoza and Terrones (2008) this was one of the main criticisms of the Gourinchas et al. (1999) approach. Mendoza and Terrones (2008) report that an expanding trend yields a trend process that is close to a smoothed, one period lagged transformation of the original credit series. This implies that the deviations from the trend will tend to be significant, especially at higher private credit to GDP ratios. For that reason, both the deterministic trends with the “standard” and the “expanding” smoothing parameters will be estimated. Comparing the two will provide some information on the validity of Mendoza and Terrones’ (2008) claims for the case of BH. Furthermore, estimating a deterministic trend with structural breaks and comparing it to the “expanding trend” as used in Gourinchas et al. (1989) would provide the information on the persistence of the effect of the structural changes on the long-term trend. If the difference between the two trends is small, than it would be safe to assume that the events from the early 2000s have altered lending policies in BH.

Figure 5.3a illustrates the absolute deviations from the loans to GDP trend based on the procedure applied by Gourinchas et al. (1989). The absolute deviation was presented because it takes into account the level of financial deepening, but the relative deviation approach report similar results. The thick black line represents the private credit to GDP ratio and the dashed line represents its long-term trend. The thin black line represents the deviations of private credit to GDP ratio from its trend for each year. A positive deviation represents a credit expansion episode. In order for a credit expansion episode to be labelled as a credit boom, the absolute deviation must exceed 5%. The results suggest that credit growth in the years 2007, and 2008 could have been described as credit boom. In other words, despite annual growth rates of loans exceeding 20% as of 2004 which is a sign of credit boom in some studies, based on this approach it is argued that euphoria-led lending occurred in the period 2006-2008.

Figure 5. 3a: Lending boom episode definition based on Gourinchas et al. (1999)

Source: CBBH, own calculations

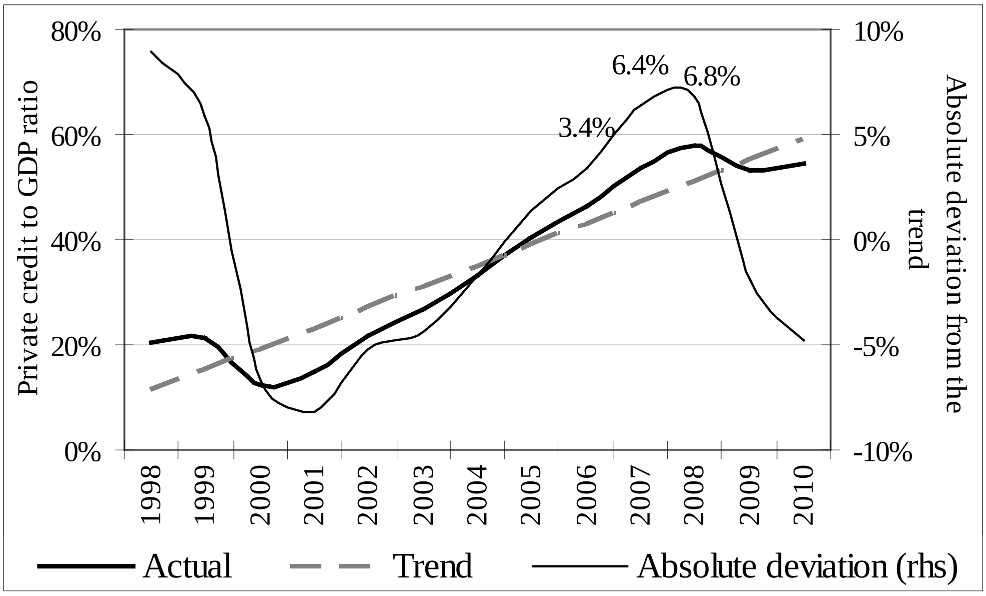
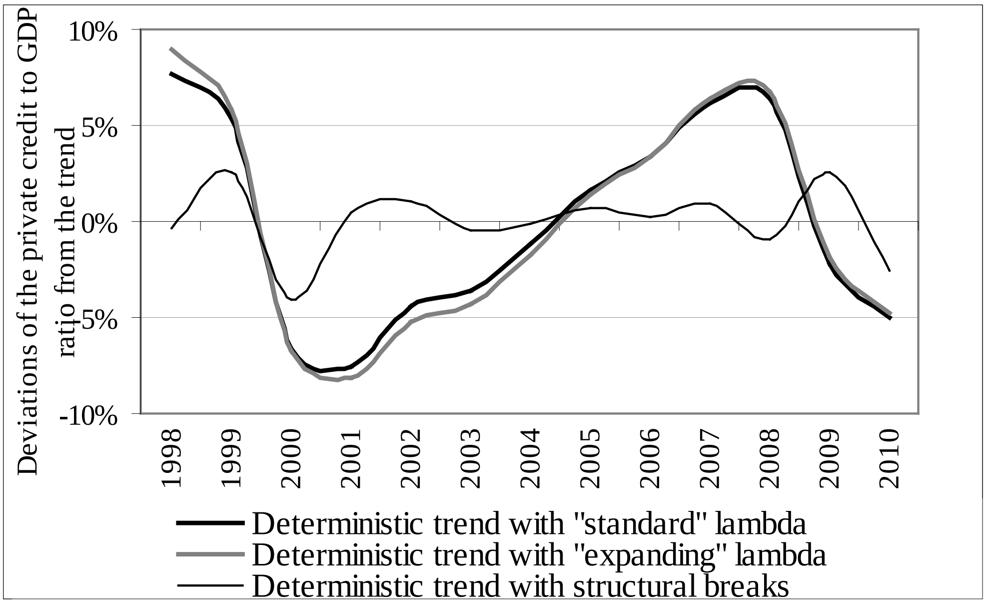


Figure 5.3b illustrates the absolute deviations in loans to GDP ratio from its long-term trend if the trend is: the "standard" HP trend; the "expanding" HP trend; and the deterministic trend that accounts for both the changes in the intercept and slope in equation 5.6. The estimation output for equation 5.6 is given in Table A5.1 (p.390).

Figure 5. 3b: Lending boom episode condition based on different assumptions of trend

Source: CBBH, own calculations

Key: The deterministic trend with a "standard" lambda has the smoothing parameter in HP filter set to 100.
The deterministic trend with an "expanding" lambda has the smoothing parameter in HP filter set to 1000.
The deterministic trend with structural breaks allows for both the changes in the intercept and slope as in equation 5.6.



The first thing that one notices about Figure 5.3b is that the difference between the deterministic trends with different smoothing parameters is very small. In other words, Mendoza and Terrones, (2008) argument regarding the use of an "expanding trend" as in Gourinchas et al. (1999) does not hold in the case of BH's private credit to GDP ratio. This finding demonstrates how the conclusions strongly depend on the period under observation. The shape of the private credit to GDP ratio (Figure 5.3a) indicates strong time trend and almost no deviations around it in the period 2000-2008. As illustrated in the discussion on the choice of structural breaks earlier in this section, the events from the early 2000 enabled strong credit activity in, at that time, a shallow market for loans. Before the wave of foreign bank entry in 2000 and 2001, domestically owned bank had not sufficient or the funds of the appropriate maturity to meet an increased demand for loans. Starting from a very low base, the changes in structure and the regulatory framework of the banking system resulted in a strong time growth pattern of the series until the macroeconomic shock in the mid-2008. The HP filter is a linear filter that generates the smoothed series *s* of *y* by minimizing the variance of y around s, subject to a penalty that constrains the second difference of s (5.7).

$$\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1}((s_{t+1} - s_t) - (s_t - s_{t-1}))^2 \tag{5.7}$$

In short samples, or in the periods that exhibit a strong time trend, both present in the BH sample, the second part of (5.7) that is related to the penalty parameter, λ, may be very close to zero. In that case, it makes a little difference if the smoothing parameter is set close to 0, making the trend similar to the original series, or goes to infinity, making the trend linear.

The specifics of the BH case are also confirmed by deviations of the private credit to GDP ratio from the deterministic trend with structural breaks (Figure 5.3b). Once the changes in the banking environment from the early 2000 and the macroeconomic shock in 2008 have been taken into the account, the deviations have a mean of zero. In such cases it is difficult to detect any significant deviations of the series from the trend. For that reason, in the cases where the sample is small or when the series records unusually high growth just because the staring level was very low, one may have problems detecting if the growth is too fast especially if it is preceded by a financial liberalization or some major event that altered the trend itself.

Based on the original lending boom condition and deviations of the private credit to GDP ratio from differently estimated deterministic trend (Figure 5.3b), there is no strong evidence that a lending boom episode occurred in BH with a possible exception of 2008. Due to the country and period specifics, the loans to GDP ratio were exhibiting a strong time trend. Just before the macroeconomic shock in 2008, lending may have started to deviate more from the long-term trend. In either case, one might claim that lending was growing fast and that there was evidence of credit expansion. Whether that expansion became a boom episode is less certain.

Another assumption made by Gourinchas et al. (1999) that may contribute to the inconclusiveness of the results for some countries, is an identical threshold for all countries in their sample. Figure 5.4 below illustrates the relationship between the average loans to GDP ratios and average annual growth rate of loans in European countries. The countries are grouped based on their status in the process of European integrations at the end of 2010[67].

Figure 5. 4: Difference in the size of financial intermediation in the European countries

[67] The countries are grouped as following.

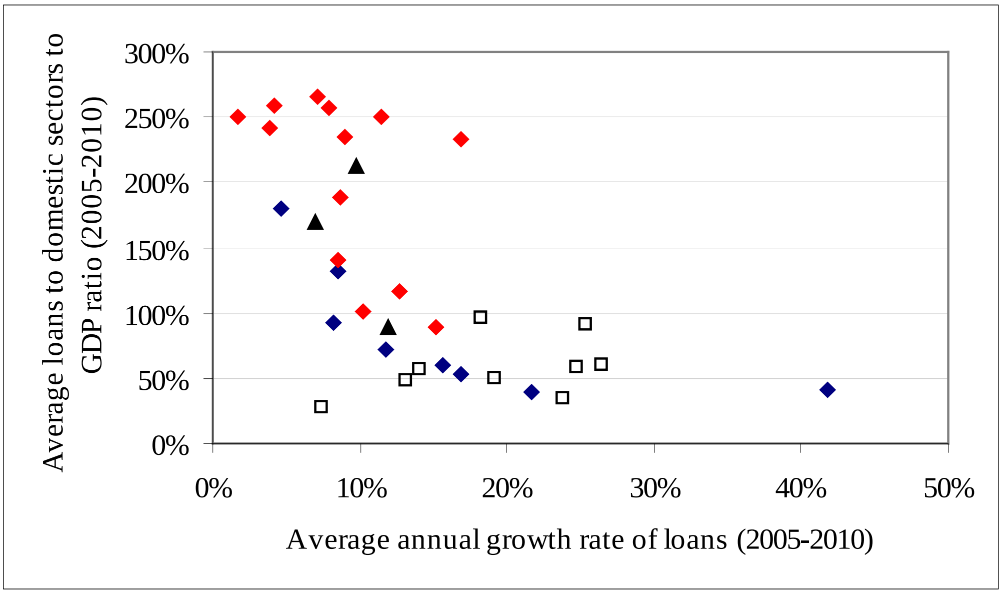
(A) The Eurozone countries: Germany, Belgium, The Netherlands, France, Austria, Malta, Italy, Portugal, Finland, Spain, Greece, Slovenia and Cyprus. Luxembourg and Ireland are not presented since they are both outliers in a sense that their average loan to GDP ratio greatly exceeds the values reported for other countries in Figure5.3.

(B) New EU member states: Hungary, Czech Republic, Slovakia, Estonia, Poland, Romania, Latvia, Lithuania, Bulgaria.

(C) Other non-Eurozone EU member states: the U.K., Sweden, Denmark.

(D) Other countries: Croatia, Albania, Bosnia and Herzegovina, Macedonia, Serbia, Switzerland and Norway.

Source: ECB, national central banks, own calculations
Key: Red diamonds: The Eurozone countries
White rectangles: New EU member states
Black triangles: Other non-Eurozone EU member states
Blue diamonds: Other countries



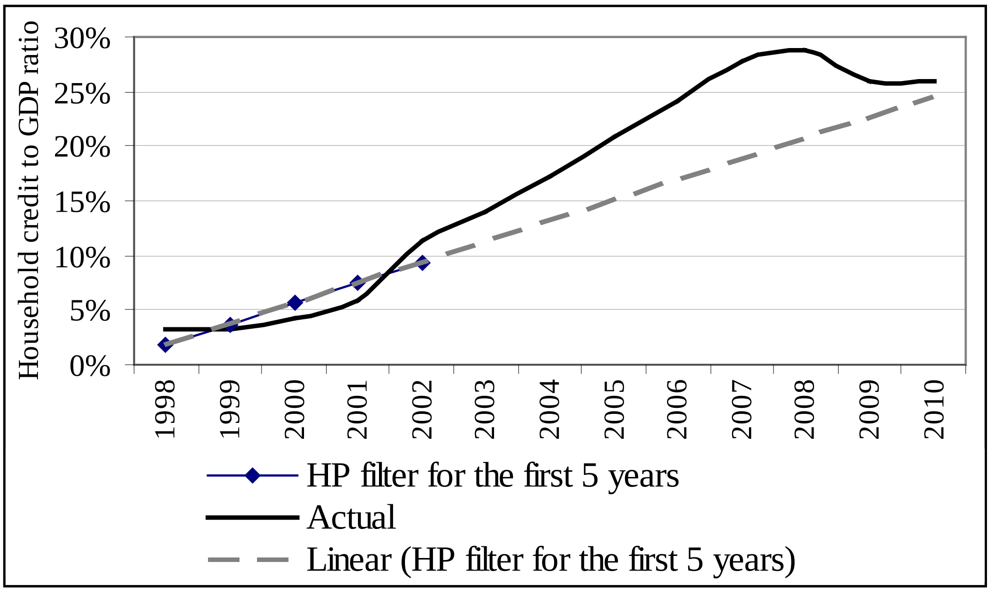
The figure illustrates a clear difference in depth of financial systems as measured by the significance of the banking system activities among the European countries. The banking sector activity in the Eurozone countries is more than threefold the size of the banking sector activity in the new EU member states and the non EU European countries. At the same time, the loans in the latter two groups were growing at much faster rates than those in the Eurozone member countries. Cotarrelli et al. (2003) by analysing bank credit growth to the private sector in CESE countries in the period 1992-2002 reached several conclusions as to the cause of differences in credit growth between the CESE countries. They argued that these differences were not a consequence of catching-up, implying that the credit activity was mostly demand rather than supply driven. Differences in the growth of credit to the private sector were more a consequence of different speeds of structural reforms, rather than the capability of the host country to attract investments from abroad. 'Crowding-in' may also have been a factor, since fiscal constraints limited borrowing by the government, resulting in banks' shift in focus towards the private sector. In their detailed explanation of the reasons for a strong credit growth in the CEE countries, Cotarrelli et al. (2003) also warn about the necessity of close monitoring of credit growth and its implications for financial stability. Maechler et al. (2007) similarly warned of the need for sound supervisory practices in the CESE countries given the higher risk profile of their foreign-owned banks, which is a reflection of their ability to rely on extra funding from the parent institution when needed. This reliance on the mother-bank funding, as noted before, made the banking sectors of the CESE countries vulnerable to changes in the financial strength of the foreign banking group as a whole.

Keeping in mind the specifics of these different groups of countries, it is safe to argue that the Gourinchas et al. (1999) approach is more suitable for the less developed financial systems. The 5% thresholds for the absolute (relative to GDP) deviations of loans to GDP ratio can be substantial in less developed financial systems and almost negligible in developed countries with strong bank-based financial sector. In other words, applying the same lending boom threshold across a sample of countries at different stage of financial sector development would result in a persistent underestimation of the lending boom build up in developed countries. At the same time a false positive signal of a lending boom may be issued in countries with less developed banking systems.

Some empirical studies focused their investigation on a sample of countries at similar stages of banking sector development. Cotarelli et al. (2005) observed 15 Central and Eastern European and Balkan countries in the period 1992 through 2002 (the actual number of observations varies by countries) and employed the technique used by Gourinchas et al. (1999). They found that despite fast credit growth (exceeding 20% annually) across the region once the privatization process was completed, a credit boom was detected only in Bulgaria in 2002. Acknowledging that excessive credit to particular sectors of the economy may result in macroeconomic imbalances and lead to asset price bubbles (Honohan, 1997; Kiss, 2002), and that strong credit growth in the countries in their sample resulted mostly from loans to households, Cotarelli et al. (2005) applied a similar procedure, but used loans to households instead and a different way of generating the trend. For each country “the backward looking stochastic trend” (p.48) is constructed for each year in the sample by applying an HP filter using data from the first five years of the sample. The authors themselves recognize that this approach may result in both an overestimation and an underestimation of credit booms. In some countries, like in the case of BH, in the early years the observed decline in the credit to GDP ratio is affected by write offs which may lead to an overestimation of credit booms. An underestimation of a credit boom may occur since the approach detects anomalies only as deviations from the level of the trend, rather than its slope. The same 5% relative deviation threshold is applied as in the case of Gourinchas et al. (1999). In Cotarelli et al. (2005) study a credit boom in the household sector became evident in Hungary with the Czech Republic and Romania also recording high ratios but falling below the threshold. The results for some of the countries, including BH, were inconclusive due to lack of time series. A replica of Cotarelli et al. (2005) approach on an increased number of observations in the sample detected a credit boom in BH in the period 2005-2008 (Figure 5.5a).

Figure 5. 5a: Lending boom episode definition based on Cotarelli et al. (2005)

Source: CBBH, own calculations

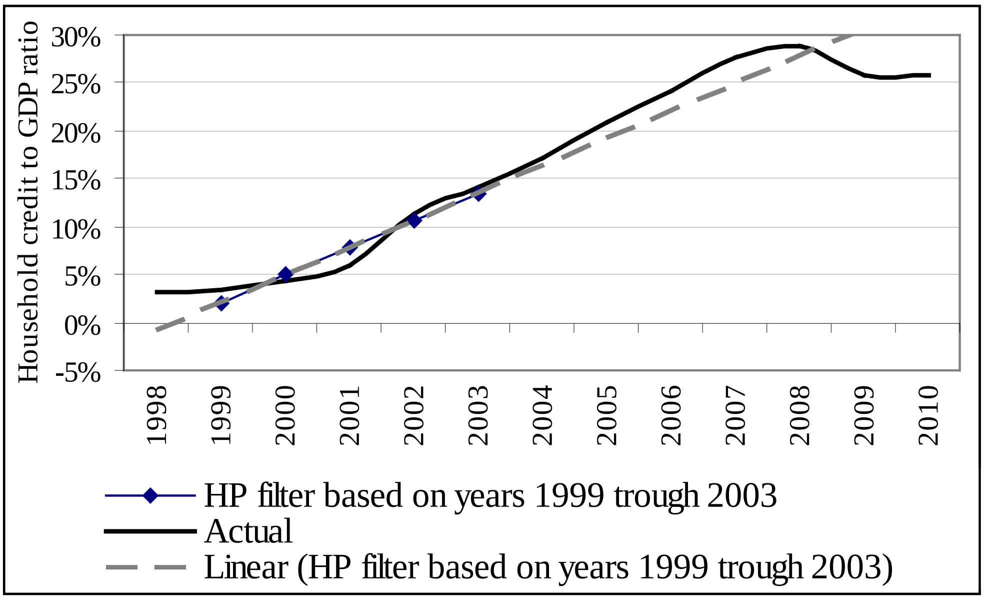


As argued earlier, there is reason to doubt that in the case of BH the trend may be too low and that a credit boom episode may have been overestimated. The first five years of the sample cover the period when the first wave of privatization occurred. As stated in Sections 1.4 and 5.2 that period is characterised by majority domestically private owned banks, low lending activity and large write offs. Although there was demand for loans by the households, short duration of banks' liabilities was preventing any stronger credit activity. As argued earlier, the lending activity of banks intensified with financial liberalization. As an illustration of how sensitive the results from Cotarelli et al. (2005) approach are to the selection of the trend period, the trend was generated by applying an

HP filter using data from the second through the sixth year of the sample. No evidence of credit boom was found (Figure 5.5b).

Figure 5.5b: Lending boom episode definition based on Cotarelli et al. (2005) with changed trend period

Source: CBBH, own calculations



As in the case of Gourinchas et al. (1999), there is a sign of credit expansion, but no strong evidence was found that a credit boom occurred. Unlike in the case of the loans to private sector to GDP ratio, the peak year of the lending activity to household sector is 2007. This finding indicates that lending to households reacts faster and more strongly to shocks from the macroeconomic environment when compared to lending to firms.

Noting that there are differences between credit booms in developed and emerging economies, Mendoza and Terrones (2008) developed an approach in which thresholds depend on each country's cyclical variability of credit. Their method was applied to 48 countries over the period 1960-2006 and 27 credit booms in industrial and 22 credit booms in emerging economies were detected. In addition to allowing for country specifics, the Mendoza and Terrones (2008) approach differs from that of Gourinchas et al. (1999) in the following ways: real credit per capita was used instead of the credit to output ratio; and the trend of credit was constructed using a standard, rather than an "expanding" Hodrick-Prescott trend. Under this approach, whenever the absolute deviation from the long-run trend exceeds the corresponding standard deviation of the cyclical component multiplied by the boom threshold factor, the period is viewed as experiencing a credit boom. The long-run trend is calculated by applying the Hodrick-Prescott filter with the smoothing parameter set at 100 to the logarithm of real credit to private sector per capita. The boom threshold factor is set to 1.75[68]. The peak of credit boom is the date that shows the biggest absolute deviation from the long-run trend. The same methodology was applied to the BH data with one exception: nominal credit per capita was deflated by the GDP deflator, rather than the corresponding end-of-year consumer price index. Given that the credit boom condition is negative across the sample (Figure 5.6) there is no supporting evidence to the claim that a credit boom occurred in BH in the 2000s.

[68] Sensitivity analysis was conducted for the boom threshold factor values 1.5 and 2 and the results were found to be robust to these changes.

Figure 5. 6: Lending boom episode definition based on Mendoza and Terrones (2008)

Source: CBBH, The World Bank, own calculations

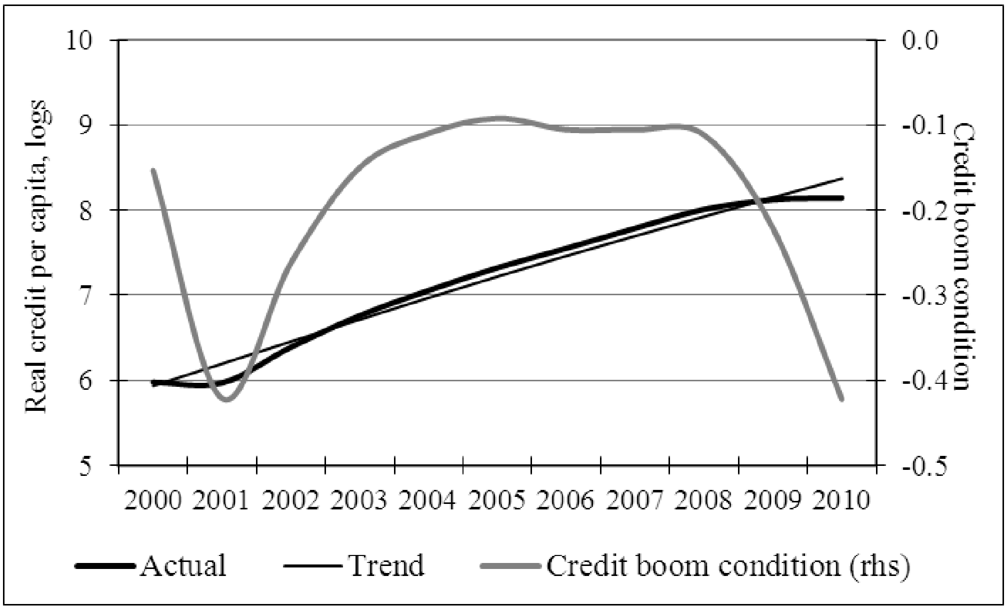


Figure 5.6 provides another example of how the conclusions on the occurrence of a credit boom episode are sensitive to the period that is used to generate the trend. Due to a lack of data, the earliest period for which it was feasible to generate the real credit per capita was 2000. The series does not seem to deviate significantly from the trend, but this is because the sample is shorter and its beginning is the period of financial liberalization, so there is no significant difference in the level of the real credit per capita when compared to 2000. As argued in the case of the private credit to GDP ratio,

financial liberalization from early 2000 resulted in a permanent change in the intercept, but also in the slope of the trend. Foreign bank entry and the removal of limitations on foreign borrowing increased the level of credit in BH, but also accelerated its growth until mid 2008. In the approach based on Gourinchas et al. (1999) it was illustrated that in periods of a strong time trend the choice of a smoothing parameter does not play any significant role. Therefore, generating a trend with an “expanding” lambda would not smooth the trend of the real credit per capita to the extent that it might generate some serious deviations from the trend. Similarly, accounting for the structural breaks would not alter the conclusion of no strong evidence of a credit boom. Finally, as evidenced by the change in the trend when it is generated based on a different sub-sample (Figure 5.5b), moving only one year from the beginning of the sample in 1998 results in a significant change in its slope. The deviations of the real credit per capita around its trend in Figure 5.6 would most likely be more pronounced had the sample covered the period pre-2000. However, it is not likely that the deviations from the trend would be so significant that one could claim that a credit boom existed in BH.

This section started by investigating the pre-conditions for banking crises. Table 5.1 provides an overview of the preconditions for banking crises identified by theory and referenced in this section. As in the case of the majority of other countries, it is perceived that the BH banking system is most vulnerable in periods when a strong domestic demand, represented by excessive credit growth, is additionally fuelled by an increase in risk-taking behaviour by banks. The two phenomena occurring jointly tend to result in excessively strong credit growth or credit boom episodes.

Table 5. 1: The preconditions for banking system failure: the theoretical framework

Criteria	Characteristics	Authors	Relevance for BH
Government permeated banking system (Sub-section 5.2.1)	1. Significant share of government ownership	Honohan (1997); Tang et al. (2000); Enoch et al. (2002); Bonin and Wachtel (2003); Barisitz (2008).	no
	2. Significant presence of compulsory deposits or sectoral allocations	Honohan (1997); Enoch et al. (2002).	no
	3. High commercial banks' borrowing from the central bank	Honohan (1997)	no
	4. Explicit and implicit financial intermediation subsidies and taxation	Honohan (1997); Tang et al. (2000).	no
Poor management and other micro deficiencies (Sub-section 5.2.2)	1. Fraudulent activities	Sheng (1996); Honohan (1997).	no
	2. Poor managerial/ lending decisions	Honohan (1997); Eichengreen and Hausmann (1999); McKinnon and Pill (1999, 2001); Borio et al. (2001); Boss et al. (2004); Dell' Ariccia and Marquez (2006); Segoviano et al. (2006); Pesola (2007); Alves et al. (2008); Tamirisa nad Igan (2008); Caporale et al. (2009); Dell' Ariccia et al. (2009).	yes
	3. Herding and reckless behaviour	Corsetti et al. (1999); Kindelberger (2000); Rötheli (2001); Burnside et al. (2003); Stever and Wilcox (2007).	yes

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	Poor management and other micro deficiencies and at least one of the following		
Macroeconomic epidemics (Sub-section 5.2.3)	1. Strong endogenous lending boom	Bernanke and Gertler (1989); Honohan (1997); Kiyotaki and Moore (1997); Bernanke et al. (1999); Eichengreen and Hausmann (1999); McKinnon and Pill (1999 and 2001); Chang and Velasco (2000); Burnside et al. 2003; Cotarelli et al. (2003); Aydin (2008); Mendoza and Terrones (2008); Brown et al. (2009); Cardarelli et al. (2009); Maechler and Ong (2009).	yes
	2. Inapropriate macroeconomic and/ or monetary policies	Carstens et al. (2004); Shulz (2004).	yes

Based on the analysis of different credit boom conditions, although there are evidences of an accelerated credit growth, one cannot claim with certainty that a credit boom episode occurred in BH. The conclusions, given the country specifics, were not found to be greatly influenced by the way the trend was generated, but rather by the period for which it was generated. The exclusion of the pre-liberalization periods tends to result in an underestimation of the overall credit growth process. On the other hand, inclusion of those periods may result in overly emphasized deviations of the credit growth series from its trend. Allowing for structural changes partially corrects for this drawback of the use of a larger sample. In any case, based on three different measures of credit activity in country and differently generated trends, one cannot rule out an excessive credit expansion, but the evidence of a credit boom in BH is inconclusive.

From the point of the SI, the inability to verify a credit boom episode in BH data is not a limitation. The index itself does not aim to predict the occurrence of banking crises, but focuses on the factors that increase the fragility of the banking sector. Identification of the variables that tend to increase credit growth or influence the quality of the banking sector's loan portfolio would explain the level of the BH banking sector fragility as measured by the SI.

5.3. The variables of importance in BH

In the previous section the relevance of a set of banking crisis preconditions previously recognized by the literature was evaluated for the case of BH. Based on current theory and keeping in mind the country specifics, the variables that may be used as the signals of a forthcoming banking crisis are those that affect credit growth and the quality of the banking sector’s loan portfolio. This section focuses on the macroeconomic variables that drive domestic credit expansion and the banking sector-specific variables that cause a rise in domestic credit above its long-term trend.

Previous empirical research recognizes that some variables behave differently during different stages of a boom episode. In the previous section it was concluded that the credit expansion in BH could be described as a credit boom only, if at all, for a very brief period of time. The peak years were found to be 2007 and 2008. In order to determine whether a set of macroeconomic variables behaved differently before and during the boom episodes, Gourinchas et al. (1999) divided those episodes into three phases: build-up; peak; and ending phase. The same approach will be followed in this research. First, the different phases of a credit cycle will be identified and then the same set of macroeconomic variables will be observed through the credit cycle in BH. It is found that although there are some country specifics that need to be accounted for, the determinants of credit growth in BH appear to be similar to those in other countries. For example, as in other countries, it is found that during the build-up phase of the credit cycle, output growth is significantly above its average during the tranquil periods. Conversely, although found significant in other countries, domestic interest rates played no significant role in explaining the level of credit in BH. The variables identified as important in signalling a credit boom in BH and microeconomic deficiencies will be used in the empirical analysis presented in Section 5.4.

Drivers of credit growth will affect both the level of capital in the system and the level of the SI. As credit growth accelerates, it will take more capital to keep the capital adequacy ratio at the prescribed level (Section 3.4). This increase in regulatory capital will be 12% of the increase in the level of credit since this fraction represents the regulatory charges for the credit risk in BH. Not all increases in capital will be an increase in equity, since there are other items besides equity that constitute regulatory capital (Table A1.5, p.333). Since the stock of loans and the level of capital are not growing at the same rates, as credit growth accelerates, deteriorations in the quality of smaller fractions of loans would result in insolvency of the banking system. Any worsening in the quality of loans would increase the cost of provisioning. Given that each category of loans is provisioned for at different rates, category A being provisioned at the lowest rate, any migration of an existing loan to a lower category would increase the cost of provisioning, affecting profitability and, indirectly, bank's capital.

The following table is a replica of the one in Ègert et al. (2006), p.13. It provides an overview of what the empirical literature considers as the main determinants of credit growth.

Table 5. 2: Overview of research analysing the determinants of credit growth

Note: GDP per capita in PPS is obtained by converting GDP per capita figures using the nominal exchange rate given by the domestic and foreign price levels (P/P*).

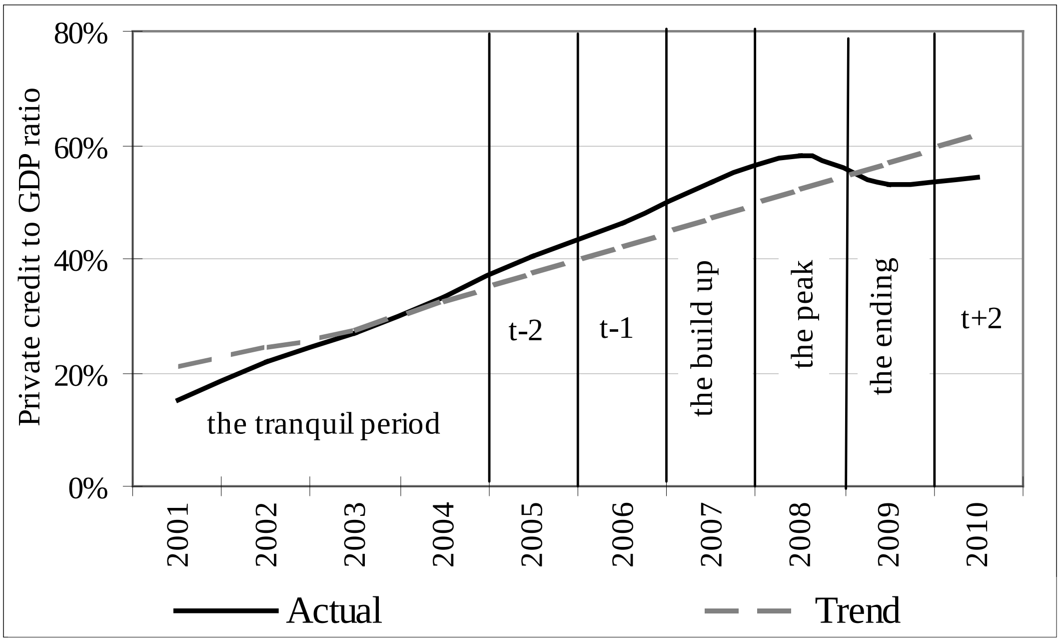
Authors	Dependant variable	Explanatory variables
Calza et al. (2001)	Real loans	-GDP per capita in PPS - short-term and long-term interest rates
Hofmann (2001)	Real loans	-Real GDP - real interest rate - housing prices
Calza et al. (2003)	Real loans	-Real GDP growth - nominal lending rate - inflation rate
Brzoz- Brzezina (2005)	Real loans	-Real GDP growth - real interest rate
Cotarelli et al. (2005)	Credit to the private sector (% GDP)	- GDP per capita in PPS - inflation rate - financial liberalization index - accounting standards -entry restrictions to the banking sector - German origin of legal system - public debt
Kiss et al. (2006)	Credit to the private sector (% GDP)	- GDP per capita - real interest rate -inflation rate

These empirical studies do not have a clear preference towards the use of nominal or real variables. It was decided that all variables used in the empirical analysis in Section 5.4 will be in nominal terms. As will be later illustrated, short-term dynamics play a significant role in the post-macroeconomic shock adjustment process towards the new equilibrium. The long-term relationships do not seem to hold strongly in the immediate post-shock periods and it is mostly because of the price variables, such as the interest rates, that the choice was made in favour of nominal variables. An increase in nominal interest rates in periods of unfavourable macroeconomic conditions caused by the reassessment of clients' creditworthiness will trigger a wave of defaults, especially if the existing loans are, as in BH, with variable interest rates. The resulting increase in the cost of provisioning, and a consequential reduction of capital, would exert an upward pressure on the SI.

GDP and interest rates appear as explanatory variables in each of the listed studies (Table 5.2) with the exception of interest rates in Cotarelli et al. (2005). Presumably, in these models GDP reflects the strengths of demand for loans, while interest rates affect both the willingness to lend and the willingness to borrow under the prevailing market price for loans. Ègert et al. (2006) used the index of industrial production instead of GDP and the properties of their credit growth model did not change substantially. Recognizing that macroeconomic variables affect credit growth differently at different stages of the business cycle, and aiming to extract the signals of an increased risk to banking sector stability, various BH macroeconomic variables were evaluated against the findings of the above empirical studies. Similar to the case of microeconomic deficiencies in Section 5.2.2, it is concluded below that some of the variables that were found to be relevant in the case of other countries are irrelevant for explaining the causes of credit expansion in BH.

Gourinchas et al. (1999) investigated how different macroeconomic variables behave during the boom episode, as well as in the build-up and ending periods. Gourinchas et al. (1999) follows the methodology that Rose et al. (1995) use to study currency crises and Razin and Milesi-Ferretti's (1996) current account reversals. For each macroeconomic indicator the difference between its sample average for each phase (including t-2, t-1, t+1 and t+2) and its average during the tranquil periods is calculated. This difference indicates if the variable in question behaves differently during the phases of a credit boom with respect to the tranquil periods. The significance of the deviation is measured by the standard deviation of each episode's average. Figure 5.7 below builds upon Figure 5.3a. Based on the approach suggested by Gourinchas et al. (1999) the credit cycle is divided into different phases.

Figure 5. 7: The phases of the credit cycle based on Gourinchas et al. (1999)



Source: CBBH, own calculations

When the Gourinchas et al.'s (1999) approach is applied to BH data, the following periods are identified: the tranquil period covers the years 2001 through 2004; the year 2005 is period t-2; 2006 is period t-1; 2007 is the build-up phase; the peak year is 2008; 2009 is the ending phase; and 2010 is period t+1. There is no period t+2 since the peak of the crisis occurred close to the end of the sample. The duration of each phase of a credit boom is conditional on the peak period. Once the peak period is identified, looking backwards, the build-up phase starts in the first year in which the ratio is above the limit threshold and ends in the year that proceeds the peak year. In the case of BH the build-up phase occurred in 2007. The year immediately preceding the build-up phase is the t-1 year. Consequently, the year before it is the t-2 period. The 'tranquil' period covers the years out of a boom episode and a couple of years before (t-2 and t-1) and after (t+1 and t+2) the boom episode. The periods after the peak are the ending phase and t+1. The ending phase starts the year after the peak and ends the year before the ratio is below the limit threshold.

Gourinchas et al. (1999) identified the following significant trends:

(A) Between t-2 and the build-up phase, output is significantly above its potential compared to tranquil periods.

(B) The domestic real interest rate rises by 665 basis points during the lending build-up. This increase is very significant.

(C) The spread between domestic lending and deposit rates decreases significantly in t+1.

(D) The international real interest rate increases significantly in the build-up period.

(E) Investment to GDP rises significantly above the tranquil periods in between t-2 and the build-up period and declines subsequently.

(F) Private capital inflows increase significantly during the build-up phase and peak year. This surge is subsequently reversed during the ending phase.

(G) International reserves are 0.6 months of imports above the tranquil period average in t-2.

(H) There is a large and significant current account deficit during the build-up phase and the peak year.

As indicated in Appendix 5.3 (p.391), although there are some country specifics that need to be accounted for, the determinants of credit growth in BH are similar to those found in other countries. In the case of BH the GDP gap in the build-up phase and during the peak was significantly above its trend in the tranquil periods. International interest rates rose significantly just before the off-set of the crisis. Investments to GDP increased significantly above the tranquil periods a couple of years before and during the build-up phase of a credit boom, and declined subsequently. These investments were mainly in the form of private capital inflows. Recall from Section 1.3 that loans to private sector were growing at exceptionally high annual rates, occasionally exceeding 30% in the period 2005 – 2007, and that such activities were mainly financed by borrowing internationally. Given the presence of excessive lending by banks (mainly to the households sector) and the inadequate maturity structure of domestic sources of financing, the evidence of significant inflow of private capital when Gourinchas et al.'s (1999) approach is employed can be explained by the international over-borrowing of BH banks that significantly surpassed activities in the real economy. This came to an abrupt halt with the liquidity freeze in international financial markets.

There is no evidence that domestic interest rates, lending or deposit, played a significant role in the process of credit expansion in BH. On one side, an inappropriate maturity structure of domestic deposits fuelled international borrowing of banks, while, on the other side, the domestic demand for loans was so strong that domestic sectors accepted any lending rate, even while recording negative real returns on funds deposited with banks. The very similar patterns in the real lending and deposit interest rates in BH (Figures A5.2a and A5.2b, p.392 and p.393 respectively), suggest that banks used deposit rates to maintain their targeted profit margin each time the lending rates changed for any reason.

This rapid credit growth increased BH imports, thus widening the current account deficit. This finding is also in line with studies, such as Sirtaine and Skamnelos (2007) who conclude that rapid credit growth resulted in the large imbalances in the Central and Eastern European countries. Mendoza and Terrones (2008) and Cardarelli et al. (2009) note that credit booms in emerging economies are often preceded by large capital inflows but not by financial reforms and productivity gain.

A possible explanation for the faster growth in foreign reserves when compared to imports is the regulation on the net open position of banks (Section 1.5). Given the need to balance the forex exposure in their balance sheets, banks usually extended long-term loans indexed to foreign currencies, mainly EUR (Section 1.3), but their clients received BAM. In other words, the whole amount of foreign liabilities of banks became a part of the forex reserves.

Credit expansion coupled with microeconomic deficiencies in banks and regulatory oversights were identified in Section 5.2 as the most likely set of preconditions for a banking system crisis. Among the signs of microeconomic deficiencies of the system, poor managerial and lending decisions and herding and reckless behaviour were emphasized (Table 5.1). The following table lists the reasons for which it is believed in this research that the variables used in Chapter 4 should also be used to explain changes in the SI.

Table 5. 3: The list of chosen variables

Variable	Aiming to capture
Index of industrial production	- Domestic demand for loans -Changes in the quality of loans that would affect the capitalization under the assumption that a slowdown in industrial production is a consequence of deteriorated macroeconomic conditions

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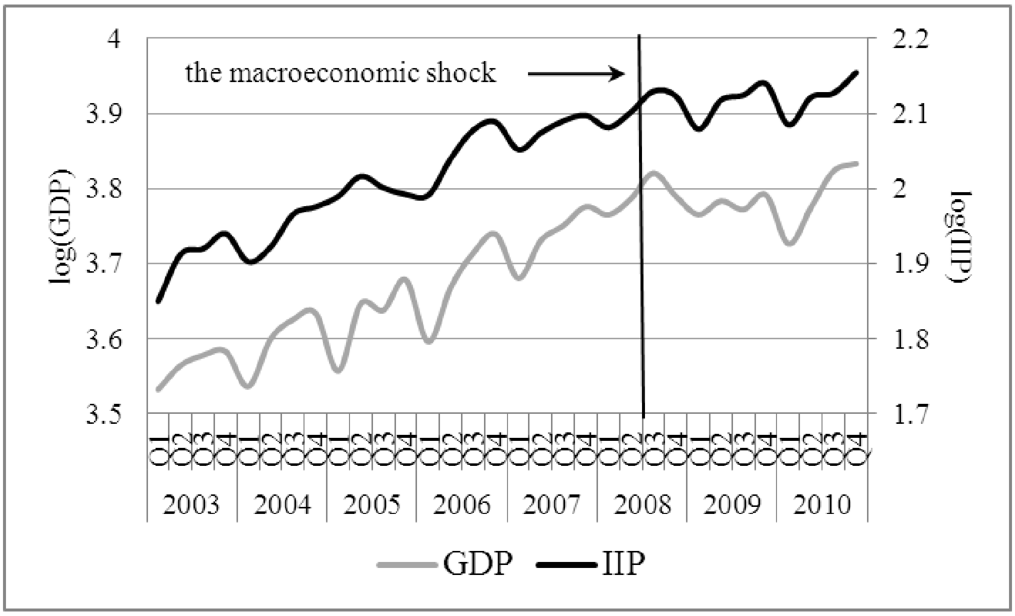
Variable	Aiming to capture
The rate of unemployment	- Domestic demand for loans -Changes in the quality of loans that would affect the capitalization under the assumption that rising unemployment is a consequence of deteriorated macroeconomic conditions
The difference between domestic and foreign nominal lending rates	- Domestic demand for loans -Macroeconomic developments abroad and liquidity in international markets effecting both banks' behaviour and the level of capitalization - The lending policies of banks - Herding and reckless behaviour
The nominal USDEUR exchange rate	- Macroeconomic developments abroad and liquidity in international markets effecting both the banks' behaviour and the level of capitalization - Possibly domestic demand for loans in export oriented BH industries
The ratio of the long term loans financed by the long-term deposits of domestic sectors	- Foreign funded consumption of domestic sectors signaling both changes in domestic sectors' perception, as well as banking sector risk tolerance
Concentration in market for loans	- Herding and reckless behaviour

Although GDP is used in most empirical studies as a measure of economic activity, the use of IIP and UNEMP is more suitable in the case of BH to establish the relationship between the excessive lending and the level of SI. The primary reason is a country specific that consumption of the public sector is not directly related to the lending activities of banks during the sample of this research (Table A1.1, p.329). According to the BH Statistical Agency (BHAS), the average share in GDP of the industries that constitute the industrial production in the period 2000-2010 was 20%. The average share of the government administration, education and health sectors in the same period was 21.5%. While the exposure of the banking sector to the industrial production sector was significant, the exposure to the government sector was low given the legal limitations on borrowing by the government (CBBH, 2011). Similarly in the agricultural sector, while its average share in GDP was around 9.8%, the banking sector exposure is much lower. Given that the SI is designed to capture increased fragility that is a consequence of either excessive credit growth or a sharp deterioration in the quality of loans, the large share of sectors that are not significant banking sector borrowers in GDP resulted in, at best, a very weak cointegrating relationship between the SI and GDP (Appendix 5.9, p.412).

As indicated in Section 4.3, given the relationship between lending to the enterprises that constitute the index of industrial production and the level of economic activity, it was concluded that IIP could be one of the proxies for GDP. IIP should be used jointly with UNEMP in order to capture the effect of the long-term lending to households, and thus, indirectly, part of the households’ consumption. Figure 5.8 below illustrates that both IIP and GDP, similar to the SI, exhibit a strong upward trend until the mid-2008. In both cases, the slope flattens in the post-shock period most likely due to the feedback effects from the banking sector.

Figure 5. 8: The measures of economic activity

Source: CBBH, own calculations

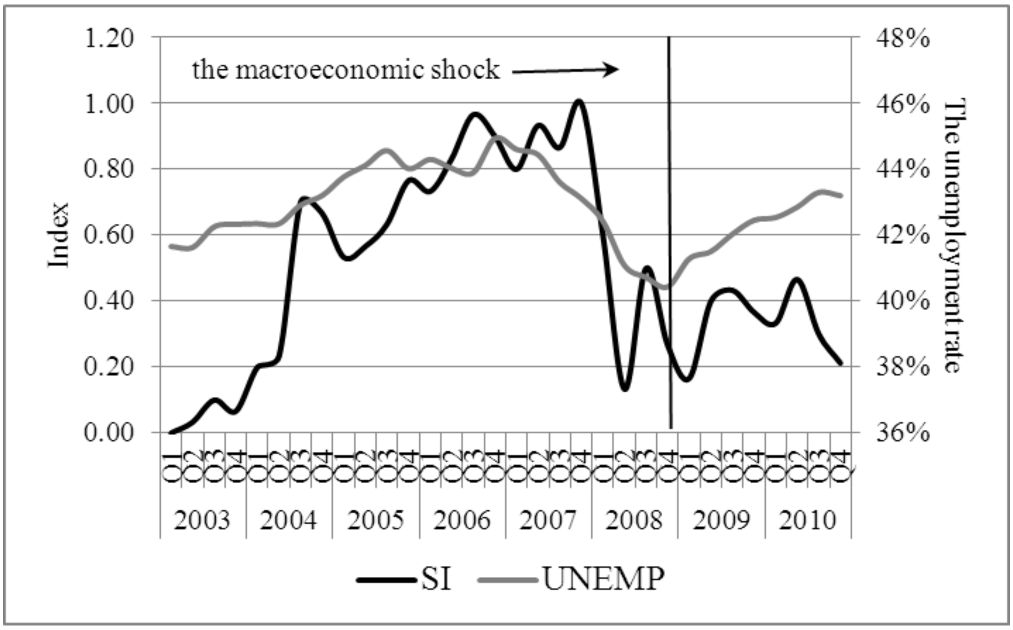


Given the resemblance between the two series, it seems reasonable to assume that IIP significantly contributes to explaining the level of economic output. The difference in levels between log(IIP) and log(GDP) in Figure 5.8 and data suggesting that over 80% of GDP by expenditure approach is generated by households final consumption expenditure (BHAS, 2013), imply that disposable income of households is, to a large extent, determined by the claims on assets (Figure 2.1). As these claims are banking sector's assets (Section 2.4) and, as such, subject to regulations on credit risk management in financial institutions, it was assumed that the level of unemployment, via the credit risk (Section 3.5), should have some explanatory power in explaining changes in the SI both in the economic upswing and post-shock periods.

One should take into the account the characteristics of the official unemployment figures in BH (Appendix 4.5, p.357). Through the end of 2006 the official rate of unemployment was rising. A rise in the lending activity of banks may be explained by “cherry picking”. As the foreign banks enter transition economies, they tend to pick up the best clients in the market, usually by offering accounts with better rates or some other perks. By examining 29,000 households in 29 transition countries, Beck and Brown (2011) concluded that the use of banking services increases with income, wealth and education. Urban households were also found to be more likely to have a bank account. Furthermore, it was argued that in countries with stronger foreign bank presence wealthy, well-educated households and those with formal employment are more likely to use banks. Until the mid-2000s not many people had bank accounts in BH and those that did were usually living in urban areas and had formal employment. Although unemployment was still rising, loans were extended to the best clients in the market. An increasing number of bank branches were indicative of the rising number of clients in the mid-2000s. Strong economic activity in 2007, with nominal GDP growing at 13%, resulted in a reduction in the rate of unemployment. Encouraged by this economic upswing, households increased borrowing while banks relaxed lending standards, which is evident from a decline in lending rates and an increase in market concentration. Once the macroeconomic shock occurred, economic activity contracted and the rate of unemployment started to rise (Figure 5.9).

Figure 5. 9: The unemployment and banking system fragility

Source: CBBH, BHAS, own calculations



5.4. The empirical analysis

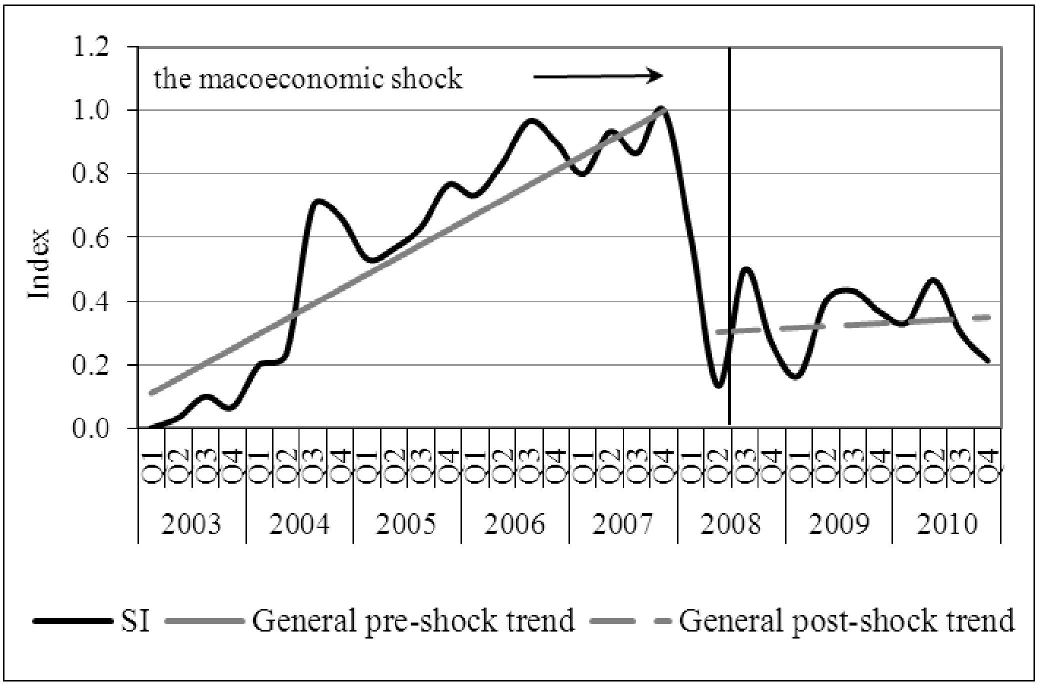
The aim of this section is to investigate empirically the relationship between the SI and a set of macroeconomic and banking sector specific variables. The index indicates the vulnerability of the banking system by measuring the size of the shock, represented by the fraction of loans that need to deteriorate, that would fatally deplete banking sector's capital (Section 3.5). The value of the SI may increase for two reasons: an expansion of the banking sector assets; or deterioration in the quality of loans. The former case is typical of the pre-crisis periods when the credit expansion is strong and driven by over-optimistic expectations of the future trends by both the borrowers and banks. The latter case is characteristic of post crisis-periods when lending contracts, but the quality of loans sharply deteriorates.

The VECM was chosen as an appropriate model to examine the determinants of changes in the perception of the risk of currency crisis in chapter 4. Since one of the aims of this research is to investigate the relationship between the two measures of the systemic risk, the possibility that the same modelling approach would be suitable in the case of the SI was considered. If that were the case, then the next step would be investigating whether the LI and SI could be observed as a system that allows for the interdependence of the two measures of the systemic risk. As will be demonstrated later in this section, the VECM approach was found superior when compared to OLS. However, before the analysis proceeds to the estimation of the relationship between the SI and the chosen variables, the statistical properties of the SI will be investigated (the properties of the explanatory variables were presented in Section 4.3).

The SI is a difference stationary variable. Detailed information on the unit root testing procedure can be found in Appendix 5.4 (p.401). Figure 5.10 below illustrates the SI and differences in the perception of risk in the periods before and after the macroeconomic shock in Q2 2008.

Figure 5. 10: The solvency index (SI)

Source: Own calculations



The first thing that one notices is the difference in the perception of risk in the pre- and post- shock periods. In the period through to the end of 2007, the solvency risk was strongly increasing over time (the solid grey line in figure 5.10)[69]. This was due to the aforementioned strong credit growth and the structure of the banks' capital. The effect

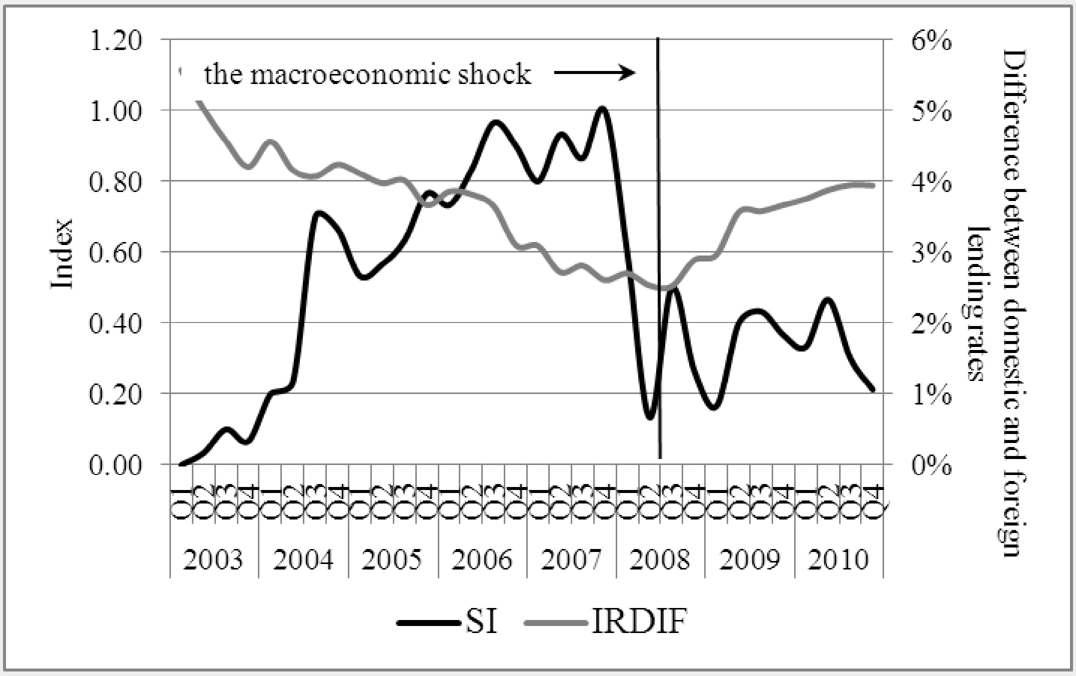
[69] Both general pre- and post-shock trends are simple linear trends in the two sub-samples and serve solely to indicate the general perception of risk over time.

of the merger between the second and the third largest banks in the system (Section 5.2) in the second half of 2004 is also one of the prominent features of the SSI. A significant increase in the market concentration shifted the measure of risk upwards. There is a sharp decline in the perception of risk at the beginning of 2008, followed by a significant rise in the perception of risk in Q3 2008. From the second half of 2008, the banking system appears to be less fragile (the broken grey line). This perception of a lower risk of banking crisis is a consequence of a series of additional capitalizations in the post-shock periods triggered by the significant losses of banks caused by a sharp deterioration in the quality of assets. Had banks not additionally capitalized, the perception of risk would be different and significantly higher (see Text box 5.2 below). This finding suggests that one must take into account all possible information on the underlying dynamics of the series when interpreting the relationship between the SI and chosen variables. A failure to do so might lead to the serious misinterpretations of the level of risk.

Text box 5.2: The effect of additional capitalization on the SI

As indicated in Figure 5.10, the level of fragility in the post-shock period seems to be lower than in the period of economic expansion and it does not seem to rise despite an increase in the difference between domestic and foreign lending rates (Figure 5.11 below) or the increase in unemployment (Figure 5.9). Both these variables are known to cause an increase in the number of defaults. As illustrated in Section 4.3, a widening gap between domestic and foreign net interest margins towards the end of our sample is a consequence of increased credit and sovereign risks in BH. An increase in unemployment is just one of the causes of an increased credit risk. Since the SI is constructed in such fashion that it picks up both an increase in banking sector fragility due to rapid credit growth and an increase in fragility due to deterioration in the quality of loans, such low levels of fragility in the post-shock periods were unexpected.

Figure 5. 11: Difference between domestic and foreign interest rates and banking system fragility



Source: CBBH, ECB, own calculations.

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Knowing that the banking sector experienced significant losses in the post-shock periods due to a deterioration in the quality of their assets, and yet not a single bank was breaching the supervisory requirement of 12% capital adequacy ratio (CAR), it was suspected that the perception of fragility may be distorted by additional capitalizations. Unfortunately, no one but the supervisors knows by how much exactly each bank was capitalized. However, by comparing the structure of capital (Table A1.5, p.312) by banks in the periods Q1 2008-Q4 2010, it was found that there is a significant relationship between an increase in losses and an increase in equity on one, and an increase in equity and an increase in net capital on the other side. The relationship between changes in equity and changes in losses suggests that banks had to undertake additional capitalization due to regulatory requirements whenever they incurred substantial losses. The latter relationship indicates that, unlike in periods of credit expansion, subordinated debt and retained earnings were not the main adjustment mechanisms to net capital. In other words, regulatory capital in the post-shock periods was maintained by capital injections from the banks' owners. For that reason, it was assumed that the losses from the current period were covered by raising additional capital. The capitalization is proxied by:

$$ADCAP_t = UNCOVLOSS_t + CURRLOSS_t - UNCOVLOSS_{t-1} \tag{5.8}$$

where ADCAP stands for additional capital raised, UNCOVLOSS stands for uncovered losses from the previous period and CURRLOSS is the current year loss. The following series of estimated additional capital raised is generated. As suspected, the largest values were recorded towards the end of the sample when one of the largest foreign banking groups recorded a significant deterioration in the quality of their loan portfolio across the CESEE region.

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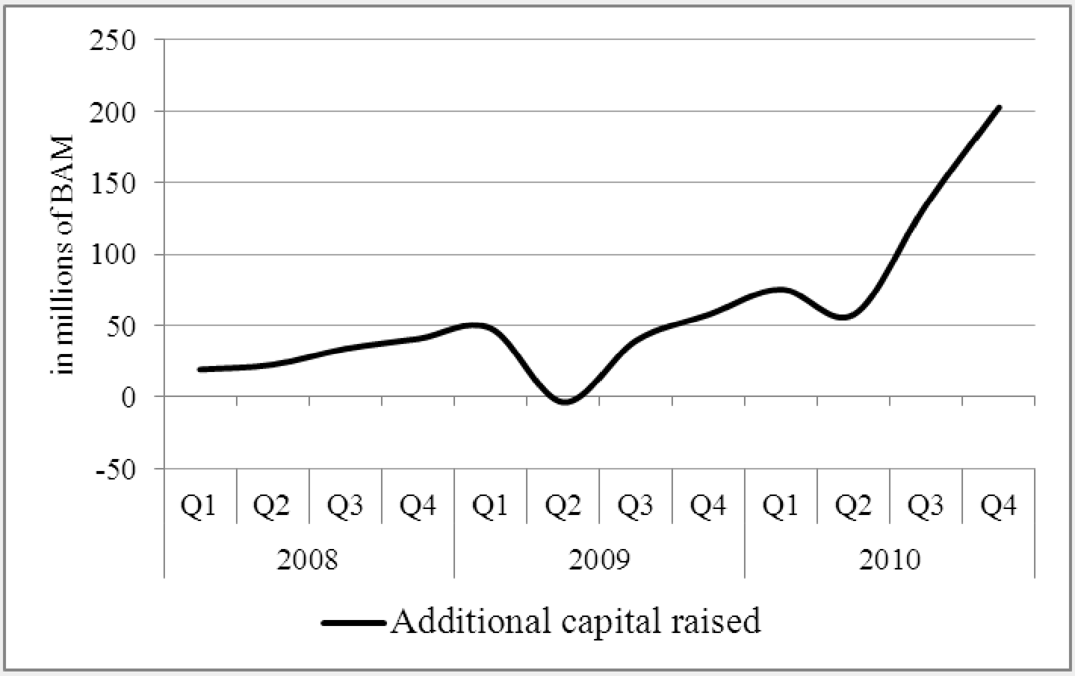
Figure 5. 12: Estimated additional capital raised



Source: Banking agencies, own calculations.

The additional capital raised is then subtracted from the net capital for the periods Q1 2008-Q4 2010 and the SI is re-calculated for the period in question. Section 3.5 provides detailed information on how the SI is generated. The following figure illustrates the original SI and the SI adjusted for this approximation of additional capital raised.

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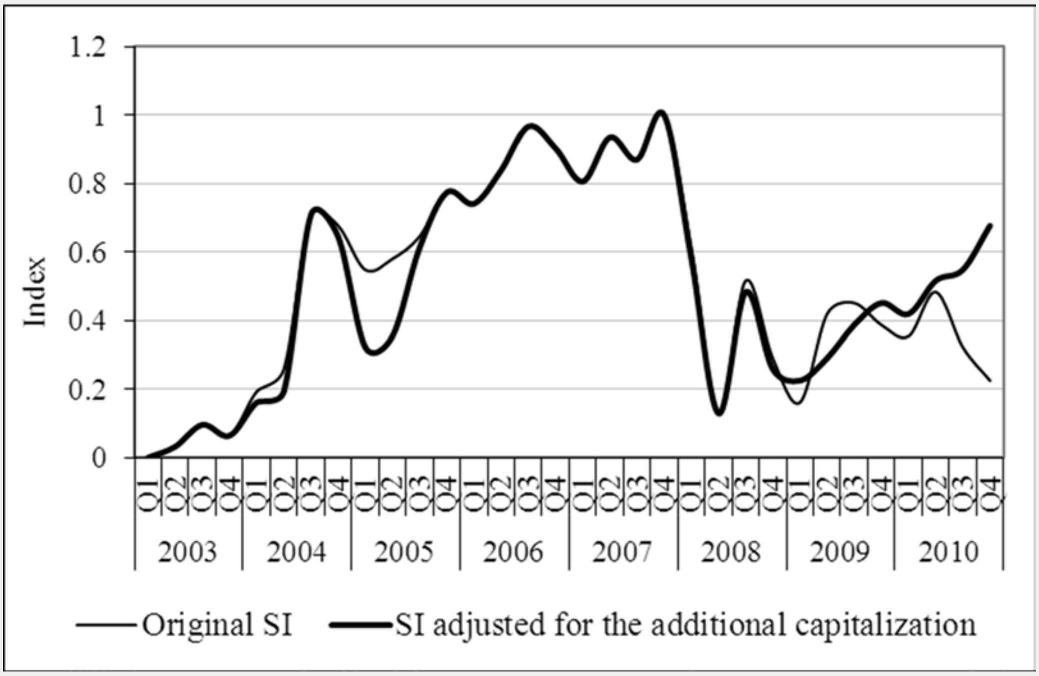
Figure 5. 13: The original SI and the SI adjusted for the additional capitalization



Source: Banking agencies, CBBH, own calculations.

Once the effect of additional capitalization is accounted for, the level of fragility tends to increase, as expected, in the post shock periods. The additional capitalization occurred, so the model will use the original SI as the dependant variable. The level of the systemic risk was deflated because banks chose to fulfill their regulatory requirements with respect to capitalization in order to cover up their losses. If they had chosen not to, the level of the systemic risk would have increased even further.

The exercise above indicates that it is important to acknowledge that different factors affect the level of fragility at different stages of the business cycle and that the structure of banking sector capital and regulatory requirements may significantly reduce the perception of the systemic risk (Demirgüç-Kunt and Detragiache, 2009 and Atik, 2011). In this specific case the level of risk in the post-shock periods seems lower when compared to the periods of credit expansion, but

5.4.1. The cointegration analysis

The VECM specification that allows for the structural breaks was found suitable to explain changes in the LI (Section 4.4). Acknowledging that the level of foreign reserves is strongly determined by the banking sector activity (Section 3.4), the system becomes more prone to currency crises as the inflows of banking sector-related capital intensify (Section 4.4). Given this relationship between the risks of currency and banking crises, the natural starting point was to test whether the same modelling approach could be used in the case of the SI. As will be demonstrated at the end of this section, the cointegration analysis approach was found acceptable. As in the case of the LI, accounting for the structural break was an imperative suggesting that the relationships between the risk of banking crisis and the set of chosen variables may be different in the pre- and post-shock periods. As cointegration analysis would provide the information on both the long-term relationship between the variables and the process of adjustment of the SI towards the equilibrium, the VECM will not be informative about the difference in relationships in the pre- and post-shock periods. This finding supports the assertion from Section 2.3 that it is unlikely that a single model, regardless of how sophisticated it is, could capture the complexity of relationships between the measures of risk and the variables that affect it through the business cycle. Finally, it will be demonstrated that country specifics must be accounted for in the case of BH since, contrary to orthodox economic theory, only a weak long-term relationship was detected between the economic output and the risk of a banking crisis.

Table 5.3 indicates the variables used in the model. Their classification is the same as reported in Table 4.6 with the following exceptions: the VECM is now normalized on the SI and PRIVATIZATION in the deterministic part of the model is replaced by MERGER, the latter accounts for the increase in the SI in Q3 2004 (Figure 5.10) when a merger between two large banks occurred (Section 3.5). Based on the residual analysis (Tables A5.4a and A5.4b, p.404 and p.405 respectively), the VAR diagnostics were rather poor, primarily indicating significant serial correlation in the errors. Recalling that IRDIF and HHI were found to be uninformative in the case of the VECM normalized on the LI (Section 4.4) and given that market-based indicators, such as interest rates, played an insignificant role in signalling microeconomic deficiencies and an individual bank's distress (Figures A5.2a and A5.2b, p.392 and 393 respectively), it is possible that these variables were causing serial correlation in all tested VAR specifications. These variables impact the level of fragility differently in the pre- and post-shock periods. In the pre-shock period, both variables are causing an increase in fragility. The aggressive lending policies of a small number of banks are increasing market concentration, thus making the system more fragile. An easy lending policy by the banks represented by a long-lasting decrease in the difference between domestic and foreign interest rates indicates a possible herding behaviour and an overly-optimistic outlook on future trends. However, once the shock occurs, the two variables are not the cause but the reaction to the changes in the environment. The lending contraction occurs because of the increased risk and reduces the market concentration. Banks with aggressive lending policies in the periods before the shock re-assess the quality of their loan portfolios, reduce lending, which, in turn, reduces the concentration in the market. An increase in the interest rates is a re-priced default risk (Section 4.3). As the majority of loans in BH are issued with variable interest rates (Section 1.3), banks will charge a higher risk premium to their existing clients following unfavourable changes in the macroeconomic environment. In other words, while changes in interest rates in periods of credit expansion caused an increase in the level of systemic risk, it is the case that an elevated systemic risk in the periods of macroeconomic turbulences causes changes in the interest rates charged to clients. Table 5.4 provides the diagnostics for various VAR specifications of the restricted model with IRDIF and HHI omitted. Clearly, in all cases the diagnostics was greatly improved when compared to the unrestricted model. The chosen VAR specification is VAR (2,1) with intercept, trend and seasonal dummy variables included.

Table 5. 4: The restricted VAR, diagnostics

	VAR (1,1), intercept, trend and seasonal dummies	VAR (2,1), intercept only	VAR (2,1), intercept and trend	VAR (2,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.0454	0.8083	0.2416	0.3365
Doornik (1996), LMF test for autocorrelation, 2 lags	0.0680	0.6098	0.7003	0.5759
Doornik (1996), LMF test for autocorrelation, 3 lags	0.1335	0.4209	0.3867	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-	-

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Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

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Doornik & Hansen (1994), joint test for non-normality	0.1877	0.0874	0.3675	0.9641
Lütkepohl (1993), joint test for non-normaility	0.2615	0.2246	0.3647	0.9458
Jarque-Bera test, u1	0.7989	0.3314	0.8268	0.8629
Jarque-Bera test, u2	0.2157	0.7202	0.8665	0.7653
Jarque-Bera test, u3	0.1737	0.0248	0.0891	0.7099
Multivariate ARCH-LM test	(1): 0.0560 / (2): 0.3854 (3): 0.7725 / (4): 0.3253	(1): 0.8904 / (2): 0.7864 (3): 0.6362 / (4): 0.3115	(1): 0.2593 / (2): 0.3553 (3): 0.1488 / (4): 0.3983	(1): 0.2676 / (2): 0.5291 (3): 0.5379 / (4): 0.3654
ARCH-LM test, u1	(1): 0.9585 / (2): 0.7744 (3): 0.9217 / (4): 0.1444	(1): 0.3141 / (2): 0.1398 (3): 0.0059 / (4): 0.0176	(1): 0.0129 / (2): 0.0072 (3): 0.0051 / (4): 0.0340	(1): 0.2470 / (2): 0.3818 (3): 0.5152 / (4): 0.2434
ARCH-LM test, u2	(1): 0.4877 / (2): 0.5697 (3): 0.7153 / (4): 0.7406	(1): 0.8771 / (2): 0.7386 (3): 0.6598 / (4): 0.7932	(1): 0.5086 / (2): 0.8394 (3): 0.4600 / (4): 0.8712	(1): 0.6977 / (2): 0.6754 (3): 0.8991 / (4): 0.8136
ARCH-LM test, u3	(1): 0.2811 / (2): 0.4257 (3): 0.6225 / (4): 0.3654	(1): 0.3878 / (2): 0.4007 (3): 0.5678 / (4): 0.6572	(1): 0.5412 / (2): 0.6711 (3): 0.8646 / (4): 0.8614	(1): 0.7055 / (2): 0.7794 (3): 0.8337 / (4): 0.9308

As suspected, IRDIF and HHI were the cause of the serial correlation. This finding suggests that although the SI adequately captures the level of risk in the system, especially if the effects of the additional capitalization are taken into the account, its changes in the pre- and post-shock periods should be modelled by two different processes. Since the causes of increased fragility are not the same, some of the variables that influence the index on both sides of the business cycle have a different nature in those two different regimes.

Based on the chosen VAR specification, both the Johansen Trace test and Saikkonen and Lütkepohl Test were executed for the case of two lags with seasonal dummies included for all three options: constant, constant and trend and orthogonal trend (Table 5.5 below). Based on the tests results, one should assume a single cointegrating relationship.

Table 5. 5: The cointegration tests

Note:
Break date in Johansen Trace Test is set to Q1 2009. The break is assumed in levels and trend jointly and ignored in "orthogonal trend". MERGER and INFLOW2008 were restricted to long run.
Saikkonen and Lütkepohl test does not have an option to set the break dates. Instead, it allows for including series that will account for changes in deterministic trend. In this case, the variables included are: MERGER, INFLOW2008, SHOCKLEVEL and SHOCKTREND.
Note that inclusion of SHOCKLEVEL and SHOCKTREND have the same effect as the introduction of the break in Q1 2009 in Johansen test.

Test	Included	Null hypothesis	Test value	p-value	Critical values		
					90%	95%	99%
Johansen Trace Test	- Constant	r = 0	58.40	0.00	38.91	41.69	47.25
		r = 1	19.19	0.26	22.83	25.09	29.73
	- Constant - Trend	r = 0	75.18	0.00	52.79	56.35	63.43
		r = 1	25.30	0.38	32.31	35.21	41.10
	- Orthogonal trend	r = 0	43.34	0.00	27.16	29.80	35.21
		r = 1	7.14	0.57	13.42	15.41	19.62
Saikkonen and Lütkepohl Test	- Constant	r = 0	22.79	0.08	21.76	24.16	29.11
		r = 1	6.08	0.43	10.47	12.26	16.10
	- Constant - Trend	r = 0	27.12	0.07	26.07	28.52	33.50
		r = 1	12.23	0.17	13.88	15.76	19.71
	- Orthogonal trend	r = 0	19.24	0.08	18.67	20.96	25.71
		r = 1	15.11	0.00	8.18	9.84	13.48

The diagnostic tests for the restricted, final model are provided in Table 5.6 below. The restrictions on both lagged endogenous and exogenous terms were made based on the p-values of the coefficients. All deterministic variables are assumed in the cointegrating vector. The diagnostic tests indicate that the VECM is correctly specified. The tests indicate autocorrelation in the errors of the equation with the SI as the dependant variable. However, one should assume the absence of any significant cross-correlation between the errors from the three equations that constitute the VECM (Figure A5.11, p.409).

Table 5. 6: The diagnostic tests for the restricted VECM (the final model)

	1 lag	2 lags	3 lags	4 lags
Doornik (1996), LM test for autocorrelation	0.837	0.889	0.343	0.365
Doornik & Hansen (1994), joint test for non-normality	0.744	0.744	0.744	0.744
Lütkepohl (1993), joint test for non-normaility	0.794	0.794	0.794	0.794
Jarque-Bera test, u1	0.826	0.826	0.826	0.826
Jarque-Bera test, u2	0.344	0.344	0.344	0.344
Jarque-Bera test, u3	0.759	0.759	0.759	0.759
Multivariate ARCH-LM test	0.992	0.867	0.650	0.375
ARCH-LM test, u1	0.329	0.016	0.059	0.130
ARCH-LM test, u2	0.162	0.103	0.247	0.409
ARCH-LM test, u3	0.457	0.661	0.608	0.646

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Note:
For Doornik (1996) p-value of LM statistics is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value of Chi^2 is reported.
For Multivariate ARCH-LM test p-value of Chi^2 is reported.
For ARCH-LM test p-value of F statistic is reported.

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The set of Tables 5.7a through 5.7d present the estimation outcome for the restricted form of VECM.

Legend:	
Variable 1	Coefficient {p - Value} [t - Value]

Table 5. 7a: Loading coefficients

	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
ec1(t-1)	-0.317 {0.000} [-9.659]	-0.018 {0.001} [-3.227]	-0.361 {0.038} [-2.071]

Table 5. 7b: Estimated cointegration relation

	ec1(t-1)
SI_log(t-1)	1 {0.000} [0.000]
IIP_log(t-1)	10.704 {0.004} [2.865]
LTDOMFUND(t-1)	0.371 {0.000} [8.012]

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merger(t-1)	-2.100 {0.000} [-4.629]
inflow2008(t-1)	0.374 {0.414} [0.818]
bankrun(t-1)	-0.208 {0.637} [-0.472]
shocklevel(t-1)	-13.44 {0.000} [-4.485]
shocktrend(t-1)	0.589 {0.000} [4.782]
CONST	-64.869 {0.000} [-3.846]
S1(t-1)	-0.23 {0.551} [-0.596]
S2(t-1)	-2.421 {0.000} [-6.013]
S3(t-1)	-0.96 {0.003} [-3.018]
TREND(t-1)	-0.416 {0.000} [-3.977]

Table 5. 7c: Lagged endogenous term

	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
d(SI_log)(t-1)	-0.519 {0.000} [-7.172]	---	---
d(IIP_log)(t-1)	---	-0.329 {0.020} [-2.325]	---
d(LTDOMFUND)(t-1)	0.211 {0.000} [6.886]	0.011 {0.055} [1.920]	0.499 {0.006} [2.723]

Table 5. 7d: Current and lagged exogenous term

	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
UNEMP(t)	0.215 {0.011} [2.550]	---	---
USDEUR_log(t)	-4.21 {0.000} [-4.154]	0.061 {0.076} [1.774]	---
UNEMP(t-1)	-0.215 {0.012} [-2.514]	---	---
USDEUR_log(t-1)	4.054 {0.000} [4.284]	---	---

The signs of the loading coefficients and the signs of the coefficients in the estimated cointegrating relation signal potentially destabilizing relationships. The only stabilizing force in the system is the SI, most likely, due to the regulatory requirements with respect to the CAR. Table 5.8 below illustrates the forces within the cointegrating vector. If the risk of banking crisis was above some long-term equilibrium level in the previous period, the self-correcting mechanism, as indicated by a negative loading coefficient in Table 5.7a, would reduce change in the SI in the current period with respect to the previous period, thus reducing the level of systemic risk towards the long-term equilibrium level. It is likely that this reduction in the SI occurs via additional capitalization that is a consequence of the credit expansion in the pre-crisis and losses in the post-crisis periods (Section 3.5). At the same time, too high a risk of banking crisis in the previous period tends to reduce IIP in the current period, as indicated by a negative loading coefficient in Table 5.7a, thus slowing down the volume of economic activity altogether. This reduction in the volume of economic activity, given the positive coefficient on IIP in Table 5.7b, would further destabilize the system by increasing the risk of banking crisis. Note that the effect of an increased risk of a banking crisis is the same as that of the currency crisis (Table 4.8b), as they both tend to depress the volume of economic activity in the long run. In other words, real economic activity favours more financially stable systems. The ratio of the long-term loans financed domestically is also a potentially disequilibrating force in the cointegrating vector, as too high a risk of a banking crisis in the previous period tends to reduce LTDOMFUND in the current period, as indicated by a negative loading coefficient in Table 5.7a. Consequently, the fraction of the long-term loans financed domestically decreases even further. This reduction in LTDOMFUND, given the positive coefficient in Table 5.7b, would further destabilize the system by increasing the risk of a banking crisis. The likely explanation for this finding is an overreliance on the external sources of financing of the lending activities (Section 1.3). As demand for loans increased, the inadequate maturity structure of banks' liabilities caused a surge of banking sector related capital inflows, of which a significant fraction affected the level of banks' capital (Table A1.5, p.333). In other words, as the systemic risk of banking crisis increased, the fraction of long-term loans financed domestically decreased.

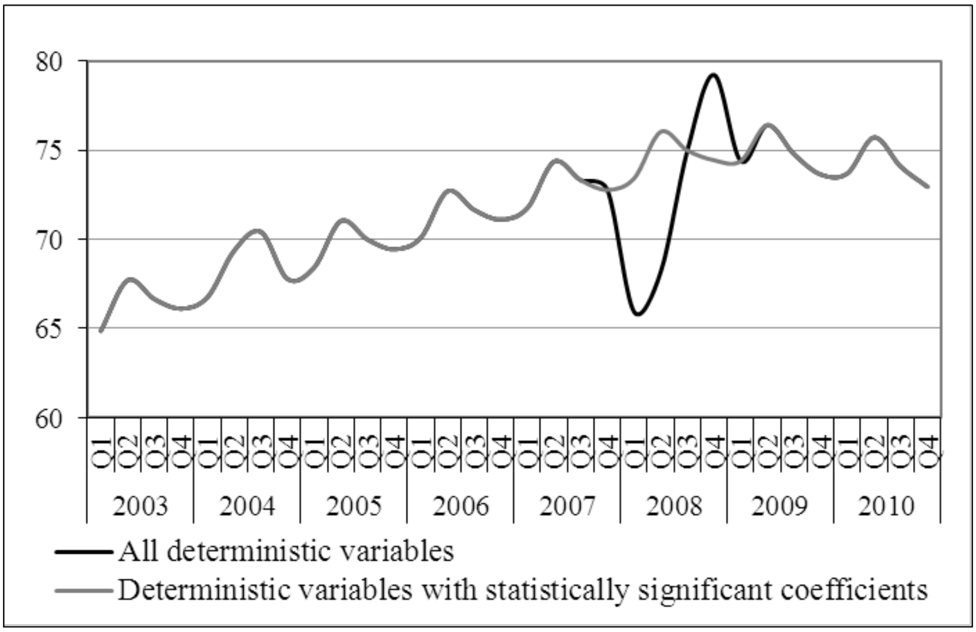
Table 5. 8: The long-term relationship within the system

If SI_{t-1} is too high, i.e $EC > 0$:		
$\rightarrow dSI_t \downarrow$	$\rightarrow dIIP_t \downarrow$	$\rightarrow dLTDOMFUND_t \downarrow$
$\rightarrow SI_t \downarrow$	$\rightarrow IIP_t \downarrow$	$\rightarrow LTDMFUND_t \downarrow$
	then positive sign on IIP in CV	then positive sign on LTDOMFUND in CV
EQUILIBRATING	BOTH DISEQUILIBRATING	

The loading coefficients (Table 5.7a) indicate a moderate speed of adjustment in the levels of endogenous variables when $EC \neq 0$ in the cases of SI and LTDOMFUND. In both cases about a third of the remaining adjustment is made per period. Similarity in the size of these two coefficients may suggest that the needed adjustment in the SI was caused by the additional inflows of loans from mother-banks that were counted towards banks' regulatory capital simultaneously increasing the exposure to risks from abroad as indicated by diminishing LTDOMFUND. As indicated by the estimated cointegrated relation, a percentage point increase in the share of the long-term loans financed domestically is found to reduce the risk of a banking crisis by 37 bp. On the other side, less than 2% of the needed adjustment in IIP is made per quarter indicating that the volume of real economic activity in the case of BH was not very responsive to changes in lending activities of banks. Given the statistical significance of the loading coefficient on the IIP, the vice-versa does not hold: banks did extrapolate their expectations of the economic trends based on the past trends in IIP when lending to other sectors, mainly households. The presence of a lending boom to the household sector is in line with studies on determinants of credit growth in transition economies, such as Cotarrelli et al. (2003), Brzoza-Brzezina (2005) and Bakker and Gulde (2010). This finding is also in line with Minsky's (1982) argument that, as the system moves from the hedge financing to speculative and Ponzi finance, developments in the real economy play a smaller role in the decision-making process of market participants. As indicated by the estimated cointegrated relation (Table 5.7b), a percentage point increase in the volume of industrial production, on average, reduces the risk of a banking crisis by 10.7 percentage points. Such a high coefficient suggests that BH banks tend to react strongly to even slight increases in the volume of economic activity. The risk of a banking crisis is temporarily reduced with each inflow of foreign liabilities.

As in the case of the LI, the error correction (EC) term defined in line with equations (4.3), (4.4) and (4.5) indicates that the effect of the deterministic variables restricted to the cointegrating vector on the endogenous variables is significant (Appendix 5.8, p.410). More specifically, as Figure 5.14 below illustrates, the systemic risk of a banking crisis tends to increase over time, based on some inherent instability of the financial system, which is in line with Minsky's instability hypothesis (Minsky, 1992). On average, it was found that in the case of BH the risk of banking crisis increases at the rate of 42 bp per quarter as indicated by TREND. SHOCKLEVEL indicates that immediately following a macroeconomic shock the SI rises by 13.4 percentage points. The trend in the SI following the shock reverses and the risk of banking crisis decreases, on average, at the rate of 59 bp per quarter as suggested by SHOCKTREND (Table 5.7b). This change in trend is likely to be the consequence of an adjustment in the lending policies of banks and different nature of the systemic risk in the post-shock periods. The remaining deterministic variables in the cointegrating vector reported in Table 5.7b indicate that: a merger between large banks, on average, temporarily increases the SI by 2.1 percentage points; and that capitalization, that temporarily decreases the SI, is usually made in the last quarter of the year.

Figure 5. 14: The deterministic component in the cointegrating vector



The short-term dynamics between the endogenous variables in the cointegrating vector have a significant effect as indicated by the plots of the various specifications of the EC term (Appendix 5.8, p.410). As Figure A5.12c (p.411) indicates, only after the short-term dynamics are accounted for does the EC term seems to stabilize around zero. The coefficients reported in Table 5.7c indicate the following. Change in the SI in the current period is affected by change in the SI and LTDOMFUND in the previous period. A percentage point increase in the level of risk in the previous period was found to result in a 52 bp decrease in the level of risk in the current period. This is a consequence of the self-correcting mechanism in the SI. A percentage point increase in LTDOMFUND in the previous period was found to result in 21 bp increase in the SI in the current period. As LTDOMFUND can increase if either long term deposits increase or long term loans decrease, it is likely that this coefficient captures the post-shock relationship between the credit crunch and an increase in the level of the systemic risk that is a consequence of the deteriorating quality of the loan portfolio. The effect of the past change in LTDOMFUND on the current change in IIP is statistically, but not economically significant. However, it was found that a percentage point increase in IIP in the past period reduces IIP in the current period by 33 bp. This coefficient is most likely capturing the persistence effect. An anticipated shock is accommodated by firms in two stages; in the first stage the unanticipated shock affect inventory levels while in the second stage inventory changes affect output levels (Blinder and Fisher, 1979). During this adjustment phase in inventories to their equilibrium (desired) levels output remains above (below) its steady state level. The estimated coefficient on d(IIP_log)(t-1) indicates that the adjustment of output levels occurs in the following quarter, i.e. BH firms tend to adjust the level of their output in the current period with respect to the level of inventories from the past period. A percentage point increase in LTDOMFUND in the past period results in a half percentage point increase in LRDOMFUND in the current period. This relationship indicates that the past changes in the ratio of long-term loans to households are likely to occur in the current period as well.

The coefficients on both exogenous variables have opposite signs but similar values in the current and past periods (Table 5.7d). Such a finding does not imply that the effect of these variables on the SI is brief and transitory, but rather the opposite. In the case of UNEMP, a percentage point increase in the rate of unemployment in (t-1) is found to result in a 22 bp decrease in the SI in the current period. As elaborated in Appendix 4.5 (p.357), following the deteriorated macroeconomic environment towards the end of 2008, the rate of unemployment exhibited a sharp increase that lasted through to the end of the period. Facing deteriorating macroeconomic conditions, banks temporarily froze their lending activities at the end of 2008. In such cases the SI temporarily decreases as new loans are not extended, some of the previously disbursed loans mature, while the level of capital remains unchanged. As the rate of unemployment continues to increase, banks face a larger number of defaults, which increase the risk of a banking crisis. This is suggested by the statistically significant UNEMP(t) coefficient of 0.215, i.e. a percentage point increase in the rate of unemployment results in a 22 bp increase in the SI in the same period. A strong persistence effect is also noted in the case of USDEUR. Being indirectly quoted, a rising USDEUR indicates an appreciation of EUR, driven by strong economic activity in the Eurozone. Favourable macroeconomic conditions resulted in high liquidity and narrowing yields in home markets for the banking groups present in the CESE countries (Section 4.4). With larger inflows of capital to host countries, the systemic risk of banking crisis increased. In the case of BH, a percentage point increase in USDEUR in period (t-1) is found to increase the SI in the current period by 4.05 percentage points. As the EUR continues to appreciate against USD, banks and their clients extrapolate their expectations of favourable economic conditions. In order to continue lending, banks need to increase their capital (note that this increase was partially completed by an inflow of loans from mother-banks), and the SI decreases. In the case of BH, a percentage point increase in USDEUR is found to result in 4.21 percentage points decrease in the SI in the same period. A percentage point increase in USDEUR in the current period is estimated to result in a 6 bp increase in IIP, most likely as a consequence of higher BH exports in periods of strong economic activity in the Eurozone.

Unlike in the case of VECM normalized on LI, the VECM normalized on SI indicates the existence of an adjustment mechanism towards the long-term equilibrium (Table 5.8). However, there is the same concern on whether one might assume a cointegrating relationship between SI, IIP and LTDOMFUND given the size of the sample (29 observations and 14 variables in the VECM normalized on SI). Despite the fact that it was concluded in Section 4.4 that all three variables are I(1) and a single cointegrating relationship between them is detected based on the Johansen Trace test and Saikkonen and Lütkepohl Test (Table 5.5), the identical robustness check was conducted as for the LI in the previous chapter.

The ARDL-ECM estimates (Appendix 5.10, p.416) support the assumption of the presence of a cointegrating relationship between SI, IIP and LTDOMFUND. The existence of an error correction mechanism was also confirmed. Given that the VECM was found to be, overall, equilibrating, the potential omitted variable bias posed less of a concern than it was the case with the long run relationship between the risk of the currency crisis and the level of real economic activity. This is also confirmed by a smaller difference between the speeds of adjustment in SI in two models. As the VECM is a system and ARDL-ECM is a single equation estimate, the speed of adjustment cannot be identical. In the case of the VECM all variables adjust when one changes and all variables change in order to restore equilibrium. In the case of the ARDL-ECM only the dependant variable, in our case SI, adjusts in order to restore the equilibrium. However, a relatively small difference between the two indicates low likelihood of the key variable being omitted. Judging by the statistically significant coefficient next to past changes in SI (Table A5.13, p.419) the level of systemic risk is a strong stabilizing force in the short-run. This finding is also in line with the VECM estimates.

The empirical analysis indicates that every system embeds a certain level of instability that tends to increase over time, only to be deflated by a crisis. The growth of economic activity and the reliance on foreign sources of financing are destabilizing forces within the system in the long run. These findings are in line with Minsky's hypothesis of the inherent instability of the financial systems. As economic activity picks up there is evidence that both banks and their clients extrapolate their expectations of future favourable trends. This increased level of systemic risk in the pre-crisis periods, following strong credit expansion, did not have a significant economic effect on real economic activity, but it fostered lending to other sectors, mainly households. It was found that firms in BH tend to adjust their inventories within a quarter depending on the possibility of placement of their products, rather than the availability of funding. In other words, while an increase in economic activity intensifies lending, this lending is not directed towards firms, as the largest fraction of new loans is directed towards households. It seems that the evaluation of the creditworthiness of banks' clients was not too rigorous as both the rate of unemployment, an indicator of client's creditworthiness, and the macroeconomic conditions in the Eurozone were found to exhibit a persistence effect as well. The only stabilizing force within the system, the regulatory capital requirements that affects the SI, was found to weaken over time thus resulting in a continuously increasing level of the systemic risk of banking crisis in the pre-crisis periods. All these findings suggest that, even in simple structured financial systems, the banking crises are almost inevitable.

5.5. Conclusion

The aim of this chapter was to investigate the relationships between the solvency index and the chosen macroeconomic and banking sector specific variables. The VECM analysis confirmed that financial systems, even as simple as the one in BH, bear a high level of inherent instability in the form of the risk of a banking crisis. This risk is found to increase steadily over time and it takes a macroeconomic shock to deflate the risk of systemic crisis via the adjustments in the SI.

Relying on economic theory and the empirical findings, strong domestic demand for loans coupled with microeconomic deficiencies was identified as the main crisis pre-condition in the case of BH. In this respect, BH is similar to other countries. However, comparing the signals of an accelerated credit growth and potentially imprudent and risky lending policies by banks in other counties to BH, there is strong evidence in favour of accounting for the country specifics when evaluating developments in the overall level of risk. For example, no strong evidence was found that the annual growth rates of loans exceeding 30% constituted a credit boom episode. The variables that were found significant in other empirical studies, such as GDP or domestic interest rates, were not found to be informative in explaining the evolution of the systemic risk of banking crisis in BH. Finally, commonly used high frequency market-based risk indicators, such as various interest rate spreads, were found to be completely uninformative in the case of BH.

The SI clearly indicates two stages in the evolution of systemic banking crisis risk. In the period between Q1 2003 and Q3 2008 the fragility of the system was increasing primarily because of the expectations of both banks and their clients that the favourable economic conditions would continue. Once the large macroeconomic shock occurred in Q4 2008, a series of adjustments occurred. This finding suggests that although the SI adequately captures the level of risk in the system, especially if the effects of the additional capitalization are taken into the account, its changes in the pre- and post-shock periods should be modelled separately. Since the causes of increased fragility are not the same, some of the variables that influence the index throughout the business cycle have different effects in those two regimes.

Chapter 6: Exploring the relationships between the liquidity and solvency indices

6.1. Introduction

Two measures of systemic risk, the liquidity (LI) and solvency (SI) indices, were developed in Chapter 3. The causes of changes in the LI, a measure of risk that indicates the distance to the point at which the currency board arrangement would be abandoned, were investigated for BH in Chapter 4. While the LI is constructed to measure the distance from a currency crisis, the SI measures the distance from the point at which the capital of the banking system would be fatally depleted. The macroeconomic and bank specific factors that affect the solvency index in BH were investigated in Chapter 5.

The aim of this chapter is to investigate the links between these two measures of systemic risk. It is unlikely that there is no relationship between the liquidity and solvency risks. Theory is undecided on which type of crisis is predominantly a cause and which is a consequence, but it suggests that the currency and banking crises are likely to coincide with each other (Section 2.2). The VECM approach was found to be suitable for explaining changes in the cases of both indices (Sections 4.3 and 5.4) with the validity of the coefficients in the individual liquidity and solvency risk equations was confirmed. Given that similar sets of variables were found to affect the LI and the SI, the starting premise is that there should be correlation between the errors of the two VECMs. In that case there would be a gain in efficiency if the two indices are observed as a system. In the case of the absence of correlation between the errors from the two VECMs, one should test whether the two measures of risk could be merged into a single indicator of systemic fragility. If the indices move in the same direction and the jointly shared coefficients in the VECMs are of the same sign, then it may be possible to merge the liquidity and solvency indices into a single measure of systemic fragility. The results and the interpretation of the findings, especially in terms of whether the two measures of systemic risk should be observed as a system, are provided in an empirical section, Section 6.2. Section 6.3 concludes.

6.2. The system of equations approach

The VECMs built to explain the changes in the perception of the currency and banking crises risks were developed in Sections 4.5 and 5.4 respectively. In both cases, links were established between the volume of economic activity and the fragility of the financial system. In the previous section, it was concluded that the errors of the equations from the two VECMs in the corresponding VAR form were likely to be correlated and that observing the two measures of risk through a system of equations would be an appropriate approach. The next step involves building the appropriate VECM structure of a system with four endogenous variables: LI, SI, IIP and LTDOMFUND. Whether it would be possible to merge the two measures of the systemic risk into a single indicator will be investigated towards the end of this section.

In the cases of both the LI and SI VECMs it was determined that the appropriate VAR structure was two endogenous lags with trend, intercept and seasonal dummies. The number of exogenous lags differed. The adopted VAR structure, based on the tests results reported in Table 6.13a below, is: two endogenous and no exogenous lag with trend, intercept and seasonal dummies. The choice was difficult given that the sample size was the limiting factor in performing some of the diagnostic tests. The presence of non-normality in the errors in the VAR (2,1) specification when only constant is included (Table 6.1b) indicates that one should favour a VAR (2,0) specification (Table 6.1a). Furthermore, due to the sample size, it is unclear whether the VAR (2,1) with trend and intercept included would outperform the similar VAR (2,0) specification. Finally, more tests, with favourable diagnostics, are reported for the VAR (2,0) specification with intercept, trend and seasonal dummies included. Bearing in mind the strong presence of seasonality in most of the variables that requires the inclusion of seasonal dummies in the model, and an issue of reduced capacity of tests to reject the null with an increasing number of regressors, the VAR (2,0) specification with intercept trend and seasonal dummies was chosen. As explained in Section 4.4, choosing too small a number of maximum endogenous lags, according to Lütkepohl and Krätzig (2004), should not matter too much since the specification tests of the final model would indicate whether the order chosen was too small. The VAR (1,0) and (1,1) specifications were found to have unfavourable diagnostics and thus were rejected (Appendix 6.1, p.421).

Table 6. 1a: The VAR specification, diagnostics: 2 endogenous and 0 exogenous lag

Note:
One exogenous lag and 2 maximum exogenous lags assumed in all 6 cases.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

	VAR (2 lags), intercept only	VAR (2 lags), intercept and trend	VAR (2 lags), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.4136	0.4602	0.2310
Doornik (1996), LMF test for autocorrelation, 2 lags	0.1326	0.0397	-
Doornik (1996), LMF test for autocorrelation, 3 lags	-	-	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994), joint test for non-normality	0.2680	0.7208	0.9274
Lütkepohl (1993), joint test for non-normaility	0.7120	0.6802	0.4910
Jarque-Bera test, u1	0.7160	0.9732	0.0514
Jarque-Bera test, u2	0.1710	0.8407	0.9383
Jarque-Bera test, u3	[illegible]	[illegible]	[illegible]

Table 6. 1b: The VAR specification, diagnostics: 2 endogenous and 1 exogenous lag

Note:
One exogenous lag and 2 maximum exogenous lags assumed in all 6 cases.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

	VAR (2 lags), intercept only	VAR (2 lags), intercept and trend	VAR (2 lags), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.1246	0.1392	-
Doornik (1996), LMF test for autocorrelation, 2 lags	Not tested for higher number of lags, like	-	-
Doornik (1996), LMF test for autocorrelation, 3 lags	multivarite and univariate ARCH-LM	-	-
Doornik (1996), LMF test	tests, due to detected	-	-

Based on the VAR specification, the chosen variables were tested for the number of cointegrating relations between them. Table 6.2 below reports the results of the Johansen trace test and the Saikkonen and Lütkepohl test. Given the strong seasonal pattern in the endogenous variables, seasonal dummies were included in both tests. A single cointegrating vector between the variables is detected.

Table 6. 2: The cointegration tests

Note:
Break date in Johansen Trace Test is set to Q1 2009. The break is assumed in levels and trend jointly and ignored in "orthogonal trend". MERGER and INFLOW2008 were restricted to long run. Saikkonen and Lütkepohl test does not have an option to set the break dates. Instead, it allows for including series that will account for changes in deterministic trend. In this case, the variables included are: MERGER, INFLOW2008, SHOCKLEVEL and SHOCKTREND.
Note that inclusion of SHOCKLEVEL and SHOCKTREND has the same effect as the introduction of the break in Q1 2009 in Johansen test.

	Included	Null hypothesi	Test value	Critical values 90%	95%	99%
Johansen Trace Test	- Constant	r = 0	70.67	58.86	62.16	68.69
		r = 1	41.14	38.91	41.69	47.25
		r = 2	18.89	22.83	25.09	29.73
	- Constant - Trend	r = 0	97.32	77.13	81.32	89.57
		r = 1	52.75	52.79	56.35	63.43
	- Orthogonal trend	r = 0	58.51	44.45	47.71	54.23
		r = 1	28.92	27.16	29.80	35.21
		r = 2	15.05	13.42	15.41	19.62
Saikkonen and Lütkepohl Test	- Constant	r = 0	45.23	37.04	40.07	46.20
		r = 1	16.75	21.76	24.16	29.11
	- Constant - Trend	r = 0	52.06	42.25	45.32	51.45
		r = 1	18.85	26.07	28.52	33.50
	- Orthogonal trend	r = 0	40.40	32.89	35.76	41.58
		r = 1	13.93	18.67	20.96	25.71

Based on the VAR specification and the cointegration tests a VEC model with the following specifications was estimated: cointegration rank of 1; 1 endogenous lags; 0 exogenous lags; trend; intercept; and seasonal dummies. Given the quarterly frequency of the seasonally unadjusted data and having found centred seasonal dummies significant in the cointegrating vectors that explain changes in the LI and SI, the dummies were included in the VECM estimated with both measures of systemic risk. In addition to the deterministic variables, the restricted constant and trend, the following variables and shift terms are also included in the cointegrating vector: MERGER, INFLOW2008, SHOCKLEVEL, and SHOCKTREND.

The set of tests above demonstrated that there is a long-term cointegrating relationship between the liquidity and solvency indices, the volume of economic activity and availability of domestic sources of long-term financing. The discussion in Chapter 3 left the choice of a possible merger of the two risk measures into a single indicator of systemic fragility for later stages of this research. Having established that modelling the relations between the LI, SI, IIP and LTDOMFUND as a system is an appropriate approach, it is concluded below that one should not merge the measures of risk into a single indicator, but rather interpret them separately while taking the behaviour of the other measure into account. Starting from low levels of economic activity in BH, such as in the years immediately following significant structural changes or in the post-crisis years when the system regained equilibrium, the two measures of risk tend to move in opposite directions (Figure 3.3). This happens because in a small open economy, the availability of funds dictates the level of credit activity in a country. Since in these initial periods the level of foreign reserves was low, any increase will contribute to the system’s resilience with respect to liquidity. At the same time, as the economy starts to show signs of a recovery, credit activity will start to pick up, thus increasing the risk of a banking crisis. Combining the two indicators might result in an incorrect perception of unchanged risk over time: just because the likelihood of a currency crisis is reducing, it does not imply that a banking crisis is not a threat, especially when there are signs of poor management and other microeconomic deficiencies in this sector. In crisis periods, the two measures of risk will tend to move in the same direction until stability is restored at a lower level of banking activity.

From a theoretical perspective normalizing the VECM on the SI should be favoured. As mentioned in Section 5.4, investment plans are made at the level of the banking group for each fiscal year at the end of the previous year. For that reason, it is likely that the planned level of funds sufficient to finance the lending activities of the banking group’s subsidiary in the host county first affects the perceived level of the currency crisis risk, and then the perceived level of the banking crisis risk once the loan is issued. The plots of the full set of the VECM forecast error impulse responses (Appendix 6.2, p.423) provide a supporting argument in favour this explanation[70]. The plots of the accumulated responses of the SI to an impulse in the LI and accumulated responses of the LI to an impulse in the SI are also provided in Figures 6.1 and 6.2 below. The LI as an impulse (innovation or shock) does not seem to cause any statistically significant response, either immediate or accumulated, to any of the variables. On the other hand, impulses from the SI cause a response from the LI. Therefore, although changes in the perception of solvency risk, mainly due to changes in the level of credit or its quality, affects the change in foreign currency denominated liabilities, the opposite does not hold; the availability of foreign currency denominated sources of funding does not imply stronger lending activity. More information on the impulse response functions will be given in Section 6.2.3 on the short-term dynamics between the endogenous variables.

Figure 6. 1: The accumulated percentage point responses of the solvency index to a percentage point impulse in the liquidity index

[70] The VECM forecast error impulse responses are legitimate since the errors from the VECM equations are not correlated. Appendix 6.4 (p.428) illustrates the cross-correlations between the residuals from 4 VECM equations with upper and lower bounds set to $\pm 2/\sqrt{T}$, where T is total number of periods in the sample. These bounds, according to Lütkepohl and Krätzig (2004), approximate 95% confidence bounds. In none of the cross-correlograms does the correlation between the two sets of residuals from individual VECM equation cross the 95% confidence bounds. Furthermore, the absence of instantaneous correlation between the errors from individual VECM equations, suggested by a small determinant of the covariance matrix (Appendix 6.4, p.428), according to the same source, enables use of the forecast error impulse responses from the observable residuals.

Key: Each plot of the responses of a variable to its own and impulses in other variables is represented by a solid black line in the figure. The dashed lines represent the confidence intervals that are set to 95% Efron percentile CI (B=2000 and h=8).

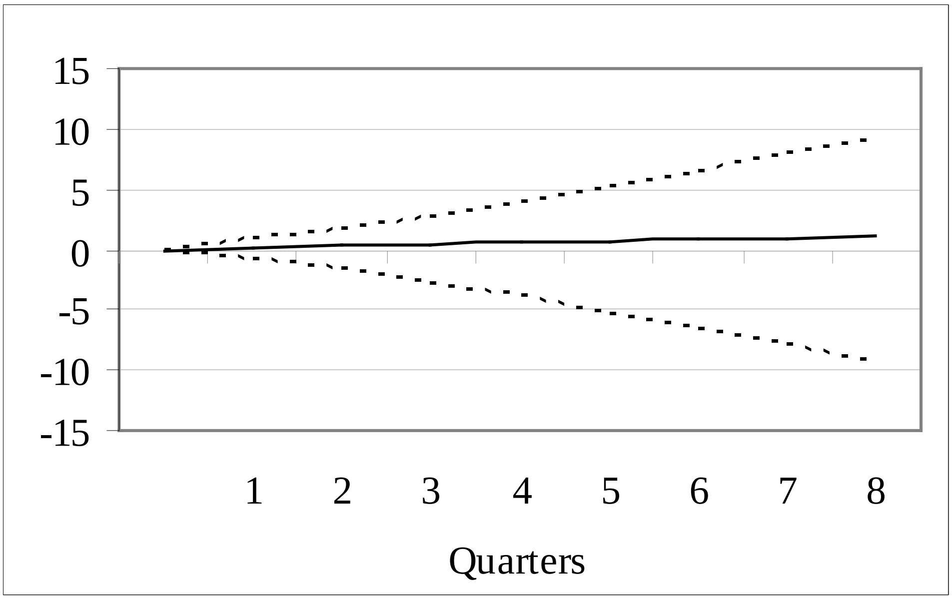
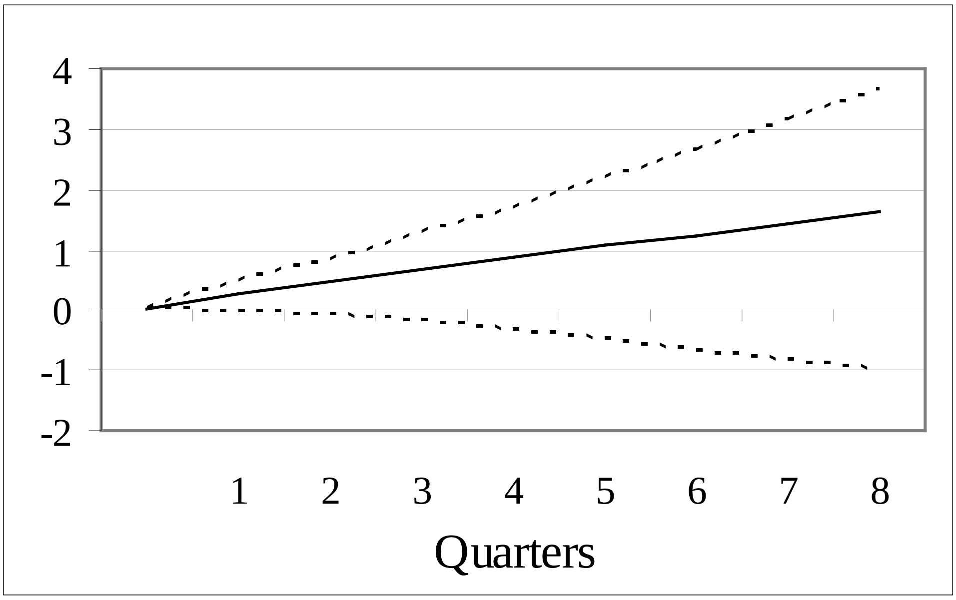


Figure 6. 2: The accumulated percentage point responses of the liquidity index to a percentage point impulse in the solvency index



Given that the purpose of cross-border inflow of banking sector related funds is to finance lending activity, normalizing the VECM to the SI seems intuitive. On the other hand, the relationships between the variables would not change since all endogenous variables in the VECM framework influence each other in the process of adjustment towards the long-term equilibrium. The choice of the variable that the system is normalized is only relevant from the point of presentation of the arguments.

The diagnostics (Table 6.3 below) indicate that the model should be regarded as correctly specified. There is some evidence of higher order autocorrelation, that, besides the possibility that it is a consequence of a limited number of degrees of freedom, is a consequence of innovations in IIP. As indicated by the auto and partial autocorrelation functions of individual residuals from the four VECM equations (Appendix 6.3, p.427), the partial autocorrelation in u3 (residuals from the equation normalized on IIP) breach the 95% confidence bounds in lags 5 and 8. Such finding indicates the persistence of the effect of the past innovations in IIP on its current values. In other words, it indicates that there is something not modelled in the IIP equation, which is not surprising given the main determinants of changes in IIP (Appendix 4.6, p.365). The only remedy would be including more variables that would capture these innovations in IIP, but that is not possible with a sample of this size. As indicated by the cross-correlogram of the residuals (Appendix 6.4, p.428), there is no sign of the cross-correlation of u3, or between any other residuals over the period of six quarters.

Table 6. 3: The VECM specification, diagnostics

Note:
For Doornik (1996) p-value of LM statistics is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value of Chi^2 is reported.
For Multivariate ARCH-LM test p-value of Chi^2 is reported.
For ARCH-LM test p-value of F statistic is reported.
"-" Insufficient data for test.

	1 lag	2 lags	3 lags	4 lags
Doornik (1996), LM test for autocorrelation	0.1279	0.1342	0.0910	0.0568
Doornik & Hansen (1994), joint test for non-normality	0.9720	0.9720	0.9720	0.9720
Lütkepohl (1993), joint test for non-normaility	0.9773	0.9773	0.9773	0.9773
Jarque-Bera test, u1	0.7578	0.7578	0.7578	0.7578
Jarque-Bera test, u2	0.9515	0.9515	0.9515	0.9515
Jarque-Bera test, u3	0.5777	0.5777	0.5777	0.5777
Jarque-Bera test, u4	0.8586	0.8586	0.8586	0.8586
Multivariate ARCH-LM test	0.5085	0.3630	-	-
ARCH-LM test, u1	0.3752	0.5965	0.7748	0.0173
ARCH-LM test, u2	0.8969	0.2898	0.3093	0.0704
ARCH-LM test, u3	0.0746	0.0547	0.1298	0.2529
ARCH-LM test, u4	0.0829	0.1980	0.2648	0.4249

The set of Tables 6.4a through 6.4d below represent the following components of the VECM estimation: the loading coefficients (Table 6.4a); the estimated cointegration relation (Table 6.4b); lagged endogenous terms (Table 6.4c); and current and lagged exogenous terms (Table 6.4d). The set of tables below reports the coefficient and standard errors in parentheses. The asterisks by the coefficients indicate the conventional confidence levels: 90% (*), 95% (**) and 99% (***).

Table 6. 4a: The loading coefficients

	d(SI_log)	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
ec1 (t-1)	-0.403***	0.159**	-0.030***	-1.076***
	(0.069)	(0.072)	(0.011)	(0.308)

Table 6. 4b: The estimated cointegration relation

	ec1(t-1)
SI_log (t-1)	1
	(0.000)
LI_log (t-1)	-0.290***
	(0.102)
IIP_log (t-1)	3.366**
	(1.650)
LTDOMFUND (t-1)	0.237***
	(0.023)
merger (t-1)	-2.700***
	(0.240)
inflow2008 (t-1)	1.482***
	0.247
shocklevel (t-1)	-6.917***
	(1.192)
shocktrend (t-1)	0.367***
	(0.048)
CONST	-24.406***
	(7.158)
S1(t-1)	-0.145
	(0.135)
S2 (t-1)	-1.632***
	(0.155)
S3 (t-1)	-0.610***
	(0.126)
TREND (t-1)	-0.287***
	(0.043)

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Table 6. 4c: Lagged endogenous terms

	d(SI_log)	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
d(SI_log) (t-1)	-0.414***	0.203*	0.005	0.136
	(0.118)	(0.114)	(0.018)	(0.524)
d(LI_log) (t-1)	0.091	0.075	-0.027	-0.003
	(0.163)	(0.157)	(0.025)	(0.722)
d(IIP_log) (t-1)	-1.087	-1.386	-0.417**	-6.206
	(1.115)	(1.109)	(0.175)	(5.100)
d(LTDOMFUND) (t-1)	0.119***	0.007	0.008	0.510***
	(0.036)	(0.035)	(0.006)	(0.162)

Table 6. 4d: Current exogenous terms

	d(SI_log)	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
UNEMP (t)	0.009 (0.006)	-0.005 (0.006)	-0.001 (0.001)	-0.039 (0.027)
USDEUR_LOG (t)	-1.466 (0.907)	0.877 (0.874)	0.152 (0.138)	5.862 (4.023)

The interpretation of the results is organized as follows. The Section 6.2.1 below investigates whether the relationship between the endogenous variables is equilibrating or not. This will be undertaken by simulating a shock to one of the endogenous variables and observing how it propagates through the system. The estimated error correction (EC) term will also indicate whether the adjustment dynamics between the variables are significant. The Section 6.2.2 interprets the long-term relationship as specified by the estimated cointegration relation (Table 6.4b). The short-term dynamics (Table 6.4c) between the variables will be further addressed in the Section 6.2.3.

6.2.1. Is the system equilibrating?

This sub-section aims to investigate whether the relationship between the endogenous variables is stabilizing. The next paragraph summarizes the relationships between the variables taking into account the significance and signs of the loading coefficients (Table 6.4a) and the coefficients from the estimated cointegrating relationship (Table 6.4b). The sub-section then proceeds with the estimation of the EC term given a shock in one of the endogenous variables and interpretation of the relationships between the endogenous variables. The effects of both positive and negative shocks to a chosen endogenous variable are investigated.

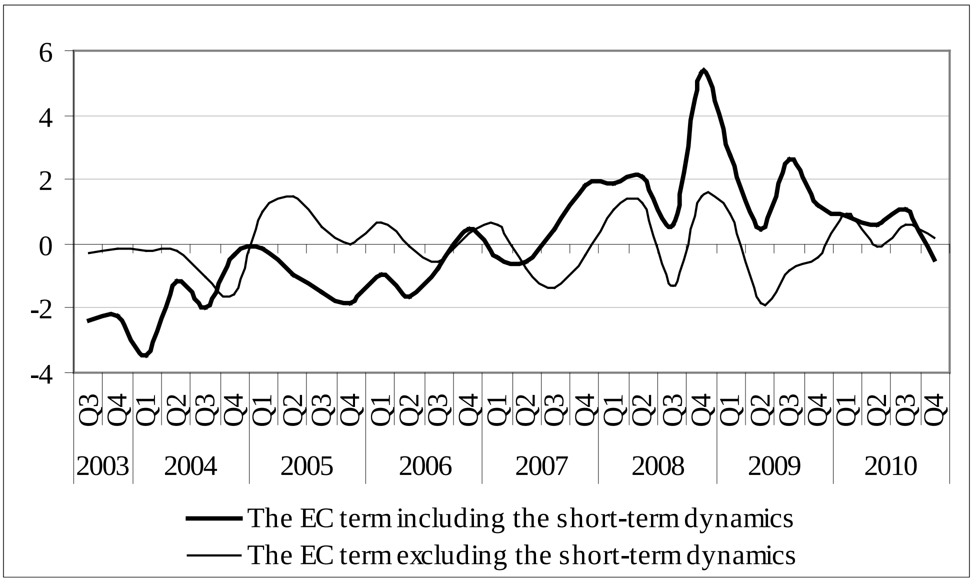
All four loading coefficients (Table 6.4a) are highly statistically significant indicating that all four variables tend to adjust when one of them changes. The signs of the loading coefficients and the signs of the coefficients in the estimated cointegrating relation signal potentially destabilizing relationships. Table 6.5 illustrates the forces within the cointegrating vector. As an example how these forces operate within the cointegrating vector, let us consider the cases of the SI and LI. If the risk of a banking crisis were above some long-term equilibrium level in the previous period, the self-correcting mechanism, as indicated by a negative loading coefficient in Table 6.4a, would reduce the change in the SI in the current period with respect to the previous period, thus pushing the level of systemic risk back towards the long-term equilibrium level. At the same time, too high a risk of a banking crisis in the previous period increases the risk of a currency crisis in the current period, as indicated by a positive loading coefficient in Table 6.4a, thus increasing the overall level of the risk of a currency crisis. This rise in the risk of currency crisis, given a negative coefficient on the LI in Table 6.4b, would further destabilize the system by increasing the risk of banking crisis.

Table 6. 5: The long-term relationships within the system

If SI_{t-1} is too high, i.e EC > 0:			
$\rightarrow dSI_t \downarrow$	$\rightarrow dLI_t \uparrow$	$\rightarrow dIIP_t \downarrow$	$\rightarrow dLTDOMFUND_t \downarrow$
$\rightarrow SI_t \downarrow$	$\rightarrow LI_t \uparrow$	$\rightarrow IIP_t \downarrow$	$\rightarrow LTDOMFUND_t \downarrow$
	- then negative sign on LSI in CV	- then positive sign on IIP in CV	- then positive sign on LTDOMFUND in CV
EQUILIBRATING	ALL DISEQUILIBRATING		

In a system where three out of four endogenous variables are potentially destabilizing one must investigate the net effect of a change in a single variable to the stability of the system as a whole. Figure 6.3 below plots the estimated error correction (EC) terms with and without the short-term dynamics (Text box 4.1 in Section 4.4). The plot of the EC term without the short-term dynamics (equation 4.5) seems to be stationary with a mean value of zero. In both cases there is some volatility clustering evident in the periods immediately following the macroeconomic shock at the end of 2008 that is consistent with the finding in Section 5.4 that those periods were characterised by adjustments in the lending policies of banks.

Figure 6. 3: The estimated error correction terms



Given significant differences in the shape of the two series, one may conclude that the short-term dynamics are especially important in the periods of economic expansion, i.e. the pre-shock periods. The following exercise aims to investigate whether the co-integrating relationship between the four endogenous variables is a stabilizing one or not. The short-term dynamics are accounted for.

Text box 6.1: The procedure for estimating the effects of a shock in a single endogenous variable

The purpose of this Text box is to outline the procedure that simulates a shock in a single endogenous variable in order to determine whether the relationship between the variables is stabilizing or not. The procedure is as follows:

1. Start with actual values of the data that give a value for the error correction mechanism (ECM) as close as possible to zero (equilibrium).

2. Shock one of the variables, i.e. change its value in the ECM.

3. Calculate the new value of the ECM.

4. Calculate the consequent change in each of the endogenous variables via the loading coefficients on the ECM in each equation of the VECM and the coefficients on the lagged endogenous term. This way the short-term dynamics are accounted for. If one wishes to ignore the short-term dynamics, then the effect of the lagged endogenous term should be left out.

5. Insert the changed values of each endogenous variable into the ECM and calculate the new value of the ECM.

6. Repeat steps 4 and 5 as many times as necessary to trace the adjustment path, i.e. when the EC term stabilizes close to zero.

Step 1:

EC without the short-term dynamics line in Figure 6.3 has the representation as specified in equation (4.5). The EC term was the closest to zero in Q4 2005 with a value of 0.015. For that reason, the period Q4 2005 was regarded as equilibrium, with the equilibrium values of the endogenous variables equal to these recorded in Q3

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2005. When the system is in equilibrium, a shock to an endogenous variable will result in EC term different from zero. In the following period each of the individual endogenous variables will change by the estimated EC term multiplied by the corresponding loading coefficient (Table 6.4a) and the past period's change in the levels of the endogenous variable multiplied by the corresponding coefficients (Table 6.4c).

Step 2:

IIP_log was arbitrarily chosen as the variable to be shocked. Later in this section the effects of both positive and negative shocks to IIP_log and different sizes of these shocks will be examined. For the illustrative purposes in this Textbox the effects of a positive shock of 5% magnitude to IIP_log will be examined.

Step 2 can be viewed as a simple case of Step 4. The difference between the two is that in Step 2 only one variable changes and even its levels do not have to be estimated, but assumed.

Step 3:

As soon as the shock occurs, the EC becomes different from zero. The post chock value of the ECM is estimated as follows:

$$New\_ECM_{2005Q3} = SI\_log_{2005Q3} - \beta_1 * LI\_log_{2005Q3} -$$

$$- \beta_2 * New\_IIP\_log_{2005Q3} - \beta_3 * LTDOMFUND_{2005Q3} - \qquad (6.1a)$$

–(the sum of the effect of deterministic variables and shift terms, all 2005Q3 values, multiplied by the corresponding coefficients from Table 6.4b)

β denotes the corresponding coefficient from Table 6.4b. The part in the parentheses

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in equation (6.1a) is the deterministic component: the restricted trend, constant and all modelled country or period specific shift terms.

Step 4:

With the change in the EC term, calculated in Step 3, the values of all endogenous variables in 2005Q4 will change as well. Variable SI_log will be used as an illustration how new value for each endogenous variable is calculated. Note that the short-term dynamics are accounted for. The new level of SI_log_{2005Q4} is estimated as follows:

$$SI\_log_{2005Q4} = SI\_log_{2005Q3} + \alpha * New\_EC_{2005Q3} + \gamma_1 * dSI\_log_{2005Q3} + \\ + \gamma_2 * dLI\_log_{2005Q3} + \gamma_3 * New\_dIIP\_log_{2005Q3} + \\ + \gamma_4 * dLTDOMFUND_{2005Q3} \tag{6.1b}$$

α denotes the loading coefficient (Table 6.4a) and γ the coefficient that determines the effect of the short-term dynamics (Table 6.4c). With the corresponding coefficients (read from Tables 6.4a and 6.4c) plugged in, equation (6.1b) is of the form:

$$SI\_log_{2005Q4} = SI\_log_{2005Q3} - 0.40 * New\_EC_{2005Q3} - 0.41 * dSI\_log_{2005Q3} \\ + 0.09 * dLI\_log_{2005Q3} - 1.09 * New\_dIIP\_log_{2005Q3} + \\ + 0.12 * dLTDOMFUND_{2005Q3} \tag{6.1c}$$

Step 5:

Step 5 is very similar to step 3. The only difference is that in Step 5 all variables have

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new values. The changed values of each endogenous variable, obtained in Step 4, are used to calculate the new value of the EC term. Note that deterministic component stays fixed at the value recorded in the period when the shock occurred, i.e. it is the same as in the equation (6.1a). The reason why this is fixed is that the purpose of this exercise is to extract the path of shock propagation and the adjustment process between the endogenous variables alone. The impact of the deterministic trend could greatly change the perception of the shock propagation.

Step 6:

Steps 4 and 5 are repeated until the EC term reaches zero again.

The following table illustrates how each of the endogenous variables changes when a positive shock increases the volume of industrial output. It was arbitrarily chosen that a shock of +5% should be applied to the IIP. The simulation is conducted by following Steps 1 through 6 described above.

Table 6. 6a: The estimates of the endogenous variables following a shock to IIP

In Equilibrium (Q4 2005 in our example) the values are:					
	EC1	SI	LI	IIP	LTDOMFUND
Period 0	0.00	0.63	0.43	100.24	53.04
After +5% shock to IIP:					
Period 0, post shock	-0.16	0.62	0.42	105.94	53.13
Adjustments in the following periods:					
Period 1	-0.24	0.69	0.39	106.61	53.40
Period 2	0.42	0.57	0.43	105.43	53.06
Period 3	0.09	0.58	0.42	105.04	52.83
Period 4	0.05	0.55	0.43	104.91	52.70
Period 5	-0.05	0.57	0.42	104.92	52.68
Period 6	-0.02	0.56	0.42	105.02	52.69
Period 7	-0.02	0.57	0.42	105.05	52.71

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Period 8	0.00	0.57	0.42	105.08	52.72
Period 9	0.00	0.57	0.42	105.07	52.73
Period 10	0.00	0.57	0.42	105.07	52.73

Had the short-term dynamics not been accounted for, the estimates of the endogenous variables following a shock to, say IIP, would be not be significantly different. In both Tables 6.6a and 6.6b the overall change in the endogenous variables is qualitatively similar and all variables would end up at similar levels once the shock is absorbed. On the other hand, the effect of the shock would be underestimated in the case when the short-term dynamics are ignored, which is evident from the significantly higher EC term in the first period following the shock when compared to the value reported in Table 6.6a. Furthermore, it would seem that the adjustment process is three quarters shorter in the case when the short-term dynamics are unaccounted for.

Table 6. 6b: The estimates of the endogenous variables following a shock to IIP without the short-term dynamics accounted for

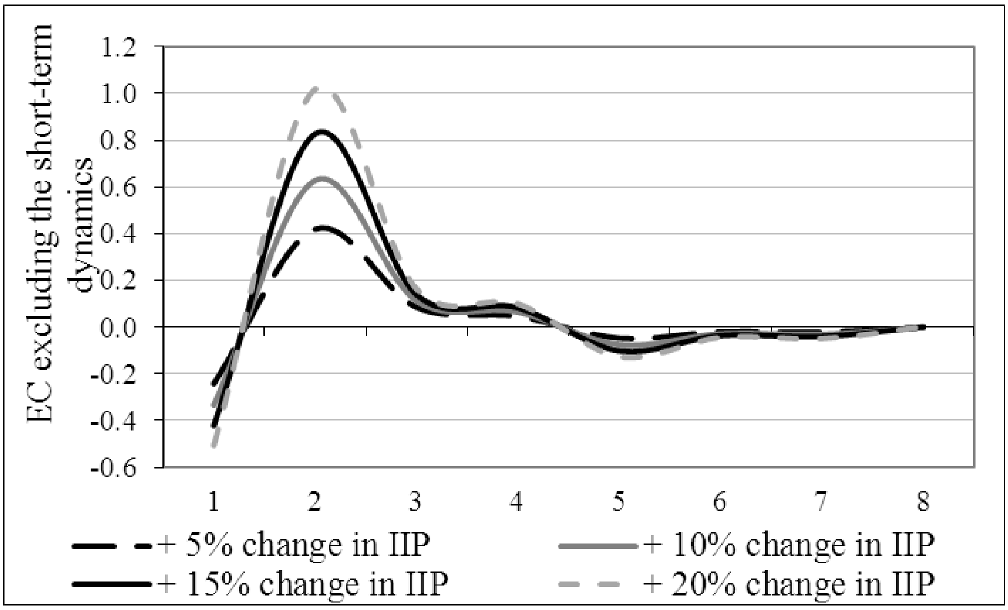
In Equilibrium (Q4 2005 in our example) the values are:					
	EC1	SI	LI	IIP	LTDOMFUND
Period 0	0.00	0.63	0.43	100.24	53.04
After +5% shock to IIP:					
Period 0, post shock	-0.16	0.68	0.42	105.77	53.21
Adjustments in the following periods:					
Period 1	-0.16	0.72	0.41	106.30	53.39
Period 2	0.44	0.60	0.44	104.89	52.91
Period 3	0.09	0.58	0.45	104.62	52.82
Period 4	0.02	0.58	0.45	104.57	52.80
Period 5	0.00	0.58	0.45	104.56	52.80
Period 6	0.00	0.58	0.45	104.56	52.80

Finally, one should note that in both Tables 6.6a and 6.6b the IIP ends near its pre-shock level after the process of stabilization is complete. This phenomenon will be investigated in more detail later in this section.

The plot of the estimates of the EC term provides information on both the duration of the effects of a shock and the degree of stabilization within the system. The duration of the effects of the shock is measured by the number of periods until the EC term reaches zero. Any cointegrating relationship, i.e. long-run equilibrium relationship, implies, by definition, an adjustment mechanism, but the shape of the EC term provides more information on the possible second round effects and feedback mechanisms. In a system with a high degree of stabilization, the pace at which the EC term approaches zero is monotonic. Conversely, in a system characterised by weak, sluggish and indirect stabilization, the EC term will resemble a damped sine wave: the amplitudes will decay over time and the EC term will gradually approach zero[71].

Figures 6.4a and 6.4b below plot the EC term without the short-term dynamics for positive and negative shocks to the IIP respectively. The endogenous variables were estimated in line with the procedure outlined in Text box 6.1. The plots of the EC term with the short-term dynamics for both positive and negative shocks to the IIP are provided in Appendix 6.5, (p.430). In both cases the shocks range from 5% to 20% in 5% increments. Shocks of the same sign but of different magnitude were chosen to test if the EC term exhibits a different pattern if a more significant shocks are applied. The estimates of the EC term when the 5% shock to IIP is applied correspond to the estimates of the EC term from Table 6.6a.

Figure 6. 4a: The effect of a positive shock to the IIP



[71] The nature of adjustment paths could be an interesting avenue of the post-doctoral investigation from the perspective of policy implementation. Table 6.9a reports that following a positive macroeconomic shock of a likely magnitude the financial system reacts swiftly: the risk of a banking crisis decreases; the risk of a currency crisis increases and the long-term lending increases. The majority of changes occur in the first two quarters following the shock. It takes two years for the system to absorb fully the shock, during which there a series of adjustments occur. Distinguishing the “period of major adjustments” from the “tremors” can determine the effectiveness and the result of the policy measures, especially if the economy is approaching the turning point of the business cycle.

When the system is in equilibrium, an increase in economic activity will result in reducing the risk of a banking crisis. This is confirmed by EC<0 in the initial period (period 0 in Table 6.6a). When the EC is negative, the variable on which the system is normalized tends to increase in the following period, thus increasing the level of the systemic risk and the EC term. However, in the case illustrated above, the EC term in period 1 is still below zero and increases in period 2 indicating that equilibrium is restored via a damped cycle. In other words, banks do not adjust their lending policies immediately following an increase in economic activity, proxied by the rising IIP. However, in the second quarter, the market participants extrapolate their expectations from the recent past and expect the favourable macroeconomic conditions to continue in the future, thus pushing the EC term well above zero. The presence of these potentially destabilizing long-term relationships, in line with Minsky's (1992) theory of inherently unstable financial systems, indicates that the financial system has a potential to become more unstable in periods of prolonged prosperity.

Judging by the size of the loading coefficients (Table 6.4a), the fraction of the long-term loans being financed domestically, LTDOMFUND, reacts the fastest to this change in expectations and the adjustment is completed in the following quarter. This variable exerts destabilizing pressure on the system as a whole (Table 6.5), i.e. the ratio declines when the SI is too high. Given the way LTDOMFUND is constructed, this may occur either through a decrease in the long-term domestic deposits, or through an increase in the long-term loans. The reduction in LTDOMFUND caused by an increase in the long-term loans is characteristic of the expansionary phase of the business cycle and again fits with Minsky's (1992) theory of inherently (endogenously) unstable systems. In a situation when both lenders and borrowers adjust their expectations of future prosperity upwards, long-term lending increases. This assertion is supported by the values of the endogenous variables following a positive shock to the IIP reported in Table 6.6a. Following a 5% increase in the IIP, LTDOMFUND increased by 26bp. By the time the adjustment process was completed, LTDOMFUND was 41 bp below the value in period 0. Given the characteristics of the BH economy (Section 1.2), in the expansionary phase of the business cycle LTDOMFUND was changing mainly because of the increase in the long-term lending to domestic sectors (Section 5.4).

Most of these new long-term loans were to the household sector. In order to test how much changes in the underlying real economic activity affect the risk of a banking crisis, the unrestricted VAR equation with IIP as a dependant variable was estimated by

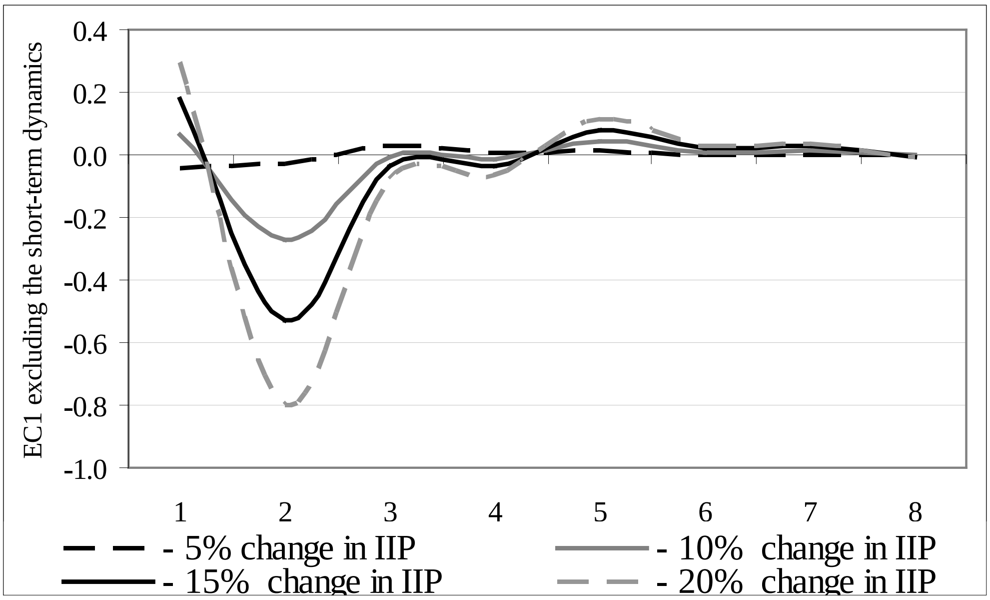
OLS as a single equation and the differences in the efficiency of the coefficient estimates, measured by the size of the standard errors of the coefficients, was small. The finding that the individual IIP equation performs equally well as when observed as a part of the system of equations indicates that changes in the systemic risks and the long-term lending financed domestically do not affect the level of the IIP significantly (but note that vice-versa holds). This extremely slow change in the IIP when other endogenous variables change is also reflected by the loading coefficient of -0.03 on IIP_log (Table 6.4a). More discussion of the cointegrating relationship between the endogenous variables can be found in the Section 6.2.2. Furthermore, building upon the arguments in Section 5.4 that the government, traditionally the biggest contributor to the national GDP next to industrial production, could not borrow long-term in the period under observation, suggests that the majority of the long-term lending was aimed at the household sector. As indicated in Section 5.4, there is a reason to suspect that the banking sector, guided by the rising level of the IIP in the expansionary part of the business cycle, which had little to do with their lending policies to that particular sector, adjusted its expectations of future prosperity upwards. This change in expectations resulted in growing exposure of banks towards the household sector.

This increase in the long-term lending is, given the country specifics, usually financed from abroad. Given the way the LI was constructed (Section 3.4) and the specifics of the BH financial system and the macroeconomic environment (Section 1.2), significant changes in the level of liquidity risk are caused primarily by cross-border flows of capital. The latter are usually banking sector-related, with the occasional inflows of privatization-related funds. Since foreign reserves increase by only a fraction of the cross-border inflow of banking sector related funds (Set of Figures 3.1 in Section 3.4), as time progresses the liquidity risk rises. This is the reason why the LI is a disequilibrating force in the cointegrating vector. As the need for foreign funding, caused by an increase in domestic demand for loans, increases, the inflow of banking sector related funds eventually results in the perception of an increased risk of currency crisis.

In summary, after the initial shock, the system moves away from equilibrium in the next quarter. Over time, the stabilizing effect of the SI gets stronger than the cumulative destabilizing effects of the LTDOM FUND, LI and IIP and the EC term begins approaching zero in the third quarter. Eventually, the EC term reaches zero after approximately 7 periods following a series of adjustments in the SI in order to restore equilibrium. Comparing the plots of the estimated EC term with the short-term dynamics accounted for (Figure 6.4) and the estimated EC term that includes the short-term dynamics (Figure A6.4a, p.430) it was found that these destabilizing forces in period 1 are present in either case. This finding implies that the adjustments in the periods immediately following the shock are mainly determined by the long-term relationships within the system. While the impact of individual adjustments may be disequilibrating, the outcome of the entire adjustment process is eventually, equilibrating. The cointegrating relationship between the endogenous variables will be addressed in detail in the following sub-section. The fluctuating path of the decay of the EC term towards zero in the subsequent periods is more a consequence of the short-term dynamics between the endogenous variables and it will be addressed in Section 6.2.3.

Figure 6.4b below illustrates the estimated EC terms following a set of negative shocks to the level of IIP. The shape of the estimated EC terms suggests that equilibrium is restored via a damped cycle and that the short-term dynamics are important (the estimated EC terms when the short-term dynamics are not accounted for can be found in Appendix 6.5 (p.430), but, when compared to Figure 6.4a, there are several differences.

Figure 6. 4b: The effect of a negative shock to the IIP



Primarily, the fluctuations of the EC term are less pronounced in the case of the negative shocks to the IIP; the span between the lowest and the highest value of the EC term when a 20% shock to IIP assumed is 1.55 compared to 1.63 when a 20% increase in IIP is assumed. This finding may suggest that the level of capitalization, and indirectly the SI, adjusts faster in adverse macroeconomic conditions, i.e. it may be the case that the regulations do a better job in stabilizing the system in the aftermath of the crisis rather than preventing the build-up of the systemic risk.

Furthermore, it seems that small shocks to IIP (5% in the example above) tend to reduce the risk of a banking crisis as indicated by EC<0 in period 1 in Figure 6.4b. As the EC term does not deviate significantly from zero in the adjustment process, it is possible that banks and their clients do not alter their expectations of future developments immediately as the economy starts to slow down. However, if the real economic activity deteriorates significantly (10%, 15% and 20% shocks to IIP in the example above), the adjustments towards the new equilibrium are more pronounced and especially significant in period 2. In the cases of these significant slowdowns in economic activity, the EC term in period 1 is positive indicating that the risk of banking crisis is too high. In the post shock periods, the rise in the SI occurs through the banking sector losses incurred by the worsening in the quality of their credit portfolio. As the credit portfolio worsens, bank lending tends to reduce significantly and this lending contraction results in EC<0 in period 2.

The pattern of the SI in periods following an episode of macroeconomic shock is interesting. When the EC term is positive, the SI will tend to decrease in order to restore equilibrium. However, Table 6.7 indicates that the risk of a banking crisis actually increases following a drop in volume of industrial production[72]. This finding may be viewed as another argument in favour of the claim that it is unlikely that a single model can be used to explain changes in the level of systemic risk over the cycle. At the end of the adjustment period, as in the case of a positive impulse to IIP, the level of IIP ends slightly below the level in period 0 (Tables 6.6b and 6.7). Unlike in the case of a positive innovation in IIP, the level of SI in the case of a shock to IIP is above the level in period 0. Therefore, although the whole adjustment process is equilibrating, there is evidence that the adjustments in the level of the SI occurs differently in the periods before and after the macroeconomic shock, which is in line with the conclusions drawn in Section 5.4.

[72]The process of shock propagation when a negative shock to IIP is applied to the system is identical to the process outlined in Text box 6.1.

Table 6. 7: The estimates of the endogenous variables following a negative shock to the IIP with the short-term dynamics accounted for

In Equilibrium (Q4 2005 in our example) the values are:					
	EC1	SI	LI	IIP	LTDOMFUND
Period 0	0.00	0.63	0.43	100.24	53.04
After -5% shock to IIP:					
Period 0, post shock	0.17	0.60	0.50	98.93	53.39
Adjustments in the following periods:					
Period 1	-0.04	0.64	0.48	97.35	53.37
Period 2	-0.03	0.64	0.49	98.25	53.50
Period 3	0.03	0.63	0.49	97.84	53.48
Period 4	0.01	0.63	0.49	97.99	53.49
Period 5	0.01	0.63	0.49	97.88	53.47
Period 6	0.00	0.63	0.49	97.91	53.47
Period 7	0.00	0.63	0.49	97.90	53.47
Period 8	0.00	0.63	0.49	97.91	53.47

Finally, the adjustment towards the new equilibrium lasts longer for larger shocks (Table 6.8 below)[73]. In the cases of positives innovations in IIP (EC case 1 through EC case 4 in table below), the equilibrium is restored after 8 quarters regardless of the size of the assumed change in IIP. However, in the case of a negative shock to IIP, the number of quarters after which the new equilibrium is reached is conditional on the size of the shock: it ranges from year and a half in the case of -5% shock to IIP to two years for shocks exceeding 15%.

Table 6. 8: The EC term at various shocks to IIP with the short term dynamics accounted for

	EC case 1	EC case 2	EC case 3	EC case 4	EC case 5	EC case 6	EC case 7	EC case 8
shock to IIP	5%	10%	15%	20%	-5%	-10%	-15%	-20%
Period 0	-0.16	-0.32	-0.47	-0.61	0.17	0.35	0.55	0.75
Period 1	-0.24	-0.33	-0.42	-0.51	-0.04	0.06	0.18	0.30
Period 2	0.42	0.63	0.83	1.02	-0.03	-0.27	-0.53	-0.80
Period 3	0.09	0.11	0.14	0.16	0.03	-0.01	-0.04	-0.08
Period 4	0.05	0.06	0.08	0.10	0.01	-0.02	-0.04	-0.06
Period 5	-0.05	-0.07	-0.10	-0.13	0.01	0.04	0.08	0.11
Period 6	-0.02	-0.03	-0.04	-0.04	0.00	0.01	0.02	0.03
Period 7	-0.02	-0.03	-0.04	-0.04	0.00	0.00	0.02	0.03
Period 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[73] Note that EC case 1 and EC case 5 correspond to values reported in Tables 6.6a and 6.7 respectively.

6.2.2. The estimated cointegrating relationship

The estimated cointegrating relationship (Table 6.4b) explains the long-term relationship between the variables within the cointegrating vector. This long-term relationship between the endogenous variables (equation 6.2 below) is obtained from the statistically significant coefficients from Table 6.4b[74].

$$\begin{aligned}\mathrm{SI\_log}_t &= 24.4 + 0.3 * \mathrm{LI\_log}_t - 3.4 * \mathrm{IIP\_log}_t - 0.2 * \mathrm{LTDOMFUND}_t + \\ &+ 2.7 * \mathrm{MERGER}_t - 1.5 * \mathrm{INFLOW2008}_t + \qquad (6.2) \\ &+ 6.9 * \mathrm{SHOCKLEVEL}_t - 0.4 * \mathrm{SHOCKTREND}_t \\ &+ 1.6 * \mathrm{S2} + 0.6 * \mathrm{S3} + 0.3 * \mathrm{TREND}_t + \varepsilon_t\end{aligned}$$

Equation (6.2) indicates that a certain level of fragility is built into the financial system regardless of the factors included in the model. This is represented by a positive and statistically significant intercept (24.4). Seasonal factors are significant as suggested by the statistically significant and positive coefficients related to the quarters with traditionally significant inflows of capital (S2 and S3). Due to seasonal factors the level of the banking crisis risk is, on average, increased additionally by 1.6 percentage points in each second quarter and by 61 bp on average in each third quarter. A departure from the trend in the systemic risk, estimated at 2.7 percentage points, tends occurs with a merger of systemically important banks. MERGER is assumed to be a transitory blip dummy variable[75], but in reality the duration of the effect of MERGER on the level of the solvency risk is uncertain. In the initial period, the level of risk is increasing. Since mergers and acquisitions are undertaken with the purpose of increasing market share, in the immediate post-merger period banks involved will tend to issue more loans while the capital remains the same thus increasing the level of systemic risk[76]. The assumption of initially unchanged level of capital holds in the cases of mergers and the cash buyouts

[74] The variable on which the EC term is normalized is left on the left-hand side of the equation, while all other variables were moved to the right-hand side. The subscripts t-1 were replaced by t.

[75] A transitory blip dummy variable is a dummy variable that accounts for a brief, transient movement in the trend of a variable. As the effect of MERGER on the SI lasted for only a quarter when the merger occurred, this could be regarded as a transitory blip variable.

[76] Also note that an increase in the RWA of the "new" bank will be higher in absolute terms than an increase in its capital, which will push the CAR somewhere between the CAR of two banks before the merger. In order to maintain the gained market share, the new bank will have to continue issuing new loans, which will require additional capital.

of the equity of acquired bank. However, the ‘new’ bank will have to increase capital because of the regulatory requirements. The additional capital raised will result in a decrease in solvency risk. The future effects on the trend will depend on the reaction of other banks to a more aggressively lending competitor and the strength of domestic demand for loans. If demand is strong and the other banks have available sources of funding, the effect on the level of risk is likely to be lasting since the increased competition in the market for loans increases the stock of loans and possibly weakens the quality of the procedures evaluating clients’ creditworthiness. The issue of the quality of the credit risk evaluation becomes greatly more important in a slowdown in economic activity or when a contractionary shock occurs.

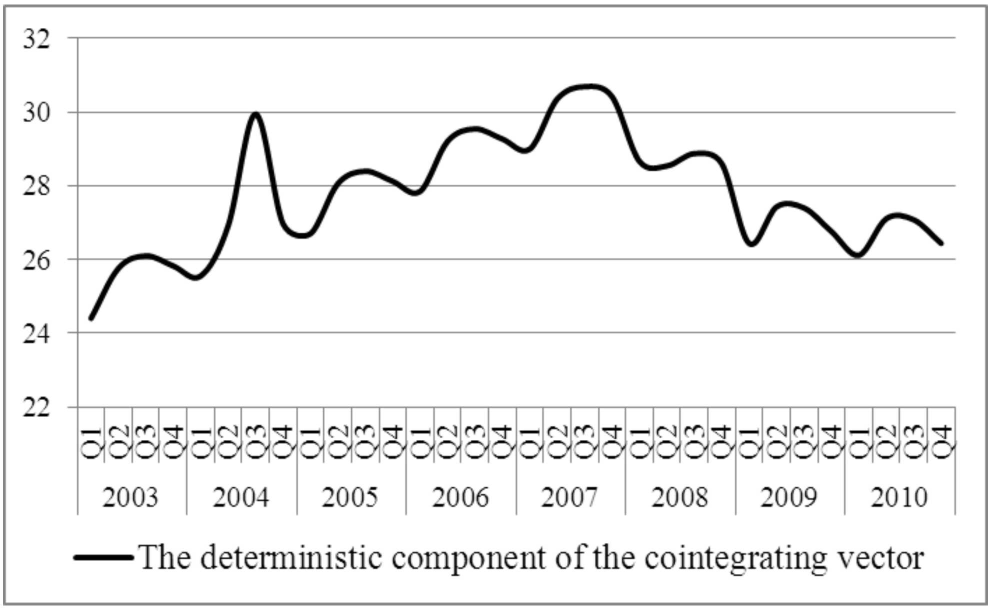
As for the slope of the trend, generally speaking, over time the fragility of the BH financial system tends to increase in periods of expansion. The positive TREND (0.3 in equation 6.2) is consistent with expectations of future economic prosperity extrapolated from past periods. Extrapolative expectations are part of Minsky’s story of the endogenous evolution of capitalist finance from stability to instability, and which we hypothesise to be the main cause of the increase in the risk both of a currency crisis and of a banking crisis. Of course, the estimated trend cannot continue indefinitely. The negative coefficient on SHOCKTREND (-0.4) indicates that once the SI has risen to a crisis level then it does not continue to rise further. As a matter of fact, the risk starts to deflate. At some point, the rise in systematic risk must be countered by policy decisions or result in a systemic collapse of the banking system. As discussed earlier (Section 5.4), the perception of the solvency risk in BH in the post- shock periods was greatly influenced by additional capitalizations (Figure 5.22). For that reason, it is possible that the speed at which the solvency risk increased over time in the post-shock periods was not declining. However, one should not adjust the level of capital for the effects of additional capitalizations, even though that might get more intuitive results for the long-term relationships between the endogenous variables in the post-shock periods. Had some of the banks not been additionally capitalizing in the periods of significant deterioration in the quality of loans, they would have become insolvent and their licences would have been revoked. In that case, the level of the systemic risk would have been higher when compared to the actual level of the SI. More importantly, it seems that the level of the risk of SI would increase regardless of the phase in the business cycle; it would increase in both the periods of economic expansion, as well as in the periods of unfavourable macroeconomic conditions. This finding implies that additional capitalization or entropy of the banking system are the only two remedies for deflating an overly-expanded banking sector. Given that banks covered their losses by raising additional capital, making adjustments in the level of capital could result in modelling a hypothetical case.

The lending freeze that followed only a couple of quarters after the substantial inflow of funds labelled as INFLOW2008 in equation 6.2 seemed to result in an increase in the level of risk of banking crisis. The coefficient on SHOCKLEVEL indicates that the risk of banking crisis rose by 6.9 percentage points, possibly because of the lending freeze and in the context of a growing incidence of NPLs. In the sample used in this research, the trend in the post-shock periods was flattened (Figure 5.10). This information, combined with a decline in the slope of the trend, indicates that the risk of a banking crisis tends to rise in the post-shock periods and from lower levels when compared to the pre-shock levels. As indicated by the cointegrating relationship, the deterministic trend is found to increase in the immediate post-shock period, but after the levels effect represented by SHOCKLEVEL there is no further tendency to increase over time. All these findings combined suggest that the banking system is more robust in the post-crisis periods than it was in periods of expansion. However, these conclusions on the level and the trend of the risk in the post-lending freeze period should be observed in the context of the banking-sector related inflow of foreign funding just a couple of quarters before the lending freeze occurred and the effect of the additional capitalizations on the SI.

In mid-2008, banks in BH had increased foreign funding of approximately BAM 550 million. This substantial inflow of foreign funding, represented by INFLOW2008 in equation 6.5, reduced the SI by 1.5 percentage points. This rather small decrease in the SI given the size of the inflows indicates that the inflows were mainly in the form of deposits from the mother-banks (Figure 1.5a). Therefore, the level of capital was not increased substantially (as indicated in Table A1.4 (p.332), only the loans from the non-residents increase the level of capital). Had these new funds been utilized for financing lending activities before the lending freeze, the SI would have risen, since it would take deterioration of a smaller fraction of total loans to collapse the banking system. From that perspective, it could be the case that the net effect of this shift in the level of risk would be more than the recorded 5.2 percentage points (-1.5 on INFLOW2008 and 6.7 on SHOCKLEVEL) had the two events not occurred within a couple of quarters of each other.

The following figure illustrates the deterministic component of the cointegrating vector based on the equation 6.5 and explained above, i.e. the effects of C, MERGER, INFLOW2008, SHOCKLEVEL, SHOCKTREND, S2, S3 and TREND.

Figure 6. 5: The deterministic component of the cointegrating vector



The previous sub-section investigated whether there was a stabilizing long-term relationship between the four chosen endogenous variables as well as whether there were stabilizing or destabilizing forces within the system. The accent in the remainder of this sub-section is on the interpretation of the estimated cointegrating coefficients, i.e. on the long-run relationship between the SI on the one hand, and the LI, IIP and LTDOMFUND on the other. The short-run dynamics between these four endogenous variables will be investigated in the following sub-section.

Changes in the risk of a currency crisis were found to be significant in explaining changes in the risk of a banking crisis in the long run. It was found that for each percentage point increase in the LI the SI rises by 29 bp (equation 6.2). The adjustment mechanism indicates that the risk of a currency crisis is a potentially destabilizing force in the system. Given the way the LI is constructed (Section 3.4), in the case of BH it changes mainly due to changes in the cross-border flow of banking sector related funds, which was also indicated by the effect of INFLOW2008 on the deterministic trend discussed earlier. Combining the main cause of changes in the LI with information on the long-run relationship between the two types of systemic risk, it is likely that there is a strong causal relationship between the SI and the cross-border flow of funds. As argued in Section 4.5 and the previous sub-section, in periods of strong economic activity, in the case of BH proxied by the increasing level of industrial production, the LI rises as a consequence of the expectations of future favourable macroeconomic and lending conditions. As the banking sector expects further growth of domestic demand for loans, more funds from abroad will be contracted in order to fund lending activities in future periods. Conversely, in periods of economic slowdown, changes in the LI are a consequence of changes in the solvency risk. As argued in Section 5.4, the solvency risk in the post-shock periods is mainly driven by deterioration in the quality of assets. In such periods, banks re-evaluate their client creditworthiness and the supply of new loans shrinks. As the plans for future lending activities are revised downwards, the need for foreign borrowing by banks falls.

In the long run the level of economic activity is found to be negatively correlated to the risk of a banking crisis. On average, a percentage point increase in the volume of industrial production reduces the risk of a banking crisis by 3.4 percentage points (equation 6.2). This result is consistent with Minsky's hypothesis of endogenous financial instability (1992). On one hand, the cointegrating vector suggests that, overall, in equilibrium, economic growth favours banking solvency. Yet, the adjustment mechanism, investigated in the previous sub-section, suggests that economic growth, ceteris paribus, can be a destabilizing force within the system. This relationship between the variables reflects the arguments from Section 5.4 and the previous sub-section that the level of credit in BH, especially in the later stages of financial sector development, was mainly determined by a strong demand for long-term loans by households and other non-industrial production-related, sectors. As already argued, a negligible gain in the coefficients' efficiency in the individual IIP equations from the unrestricted VAR, regardless of whether one observes the equation in isolation or as a part of the system, indicates that changes in the systemic risks do not significantly affect IIP. In other words, stronger lending activity does not necessarily imply a significantly higher volume of industrial production. However, changes in the IIP tend to be interpreted as a sign of a positive macroeconomic climate, which eventually increases lending to other sectors.

A percentage point increase in the share of the long-term loans financed domestically is found to reduce the risk of a banking crisis by 24 bp. This coefficient indicates that the risk of a banking crisis tends to increase with increased reliance on the foreign sources of funding. Orthodox theory suggests that the mother-banks tend to allocate more financial support to their subsidiaries that report high interest margins and/or low loan loss provisioning (De Haas and Van Lelyveld, 2006). As previously mentioned, low loan loss provisioning is a characteristic of the early stages of credit expansion. An increased incentive for foreign mother-banks to invest in the BH banking system increases both the liquidity and solvency risks.

6.2.3. The short-term dynamics between the endogenous variables

The simulation of a shock propagation conducted in Text box 6.1 emphasized the importance of the short-term dynamics between the endogenous variables. It was found that the short-term interaction between the variables increases disequilibrating relationships among the variables within the cointegrating vector. Based on Table 6.4c, the following set of equations indicates the significant short-term dynamics between the four endogenous variables.

$$\mathrm{d(SI\_log)}_t = -0.41 * \mathrm{d(SI\_log)}_{t-1} + 0.12 * \mathrm{d(LTDOMFUND)}_{t-1} + \varepsilon_1 \tag{6.3a}$$

$$\mathrm{d(LI\_log)}_t = 0.21 * \mathrm{d(SI\_log)}_{t-1} + \varepsilon_2 \tag{6.3b}$$

$$\mathrm{d(IIP\_log)}_t = -0.42 * \mathrm{d(IIP\_log)}_{t-1} + \varepsilon_3 \tag{6.3c}$$

$$\mathrm{d(LTDOMFUND)}_t = 0.51 * \mathrm{d(LTDOMFUND)}_{t-1} + \varepsilon_4 \tag{6.3d}$$

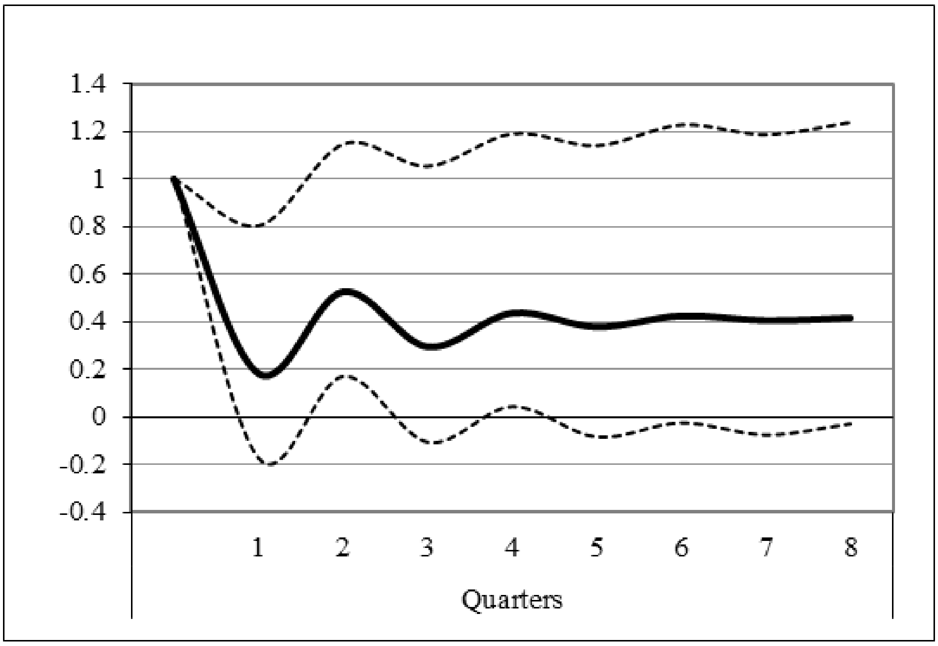
The change in the level of the solvency risk was found to depend on its growth in the previous period and the fraction of the long-term loans financed by domestic long-term deposits (Equation 6.3a). A percentage point increase in the level of the SI in the previous quarter tends to reduce the change in the SI by 41 bp. This finding is in line with the self-correcting process in the solvency risk indicated by the opposite signs of the coefficient in the cointegrating vector (Table 6.4b) and the corresponding loading coefficient (Table 6.4a). The self-correcting process is confirmed by the plot of the impulse response function (IRF) in Figures 6.6a and 6.6b[77]. Using Figure 6.6a as an example, the Figure plots a response of the SI_log to a unit innovation in the residuals

[77] The whole set of VECM Forecast Error Impulse Responses can be found in Appendix 6.2 (p.423).

In all cases the forecast error variance impulse response cases are based on a unit innovation in the residuals of the single equations of the VECM (standard setup in JMulti). As a robustness check the orthogonal impulse responses, based on an innovation of a standard deviation in the transformed model in JMulti, were also generated and there were no different conclusions when compared to the impulse response functions reported in Appendix 6.3. According to Lütkepohl (2005), this is a common finding when the impulse response function is estimated in the VECM. The only thing that differs in such cases is the scaling.

from the individual SI equation of the estimated VECM over the period of 8 quarters[78]. None of the impulse responses die out to zero, but approach some non-zero value as time passes and this is a common finding since it reflects the non-stationarity of the system where one time impulses have permanent effects (Lütkepohl, 2005 p.264).

Figure 6. 6a: The responses of SI to a percentage point impulse in SI



With respect to the self-correcting mechanism in the SI, it is indicated that the largest part of the response occurs within the first quarter, which suggests that the short-term dynamics between change in the SI and its past changes is well specified in the VECM. The response of the SI_log to an impulse in the SI_log is statistically significant, decreasing, but still positive. In other words, an increase in the perception of the risk of a banking crisis in past periods is most likely going to result in an increase in the current period as well, but the increase in the current period is going to be smaller in absolute terms.

[78]The confidence intervals are 95% Efron Percentile CI (Efron and Tibsirani, 1993) with the following specifications: 2000 bootstrap replications, 8 periods and seed of 5000. As a robustness check Hall's percentile intervals (Hall, 1992) were used as confidence intervals and the conclusions did not change.

Figure 6. 6b: The accumulated response of SI to a percentage point impulse in SI

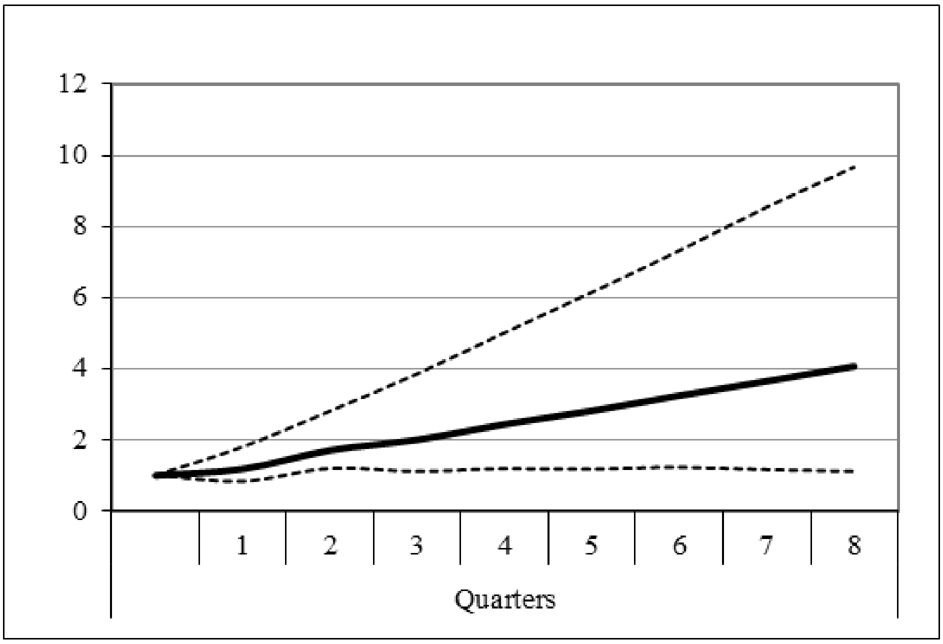


Figure 6.6b indicates that the shocks in SI_log result in a permanent increase in the SI_log. Consider the case when the SI_log is too high. This occurs when the banking sector lending is expanding too fast or when the deterioration in the quality of loans is significant. In either case, the SI, being the equilibrating force in the system reduces in the following period due to increase in capital buffers, which is also indicated in Figure 6.6a. Over time, these decreases in the SI become smaller and the overall level of risk gradually increases.

A percentage point increase in the share of the long-term loans financed domestically in the past quarter increases the solvency risk by 0.12 percentage points (Equation 6.3a). In other words, the coefficient suggests that the risk between the two periods tends to increase with each increase in the share of the long-term loans financed domestically. This positive sign contrasts with the negative sign in the long-run relationship (Equation 6.2). In other words, while an increased reliance on domestic sources of financing credit expansion tends to reduce the risk of a banking crisis, in the short-run an increase in the long-term domestically financed loans would increase the risk of banking crisis. This finding can be explained by the role of banking sector related inflows of capital. As Equation 6.2 suggests, there is a positive long-term relationship between the risks of banking and currency crises. Consequently, with each rise in the foreign liabilities of banks used to finance domestic credit expansion (and, as indicated by Section 1.3, mainly the long-term loans to households) the risk of a banking crisis increases, reflecting increasing currency mismatch. Any rise in the long-term domestic funding would not fuel an increase in the risk of a currency, and indirectly, the risk of a banking crisis. In the short-run, however, the positive sign on LTDOMFUND may indicate that the system temporarily becomes more prone to risk of a banking crisis, since an increase in banking sector assets is not met immediately by an increase in capitalization.

A percentage point increase in the level of the SI in the previous quarter tends to increase the LI in the current quarter by 21 bp (Equation 6.3b). As in the cases of responses of the SI to impulses in the SI, neither current (Figure 6.7a) nor accumulated responses of the LI (Figure 6.7b) die out to zero, suggesting that one-time impulses in the SI have permanent effects on the LI. In other words, an increase in the level of the risk of a banking crisis permanently raises the level of risk of currency crisis. The vice-versa does not hold.

Figure 6. 7a: The responses of LI to a percentage point impulse in SI

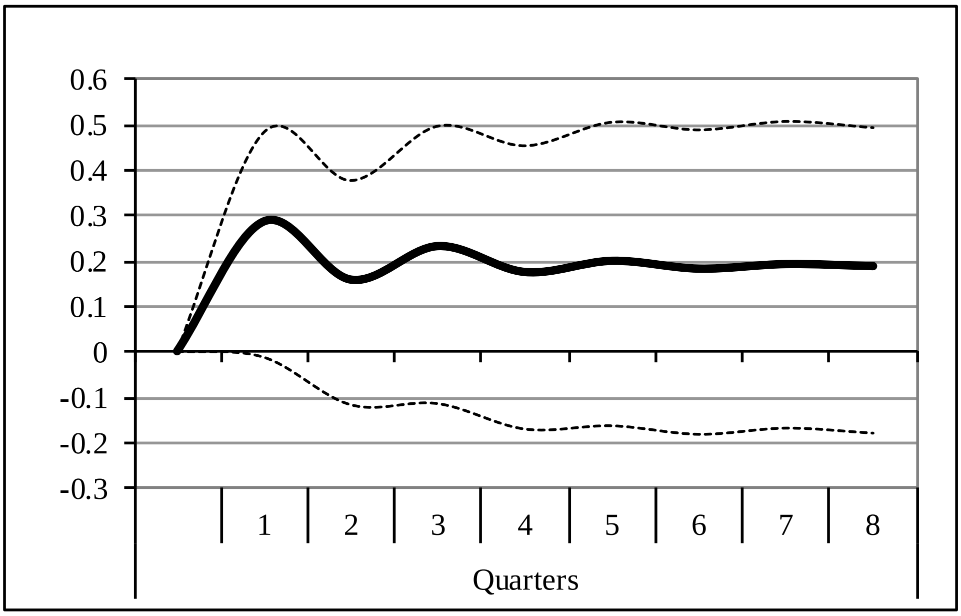
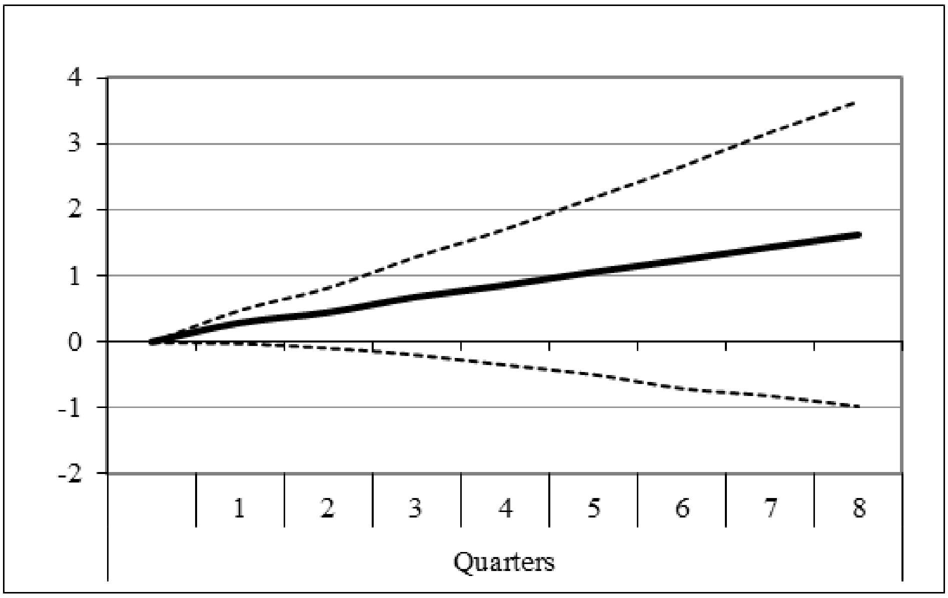


Figure 6. 7b: The accumulated responses of LI to a percentage point impulse in SI



The estimated short-term dynamics between the endogenous variables indicate that past period changes in the IIP affect its change in the current period. It was estimated that a percentage point increase in the IIP in the past quarter would result in a 0.42 percentage points decrease in the IIP in the current quarter (Equation 6.3c). This estimated relationship indicates the sensitivity of changes in inventories to changes in demand and the persistence effect. In other words, the result suggests that in the short-run adjustment in inventories occurs swiftly following the change in demand, rather than the availability of funding. The impulse response functions indicate that an impulse in IIP results in a permanent increase in IIP (Figures 6.8a and 6.8b). The response is quantitatively smaller than the impulse, which explains the flattening slope of IIP towards the end of the sample (Figure 4.8).

Figure 6. 8a: The responses of IIP to a percentage point impulse in IIP

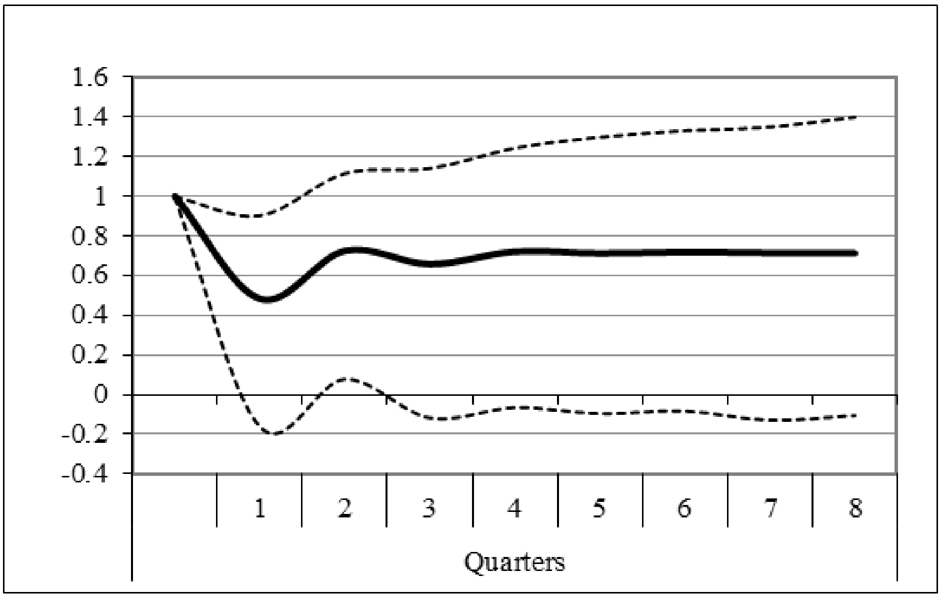
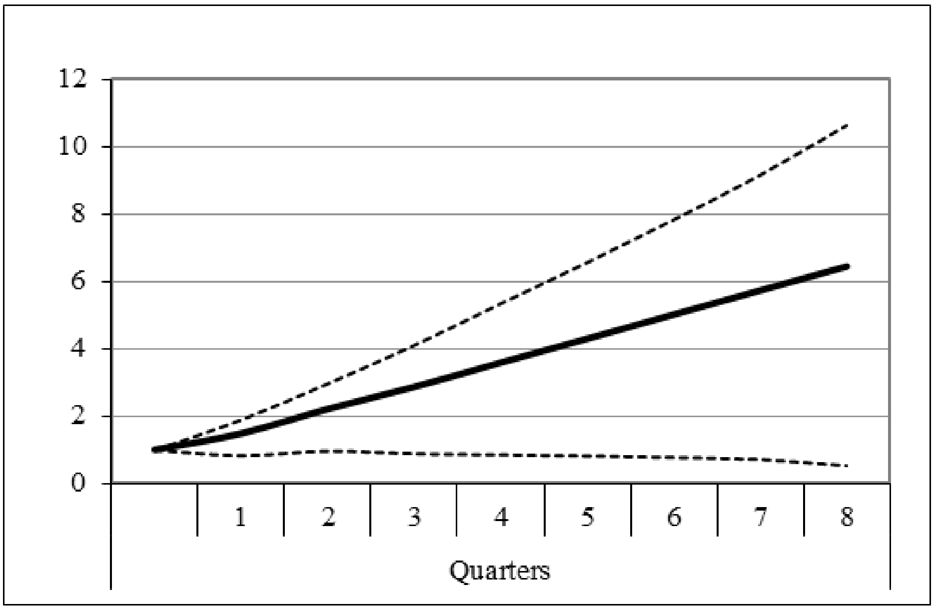


Figure 6. 8b: The accumulated responses of IIP to a percentage point impulse in IIP



The final statistically significant short-term dynamic relationship between the endogenous variables, as indicated by the set of equations (6.3), is the impact of the past change in the fraction of long-term loans financed domestically on the levels in the current period. It was estimated that for each percentage point increase in the previous period, LTDOMFUND in the current period increased by 0.51 percentage points (Equation 6.3d). This relationship indicates a strong self-fuelling mechanism in LTDOMFUND. Let us consider the case when innovation was such that it increased LTDOMFUND by 1 percentage point via a reduction in long-term loans (Figure 6.9a).

The relationship from Equation 6.6d indicates that, ceteris paribus, LTDOMFUND in the current period will increase by additional 0.51 percentage points. In other words, the long-term loans will continue to decrease. In the following periods there will be a pressure on long-term domestic deposits to decrease, which will, eventually, push LTDOMFUND below the pre-innovation level, but at the lower level of banking sector activity. The slope of the response function to accumulated impulses in LTDOMFUND (Figure 6.9b), indicates that over time, responses get larger than the sum of innovations, reflecting earlier assertions on LTDOMFUND as a potentially destabilizing force within the VECM.

Figure 6. 9a: The responses of LTDOMFUND to a percentage point impulse in LTDOMFUND

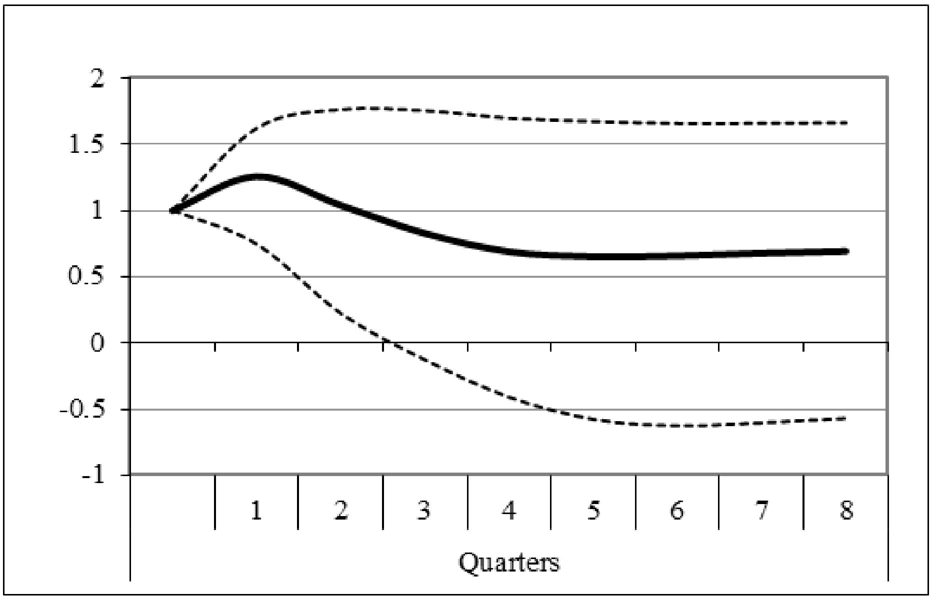
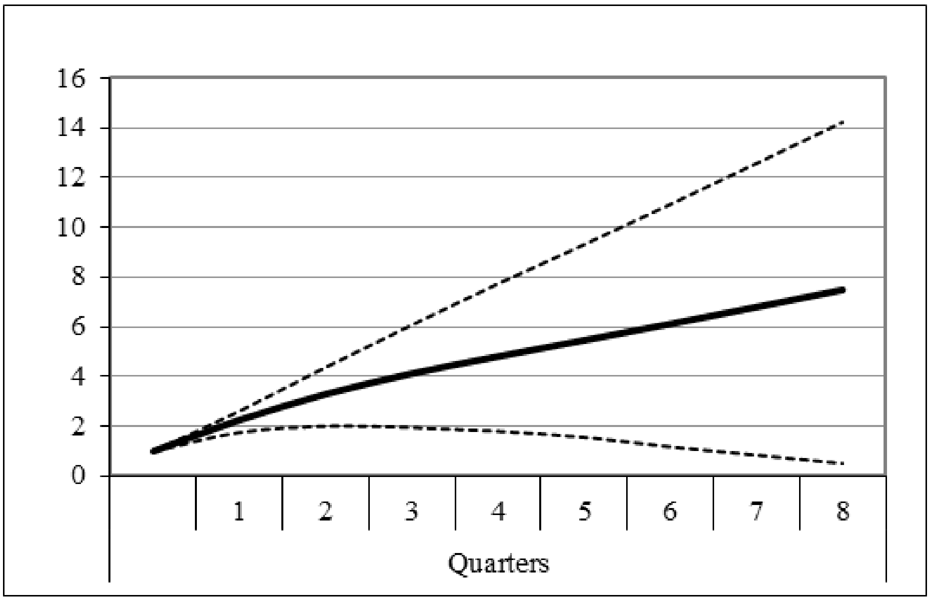


Figure 6. 9b: The accumulated responses of LTDOMFUND to a percentage point impulse in LTDOMFUND



Finally, note that, despite the finding that the rise in the level of solvency risk even in the pre-shock periods was caused by factors other than the level of economic output, the coefficient on the current values of UNEMP was found to be statistically insignificant. As discussed in Appendix 4.5 (p.357), it is questionable how accurate is the available measure of the level of unemployment in BH. The changes in unemployment, however, were found to behave as one would expect in different macroeconomic environments. Generally, it was found that unemployment tends to increase in the periods when the real economy is showing signs of a slowdown and decrease when the economy is booming. Yet, it seems that the banking sector did not take this into consideration when deciding on the level of lending activities. The explanation may be that the banks were relying on the institution of debt guarantor (Section 5.2) as one of the means of credit risk arbitrage. From the perspective of credit risk mitigation, at least theoretically, it is the same whether the loan is being repaid by the original borrower or the guarantor, as long as the loan is performing. From the financial stability perspective this might not be true, given the self-fuelling mechanism in LTDOMFUND and its potentially destabilizing role in the estimated VECM.

6.3. Conclusion

The aim of this chapter was to establish the links between the two measures of systemic risk. It is concluded that the nature of the linkage between the two indices does not support their merger into a single index, but does support considering them jointly as separate parts of an overall system.

The estimated deterministic trend revealed that a certain level of fragility is built into BH's financial system regardless of the factors included in the model. Furthermore, the fragility of this financial system was found to increase over time. This positive trend is consistent with expectations of future economic prosperity extrapolated from past periods and in line with Minsky's (1982, 1992) story of the endogenous evolution of capitalist finance from stability to instability. This we hypothesise to be the main cause of the increase in the risk of both a currency and banking crisis. Of course, the rise in systemic risk cannot continue indefinitely. At some point, it must be countered by policy decisions or lead to a systemic collapse of the banking system. Since BH had not experienced any type of financial crisis as conventionally defined, it must be the case that the regulatory framework in place and adjustments in the policies of banks that affected primarily the short-term dynamics between the variables, altered the shape of the deterministic trend and slowed down the pace at which systemic risk was rising. This perception of the lower risk of a banking crisis in post-macroeconomic shock periods, characterised by the deteriorating quality of banking sector assets and a slowdown in economic activity, is mainly caused by a series of additional capitalizations. Therefore, a more accurate description of the post-shock trend in systemic risk was "gradually deflating by the regulations" rather than "declining". More specifically, the trend in systemic risk in the post-shock periods did not decrease as a consequence of a banking system collapse. A more accurate description of the whole process would be that the risk was deflated by banks choosing to comply with the existing regulations. These additional capitalizations, via their influence on the SI, were found to be the main reason why the long-term relationships between the endogenous variables did not hold in 2009 and 2010.

The estimated long-term cointegrating relationship between the different types of systemic risk, economic activity and the level of domestically funded long-term lending activities in BH was found to be stabilizing, but stabilization occurs via a damped cycle. In none of the cases of arbitrarily chosen positive or negative shocks of different magnitudes to the level of economic activity were the estimated EC mechanisms found to monotonically decrease towards zero. On average, it was found that equilibrium is restored two years following the change in IIP, except for the cases of negative shocks of smaller magnitude in which equilibrium is restored a couple of quarters earlier. The main equilibrating force within the system is the SI, while the other three endogenous variables were found to be potentially destabilizing.

The estimated long-term cointegrating relationship between the variables suggests that, overall, in equilibrium, economic growth, proxied by IIP, favours banking solvency. Yet, the adjustment mechanism suggests that economic growth, ceteris paribus, can be a destabilizing force within the system, which is again consistent with Minsky's (1992) hypothesis of endogenous financial instability. As the IIP grew (at the slower pace over time) in the low risk environment, the market participants, expecting the continuation of the favourable macroeconomic conditions, engaged in stronger lending and borrowing activities. In order to meet the rising demand for loans, banks in BH substantially increased their foreign liabilities thus resulting in a higher risk of a currency crisis.

Finally, the legitimacy of using the VECM forecast error impulse responses for short-term forecasting was demonstrated. This was especially the case with the risk of a banking crisis where the plot of responses of the risk of banking crisis to its own impulses clearly indicates a self-correcting mechanism in the perception of risk. As the impulse response function indicated, most of this adjustment occurs in the following quarter.

Chapter 7: Conclusion

7.1. Introduction

This thesis investigates systemic risks and financial fragility in a specific environment. Bosnia and Herzegovina (BH) is a small open economy that shares some similarities with other Central, Eastern and South-Eastern European (CESE) counties, such as the process of transition from planned to a market economy, including the first wave of privatization and banking and currency crises in the late 1980s and early 1990s. BH is unusual in that the 1992-1995 war literally wiped out the financial system of the country. The second wave of privatization did not occur until a new institutional framework was built, starting with the establishment of the Central Bank in 1997. The presence and activities of foreign banking groups increased with changes in the regulatory framework and capital account liberalization in the late 1990s.

All these events resulted in a financial system of a relatively simple structure, dominated by majority foreign-owned banks. There were no significant lending activities until early 2000s and no systemic financial crisis, as conventionally defined, has occurred since the CBBH was established. Therefore, it was possible to, in a sense, set the clock to zero in the early 2000s and regard the BH financial system as a system in its simplest form and at the earliest stages of development. Understanding the underlying relationships between systemic risks and the real economy in this environment is important, since examination of a simple structure may provide important insights into the behaviour of more complex systems.

This chapter aims to: summarize the main findings of the research programme reported in this thesis and identify their main contributions to knowledge; identify the main limitations of the analysis undertaken and list the possible future extensions of the research; and suggest appropriate policy recommendations. The rest of this chapter is structured as follows. Section 7.2 examines the main findings with respect to the main research questions: what causes changes in the level of systemic risks and how are the risks of a banking and currency crisis related? Section 7.3 provides the policy recommendations. Section 7.4 lists some of the possible avenues for future extensions of the thesis. Finally, Section 7.5 presents concluding thoughts on this research programme.

7.2. The main findings and contributions to knowledge

This research was conducted to assess the determinants and the level of financial fragility in BH. The research process started with the investigation of the current conventional theoretical framework employed to examine financial fragility. It indicated that the appropriate approach to measuring systemic risk would require constructing a country-specific measure of systemic fragility. For that purpose, it was concluded that both measures of the risks of currency and banking crises should be constructed for BH. The next step involved estimating how these two measures of the systemic risk, named the liquidity and solvency indices, react to changes in the chosen macroeconomic and banking sector specific variables. Finally, in order to determine whether the financial system is inherently unstable and whether there are stabilizing mechanisms, the models developed to explain the changes in the liquidity and solvency risks were observed as a system.

The rest of this section lists the findings and original contributions to knowledge of this thesis that are used as the arguments in formulating the following answers to the main research question:

> *What are the sources of financial system fragility in a small open economy with a traditional banking system such as BH?*
>
> Extrapolated expectations of future positive trends are the main causes of rising systemic risks even in simple financial systems. Country specific measures of the systemic risks should be observed as a system rather than independent signals of forthcoming crises.

7.2.1. The main findings

(A) Country-specific measures of the systemic risks should be constructed

By utilizing Minsky's (1975; 1986; 1992) notion that financial systems are inherently unstable, i.e. acknowledging that there is no riskless environment and the level of systemic risk can be represented by a series of swings between different levels of fragility accompanied by the boom and bust cycles, the measures of systemic risk for BH were constructed. The LI was constructed to indicate how close the financial system is to the point at which the CBA would be abandoned. In essence, it reflects the sensitivity of the system to a currency crisis. The SI was constructed to measure fragility in terms of how close the system is to the point at which the capital of BHs banking system would be fatally depleted, thus indicating sensitivity to a banking crisis.

Our approach clearly distinguishes between financial stability and financial fragility allowing for the constant presence of a certain level of systemic risk. At lower recorded levels of systemic risk, the system is perceived to be more stable. Using system-level aggregates, rather than indicators of the performance of individual financial institutions, allowed the measuring of the build-up of financial instability. Whether individual financial institutions are capable of bearing the effects of the risks should they materialize is another issue usually tackled by introducing a suite of models aiming to capture the risk-absorbing capacity of individual segments of the financial system. It is possible to have a situation where the system as a whole is perceived as stable, whilst there are some financial institutions that are on the verge of bankruptcy. Employing models aimed at the early detection of imbalances in specific groups of institutions enables a proactive approach to regulation, thus reducing systemic risks even further. This argument is developed further in Section 7.3 (policy recommendations).

Judging by the shape of the LI, the risk of a currency crisis in BH seemed to decline from 2003 to 2006. These were years in which foreign banks were lending aggressively in order to seize a larger share of the BH market. An unfavourable maturity structure of domestic liabilities fuelled cross border funding of domestic lending activities. In the period up to the end of 2006, given the relatively low initial level of the foreign liabilities of the banking sector, the additional increase in foreign reserves per unit of time was diminishing at a slower pace than the foreign currency denominated liabilities of banks, thus resulting in a perception of a declining liquidity risk. With the expansion of banking sector activities, the role of banking sector foreign liabilities gained in significance for BH's overall level of the foreign currency reserves. Eventually, a point was reached when the additional increase in foreign reserves per unit of time started to diminish at a faster pace than the foreign currency denominated liabilities of banks. As the foreign investment dried up in the period following the global financial crisis of 2007, liquidity risk continued to rise. The highest level of risk was reached in the period before a large tranche of the SBA increased BH's level of foreign reserves. The effect of the SBA on the perceived level of the risk of currency crisis is one country-specific factor that needs to be taken into account in any analysis of systemic risk and financial fragility.

In the case of the SI, the low initial level and strong domestic demand for loans, increasing competition from foreign banks in the domestic market for loans and high liquidity in international markets made the BH banking system increasingly prone to a banking crisis. As the level of lending activity was increasing, it took a smaller deterioration in the quality of banking sector's assets to result in a banking crisis. After the credit crunch in the second half of 2008, the perception of the risk of a banking crisis appeared to reduce. This perception of a lower banking crisis risk in the immediate post-shock periods was a consequence of the additional capitalization ordered by the supervisors for banks that were in breach of the regulations regarding the minimum capital requirements. This is a period-specific factor that one needs to take into account when interpreting the level of systemic risk.

(B) The financial system of Bosnia and Herzegovina is inherently unstable

This research provided sufficient evidence to argue that a certain level of fragility is built into the financial system, regardless of the factors included in the model and that systemic risks tend to increase with time. Eventually, the level of systemic risk is offset by policy changes or the new equilibrium is restored as a consequence of a systemic collapse of the banking system.

In the case of the risk of a currency crisis, the BH system was found to be sensitive to external shocks, while the relationship between the level of risk and economic activity was found to be disequilibrating. In other words, higher economic activity in the long run fuels the risk of a currency crisis, while this increased level of risk, being a consequence of significant banking sector related cross-border inflows of investments, will increase the level of economic activity via banking sector lending. Since there is no self-correcting mechanism, it takes a shock to deflate the risk of a currency crisis. Generally speaking, under the full convertibility of domestic currency (or a managed float that allows fluctuations only in a narrow band) and significant dependence on the cross-border flows of funds to finance domestic lending activity, domestic policy-makers have a very limited ability to address the higher risk of a currency crisis.

Relying on economic theory and the empirical findings, strong domestic demand for loans coupled with deficiencies in bank's decision-making were identified as the main crisis pre-conditions in BH. As in the case of the LI, the level of the systemic risk of a banking crisis was found to increase over time. However, unlike the case of the LI, the long-term relationship between the SI, economic activity and local long-term financing conditions was found to be equilibrating. More specifically, it was found that changes in the perception of the risk of a banking crisis, mainly through the additional capitalizations, were the stabilizing force within the system.

Initially, the LI and SI were represented by two separate VECMs. Satisfactory diagnostics for both models and estimated long-term relationships between the measures of systemic risks and explanatory variables that were in line with economic theory, were taken as sufficient to regard the models as suitable to explain changes in perception of the two systemic risks. In a system normalized on the measure of the risk of a banking crisis, the measure of the risk of a currency crisis, the level of economic activity and the reliance on foreign sources of domestic long-term funding were found to be potentially destabilizing. However, adjustment towards the new equilibrium occurred via changes in the level of the risk of a banking crisis. In other words, in an environment such as BH, the policymakers may affect the level of the systemic risk of a financial crisis only by affecting the speed of lending in the pre-crisis periods or by ensuring sufficient and adequate capital buffers to absorb the shocks.

The estimated cointegrating relationship indicates that the cross-border flow of funds increases the risk of a banking crisis. In line with, among others, Minsky (1982, 1992) and Honohan (1997), the LI is found to rise in the expansionary stages of the business cycle as a consequence of the expectations of future favourable macroeconomic and lending conditions. As the banking sector expects further growth of domestic demand for loans, more funds from abroad will be contracted in order to fund domestic lending activities in future periods. Conversely, in the periods of economic slowdown, changes in the LI are a consequence of changes in the SI. In periods of economic contraction, banks re-evaluate their client creditworthiness and the supply of new loans shrinks. As the plans for future lending activities are revised downwards, the need for foreign borrowing by banks falls. In line with Minsky’s financial instability hypothesis, hedge financing turns into speculative financing in the expansionary stages of the business cycle, resulting in rising systemic risk that is not mirrored by a significant increase in the volume of economic activity. This is also evident from the statistically significant, but very low loading coefficient on IIP in the VECM. Therefore, one possibility for policymakers to reduce the level of systemic risk is to discourage speculative financing.

When discussing the stabilizing effect of banking sector’s capital on the system as a whole, there are some issues that must be kept in mind. The structure of banking-sector capital is significantly different at different points of the business cycle. In periods of economic expansion, the share of supplementary capital in the regulatory capital is much larger when compared to the periods of economic contraction. The two categories of supplementary capital that heavily influence the level of the banking sector capital in the periods of favourable macroeconomic conditions are the general reserves for losses on the A category assets and the fraction of loans from the foreign owners. In other words, the consequence of the credit expansion (reserves for losses on the performing assets) and one of the sources of the credit expansion (subordinated and hybrid debt to the mother-banks) are regarded as a stabilizing factor for the financial system itself.

Regarding these items as capital buffers, against the very risk they are causing is perverse and one of the reasons why capital adequacy falls rapidly when a macroeconomic shock occurs. Capital adequacy is the ratio of regulatory capital to the sum of total weighted risk. In the case of BH, the total weighted risk in the periods covered by this thesis consisted of credit risk alone. As of the beginning of 2011, operational risk is included, but its share, given the way it is calculated, is almost negligible. The capital charges for the market risk are still not prescribed. When a macroeconomic shock occurs, a fraction of the credit portfolio will deteriorate in quality thus reducing the regulatory capital directly through the reduction in a component of the supplementary capital, and indirectly via the profit and loss account as a consequence of the higher provisioning costs. This reduces capital adequacy, in some cases below the legally prescribed minimum and some banks need to capitalize additionally. As the domestic demand for loans weakens, the need for foreign funds reduces and the subordinated and hybrid debts, just like the other types of bank's foreign liabilities, deplete thus reducing the capital adequacy even further. Additional capitalization is usually reflected in an increase in bank's equity, which is the mechanism by which the structure of banking sector's capital changes through the cycle. This weakness evident in BH's relatively simple financial system, is magnified in systems with more complex financial instruments (Haldane, 2009 and Gai et al., 2011).

(C) The adjustment towards a new equilibrium in the financial system occurs via a damped cycle

The simulation of a shock propagation indicated that adjustments towards equilibrium following either a positive or negative shock is not straight forward, mostly because of the short-term dynamics between the two measures of the systemic risk, the level of economic activity and the availability of foreign funding for domestic long-term lending. Although the majority of the adjustment in the long-term relationship between the variables occurs in the first two quarters following the innovation/shock, it takes, on average, 8 quarters to restore equilibrium in the cointegrating vector for any size of a positive shock. In the cases of negative shocks to IIP, the adjustment occurs within 6 (for smaller shocks) to 8 quarters. Interestingly, the shock propagation exercise also suggested that the regulators in BH may have been more active in stabilizing the system in the aftermath of the crisis than in preventing the build-up of the systemic risk.

(D) A single model is insufficient for modelling systemic risks over the cycle

The behaviour of the SI clearly indicates two stages in the evolution of systemic banking crisis risk. In this research, it was found that the causes of an increased risk of a systemic banking crisis were different at different stages of the business cycle. In the periods of rapid economic growth, the fragility of the system was increasing primarily because of the expectations of both banks and their clients that the favourable economic conditions would continue. In the periods of economic contractions, the risk of a banking crisis increases due to a deterioration in the quality of assets. It was concluded that the short-term dynamics between the variables, also evident from the impulse response functions, are significant.

These short-term dynamics were found to affect the levels of systemic risks in both pre- and post-shock periods. It was argued that in pre-shock periods the level of financial fragility may be adequately explained by the estimated long-term relationships between the systemic risks, the level of the economic activity and domestic long-term financing conditions. The short-term dynamics between the variables are significant, but are not the main determinant of changes in the systemic risk. With a macroeconomic shock of the magnitude that occurred in BH in the second half of 2008, the nature of risk changes as the financial system enters the Ponzi stage of Minsky’s cycle. At this point the long-term relationships between the measures of systemic risk and the level of economic activity breakdown and a series of the short-term adjustments occur. In the immediate post-shock periods, only the short-term relationships between the variables hold. Furthermore, the latest crisis revealed that these short-term relationships between the risks and the underlying trends in the real economy and financial sector specifics in the immediate post- shock periods are highly non-linear. Kahneman and Tversky (1979), in their critique of expected utility, developed an alternative: prospect theory. Prospect theory argues that individuals mistake negligibly small probabilities for zero probabilities. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and risk seeking in choices involving sure losses. Staudt (2010) argues that these remote events are not only likely, but often their likelihood is understated due to a limited understanding of the increasingly small numbers. According to the same author, and numerous other recent empirical studies, a major shortcoming of the models built to explain trends in the financial system is that they fail to adequately comprehend, or simply choose to ignore, the risks of extreme events. Such practices, given a shock of substantial size, as was the case in BH, or significant inter-linkages between the components of the financial system, as was the case in developed financial systems before the latest crisis, reveal that the decisions made in the expansionary periods were often based on estimated relationships between various risk factors that were "precisely wrong" rather than "approximately right".

(E) Country and period specifics must be accounted for

The importance of country and period specific factors was emphasized throughout the thesis. It was demonstrated how the use of the official data may cloud the underlying relationships between systemic risks and the macroeconomic and banking sector specific variables. Furthermore, even variables that are found to have some explanatory power in the similar models developed for countries that are at the same stage of development may not be useful in a model for another specific country. In this thesis, it was demonstrated that the structure of the economy, observed through the components of GDP and the structure of the financial system, play prominent roles in the choice of explanatory variables. For illustration, three country and period specific effects related to the measures of systemic risks will be addressed. The chosen country specifics are the effects of the SBA and additional capitalization needs, while the period specific is the accounting effect of the current year profit on the capital adequacy.

Country specific adjustments to the level of BH foreign currency reserves had to be made in order to avoid misperception of systemic risk. Two tranches of the SBA were drawn, one in 2009 and the other in 2010. An immediate effect of this was an increase in the level of foreign currency reserves that made the system appear more resilient to the currency crisis. In reality, the system was more vulnerable since inwards foreign investment was drying up and so was the profit that was earned on investing the reserves abroad. The effect of the SBA tranches was so significant that the use of the unadjusted series of the foreign currency reserves would result in the perception of an unchanged systemic risk in periods of slow economic and lending activities. Therefore, when determining the level of the currency crisis risk the effects of both the availability and the utilization of the SBA should be accounted for since they tend to distort the perception of systemic risk downwards.

In the case of the SI, certain country-specific information must also be taken into account when interpreting the level of systemic risk. In the period following the credit crunch, the level of risk was oscillating in a narrow band around a rather flat trend that was much lower compared to the pre-shock period. In other words, once the credit crunch started, the system appeared to be more stable, which was unexpected and counter-intuitive. However, once a proxy for additional capitalization was taken into account, the banking system fragility was found to increase in the post-crisis periods. The only difference in the perception of the banking crisis risk is in the nature of the risk: while the banking sector fragility in the pre-crisis period was driven by the excessive credit growth, the main risk in the post crisis-period was of deterioration in the quality of loans. The original level of net capital was not adjusted for the additional capitalization for two reasons. Unlike in the case of the SBA tranches, the exact amounts of the effect were unknown (as those are never reported separately, but as a part of banks' equity), so they would have had to be approximated. The second, more important reason is that the additional capitalization in a number of banks was the result of stabilizing measures ordered by the banking supervisors. Each time a bank incurred losses due to a worsening in the quality of its assets, it had to raise additional capital in order to increase the capital adequacy ratio above the prescribed minimum of 12%. Since the purpose of the stabilizing mechanisms is to increase the resilience of the banking sector, it was decided against the adjustment of the original SI. However, the effects of the corrective actions have to be taken into account when interpreting the level of the systemic risk in the post-shock period. Possible lower levels of the SI in the post-shock period, when compared to the periods of lending expansion, should not be interpreted as the banking system becoming more resilient and unaffected by the changes in the macroeconomic environment without taking all relevant information into account as the nature of risk is different.

There is a calendar effect, due to accounting practices, that also needs to be taken into account when constructing a measure of the risk of a banking crisis. When official regulatory capital data is observed, there are clear spikes in the series in each fourth quarter. This is a consequence of accounting practices. Consequently, it was perceived that the risk of a banking crisis at the end of the year was significantly lower when compared to the trend. Usually this type of issue in modelling is resolved by the use of dummy variables. In the case of BH the small size of the sample required an alternative approach. It was demonstrated that if the sum of the quarterly profit in a fiscal year corresponds to the amount confirmed by the external auditor at the end of the year, then the banking sector capital should be amended. Specifically, it should be increased by the reported profits in each quarter, rather than attributing the whole amount of the annual profits to the end of the year. No adjustments need to be made in the case of losses since the existing regulations require their recording against capital as they occur.

Domestic interest rates, regardless of the context in which they were observed, were generally found to be insignificant in explaining the trends in systemic risks. It is argued that a possible explanation for this is the structure of the banking sector in BH. As domestic demand for loans increased, domestic sources of funding were exhausted and banks had to rely on the external sources of financing and domestic deposit rates became sticky. In addition, it could be the case that interest rates tend to play an insignificant role in the systemic risk propagation in the later stages of speculative and Ponzi financing, as suggested by Minsky (1992).

Based on three different measures of credit activity and differently generated trends, though there is evidence of an accelerated credit growth, one cannot claim with certainty that a credit boom episode occurred in BH. This is despite very high annual growth rates of loans even exceeding 30% at the peak of lending activity. In addition, despite the finding that the rise in the level of solvency risk, as a consequence of excessive credit growth, in the pre-shock periods was caused by factors other than the level of economic output, there was no explanatory power in the rate of unemployment. The practice of using the institution of debt guarantor as one of the means of credit risk arbitrage suggests an uncommon relationship between the strength of lending activity and the measure of general level of creditworthiness. One of the possible explanations for this phenomenon is unreliable labour force statistics given the large informal sector. It could be the case that the number of employed persons is underreported.

A proxy for economic activity, the index of industrial production, was found to be more informative in explaining the causes of changes in the level of the systemic risk than the more commonly used measure, gross domestic product. One reason for this unexpected finding probably lies in the structure of GDP based on the production approach and the structure of the banking sector's loan portfolio. In all the periods covered by the thesis, the share of government sectors, including public administration, public education, health and pension systems, in annual GDP was about one quarter. At the same time, the share of banking sector's claims on these sectors was less than 5% of their portfolio.

7.2.2. Original contributions to knowledge

Below is the list of original contributions to knowledge of the research programme reported in this thesis.

To our knowledge, the LI and SI are the only measures of systemic risk that have been constructed for BH.

1) Similar measures of systemic risk may be constructed and utilized in any small open economy once the country specifics are adjusted for, such as the accounting practices, calendar effects, or known structural breaks or specific changes in variables. The limited number of observations did not prove to be an obstacle since both indices managed to capture what were widely perceived to have been the most vulnerable points and the general trends of risks in BH. Furthermore, the way both indices were constructed ultimately requires individual interpretation to be made about the level of systemic risk as both indicate how much riskier is the system today when compared to the past periods and how close it is to either a currency or banking crisis. The conclusion as to whether systemic risk is high or low is conditional on the risk preferences of the observer.

2) It was demonstrated that even simple financial systems, free of large and complex financial institutions and complex financial instruments, are inherently unstable with a tendency for a constant increase in the level of systemic risk. Therefore, the only way to prevent systemic crises in any financial system is to use the regulatory framework to curb the lending activity thus extending the hedge financing stage of the Minsky's cycle. Despite this general principle, even in a simple system such as that in BH, the role of the regulators is found to be more pronounced in the post-crisis periods, i.e. their ability to partially neutralize the effects of the crisis (but not necessarily to result in the crisis resolution) outperforms their ability to prevent the build-up of systemic risks.

3) It was demonstrated that the systemic risks of different types of financial crisis should be observed as a system, rather than independently. This is especially the case in small open economies that operate under the commitment of full convertibility of domestic currency. In the cases where countries gave up their monetary policies, the only way to tackle the rising risks of a currency crisis is to deflate the risks of banking and sovereign crises.

4) It was demonstrated that a single model, regardless of how sophisticated it is, cannot equally successfully explain changes in the perception of financial fragility at different stages of the business cycle. In the final stage of the Minsky's cycle, when the systems starts to adjust towards the new equilibrium following a shock, the short-term relationships between the real economy and the financial system dominate the pre-crisis long-term relationships between these sectors.

In addition, in more complex financial systems one also needs a suite of models to adequately explain the relationships between the real economy and the financial system in the pre-crisis periods. In these cases, non-linearities in the shock propagation process suggest that understanding the long-term relationship between these sectors is not sufficient to adequately assess the level of systemic risk.

The above list of findings and original contributions to knowledge indicate the complexity of measuring the level of the systemic risk. The case of BH investigated in this research may be used as an argument that these general conclusions hold in any country once the country specifics are accounted for and tailored measures of the systemic risks are constructed.

7.3. Policy recommendations

Based on the main findings of this research highlighted in the previous section, the following set of complementary policy recommendations is proposed.

Policy recommendation 1: Country specific measures of systemic risk need to be developed and revised regularly

Each country should develop its own measure of financial fragility. A standardized set of indicators, such as the Financial Soundness Indicators introduced by the IMF enable the cross-country comparison of various risks. The core set of standardized indicators for the banking system are grouped into one of the following categories: capitalization; quality of assets; profitability; liquidity; and foreign currency exposure. While each of the core and recommended indicators collected enable the comparison within a peer group of countries at similar stages of the financial sector development and comparison to a benchmark set by the best international practices, these are not sufficient for credible policy actions. Therefore, a set of measures aiming to determine the levels of risk of currency, banking and sovereign crises needs to be developed for each country.

These measures of systemic risks should be custom made and account for the country and period specifics. In the case of BH it was illustrated that a measure of the risk of sovereign crisis was not necessary given the chosen monetary policy and the regulatory framework that prohibited the government from running large budget deficits and borrowing long-term from the banking sector. With less restrictive regulations on budget financing, the risk of a sovereign crisis increases and this should be taken into consideration when one makes an overall assessment of the fragility of the financial system. The measures of each of the three types of systemic risk should be regularly evaluated in order to ensure the inclusion of the effects of all relevant information, such as accounting for the effects of changes in the regulatory framework and accounting and reporting practices.

Useful information on the causes and consequences of the financial sector developments may be obtained by observing each risk individually. However, it is argued that a more efficient assessment of the overall level of fragility will be obtained, as was the case for BH, if the risk measures are observed as a system, with a set of relevant macroeconomic and financial sector specific variables.

Policy recommendation 2: The policy makers should focus on identification of the speculative financing stage of the Minsky cycle

The correct identification of the stage at which banking sector lending increases above the levels that could be justified by the real economic activity is critical for timely policy action. As argued above, all financial systems are inherently unstable, but a certain level of instability is a necessary condition for regular business operation and economic growth. Poorly timed policy action, or not accounting for the policy implementation lags, may even be worse than not taking any action at all since the risks may be amplified.

It was demonstrated that, even in a simple financial system such as the BH, the main source of the rise in the risk of a banking crisis in the pre-crisis periods was a shift from the risk averse to increasingly risk-taking behaviour of both the lenders and borrowers that coincided with the periods of high liquidity in international markets. Imposing limits on the credit activity of banks in the early stages of financial sector development, such as the hedge financing stages as Minsky named them, would seriously limit economic growth. The absence of refinancing, which is a characteristic of the least risky stage of financial sector development, implies no investment and limited expansion of the production capacities. On the other side, in the later stages, when domestic credit expansion is used to finance the purchases of assets acquired only for the purpose of speculating on their future value, which is a characteristic of the late speculative and Ponzi stages of financial sector development, sudden contractionary policies usually result in a re-valuation of assets and financial crisis.

Regulatory policy should aim to keep the financial system in the early stages of the speculative financing phase for as long as possible. Achieving this goal in practice can be very difficult since the policy makers would be accused of constraining economic activity and reducing the welfare of society. Communicating their concerns to the general public regarding the specific risks may ease the pressure on the policy makers. If, for example, it is noticed that systemic risks are growing at a much faster pace than the core real economy activities, then policy makers should make it clear to the market participants that there will be a reaction that targets deflating the built-up risks. The identification of the core real economy activities cannot be emphasized enough as it was demonstrated that the use of some standard indicators such as real GDP, nominal or its growth, may lead to a wrong prognosis.

In the case of BH, three years after the sample covered by this research there are still no macroprudential measures in place to curb excessive credit growth.

Policy recommendation 3: Place the burden of potential losses on equity

The latest financial crisis emphasized the problem of the structure of banking sector capital. The Basel III regulatory framework, currently being implemented internationally prescribes capital adequacy with core, rather than regulatory capital in the numerator, forcing banks to use a significantly larger fraction of their own capital as the buffer against the risks of their business. The regulatory framework in BH is still a hybrid between the national regulations and Basel I, this has proved to be inadequate even in this simple financial system. The capitalization is still very procyclical and there are no automatic stabilizers in place.

In addition, there are still no measures in place that would prevent uncontrollable deleveraging of banks with respect to their foreign liabilities. BH is not among the most significant countries in the CESEE region in terms of the volume of activities of the main foreign banking groups. Allowing foreign banking groups to operate under more flexible regulations has negative consequences for the stability of BH's banking system, regardless of whether local subsidiaries of foreign banks report to the group level in accordance with the more strict regulations or not. If that is not the case, given the relatively small exposure to BH at the group level, the operational risk is proportionally small for the banking group even if the risks in BH are rising. At the same time, the management of the local subsidiaries will pursue targeted levels of profitability and have little incentive to evaluate the risks adequately. If, however, the subsidiaries operate and report to the headquarters in line with a different set of regulatory requirements, this difference in the regulatory framework is only a burden of double reporting. More relaxed local regulation will not necessarily result in a stronger activity of the subsidiaries since the foreign banking group is evaluated by their own supervisors at the consolidated level.

The current regulation in BH encourages an overly-optimistic assessment of the quality of assets, as that increases the level of regulatory capital and a perception of better capitalization. The regulators should catch-up with the current international best practices. These will not ensure a future free of financial crises, but would discourage excessive lending as the profit margins for banks would be reduced at the same time lifting the price of potential crisis. This is especially important in countries like BH that have a fully liberalized capital account and operate under a CBA or managed floats as a banking crisis would likely to be coupled with a currency crisis.

7.4. Possible future extensions

Based on the main findings and policy recommendations outlined in the previous two sections there are a couple of interesting future extensions of this research. The first possible extension that will become important in the future in the case of BH is developing a third index that will indicate the vulnerability of the system to a sovereign default crisis. At the beginning of the crisis, the government in BH amended the auspices of the law on public debt, thus allowing the government to borrow long-term from banks. At the end of 2011 the banking supervisors changed the principles on the management of banking sector capital risk exposures allowing for a significant build-up of both credit and market risk associated with lending to the government. With these changes in regulations, systemic risk was increased. On the one hand, capital charges are still not required for market risk, i.e. it does not affect the level of capitalization. On the other hand, exempting the claims on the government from the credit risk, i.e. treating them as the cash equivalent, resulted in a further reduction in total weighted risks that, in turn, changed the perception of capitalization upwards. In periods of growing budget deficits and expected weak economic activity, the sovereign default risk must also be measured.

The nature of adjustment paths could be an interesting avenue for post-doctoral investigation from the perspective of policy implementation. The shock propagation simulation indicated that the majority of changes occur in the first two quarters following the shock. It takes two years for the system to fully absorb the shock, during which there a series of adjustments occur. Distinguishing the “period of major adjustments” from the “tremors” can determine the effectiveness and the result of the policy measures, especially if the economy is approaching the turning point of the business cycle

The third possible extension of this research is linking the macroeconomic developments to individual financial institutions balance sheets via the structure of their portfolios. The potential benefit of this approach is a clearer picture of the sensitivity of individual bank’s portfolio to changes in the macroeconomic environment that would be a first step towards building a model that estimates the effects of the tail events on systemic risk. Building a suite of models, of which some are time series and some panels, would improve the accuracy of the measurement of the perceptions of systemic risks through the cycle.

The type of the analysis conducted in this research faces constraints in terms of: an incomplete theoretical framework; inadequately developed modelling techniques; and lack of data. In the case of the theoretical framework there are “dots” that still need to be connected, not only in terms of reconciling the short-term with long-term developments, but also in terms of incorporating changes in expectations during the various stages of the business cycle, from adaptive, via rational to extrapolative. In this sense Minsky's work provide a coherent explanation of the process and the findings of this thesis are in line with this intuitive explanation of the whole process of endogenously generated instability towards the long-term stability of the system. As for the modelling techniques, empirical analysis is, to our knowledge, still far from providing a model that will allow for breaks and non-linearities in the cointegration analysis. That is why one of the conclusions from Chapter 6 is that a single model is insufficient to capture developments at different stages of the business cycle which is also reflected in the strong presence of the deterministic trend in all three estimated VECMs. Finally, data issues, especially soft information such as changes in incentives and expectations, are bound to be a challenge in this type of analysis regardless of the stage of development of the financial system.

Despite the limitations in terms of inadequately developed modelling techniques, we wish to emphasize the need for caution when interpreting the cointegration results in small samples and the importance of cross-checking the validity of the estimated long-term relationships by employing different techniques and models. It was demonstrated that it is possible to extract a long-term relationship that is supported by economic theory even in samples that span less than a decade provided that there were not too many structural breaks. However, although the estimated relationships might be in line with the existing theoretical framework (regardless of how incomplete it may be currently), they might be at odds in certain respects with current modelling techniques. An example would be a detection of the long-run cointegrating relationship between the measure of the systemic risk of currency crisis and the level of economic activity, while failing to detect the short-run adjustment mechanism. In such cases we recommend examining the potentially cointegrating relationship between the variables from various aspects and investigating single equation as well as the system of equations models. In small samples especially, it would not be appropriate to ground policy decisions based on the quantitative estimates. One should rather focus on any detected relationships between the variables and understand the interaction mechanism among the variables in both the short and long run.

The findings of this specific research should be re-assessed under two scenarios: a persistence of the episodes of significant stress or their prolonged duration and the abandonment of the current monetary policy in BH. Each episode of financial distress represents a structural break and it takes a while for a system to restore the new equilibrium at some lower level of the systemic risk. Frequent distress episodes or a lengthy adjustment phase towards the new equilibrium in which, as demonstrated, no long-run relationships hold, may exclude the use of cointegrating analysis as cointegration is ultimately a long-run phenomenon. One of the possible reasons why the VECMs in this research managed to capture the long-run relationships between the measures of systemic risk, the real economic activity and banking sector specific variables could be that the first three stages of the Minsky cycle lasted long enough to extract the long-run relationship at that specific period and that the distress episode occurred towards the end of the sample.

In the case of an abandonment of the currency board arrangement (or a significant increase in lending in currencies other than anchor currency) the non-hedged exposure of banks' clients may dramatically increase in nominal terms posing a significant threat to banking sector stability. Under such a scenario the relationship between banking and currency crises will become more complex which will inevitably alter the currently estimated relationships.

7.5. Final remarks

Investigating systemic risks and financial fragility in the context of a small open economy with a relatively simple financial system highlighted several findings that are likely to hold universally. Most importantly, it was demonstrated that a certain level of financial fragility exists in all systems regardless of their complexity. Although it is impossible to eliminate these risks, there are ways of measuring their trends in order to appropriately time regulatory responses and deflate the built-up risks gradually.

Based on the findings, it is safe to conclude that the causes of an increased fragility in the case of BH are broadly similar to the causes elsewhere. The ultimate driving force behind the increased financial fragility was an expectation that the favourable macroeconomic climate would continue in future periods. Similar to other countries in the region and small open economies at similar stages of development, the degree of domestic banking sector activity is conditional on developments in international financial markets. For that reason, the most efficient way to estimate trends in systemic risks is to observe them as a system together with the sets of the country-specific macroeconomic and financial sector variables. The finding regarding the inappropriateness of a single model of systemic risk over the cycle is significant, not only from the perspective of a small open economy with the characteristics similar to

BH, but also from the perspective of those countries with more complex financial systems. If there is no evidence that a single model can explain the changes in perception of systemic risk in a financial system with a simple structure characterized by a strong dominance of commercial banking and an absence of complex financial instruments, it is unlikely that success could be expected in more complex systems.

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APPENDICES

Appendix 1.1: The characteristics of the BH banking sector

Table A1. 1: Consolidated claims by sectors and maturity

in millions of BAM

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Short-term	**956.7**	**1,028.2**	**852.3**	**878.3**	**913.3**	**1,097.8**	**1,233.5**	**1,576.2**	**1,837.0**	**2,068.8**	**2,552.7**	**3,439.0**	**3,399.7**	**3,626.5**
Public sector	*335.9*	*312.8*	*226.0*	*280.4*	*248.1*	*271.2*	*204.5*	*206.2*	*166.9*	*99.4*	*94.1*	*106.7*	*167.5*	*151.8*
Government	133.8	113.0	36.7	33.8	32.9	60.7	45.6	45.6	50.1	10.6	9.5	19.3	76.6	71.5
Public non-finan. enterprises	202.1	199.8	189.2	246.6	215.2	210.5	158.9	160.6	116.8	88.8	84.6	87.4	90.9	80.3
Private sector	*583.6*	*578.6*	*610.2*	*557.8*	*628.6*	*790.9*	*969.2*	*1,326.1*	*1,610.2*	*1,920.0*	*2,383.5*	*3,225.4*	*3,176.2*	*3,426.0*
Private non-finan. enterprises	516.6	535.9	548.6	469.5	544.5	655.9	815.2	1,056.0	1,213.8	1,453.4	1,819.0	2,579.8	2,459.8	2,624.0
Households	66.9	42.7	61.6	88.3	84.1	135.1	154.0	270.1	396.4	466.6	564.5	645.7	716.4	801.9
Other sectors	*37.2*	*136.8*	*16.1*	*40.1*	*36.6*	*35.7*	*59.8*	*43.8*	*60.0*	*49.4*	*75.1*	*106.8*	*56.0*	*48.7*
Long-term	**1,482.9**	**1,892.6**	**1,928.9**	**2,138.6**	**2,425.7**	**3,183.3**	**3,888.0**	**4,350.9**	**5,707.1**	**7,130.4**	**9,298.7**	**11,070.5**	**10,650.4**	**10,916.9**
Public sector	*897.0*	*900.2*	*814.0*	*1,426.5*	*1,215.6*	*1,044.2*	*1,007.8*	*531.1*	*578.3*	*601.1*	*657.9*	*783.3*	*810.8*	*1,031.5*
Government										*58.5*	*118.3*	*244.3*	*267.9*	*374.2*
Public non-finan. enterprises	897.0	900.2	814.0	1,426.5	1,215.6	1,044.2	1,007.8	531.1	578.3	542.5	539.6	539.1	542.9	657.4
Private sector	*572.2*	*983.3*	*1,107.2*	*701.2*	*1,196.1*	*2,107.5*	*2,856.7*	*3,779.7*	*5,087.2*	*6,485.7*	*8,543.5*	*10,193.2*	*9,777.7*	*9,831.8*
Private non-finan. enterprises	518.1	778.4	900.8	405.4	598.3	786.3	1,044.3	1,422.2	2,030.2	2,592.7	3,439.2	4,142.2	4,186.9	4,309.5
Households	54.0	204.8	206.4	295.9	597.8	1,321.2	1,812.4	2,357.5	3,057.0	3,893.0	5,104.4	6,051.1	5,590.8	5,522.3
Other sectors	*13.8*	*9.1*	*7.7*	*10.9*	*14.0*	*31.6*	*23.5*	*40.2*	*41.7*	*43.6*	*97.3*	*93.9*	*61.8*	*53.5*

Notes: All reported values are in nominal terms, stock at the end of December of the corresponding year. There were no long-term claims by the banking sector from the government until 2006. The amendments to the existing Law in 2005 allowed for higher levels of the government long-term debt with domestic banks conditional on the limitations in total public long-term debt. Growing fiscal imbalances and budget deficits as of 2008 resulted in a significant increase in debt of the sub-state levels, primarily entities and municipalities. The trend in claims from the government continued in the periods not covered by this research. In 2011 the government debt doubled: in addition to significant increase in loans, the entities, Federation BH and Republic of Srpska, issued significant amount of treasuries, out of which BAM 272 million was held by the commercial banks. Until May 2004 consolidated balance sheet of banking sector consisted of both on- and off-balance sheet items. In May 2004 the Ministry of Finance of RS took over the passive sub-balance items, pre 1992 loans and foreign currency savings (*cca* BAM 460 million), in accordance to the entity Law on initial balance sheet of enterprises and banks and Law on Privatization thus reducing the long-term claims on public non-financial enterprises. Once the FBH Ministry of Finance takes over the pre 1992 claims in the process of privatization , the long-term claims on public non-financial enterprises will decrease by additional *cca*

Table A1. 2: Deposits by sectors, maturity and currency

Source: CBBH. All reported values are end of period stock.

in millions of BAM

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Short-term (a+b+c)	**784.1**	**983.8**	**1,107.7**	**1,385.8**	**2,061.5**	**2,293.8**	**2,553.8**	**3,121.7**	**3,876.1**	**4,942.2**	**6,025.8**	**5,480.5**	**5,771.6**	**6,231.9**
(a) Government (1+2)	*132.6*	*109.0*	*146.3*	*186.5*	*299.1*	*377.4*	*456.4*	*629.8*	*783.0*	*1,096.1*	*1,361.5*	*866.6*	*1,309.2*	*1,261.8*
BAM (1)	66.4	59.7	122.0	158.5	273.2	297.9	412.8	589.4	710.3	1,030.1	1,207.7	820.1	1,093.4	1,074.4
Foreign currencies (2)	66.2	49.4	24.3	28.1	25.9	79.5	43.6	40.4	72.8	65.9	153.8	46.5	215.8	187.4
(b) Private sector (3+4)	*357.9*	*539.7*	*457.5*	*631.1*	*1,267.1*	*1,334.0*	*1,399.2*	*1,791.7*	*2,304.5*	*2,839.0*	*3,536.5*	*3,483.0*	*3,419.0*	*4,011.7*
(3) BAM (i+iii)	41.3	41.3	215.6	299.9	529.0	678.1	752.6	1,045.2	1,406.4	1,805.0	2,371.7	2,230.8	2,200.1	2,547.5
(4) Foreign currencies (ii+iv)	316.6	498.4	241.9	331.1	738.1	655.9	646.6	746.6	898.1	1,034.1	1,164.8	1,252.2	1,218.8	1,464.2

Table A1. 3: Foreign investment to BH banking sector

Source: CBBH. All reported values are end of period stock.

in millions of BAM

Foreign investment to banking sector											
		Foreign direct investment				Portfolio and other investment					
Year	Quarter	Equity, above 10%	Inter-company loans	Other	Subtotal 1	Equity, less than 10%	Deposits of foreign direct investors	Other non- residents		Subtotal 2	**Total**
								Loans	Deposits		
2004	Q1	528	330	31	890	34	786	270	240	1,330	**2,220**
	Q2	573	416	21	1,011	33	799	348	246	1,425	**2,436**
	Q3	595	458	21	1,074	31	909	354	232	1,526	**2,600**

Table A1. 4: The term structure of claims by sectors and the corresponding annual growth rates

Source: CBBH.

Note: Loans to other sectors (less than 10% of total loans in all periods) were not reported. Other sectors include: government, public enterprises, non-bank financial institutions, non-profit organizations and other.

Year	Month	Stock, end of period, millions of BAM									Annual growth rates, %								
		Total credit			Private non-fin. enterprises			Households			Total credit			Private non-fin. enterprises			Households		
		Short-term	Long-term	Total	Short-term	Long-term	Total	Short-term	Long-term	Total	Short-term	Long-term	Total	Short-term	Long-term	Total	Short-term	Long-term	Total
2006	03	1,819	5,948	7,766	1,286	2,073	3,359	384	3,204	3,600	10.6	30.4	25.2	16.8	35.3	27.5	28.3	30.4	30.6
	06	1,997	6,281	8,278	1,399	2,218	3,617	442	3,455	3,910	15.9	30.8	26.8	17.9	30.7	25.4	36.2	29.3	30.5
	09	1,971	6,622	8,594	1,361	2,334	3,695	462	3,674	4,136	10.8	25.9	22.1	15.5	27.9	23.0	27.8	28.9	28.8
	12	2,069	7,130	9,199	1,453	2,593	4,046	467	3,893	4,360	12.6	24.9	21.9	19.7	27.7	24.7	17.7	27.3	26.2
2007	03	2,389	7,495	9,887	1,579	2,747	4,326	513	4,130	4,643	24.9	26.6	26.2	22.3	29.4	26.7	26.5	29.3	29.0
	06	2,470	8,137	10,607	1,627	2,972	4,600	536	4,513	5,049	18.5	29.9	27.1	16.2	33.3	26.7	17.8	30.6	29.1
	09	2,599	8,639	11,238	1,708	3,171	4,879	578	4,812	5,390	25.5	31.1	29.8	25.7	35.4	31.8	21.7	31.0	29.9
	12	2,752	9,211	11,964	1,822	3,466	5,288	586	5,100	5,686	24.1	29.9	28.5	24.3	32.8	29.8	20.7	31.2	30.0
2008	03	3,047	9,703	12,749	2,070	3,682	5,752	602	5,396	5,998	27.5	29.5	29.0	31.2	34.0	33.0	17.3	30.7	29.2
	06	3,465	10,283	13,748	2,348	3,904	6,251	637	5,768	6,405	40.3	26.4	29.6	44.3	31.3	35.9	18.8	27.8	26.9
	09	3,615	10,759	14,374	2,475	4,075	6,550	660	6,030	6,690	39.1	24.5	27.9	44.9	28.5	34.2	14.2	25.3	24.1
	12	3,714	10,847	14,561	2,583	4,154	6,737	646	6,050	6,696	34.9	17.8	21.7	41.8	19.8	27.4	10.3	18.6	17.8
2009	03	3,498	10,958	14,456	2,606	4,122	6,727	705	5,929	6,634	21.3	11.9	14.0	25.7	12.8	17.5	16.3	10.1	10.7
	06	3,620	10,840	14,460	2,573	4,131	6,704	713	5,811	6,524	12.9	3.6	5.8	9.5	6.7	7.7	12.0	0.7	1.8
	09	3,419	10,689	14,109	2,490	4,120	6,609	729	5,702	6,432	2.1	-2.4	-1.3	0.4	1.9	1.3	10.7	-5.5	-3.9
	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table A1. 5: Comparative schedule of capital balance and adequacy active sub-balance sheet

Ord. No	Description
1	**BANK'S CORE CAPITAL: (1.a.-1.b.)**
1.a.	*Share capital, reserves and income: (from 1.1. to 1.6.)*
1.1.	Share capital - common and perm. priority non-cumulat. shares - cash payments
1.2.	Share capital - comm. and perm. prior. non-cumul. shares-invested posses and rights
1.3.	Issued shares income at share payments
1.4.	General regulatory reserves (reserves as regulated by the Law)
1.5.	Other reserves not related to assets quality assessment
1.6.	Retained - undistributed income from previous years
1.b.	*Offsetting items from 1.a.: (from 1.7.to 1.10.)*
1.7.	Uncovered losses transferred from previous years
1.8.	Losses from current year
1.9.	Book value of treasury shares owned by the bank
1.10.	Amount of intangible assets
2	**BANK'S SUPLEMENTARY CAPITAL: (from 2.1. to 2.8.)**
2.1.	Share capital - common and perm. priority non-cumulat. shares - cash payments
2.2.	Share capital - comm. and perm. prior. non-cumul. shares-invested posses and rights
2.3.	General reserves for losses on loans from class. A - performing assets
2.4.	Accrued income for current year audited and confirmed by external auditor
2.5.	Income under FBA's temporary restriction on distribution
2.6.	Subordinated debts, the most 50% of core capital
2.7.	Hybrid convertible items - the most 50% of core capital
2.8.	Items-permanent liabilities without repayment duty
3	**OFFSETTING ITEMS FROM BANK'S CAPITAL: (3.1. to 3.4.)**
3.1.	Part of invested share capital that according to FBA's assessment represents accepted and overestimat
3.2.	Investments in capital of other legal entities exceeding 5% of bank's core capital
3.3.	Receivables from shareholders for significant voting shares - approved aside from regulations
3.4.	VIKR to shareholders with significant voting shares in the bank without FBA's permission
A	**AMOUNT OF BANK'S NET CAPITAL (1.+2.-3.)**
B.	**RISK FROM RISK-WEIGHTED ASSETS AND LOAN EQUIVALENTS**
C.	**NET CAPITAL RATE (CAPITAL ADEQUACY): (A./B.) X 100**

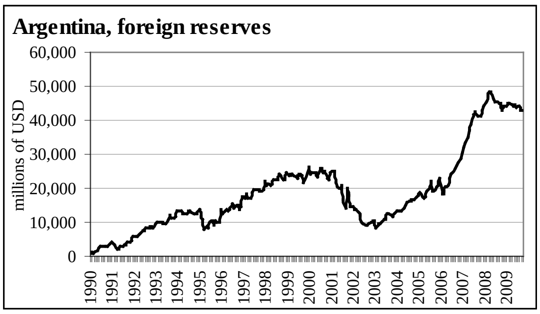
Source: FAB.

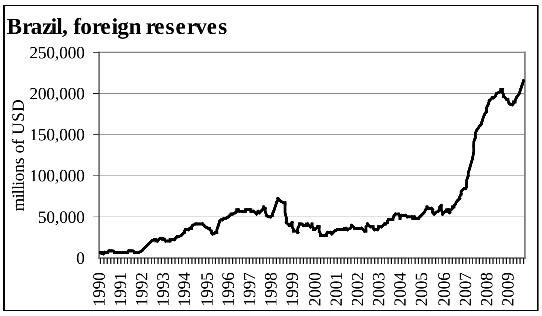
Notes: The structure of capital is identical in banks under the jurisdiction of BARS. Detailed explanation for each of these items can be found at http://www.fba.ba/en/regulations/ or http://www.abrs.ba/propisi/propisi_eng.htm

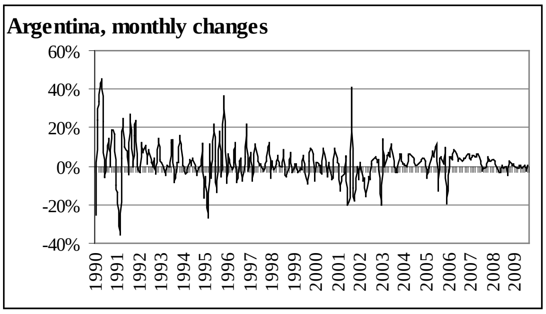
The structure of regulatory capital is regulated by the by-law named Decision on Minimum Standards for Capital Management in Banks. Applicable Decisions on changes and amendments should be consulted as well.

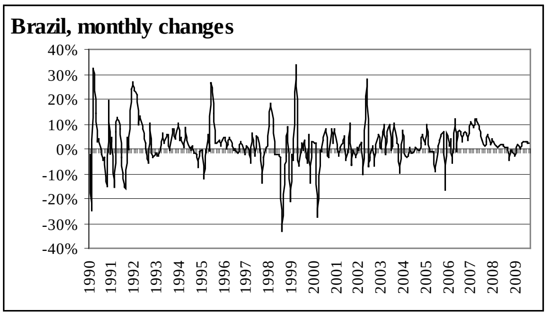
Appendix 3.1: Foreign reserves of the selected countries

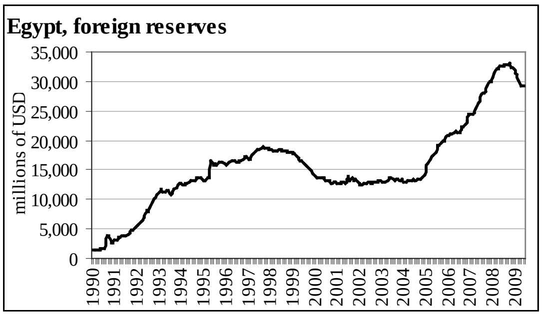
Set of Figures A3. 1: Foreign reserves of the selected countries, stock at the end of the period and monthly changes

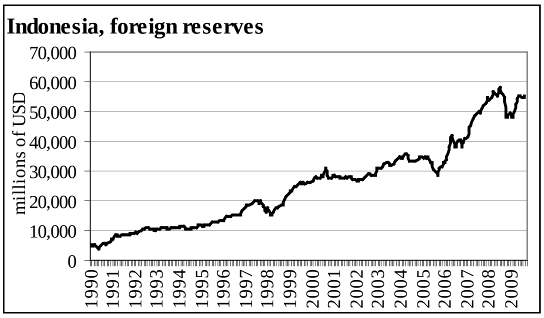


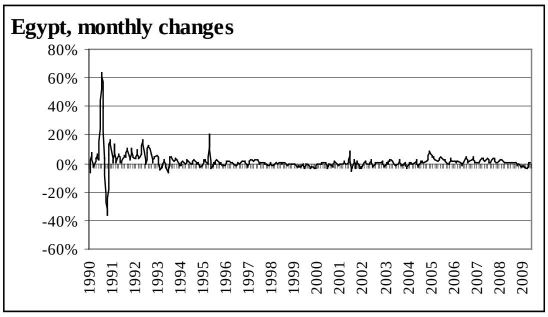


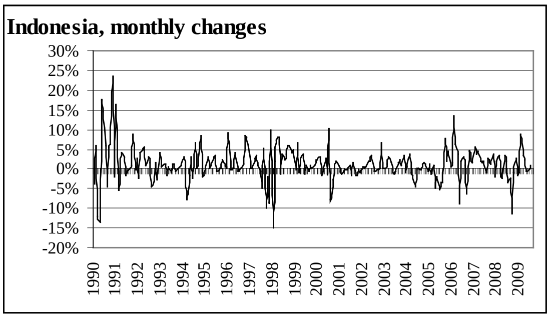


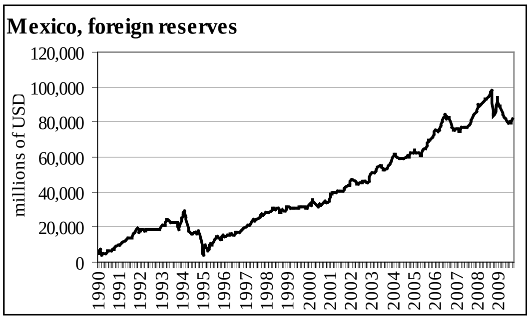




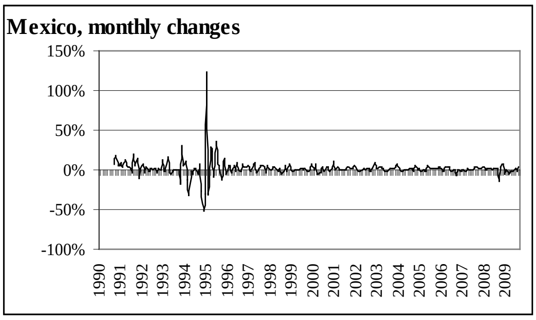


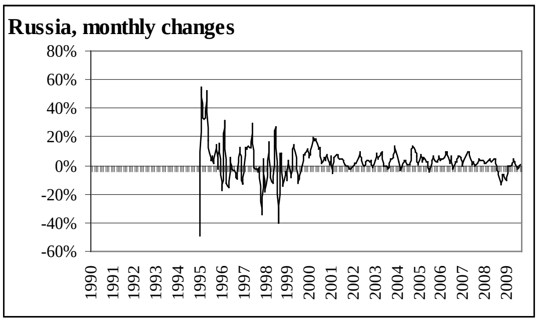


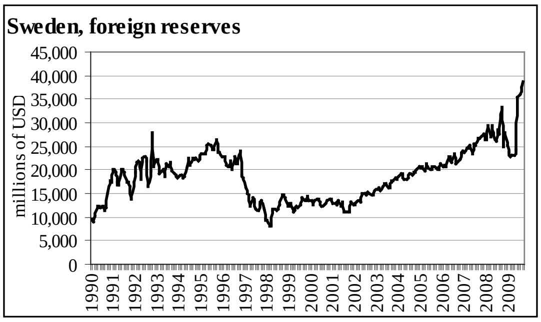


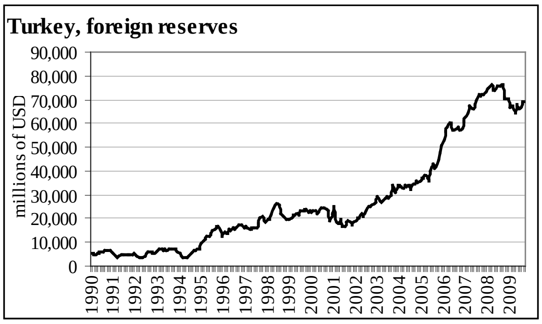

Mexico, foreign reserves
millions of USD

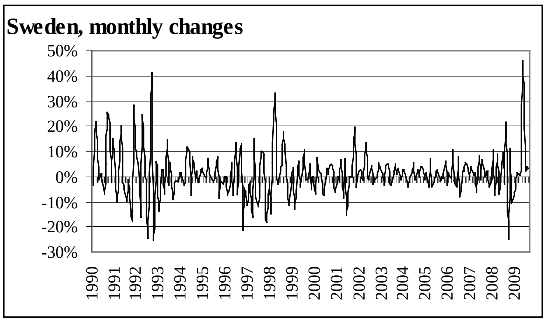

Russia, foreign reserves
millions of USD

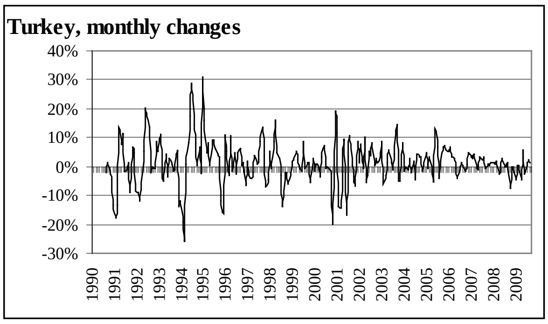

Mexico, monthly changes


Russia, monthly changes

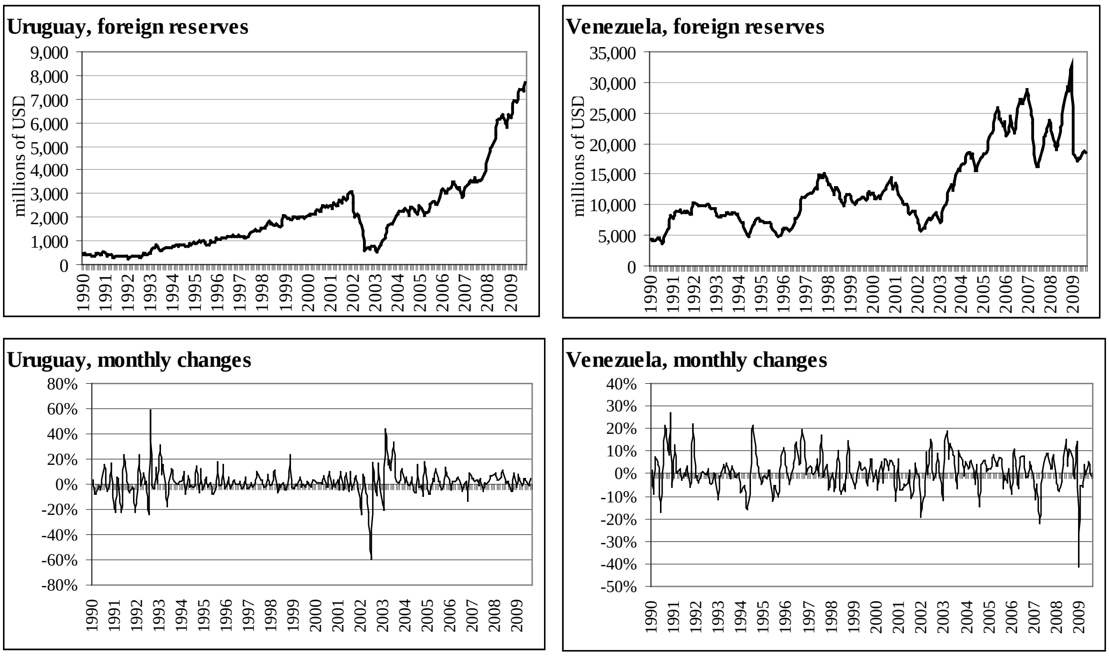

Sweden, foreign reserves
millions of USD


Turkey, foreign reserves
millions of USD


Sweden, monthly changes


Turkey, monthly changes

Source: IMF IFS, November 2009.



Appendix 3.2: The effect of the stand-by arrangement on the perception of risk of currency crisis

The stand-by arrangement (SBA) framework is used by the IMF in order to respond quickly to countries' external financing needs, and to support policies designed to help them emerge from crisis and restore sustainable growth (IMF, 2012). This facility was introduced in 1952 and *upgraded* in 2009 (IMF, 2012) in order to increase flexibility and responsiveness to member countries' needs. All member countries are eligible for SBAs and duration is limited to maximum 36 months. The borrowing terms are conditional on: a country's need for financing; its ability to repay; and track record of uses of the IMF resources.

There are several types of access to the IMF funds, but normal access assumes the access of up to 200 percent of quota for any 12 months period (as of 2009 when the borrowing limits was doubled), and cumulative access over the life of the programme of up to 600 percent of quota, net of scheduled repayments. Fund disbursement is conditional on the applicant country meeting a set of quantitative performance criteria, unless the Executive Board decides to wave them. Regular reviews by the IMF ensure that the applicant country is meeting the quantitative performance criteria as specified in the Letter of Intent sent on behalf of the government to the IMF. The disbursements are usually repaid in 8 equal quarterly instalments staring 3 years and a quarter after the initiation of the SBA. The lending rate is linked to the Special Drawing Rights (SDR) with surcharges applied to large and prolonged borrowing. A commitment fee is paid for contracted, but undrawn funds, while the service charge is applied on each amount drawn.

As of 1997, BH entered 4 SBAs with the IMF. All information on the SBAs of BH with the IMF were taken from the IMF press releases listed under the *News* section on their web site. In 1998 a 12 months stand-by credit was approved in the amount of SDR 60.6 million in support of the government's 1998-1999 economic program. This SBA was augmented by the additional SDR 16.9 million in 1999 with an extension through 2000. The second augmentation of the initial SBA occurred in 2000 for the additional SDR 16.9 million and a year of extension. With these extensions and additional disbursements the stand-by credit approved in 1998 raised to the amount of SDR 94.2

million, of which an amount equivalent to SDR 64.3 million was drawn. In 2001 the stand-by credit was extended by the additional 2 months.

The second stand-by arrangement with the IMF was agreed in 2002. The IMF approved SDR 67.6 millions in support of the BH economic programme for the period August 2002- November 2003. In October 2003 this SBA was extended through December 2003. At that time BH has drawn SDR 55.6 million of the approved amount. In December 2003 the SBA arrangement was extended through the end of February 2004 in order to enable the BH government to carry out prior actions on budgetary transfers. The remaining SDR 12 million were drawn before the SBA ended.

The third 36-month SDR 1.01 billion SBA aiming to support an economic programme designed by the authorities to mitigate the risks of the global financial crisis (GFC) was approved in July 2009. SDR 182.6 million was disbursed immediately following the approval of the SBA with the remainder to be disbursed in instalments following the quarterly reviews. Additional SDR 121.8 million were disbursed in March 2010. Following the second and third reviews of the BH's performance under the programme, in October 2010 the IMF enabled an immediate disbursement of SDR 118.4 million, of which the BH authorities drew SDR 33.8 million thus raising the drawn amount to SDR 338.2 million. As mentioned in Section 2.4, a consequence of a political crisis in country and an inability to meet the obligations outlined in the Letter of Intent, the remaining amount approved by the third tranche was never drawn, nor were the tranches four and five ever approved. The SBA was frozen and it finally expired in April 2012.

In September 2012 the fourth, 24-months SBA was approved. The terms were roughly similar to those outlined in the Letter of Intent for the previous SBA and the approved amount was equal to the amount drawn by the third SBA. The initial disbursement of SDR 50.73 million was approved immediately.

A failure to take the effect of the funds drawn under the SBA on foreign reserves into account may result in a perception of rather stable level of foreign reserves in the periods when the macroeconomic fundamentals deteriorate. Once the tranche is drawn in full or partially, the funds are transferred to the accounts with the central bank. The central bank then distributes them to the geo-political units, the entities, in accordance with the pre-defined ratios specified in the Letter of Intent. Therefore, with each tranche the foreign reserves raise. The currency in circulation also raises by the amount converted to the local currency at the exchange rate of the central bank at that day. The process is reversed when the loans is being repaid: the government transfers funds to the accounts with the central bank and the central bank uses the foreign reserves to repay the annuity. In the case of BH, the level of foreign currency reserves at any time is a consequence of: initial level at the moment of the CBBH establishment; privatization and capital investment related inflows; increase in the public sector foreign debt, including the SBAs; servicing of the foreign public debt; financial, primarily banking, sector activities; the real sector developments; and, to a lesser extent, the investment policy of the CBBH (CBBH, 2012). Unlike privatization and capital investment related inflows or the investment policy of the central bank that permanently shift the level of foreign reserves, an increase in the foreign public debt only temporarily increases the level of foreign reserves since it is subject to repayment. The perception of the robustness of the financial system and the likelihood of currency crisis may be significantly biased if one does not account for the transitory stabilizing effect of an increase in public debt.

In order to estimate the effect of the SBAs to the level of foreign reserves in the case of BH, the following steps were undertaken:

The life cycle of each SBA tranche was reconstructed in the following fashion:

1. From the moment the tranche was drawn until the repayment begins the amount of the tranche is used for each period. The annual SDR interest rate (available at the IMF web site) is used to increase the debt outstanding by each tranche once a year until the repayment begins. The service charge is applied when the tranche is drawn, but the commitment fee is not taken into account. The surcharges are not applied to large and prolonged borrowing.

2. In the repayment periods the remaining debt by each tranche is used. The life cycle of the tranche ends when the remaining debt reaches zero.

3. The values of tranches are summed for each period.

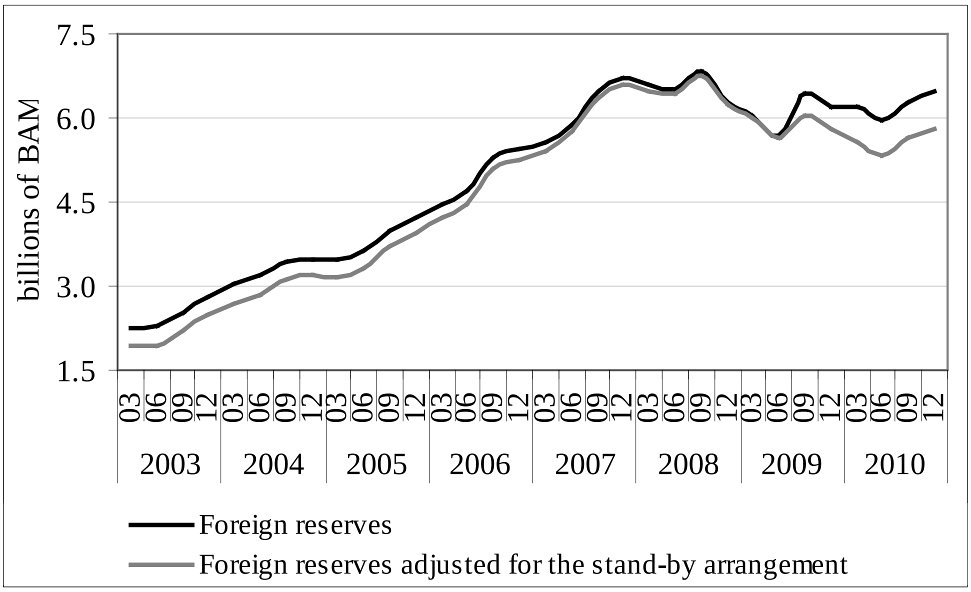
4. The values obtained in the previous step (in SDR million) are converted into EUR values at the SDR/EUR exchange rate for the last day of the calendar month. The SDR exchange rates vis-à-vis national currencies are available at the IMF web site. The EUR amounts are then converted into BAM by applying the fixed EUR/BAM exchange rate.

5. The vales obtained in the previous step are subtracted from the official foreign reserves data.

Figure 3.3 (a copy provided below) illustrates the difference between the official and foreign reserves adjusted for the effect of the SBA. The difference between the two series is particularly significant in the post 2008 periods. At the end of 2010 the official foreign reserves were 11.6% higher because of the SBA related inflows. With an exception of the last quarter of 2008 and the first quarter of 2009, the official foreign reserves do not decline despite the significant slowdown in economic activity (Section 1.3) indicating that the SBA arrangement effect partially offsets the effect of deterioration in macroeconomic environment.

Figure A3. 2: The effect of the stand-by arrangement on foreign reserves

Source: CBBH, IMF, own calculations.
Similar Figure with slightly different purpose was constructed for CBBH (2012).



Appendix 3.3: A loss sufficient to collapse the currency board arrangement

Table A3. 1: A loss sufficient to collapse the currency board arrangement, % of total

Year	Month	Total foreign currency denominated liabilities	Or: Foreign currency deposits of domestic sectors	Deposits of non-residents	Loans from non-residents
2003	01	12.25	23.53	75.42	38.84
	02	12.13	23.43	71.93	38.90
	03	12.30	23.89	72.71	39.00
	04	11.82	23.18	69.42	37.10
	05	11.82	23.30	65.97	37.89
	06	11.66	23.61	61.28	37.03
	07	11.77	23.85	64.13	36.63
	08	12.04	24.42	66.36	37.09
	09	12.69	26.08	66.59	39.51
	10	12.80	26.79	64.52	39.72
	11	12.89	26.96	63.69	40.62
	12	12.94	28.45	59.44	39.80
2004	01	12.60	27.93	55.32	39.53
	02	12.51	27.78	54.47	39.33
	03	13.16	28.98	56.04	42.77
	04	12.93	28.22	57.07	41.40
	05	13.34	28.70	59.49	43.37
	06	14.45	29.09	59.45	56.03
	07	14.48	28.90	61.19	55.85
	08	14.69	29.04	63.06	57.16
	09	14.76	29.14	60.99	59.45
	10	14.50	28.51	59.12	59.64
	11	13.67	26.52	56.66	57.32
	12	13.87	27.48	54.10	58.99
2005	01	13.78	26.84	55.33	58.85
	02	13.68	26.47	56.83	57.37
	03	13.44	26.33	56.69	54.13
	04	13.54	26.65	56.54	54.65
	05	12.97	25.73	53.26	52.13
	06	13.17	26.02	54.36	52.99

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2005	07	13.69	27.11	54.70	56.54
	08	14.04	27.85	54.49	59.51
	09	13.82	27.31	54.00	58.67
	10	13.65	26.98	53.21	58.15
	11	13.48	27.23	51.68	55.79
	12	13.51	28.17	48.45	56.49
2006	01	13.78	28.26	51.71	56.97
	02	14.05	28.68	53.07	57.89
	03	14.14	28.12	55.48	59.05
	04	14.01	28.10	56.08	56.23
	05	14.15	28.36	57.08	56.94
	06	14.28	28.60	56.28	58.56
	07	14.87	29.15	59.98	62.31
	08	15.04	29.55	59.61	63.90
	09	15.46	30.32	60.77	66.07
	10	15.44	30.24	60.83	66.09
	11	15.37	30.04	61.03	65.59
	12	15.20	30.45	57.80	64.55
2007	01	14.99	29.76	57.59	64.11
	02	14.98	29.33	59.04	64.75
	03	15.14	30.42	60.24	61.16
	04	15.45	30.74	63.37	62.14
	05	15.37	30.18	63.77	62.88
	06	13.23	23.88	60.51	58.82
	07	14.01	25.44	63.50	62.05
	08	14.06	25.42	63.34	63.21
	09	14.26	26.14	62.75	63.48
	10	13.89	25.15	62.43	62.24
	11	13.44	24.31	59.98	60.88
	12	13.75	25.59	57.36	62.45
2008	01	13.36	24.48	56.31	62.23
	02	13.33	24.25	57.13	61.79
	03	13.32	24.62	55.80	60.89
	04	13.18	24.31	55.91	59.79
	05	12.81	23.77	53.90	57.73
	06	12.68	23.83	51.22	58.39
	07	12.87	23.85	49.56	64.53
	08	13.01	24.12	50.85	64.28
	09	12.83	23.85	51.05	62.71
	10	12.36	23.93	47.59	57.09
	11	11.73	23.25	46.54	50.30
	12	11.75	24.02	43.27	51.05

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Source: Own calculations.

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2009	01	11.48	23.37	43.02	49.49
	02	11.35	23.02	42.91	49.06
	03	11.40	23.06	42.76	49.85
	04	11.22	22.65	42.58	49.12
	05	10.91	22.00	39.10	51.54
	06	10.88	21.94	38.63	51.48
	07	11.14	22.44	39.75	52.44
	08	11.87	23.84	42.51	56.24
	09	11.81	23.39	42.29	57.75
	10	11.42	22.51	41.52	55.53
	11	11.12	21.99	40.22	54.35
	12	11.53	22.56	40.62	59.21
2010	01	11.32	22.04	40.85	57.33
	02	11.18	21.82	39.89	57.36
	03	10.97	21.08	39.59	57.41
	04	10.76	20.55	38.87	57.05
	05	10.75	20.27	40.21	56.44
	06	10.65	19.49	39.87	60.61
	07	11.24	20.47	43.41	62.26
	08	11.63	21.03	46.19	63.48
	09	11.68	21.30	44.77	65.39
	10	12.10	22.10	48.30	64.27

Appendix 4.1: Exposure of banking sector to legal entities by industry

Table A4. 1: The largest borrowers at the end of 2010, legal entities

in thousands of BAM

Area	Loans, outstanding debts	Share in the area	Share in total claims
A: Agriculture, hunting and forestry	**174,319**		**3.0%**
Livestock, poultry and other animals breeding , out of which:			
Beef cattle for milk and seedstock breeding	27,754	15.9%	0.5%
B: Fishing	**7,494**		**0.1%**
C: Mining and quarrying	**169,407**		**2.9%**
Crude and row material mining , of which:			
Coal mining and briquetting	59,137	34.9%	1.0%
D: Processing industry	**1,600,061**		**27.5%**
Production of food products and beverages, out of which:			
Production of beer	93,321	5.8%	1.6%
Production of fruit and vegetable juices	72,496	4.5%	1.2%
Production of bread (FBH)	54,351	3.4%	0.9%
Processing and producing of canned fruit and vegetables	53,890	3.4%	0.9%
Processing of wood, manufacturing of wooden, cork , straw and plaiting materials items except for furniture, of which:			
Sawmilling of wood, except for non-assembled floor woodwork	94,117	5.9%	1.6%
Manufacture of metal and metal products			
Production of metal constructions and parts	45,777	2.9%	0.8%
E: Electricity, gas, and water supply	**98,967**		**1.7%**
F: Construction industry	**337,197**		**5.8%**
High-rise and low-rise construction, construction of entire structures or parts thereof, out of which:			
High - rise construction	160,592	47.6%	2.8%
G: Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and households items	**1,866,945**		**32.1%**
Trade of motor vehicles and motorcycles, their maintenance, retail trade of automotive oils and lubricants, of which:			
Retail sale of automotive oils and lubricants	84,087	4.5%	1.4%
Wholesale and commission trade, except of motor vehicles and motorcycles, out of which:			
Wholesale trade of other household products	82,198	4.4%	1.4%
Wholesale trade of pharmaceutical products	76,757	4.1%	1.3%
Commission trade of various items	68,270	3.7%	1.2%
Wholesale trade of construction materials and bathroom and toilet equipment	67,679	3.6%	1.2%

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Source: CRC.

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Other wholesale trade	365,865	19.6%	6.3%
Other wholesale trade solely for own account (RS)	64,242	3.4%	1.1%
Wholesale trade of solid, liquid and gaseous fuels and similar products	61,393	3.3%	1.1%
Retail trade, except for trade of motor vehicles and motorcycles, repair of items for personal and household use, of which:			
Retail trade in non-specialized stores with predominantly food, beverages and tobacco	125,076	6.7%	2.2%
Other retail sale in non-specialized stores	96,277	5.2%	1.7%
Retail sale of iron ware, paints, glass and other constructior	75,125	4.0%	1.3%
H: Hospitality industry	**133,446**		**2.3%**
Hotels, out of which			

Appendix 4.2: The adjustments to the original series of the number of employed persons

The figures on the labour force were downloaded from the Agency for Statistics of Bosnia and Herzegovina's (BHAS) web site. The data is published in the form of Monthly bulletins on the employment by industries and total unemployment, both in *.pdf format. Once the data was sorted, a significant temporary increase in the number of total employed persons was noted in periods January through June 2008 and January through April 2009 (Figure A4.1 below). This temporary increase in the number of employed persons was not mirrored in a temporary decrease in the number of unemployed persons thus indicating that the labour force was temporarily increased.

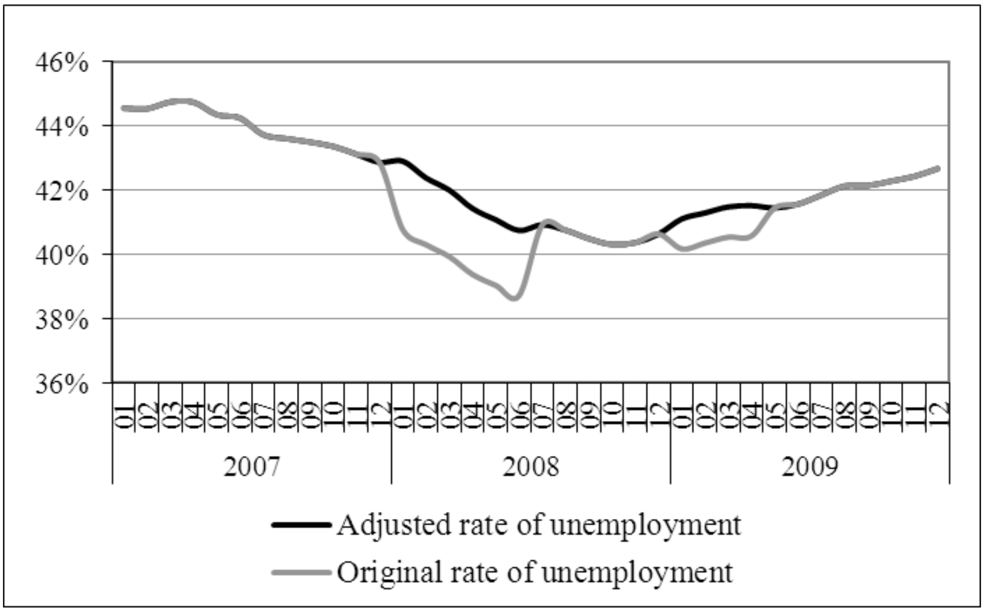
Figure A4. 1: The number of employed and unemployed persons, the original series

Source: BHAS.

When the number of the employees per industry was checked, it turned out that the ones that are mainly responsible for this increase in the first half of 2008 and, to a bit less extent, in 2007 are: manufacturing, trade and public administration (each accounting for some 25% of increase at the beginning of the year and the same share of total decrease in July of 2008). This increase was not too obvious in the cases of manufacturing and trade given their size, i.e. the number of employees in these sectors. However, such an increase in the government sector resulted in an increase in the number of the employees from 71,214 in December to 104,354 in January. In July the number was back to 67,809. This was a rather peculiar finding given that in that period no major public sector activities (such as the elections, census, etc.) that could explain this increase in the number of employed persons occurred. There were several attempts to contact the Agency in writing asking for the clarification, but there was no reply. Given the limitations in the number of observations (the sample covers the period Q1 2003 through Q4 2010), "smoothing" the series was chosen instead of introducing a shift dummy variable to account for the two glitches in the rate of unemployment (Figure A4.2 below). The labour force was adjusted by excluding these unexplainable spikes in the number of employees.

Figure A4. 2: The original and the adjusted rates of unemployment

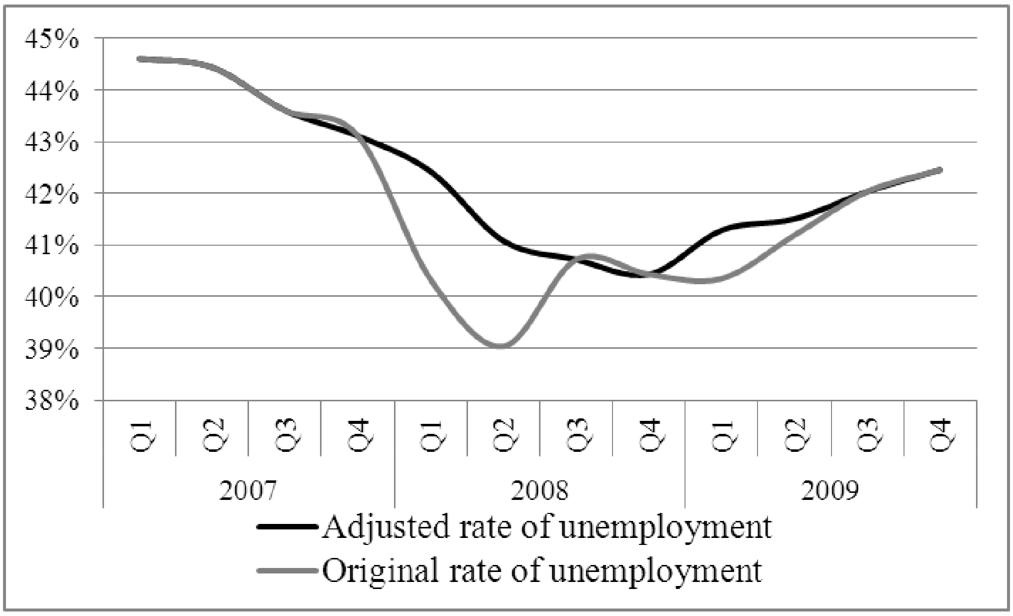
Source: BHAS.



The series with quarterly frequency was generated by averaging the values recorded in the months that constitute the quarter (Figure A4.3).

Figure A4. 3: The original and the adjusted rates of unemployment, quarterly figures

Source: BHAS.



Appendix 4.3: Unit root tests, Augmented Dickey-Fuller

Set of Tables A4. 2a: Augmented Dickey-Fuller (ADF) test for unit root in levels

Null Hypothesis: LI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.714464	0.7206
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IIP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.229594	0.9999
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: UNEMP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.411381	0.3664
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IRDIF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.446646	0.8261
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: HHI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.191772	0.8942
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: USDEUR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.641850	0.0429
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Set of Tables A4. 2b: Augmented Dickey-Fuller (ADF) test for unit root in first differences

Null Hypothesis: D(LI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.346521	0.0008
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IIP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.348444	0.8488
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(UNEMP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.748964	0.0342
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IRDIF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.255823	0.0001
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LTDOMFUND) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.814928	0.0296
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HHI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.203588	0.0124
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(USDEUR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.418476	0.0007
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

*MacKinnon (1996) one-sided p-values.

Appendix 4.4: Unit root tests, Phillips-Perron

Set of Tables A4. 3a: Phillips-Perron (PP) test for unit root in levels

Null Hypothesis: LI has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.826181	0.6675
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IIP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.802728	0.0300
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: UNEMP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.822794	0.6692
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IRDIF has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.468337	0.8189
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LTDOMFUND has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.903235	0.6288
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: HHI has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.032901	0.9938
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: USDEUR has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 10 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.925363	0.6174
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Set of Tables A4. 3b: Phillips-Perron (PP) test for unit root in first differences

Null Hypothesis: D(LI) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.351433	0.0008
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IIP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 12 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.20502	0.0000
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(UNEMP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.815770	0.0296
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IRDIF) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.240034	0.0001
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LTDOMFUND) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.733520	0.0353
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HHI) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 17 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.895667	0.0024
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(USDEUR) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 26 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.279792	0.0104
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Appendix 4.5: Testing for unit root under the assumption of structural break

Perron's (1989) procedure is characterised by a single exogenous, known break and it uses a modified Dickey-Fuller (DF) unit root test that includes dummy variables to account for that break.

Based on this approach, three equations are estimated to test for the unit root:

A 'crash' model which allows for the break in the intercept:

$$Y_t = \alpha_0 + \alpha_1 * DU_t + \beta * t + \gamma * d(DTB) + \rho * Y_{t-1} + \sum_{i=1}^{p} \phi_i * \Delta Y_{t-1} + e_t \tag{A4.1}$$

A 'changing growth' model that allows for a change in the slope:

$$Y_t = \alpha_0 + \alpha_2 * DT_t + \beta * t + \rho * Y_{t-1} + \sum_{i=1}^{p} \phi_i * \Delta Y_{t-1} + e_t \tag{A4.2}$$

And a model that allows for both changes in the intercept and the slope simultaneously:

$$Y_t = \alpha_0 + \alpha_1 * DU_t + \alpha_2 * DT_t + \beta * t + \gamma * d(DTB) + \rho * Y_{t-1} + \tag{A4.3}$$

$$+ \sum_{i=1}^{p} \phi_i * \Delta Y_{t-1} + e_t$$

where

DU_t represents a change in the level and is assigned 1 if t > TB (i.e. the break period);

$DT_t = 0$ if $t \leq$ 2008 Q1 and $DT_t = t - T_B$ if $t > 0 = T_B$; and

DTB is a crush dummy assigned the value of 1 for t = TB+1.

IIP was tested for a unit root under the assumption of the presence of a structural break at the end of 2008, when the growth of IIP was notably reduced (Figure 4.8). The last quarter of 2008 as a break date is chosen since the volume of industrial output was reduced as a consequence of deterioration in macroeconomic environment, which resulted in a slowdown of growth of IIP. The changing growth model represented by

Equation (A4.2) above is an appropriate representation of the test on unit root under of the assumption of a structural break. Table A4.4 below represent an estimation output of a model estimated in line with the Equation (A4.2)[79].

Table A4. 4: Estimation output based on Equation (A4.2)

Dependent Variable: IIP
Sample (adjusted): 2005Q1 2010Q4
Included observations: 24 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	99.258	18.613	5.333	0.000
DT	-2.371	0.673	-3.525	0.002
TIME	3.482	0.712	4.889	0.000
IIP(-1)	-0.344	0.259	-1.328	0.196
D(IIP(-1))	0.431	0.185	2.326	0.028

R-squared	0.935	Mean dependent var	113.927
Adjusted R-squared	0.925	S.D. dependent var	18.476
S.E. of regression	5.075	Akaike info criterion	6.238
Sum squared resid	643.959	Schwarz criterion	6.471
Log likelihood	-88.565	Hannan-Quinn criter.	6.312
F-statistic	89.832	Durbin-Watson stat	2.381
Prob(F-statistic)	0.000		

If it is the case that t-statistics associated with the coefficient on the lagged dependant variable in Table A4.4 is larger when compared to the test critical values, one should accept the null hypothesis of a unit root against the alternative hypothesis of a broken trend stationary process. The t-statistic of the coefficient next to the lag of dependant variable in Table A4.4 is estimated to -1.328, which is significantly larger than 1% level test critical value (-4.394 reported in Table A4.5) indicating that the hypothesis of unit root should not be rejected. In other words, even when one takes into account change in the slope of IIP following the economic slowdown, there is still no sufficient evidence to rule out the unit root process, which is in line with the conclusion implied by Figure 4.8.

[79] The model with 7 endogenous lags was also estimated, since the automatic lag length in ADF based on Schwarz Info Criterion (SIC) is 7 (Table A4.5 below), but the conclusion is the same. The t-statistics on lagged IIP is less negative, i.e. suggesting even more that one should not reject the null hypothesis.

Table A4. 5: Test critical values

Null Hypothesis: IIP has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 7 (Automatic based on SIC, MAXLAG=7)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.230	1.000
Test critical values:	1% level	-4.394	
	5% level	-3.612	
	10% level	-3.243	
*MacKinnon (1996) one-sided p-values.			

The case of UNEMP is a bit more complex since both tests indicate the presence of unit root and an order of integration that one would expect for the price indices. Furthermore, the plot of UNEMP in Figure 4.8 is inconclusive. A known break in UNEMP occurred at the beginning of 2007, when the BH Agency for Statistics, based on the labour force survey for 2007 and their monthly surveys, adjusted the number of unemployed persons. Figure A4.1 indicates that this decline in the number of unemployed persons was not large in absolute numbers (about 9 thousand), but the impact on the rate of unemployment was significant given the relatively small official figures on total labour force. However, this break is not the only one in UNEMP. As a consequence of deteriorated macroeconomic environment towards the end of 2008, the rate of unemployment exhibited a sharp incline that lasted through the end of the sample. For that reason, UNEMP will be tested for unit root under the assumptions of both one and two structural breaks. The case of a single structural break corresponds to model represented by Equation (A4.3) above. Testing for a unit root in UNEMP assuming two structural breaks is conducted in line with Lumsdaine and Papell (LP) (1997). Their model, an extension of Zivot and Andrews (1992), is a modified version of ADF test that is augmented by two endogenous breaks:

$$\Delta Y_t = \alpha_0 + \alpha_1 * DU1_t + \alpha_2 * DT1_t + \alpha_3 * DU2_t + \alpha_4 * DT2_t + \beta * t + \qquad \text{(A4.4)}$$
$$+ \rho * Y_{t-1} + \sum_{i=1}^{p} \phi_i * \Delta Y_{t-1} + e_t$$

where DU1 and DT1 correspond to DU_t and DT_t in Equation (A4.3) respectively. DU2 and DT2 represent the corresponding elements for the second structural break with Q4 2008 set as a break period. Break period for DU1 and DT1 is Q1 2007. The following table summarizes the results of the ADF test for unit root in UNEMP in levels, the PP test for unit root under the assumption of single breaks in both Q1 2007 and Q4 2008, and the LP test for multiple breaks in the two periods. The original estimations and test critical values are presented in Tables A4.7 through A4.10.

Table A4. 6: Tests of unit root in UNEMP

		t-statistics of UNEMP(-1)
ADF, levels		-2.411
Critical values:		
	1% level	-4.310
	5% level	-3.574
	10% level	-3.222
Single break in Q1 2007		12.224
Single break in Q4 2008		11.170
Multiple breaks in Q1 and Q4 2008		-3.357

Based on the results of the tests that assume a single break in UNEMP, one should not reject the null of unit root in UNEMP. This finding implies that the rate of unemployment is not a mean-reverting process, i.e. there is no natural rate of unemployment in the case of BH. In other words, it seems that economic shocks have permanent effects on unemployment rates, which is in line with Blanchard and Summers (1987) and Cheng et al. (2011) who argue that the movement of unemployment has a characteristics of hysteresis.

On the other hand, the LP test suggests that one should reject the null once both structural breaks are accounted for. This finding may suggest two things: that the official rate of unemployment may be exaggerated (Section 4.3); and that UNEMP may be exogenously determined. The suspicion of an unrealistically high level of the official rate of unemployment stems from the difference in measurement with respect to the International Labour Organization (ILO) methodology and suspected significant level of unregistered employment (unregistered self-employment or employment in grey economy). The annual BH labour force survey, conducted in accordance with the ILO methodology, is an annual publication and it covers very limited number of periods. However, it does suggest that the rate of unemployment some 15 percentage points below the official rate published monthly is more realistic. Having in mind that this gap between the two measures of unemployment is rather constant, it is likely that it is a consequence of demographic change over the past decades (frictional unemployment), or, more specifically, the levels of voluntarily unemployment (a significant fraction of the rural population, especially female).

The official registered monthly unemployment rate in the case of BH encompasses all mature adults that are not registered as employed at the national bureaus for unemployed persons. According to the existing laws, in order to get an access to, at least, basic medical healthcare, all mature adults that are not working should be registered at the national bureaus for unemployed persons, or provide the letters of enrolment to educational institutions (if they are not working students) and armed forces (both until the age of 28). That is why the official unemployment figures are so high. By using the surveyed level of unemployment in line with the ILO methodology, the level of registered unemployment is adjusted for those not actively seeking for employment, part-time or self-employed as of 2007, which resulted in a decline in the rate of unemployment.

A strong, non-linear trend in UNEMP in the periods after 2008 is a consequence of asymmetries in the adjustment process. Empirical research such as Arestis et al. (2002) or Ghosh and Dutt (2008) suggest that macroeconomic series tend to change dramatically following a significant shock, but that mean reversion occurs gradually over much longer period of time. Given that the macroeconomic shock occurred towards the end of the sample, and that the LP test suggests the rejection of the null of unit root in UNEMP once both structural breaks are accounted for, it will be assumed in this research that UNEMP is a mean-reverting process. This may not be true if the sample is extended to the periods pass 2010. Gozgor (2013) argues the validity of the hysteresis hypothesis, i.e. unemployment persistence, in the case of ten Central and Eastern European countries.

Table A4. 7: Test for unit root in UNEMP, single break in Q1 2008

Dependent Variable: UNEMP				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	7.825	2.893	2.705	0.012
DU1	-0.969	0.316	-3.062	0.005
D(TB1)	0.387	0.297	1.302	0.205
TIME	0.037	0.018	2.072	0.049
UNEMP(-1)	0.816	0.067	12.224	0.000
D(UNEMP(-1))	0.286	0.154	1.855	0.076
R-squared	0.900	Mean dependent var		42.956
Adjusted R-squared	0.879	S.D. dependent var		1.205
S.E. of regression	0.420	Akaike info criterion		1.278
Sum squared resid	4.226	Schwarz criterion		1.558
Log likelihood	-13.170	Hannan-Quinn criter.		1.368
F-statistic	43.021	Durbin-Watson stat		2.203
Prob(F-statistic)	0.000			

Table A4. 8: Test for unit root in UNEMP, single break in Q4 2008

Dependent Variable: UNEMP				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.180	3.832	0.047	0.963
DU2	1.386	0.557	2.490	0.021
D(TB2)	0.243	0.326	0.743	0.465
DT2	-0.017	0.073	-0.240	0.812
TIME	-0.058	0.019	-3.020	0.006
UNEMP(-1)	1.011	0.091	11.170	0.000
D(UNEMP(-1))	-0.078	0.238	-0.326	0.747
R-squared	0.902	Mean dependent var		42.956
Adjusted R-squared	0.877	S.D. dependent var		1.205
S.E. of regression	0.423	Akaike info criterion		1.319
Sum squared resid	4.119	Schwarz criterion		1.646
Log likelihood	-12.785	Hannan-Quinn criter.		1.424
F-statistic	35.351	Durbin-Watson stat		1.957
Prob(F-statistic)	0.000			

Table A4. 9: Test for unit root in UNEMP, multiple breaks in Q1 2007 and Q4 2008

Dependent Variable: D(UNEMP)				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	27.467	8.079	3.400	0.003
TIME	0.128	0.047	2.746	0.012
DU1	0.278	0.393	0.707	0.487
DT1	-0.576	0.167	-3.445	0.002
DU2	1.030	0.420	2.453	0.023
DT2	0.614	0.202	3.041	0.006
UNEMP(-1)	-0.655	0.195	-3.357	0.003
D(UNEMP(-1))	0.000	0.170	0.001	0.999
R-squared	0.720	Mean dependent var		0.052
Adjusted R-squared	0.631	S.D. dependent var		0.527
S.E. of regression	0.320	Akaike info criterion		0.782
Sum squared resid	2.253	Schwarz criterion		1.156
Log likelihood	-3.734	Hannan-Quinn criter.		0.902
F-statistic	8.072	Durbin-Watson stat		1.923
Prob(F-statistic)	0.000			

Table A4. 10: Test critical values

Null Hypothesis: UNEMP has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 2 (Automatic - based on SIC, maxlag=7)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.411	0.366
Test critical values:	1% level	-4.310	
	5% level	-3.574	
	10% level	-3.222	
*MacKinnon (1996) one-sided p-values.			

The LP test for unit root under the assumption of multiple structural breaks was carried out in the case of USDEUR as well. The break periods are set to Q4 2008 and Q2 2010. The first period corresponds to the Euro zone banking crisis, while the latter to the Euro zone sovereign debt crisis, both threatening the common currency. Consequently, EUR suffered significant losses in nominal value against the USD. Table A4.11 below suggests the rejection of the null of unit root in USDEUR once both structural breaks are accounted for. Table A4.12 below provides test critical values.

Table A4. 11: Test for unit root in USDEUR, multiple breaks in Q4 2008 and Q2 2010

Dependent Variable: D(USDEUR)				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.698	0.169	4.136	0.000
TIME	0.008	0.003	3.083	0.005
DU_EUSHOCK1	0.090	0.063	1.413	0.172
DT_EUSHOCK1	-0.018	0.008	-2.285	0.032
DU_EUSHOCK2	0.068	0.059	1.155	0.261
DT_EUSHOCK2	0.025	0.032	0.795	0.435
USDEUR(-1)	-0.626	0.153	-4.101	0.001
D(USDEUR(-1))	0.849	0.209	4.064	0.001
R-squared	0.581	Mean dependent var		0.008
Adjusted R-squared	0.447	S.D. dependent var		0.062
S.E. of regression	0.046	Akaike info criterion		-3.090
Sum squared resid	0.047	Schwarz criterion		-2.716
Log likelihood	54.344	Hannan-Quinn criter.		-2.970
F-statistic	4.351	Durbin-Watson stat		1.822
Prob(F-statistic)	0.004			

Table A4. 12: Test critical values

Null Hypothesis: USDEUR has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 1 (Automatic based on SIC, MAXLAG=7)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.642	0.043
Test critical values:	1% level	-4.297	
	5% level	-3.568	
	10% level	-3.218	
*MacKinnon (1996) one-sided p-values.			

Appendix 4.6: Testing for multicolinearity and potential endogeneity in variables

The absence of multicolinearity between the variables implies that the covariance between the variables is zero. Although it is quite rare to have two variables with virtually no correlation between them, it is rather common to find the variables strongly (but not exactly) related. Detecting severe multicolinearity, which would result in an underestimation of the t-statistics next to the model parameters, between more than two variables would make the rule of thumb based on sample correlation inappropriate. For that reason, the variance inflation factor (VIF) is used.

The process is the following.

1. Regressing each independent variable on all the other independent variables;

2. Collecting the R-squared for each of these auxiliary regressions;

3. And computing the VIF in the following fashion:

$$VIF(X_j) = 1/(1 - Rsqrd_j)$$

Based on the rule of thumb, the VIF>5 is a sign of severe multicolinearity.

The following Table A4.13 summarizes the R-squared and the VIFs of all 6 explanatory variables. The simple static model specification is used. Clearly, none of the VIFs indicate the presence of severe multicolinearity between the variables.

Table A4. 13: The VIF of the explanatory variables

Variable	R-sqrd	VIF
USDEUR	0.629	2.695
IRDIF	0.582	2.394
LTDOMFUND	0.224	1.288
UNEMP	0.295	1.419
IIP	0.107	1.119
HHI	0.083	1.090

Note, however, that the two variables with the highest VIFs might be correlated based on the economic theory.

As for the endogeneity issue, the absence of it implies that there is no significant covariance between the explanatory variables and the error term. Variables in a regression can be endogenous for several reasons, including measurement error, simultaneity/ reverse causation and omitted variable bias. Any significant measurement error would be detected on the plot of the variable. Based on the results of the pairwise Granger (1969) causality tests (4 lags included) represented in Table A4.14 below, one should not reject the possibility of reverse causation in the case of IRDIF. As the causality test indicates, the past values of LI contain certain information that may explain the current value of IRDIF. Also note that reverse causation is not detected. The signs of endogeneity of IRDIF and its possible high correlation with USDEUR (Table A4.13) could be a consequence of a different nature of IRDIF in the periods before and after a macroeconomic shock as suggested in Section 4.3. As suggested, while the difference between domestic and foreign lending rates may cause changes in foreign liabilities in the pre-shock periods, thus affecting LI, once the crisis materialises, the difference between the interest rates could be a consequence of adjustments in business policies of banks. For all these reasons, IRDIF may have to be omitted from the list of explanatory variables.

Table A4. 14: Pairwise Granger causality tests

Pairwise Granger Causality Tests, 4 lags			
Null Hypothesis:	Obs	F-Statistic	Prob.
IIP does not Granger Cause LI	28	2.902	0.050
LI does not Granger Cause IIP		4.896	0.007
LTDOMFUND does not Granger Cause LI	28	0.878	0.496
LI does not Granger Cause LTDOMFUND		0.747	0.572
IRDIF does not Granger Cause LI	28	0.992	0.436
LI does not Granger Cause IRDIF		4.009	0.016
UNEMP does not Granger Cause LI	28	1.950	0.143
LI does not Granger Cause UNEMP		0.461	0.763
USDEUR does not Granger Cause LI	28	0.799	0.540
LI does not Granger Cause USDEUR		0.720	0.589
HHI does not Granger Cause LI	28	0.798	0.541
LI does not Granger Cause HHI		1.197	0.345

Two-way causality is detected in the case of IIP. The economic theory suggests that there is causation between economic activity, in this research represented by IIP, and the risk of currency crisis in open economies that rely on foreign sources of funding (Section 4.3). As the economic activity increases, demand for loans also raises. In the cases where banks rely of foreign sources of funding, this increased demand for loans will result in banking-sector related inflows of foreign investment thus affecting the risk of currency crisis. This finding, conditional of the existence of cointegration between LI and IIP, suggests that these two variables should be allowed to influence each other in the chosen model. However, one must be certain that the potential endogeneity of IIP is not a consequence of omitted variable. In order to test for this, the Hausman test for endogeneity is used (Kennedy, 1998 and Wooldridge, 2003).

The following linear regression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \tag{A4.5}$$

where X_1 is potentially endogenous, can be rewritten as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \gamma \hat{X}_1 + \varepsilon \tag{A4.6}$$

Where $\hat{X}_1$ is the predicted value of X_1 from a regression of X_1 on the instrumental variable Z.

The Hausman test for endogeneity tests whether $\gamma = 0$ (if X_1 is endogenous, then $\gamma \neq 0$).

Based on the statistical data, IIP in BH is significantly determined by the volume of electricity production. Electricity is also one of the BH major export products with annual shares in total exports in the period 2003 through 2010 ranging from 8% in 2007 to 15.6% in 2010. The majority of electricity is exported to our neighbouring countries, primarily Croatia. In order to test whether IIP is significantly determined by the level of world energy prices, the harmonized index of consumer prices (HICP), the subcategory electricity, for Croatia will be used as the instrumental variable[80].

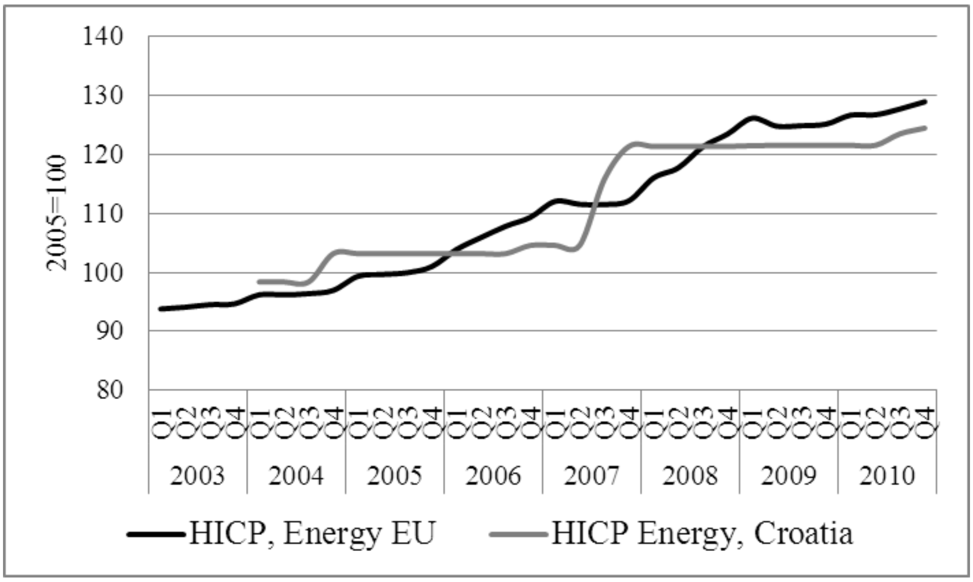
The historical values of world energy prices are not widely available. Therefore, it was assumed that the HICP sub-category Energy changes with changes in electricity prices in international markets. In order to be certain that consumer prices in Croatia follow

[80] Source: Harmonized Index of Consumer Prices: Electricity for Croatia. Not Seasonally Adjusted. Monthly.Index 2005=100.

Quarterly values are obtained as arithmetic averages of the values reported for the months constituting the quarter in question.

the same pattern as the same category in the rest of our main trading partners, the two series were plotted in Figure A4.4 below.

Figure A4. 4: The HICP sub-category Energy in Croatia and the EU



The general trend in energy prices in Croatia is similar to that in the EU, but one notices a couple of specifics. Every time there is an increase in energy prices, it occurs sooner in Croatia and it is less gradual increase when compared to the EU suggesting that prices of energy in Croatia are more responsive to shocks in international markets. However, prices of energy in Croatia tend to hover longer at a certain level indicating that contracted prices may play a significant role. This is especially the case between BH and Croatia since the contracts are made for the period of several years and the contracted prices are not subject to frequent reviews. For that reason, the energy prices in Croatia were used as the instrumental variable in the endogeneity test. The following tables report the outputs of the auxiliary regression of energy prices in Croatia on IIP (Table A4.15), used to construct the fitted values of IIP that will be used to estimate Equation (A4.6). Table A4.16 provides the estimation output for Equation (A4.6). Note that due to limitations in the length of the series of energy prices in Croatia the sample is reduced to period 2004 Q1 through 2010 Q4.

Table A4. 15: The auxiliary regression

Dependent Variable: LOG(IIP)				
Sample (adjusted): 2004Q1 2010Q4				
Included observations: 28 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.063	0.695	-4.409	0.000
LOG(ENERGY_CRO)	1.654	0.147	11.238	0.000
R-squared	0.829	Mean dependent var		4.742
Adjusted R-squared	0.823	S.D. dependent var		0.158
S.E. of regression	0.066	Akaike info criterion		-2.518
Sum squared resid	0.115	Schwarz criterion		-2.423
Log likelihood	37.255	Hannan-Quinn criter.		-2.489
F-statistic	126.287	Durbin-Watson stat		0.971
Prob(F-statistic)	0.000			

Table A4. 16: The Hausman endogeneity test

Dependent Variable: LOG(LI)				
Sample (adjusted): 2004Q1 2010Q4				
Included observations: 28 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-23.854	12.049	-1.980	0.062
LOG(USDEUR)	-1.042	2.563	-0.406	0.689
IRDIF	0.618	0.287	2.153	0.044
LTDOMFUND	0.002	0.075	0.027	0.979
UNEMP	-0.157	0.103	-1.534	0.141
LOG(IIP)	-4.147	1.947	-2.130	0.046
IIP_IV1_FITTED	5.650	3.153	1.792	0.088
LOG(HHI)	3.005	1.591	1.889	0.074
R-squared	0.701	Mean dependent var		-0.930
Adjusted R-squared	0.596	S.D. dependent var		0.598
S.E. of regression	0.380	Akaike info criterion		1.139
Sum squared resid	2.891	Schwarz criterion		1.519
Log likelihood	-7.942	Hannan-Quinn criter.		1.255
F-statistic	6.696	Durbin-Watson stat		1.368
Prob(F-statistic)	0.000			

The results reported in the above tables suggest that although there is a significant relationship between the volume of industrial production in BH and electricity prices in international markets (as represented by a very high t-statistics in Table A4.15), omitting electricity prices from the model should not cause significant endogeneity of IIP. Given these findings, one should assume that endogeneity of IIP is a result of reverse causation between LI and IIP.

Appendix 4.7: The unrestricted VECM (1.0)

Set of Tables A4. 17: The estimation output for the unrestricted VECM

VEC REPRESENTATION	
endogenous variables:	LI_log, IIP_log, LTDOMFUND
exogenous variables:	USDEUR_log, HHI_log, IRDIF, UNEMP
deterministic variables:	inflow2006, privatization, inflow2008, bankrun, shocklevel, shocktrend, CONST, S1, S2, S3, TREND
endogenous lags (diffs):	1
exogenous lags:	0

sample range: [2003 Q4, 2010 Q4], T = 29
estimation procedure: Two stage. 1st=Johansen approach, 2nd=OLS
[t statistics]

Table A4. 17a: Loading coefficients

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
ec1(t-1)	0.154 [2.194]	-0.059 [-9.320]	-0.843 [-2.972]

Table A4. 17b: Estimated cointegration relation(s)

	ec1(t-1)
LI_log (t-1)	1.000 [0.000]
IIP_log (t-1)	18.076 [4.999]
LTDOMFUND (t-1)	0.066 [1.850]
inflow2006 (t-1)	0.245 [0.361]
inflow2008 (t-1)	2.09 [2.375]
shocklevel (t-1)	-10.655 [-4.558]
shocktrend (t-1)	0.456 [4.812]

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CONST	-79.996 [-5.055]
S1 (t-1)	-1.023 [-3.979]
S2 (t-1)	-1.073 [-3.612]
S3 (t-1)	-1.773 [-5.390]
TREND (t-1)	-0.523 [-5.478]

Table A4. 17c: Lagged endogenous term

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
d(LI_log) (t-1)	-0.114 [-0.533]	0.068 [3.539]	1.644 [1.893]
d(IIP_log) (t-1)	-3.347 [-2.567]	0.261 [2.221]	14.350 [2.722]
d(LTDOMFUND) (t-1)	0.006 [0.146]	0.004 [0.981]	0.215 [1.239]

Table A4. 17d: Current exogenous term

	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
USDEUR_log(t)	1.033 [0.593]	0.063 [0.404]	2.688 [0.382]
HHI_log (t)	0.027 [0.055]	0.070 [1.566]	-3.754 [-1.862]
IRDIF (t)	-0.090 [-0.703]	0.010 [0.876]	-0.321 [-0.620]
UNEMP (t)	0.000 [0.002]	-0.012 [-1.806]	0.594 [1.988]

Table A4. 17e: Deterministic term

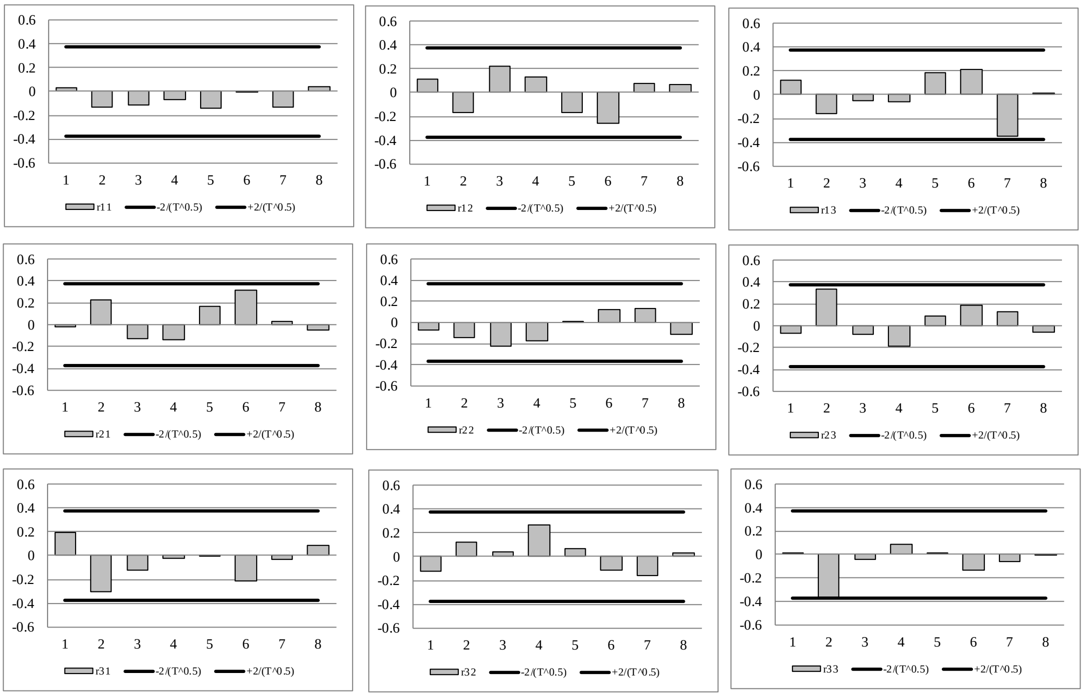
	d(LI_log)	d(IIP_log)	d(LTDOMFUND)
privatization (t)	0.007 [0.031]	-0.090 [-4.502]	-0.149 [-0.166]
bankrun (t)	0.254 [0.948]	0.078 [3.216]	-1.846 [-1.701]

Table A4. 18: The diagnostics of the unrestricted VECM

Note:
For Doornik (1996) p-value of LM statistics is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value of Chi^2 is reported.
For Multivariate ARCH-LM test p-value of Chi^2 is reported.
For ARCH-LM test p-value of F statistic is reported.
"-" Insufficient data for test.

	1 lag	2 lags	3 lags	4 lags
Doornik (1996), LM test for autocorrelation	0.061	0.036	0.045	0.049
Doornik & Hansen (1994), joint test for non-normality	0.731	0.731	0.731	0.731
Lütkepohl (1993), joint test for non-normaility	0.973	0.973	0.973	0.973
Jarque-Bera test, u1	0.719	0.719	0.719	0.719
Jarque-Bera test, u2	0.768	0.768	0.768	0.768
Jarque-Bera test, u3	0.392	0.392	0.392	0.392
Multivariate ARCH-LM test	0.897	0.137	0.195	0.349
ARCH-LM test, u1	0.773	0.864	0.904	0.906
ARCH-LM test, u2	0.857	0.018	0.041	0.078
ARCH-LM test, u3	0.630	0.436	0.592	0.652

Figure A4. 5: Serial correlation between the residuals from individual equations of the unrestricted VECM



The upper and lower bounds in Figure A4.5 were set to $\pm 2/\sqrt{T}$, where T is total number of periods in the sample. These bounds, according to Lütkepohl and Krätzig (2004), approximate 95% confidence bounds. In none of the cross-correlograms does the correlation between the two sets of residuals from individual VECM equation cross the 95% confidence bounds.

Figure A4. 6a: Autocorrelation and partial autocorrelation functions of the residuals from the unrestricted VECM (dependant variable d(LI_log))

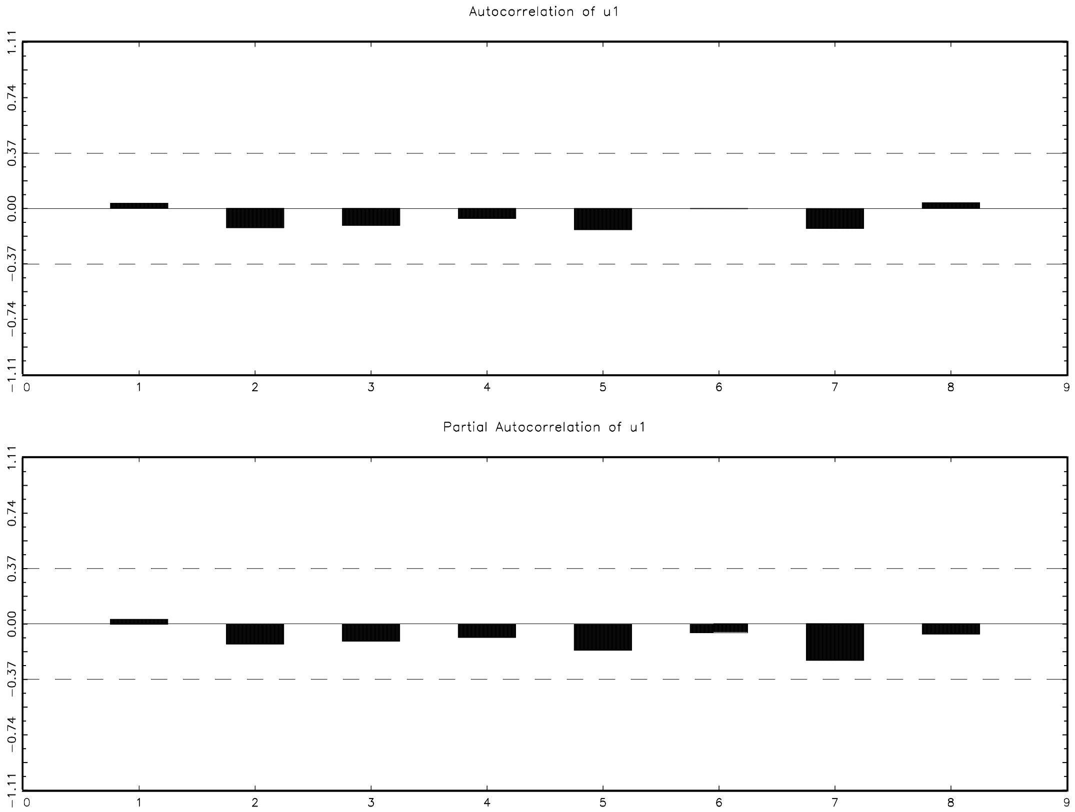


Figure A4. 6b: Autocorrelation and partial autocorrelation functions of the residuals from the unrestricted VECM (dependant variable d(IIP_log)

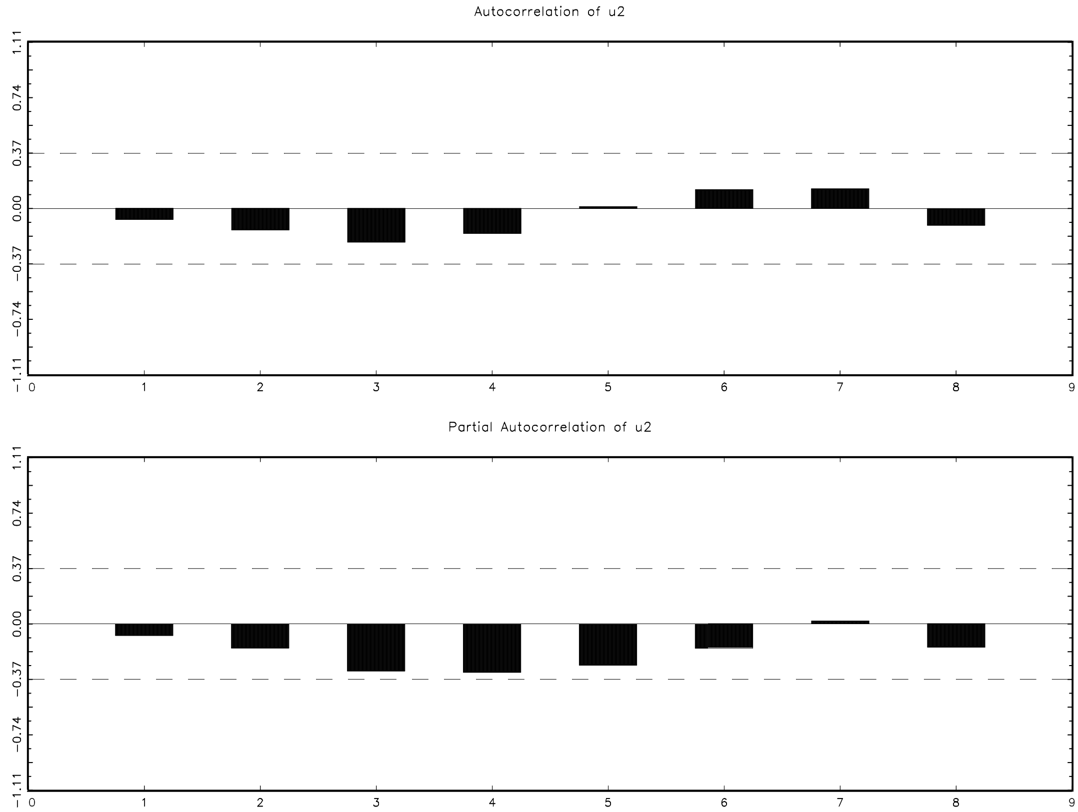
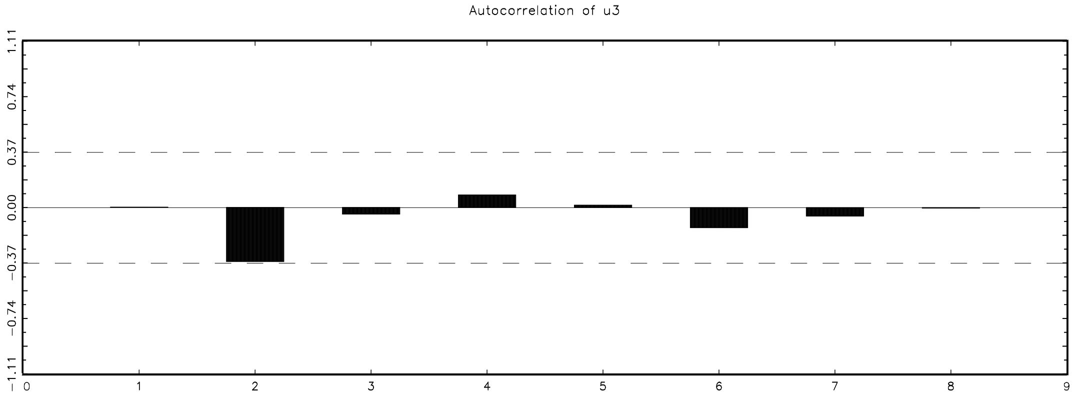
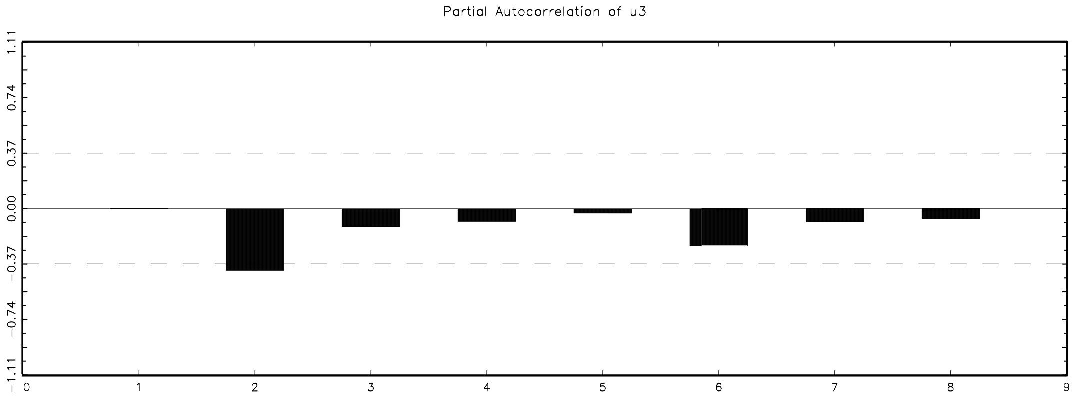


Figure A4. 6c: Autocorrelation and partial autocorrelation functions of the residuals from the unrestricted VECM (dependant variable d(LTDOMFUND))





Appendix 4.8: The ARDL Bounds Testing methodology for the liquidity index

Given the shortness of our sample, as the consistency and robustness checks of the estimates of the VECM normalized on LI, the ARDL Bounds Testing methodology of Pesaran and Shin (1999) and Pesaran et al. (2001) will be utilised as it: can be used with a mixture of I(0) and I(1) data: is simple to implement and interpret; is suitable for small and finite sample size; and allows for different lag-lengths in the model.

Any VECM can be re-written such that it takes the unrestricted VAR form (Campbell and Schiller, 1987 and Gaglianone and Issler, 2008). One of the equations from the VECM normalized on LI (set of Tables 4.9) has ΔLI_t as the dependant variable. This equation, rewritten in its VAR form is of the following format:

$$\begin{aligned} \mathrm{logLI} = {} & \mathrm{C} + \mathrm{logLI}(-1) + \log \mathrm{LI}(-2) + \mathrm{logIIP}(-1) + \mathrm{logIIP}(-2) + \\ & + \mathrm{LTDOMFUND}(-1) + \mathrm{logUSDEUR} + \mathrm{INFLOW2006}(-1) + \\ & + \mathrm{INFLOW2008}(-1) + \mathrm{SHOCKLEVEL}(-1) + \mathrm{SHOCKTREND}(-1) + \\ & + \mathrm{S1}(-1) + \mathrm{S2}(-1) + \mathrm{S3}(-1) + \mathrm{TREND}(-1) \end{aligned} \tag{A4.7}$$

In its basic form, an ARDL regression model is of the following form:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \cdots + \beta_k Y_{t-p} + \alpha_0 X_t + \alpha_1 X_{t-1} + \cdots + \alpha_q X_{t-q} + \varepsilon_t \tag{A4.8}$$

where ε_t is a random error term.

Note that equation (A4.7) above is a form of equation (A4.8). The model is "autoregressive" in the sense that logLI_t is partially explained by lagged values of itself. It also has a "distributed lag" component in the form of successive lags of the explanatory variables. The only variable that has its current value included in the distributed lag part of the model is USDEUR (the exogenous variable in the VECM) which is not uncommon as the current levels of the explanatory variables may be omitted from the ARDL. This characteristic of the equation (A4.7) will be utilised to conduct both the appropriateness of the relationships established by the VECM normalized on LI (set of Tables 4.9) bearing in mind the small sample size, and to a lesser extent the potential robustness of the VECM results. In the case of the latter, one should pay attention only on the sign of the coefficients as the VECM is constituted by a system of equations in which each endogenous variable is both explained by all the others while simultaneously affecting them, while the ARDL-ECM approach assumes a single equation, i.e. the relationship between the variables is one way.

There are several steps to implement it.

Step 1: Ensuring that none of the variables are I(2)

The unit root tests were conducted in Section 4.4 and it was demonstrated that none of the variables is I(2) as that would invalidate the methodology.

Step 2: Formulating the "unrestricted" ECM

In this step one needs to formulate the following model:

$$\Delta Y_t = \beta_0 + \sum \beta_i \Delta Y_{t-i} + \sum \gamma_j \Delta X_{1t-j} + \sum \delta_k \Delta X_{2t-k} + \theta_1 Y_{t-1} + \theta_2 X_{1t-1} + \\ + \theta_3 X_{2t-1} + \varepsilon_t \tag{A4.9}$$

Note that this is almost like a traditional ECM

$$\Delta Y_t = \beta_0 + \sum \beta_i \Delta Y_{t-i} + \sum \gamma_j \Delta X_{1t-j} + \sum \delta_k \Delta X_{2t-k} + \varphi z_{t-1} + \varepsilon_t \tag{A4.10}$$

with z, the "error correction term", defined as the OLS residuals series from the long-run "cointegrating regression" of the form:

$$Y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + v_t \tag{A4.11}$$

The main difference between (A4.9) and (A4.10) is that the former does not restrict the coefficients on the lagged levels also present in the error-correction term z.

The following table represents the estimation output for the unrestricted ECM outlined in Step 2 based on the relationship reported in the set of equations 4.9. Note that the cointegrating relationship reported in Table 4.9b is represented by the variables next to θ coefficients in equation (A4.9).

Table A4. 19: The estimation output for the unrestricted ECM

Dependent Variable: D(LOG(LI))				
Method: Least Squares				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.483	11.862	-1.137	0.272
D(LOG(LI(-1)))	-0.035	0.295	-0.120	0.906
D(LOG(IIP(-1)))	-0.902	1.982	-0.455	0.655
LOG(LI(-1))	0.605	0.241	2.512	0.023
LOG(IIP(-1))	2.998	2.712	1.106	0.285
USDEUR	-0.078	0.913	-0.086	0.933
INFLOW2006(-1)	-1.001	0.541	-1.849	0.083
INFLOW2008(-1)	0.570	0.295	1.934	0.071
S1(-1)	-0.016	0.217	-0.075	0.941
S2(-1)	-0.436	0.221	-1.972	0.066
S3(-1)	-0.157	0.222	-0.708	0.489
TREND(-1)	-0.083	0.071	-1.172	0.258
SHOCKLEVEL(-1)	1.091	1.895	0.576	0.573
SHOCKTREND(-1)	-0.008	0.078	-0.097	0.924
R-squared	0.649	Mean dependent var		-0.010
Adjusted R-squared	0.363	S.D. dependent var		0.381
S.E. of regression	0.304	Akaike info criterion		0.759
Sum squared resid	1.475	Schwarz criterion		1.413
Log likelihood	2.615	Hannan-Quinn criter.		0.968
F-statistic	2.272	Durbin-Watson stat		2.077
Prob(F-statistic)	0.061			

Step 3: Determining the appropriate lag structure for the model in Step 2

In principle, one should test for the appropriate lag structure when building a model. However, as argued in Section 4.4, the sample size was the limiting factor in testing for the appropriateness of including the AR component higher than one. The first lag was used under the assumption that an inappropriate lag length would be detected by the tests for serial correlation. The VECM diagnostics were satisfactory.

Step 4: Ensuring that the errors of this model are serially independent

The results of the tests for serial correlation up to four lags are reported in the table below. There is no indication of a violation of the assumption of the serial independence of the residuals.

Table A4. 20: The Breusch-Godfrey Serial Correlation LM Test

	F-statistic		Probability
1 lag	0.401	F(1,15)	0.536
2 lags	2.213	F(2,14)	0.146
3 lags	1.376	F(3,13)	0.294
4 lags	1.464	F(4,12)	0.274

Step 5: Ensuring that the model is "dynamically stable"

With a coefficient on the lagged dependant variable of -0.035 (Table A4.19), the model can be considered as dynamically stable as the stationarity condition, $|-0.035| < 1$, holds.

Step 6: Performing a "Bounds Test"

In this step one needs to obtain the F-statistic associated with the Wald test for the joint significance of the coefficients next to LOG(LI(-1)) and LOG(IIP(-1)) in Table A4.19 and interpret it in the context of the Bounds Test tables of critical values reported in Pesaran et al. (2001). The value of our F-statistic is 7.19 (Table A4.21 below).

Table A4. 21: The Wald Test for restrictions in coefficients

Test Statistic	Value	df	Probability
F-statistic	7.190	(2, 16)	0.005
Chi-square	14.381	2	0.001
Null Hypothesis: C(4)=C(5)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		-0.629	0.230
C(5)		4.882	2.134
Restrictions are linear in coefficients.			

With k=1 (there are k+1 = 2 potentially cointegrating variables in our model), the relevant Bounds Test table of critical values is Table CI (v) on p.301 of Pesaran et al. (2001) as both the intercept and linear trend are included in the model. The lower and upper bounds for the F-test statistic at the 10%, 5%, and 1% significance levels are $[5.59, 6.26]$, $[6.56, 7.30]$ and $[8.74, 9.63]$ respectively. Given the size of our sample, as the value of our F-statistic exceeds the upper bound at the 10% significance level we assume a long-run relationship between LI and IIP. Ideally, one would wish to reject H_0 at 5% or less. In this specific test if the computed F-statistic falls below the lower bound one should conclude that the variables are I(0), so no cointegration is possible, by definition. If the F-statistic exceeds the upper bound, one concludes that there is cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive; i.e. unit root tests of the variables need to be constructed before proceeding with the ARDL technique. In our case, the test is inconclusive at 5% level. As the Bounds Test table of critical values of Pesaran et al. (2001) are generated for sample sizes of 500 and 1,000 observations and 20,000 and 40,000 replications respectively, Narayan (2005) approximated critical values of the bounds F-test for relatively small sample sizes which are different from critical values when there are many observations. The lower and upper bounds for the F-test statistic at the 10%, 5%, and 1% significance levels for 30 observations and k=1 are $[6.01, 6.78]$, $[7.16, 8.27]$ and $[10.61, 11.65]$ respectively. Again, the test is inconclusive at 5%.

The small sample used in this research and the known property of standard unit root tests to be biased towards the acceptance of the null hypothesis of unit root (Maddala, 1992) were the main arguments in favour of employing the ARDL-ECM methodology in order to verify the findings of the VECM normalized on LI. If a series is integrated, i.e. difference stationary, then the effect of any shock is permanent. If, however, a series is trend stationary, i.e. mean reverting as the shocks would fade away over time, its differencing (required in cointegration analysis) would result in spurious autocorrelation (Nelson and Kang, 1981). As the Bounds Test did not provide sufficient information on whether LI and IIP are stationary or integrated, the choice had to be made based on the standard unit root tests (Section 4.4), provided that they were not contradicted by other tests, such as Kwiatkowski, Phillips, Schmidt and Shin (KPSS) that test for unit roots with the null hypothesis of stationary series. The KPSS tests results reported in Tables A4.22 and A4.23 below for LI and IIP respectively indicate that these series appear to have unit roots. The reported tests were done for lag length = 0 as these have the correct test size even for the sample size of 30 (Kwiatkowski et al., 1992), indicating that the asymptotic validity of the tests hold even for fairly small samples. Tests with lag length selected in Eviews automatically did not change the conclusions regarding the presence of unit root process in either LI or IIP.

Table A4. 22: Unit root test for LI with the null of stationarity

Null Hypothesis: LI is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 0 (Used-specified) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.269
Asymptotic critical valu	1% level	0.216
	5% level	0.146
	10% level	0.119
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)		
Residual variance (no correction)		0.033
HAC corrected variance (Bartlett kernel)		0.033

Table A4. 23: Unit root test for IIP with the null of stationarity

Null Hypothesis: IIP is stationary		
Exogenous: Constant, Linear Trend		
Bandwidth: 0 (Used-specified) using Bartlett kernel		
		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.296
Asymptotic critical valu	1% level	0.216
	5% level	0.146
	10% level	0.119
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)		
Residual variance (no correction)		38.641
HAC corrected variance (Bartlett kernel)		38.641

Being fully aware of the questionable reliability of unit root tests in small samples that are, in addition, characterized by transitional growth dynamics (Section 4.4), after inspecting the series, a set of conventional unit root tests, such as ADF and PP and Perron's (1989) test for unit root under the assumption of structural break in the case of IIP (Appendix 4.5) were performed. It was concluded that the hypothesis of unit root should not be rejected. Additionally, the KPSS test suggested that one should reject the hypothesis of stationarity. Together these results strongly indicate that both LI and IIP are I(1).

Step 7: Estimating the long-run relationships

From the unrestricted ECM (Table A4.19), the long-run multiplier between LI and IIP is$-\left(\frac{2.998}{0.605}\right) = -4.96$. In the long run, a percentage point increase in the index of industrial production leads to 4.96 percentage points decrease in the level of the systemic risk of currency crisis. In other words, the level of systemic risk in the long run tends to diminish with an increase in real economic activity. In terms of the sign, the estimated long-run multiplier is consistent with the coefficient next to IIP reported in Table 4.9b. The size of the coefficient is smaller, but, as already emphasized, these two estimates of the long-run relationship were not expected to be similar in size.

Step 8: Estimating a long-run "levels model" and measuring short-run dynamic effects

By estimating the levels model by OLS and constructing the residuals series, one can fit a restricted ECM (Table A4.22).

Table A4. 24: The restricted ECM estimation output

Dependent Variable: D(LOG(LI)) Sample (adjusted): 2003Q3 2010Q4 Included observations: 30 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.334	0.850	-0.393	0.698
D(LOG(LI(-1)))	-0.035	0.170	-0.208	0.837
D(LOG(IIP(-1)))	-1.863	1.052	-1.771	0.089
USDEUR	0.293	0.641	0.458	0.651
RES_LI(-1)	-0.586	0.258	-2.270	0.032
R-squared	0.262	Mean dependent var	-0.010	
Adjusted R-squared	0.143	S.D. dependent var	0.381	
S.E. of regression	0.352	Akaike info criterion	0.902	
Sum squared resid	3.101	Schwarz criterion	1.135	
Log likelihood	-8.524	Hannan-Quinn criter.	0.976	
F-statistic	2.214	Durbin-Watson stat	1.844	
Prob(F-statistic)	0.096			

Given the established cointegrating relationship between LI and IIP, one would expect both negative and statistically significant coefficient. The sign of the coefficient next to the error-correction term indicates that there is an adjustment mechanism towards the equilibrating values LI and IIP, as the Granger Representation Theorem suggests there should be. The magnitude of RES_LI(-1) implies that 58.6% of any disequilibrium between IIP and LI is corrected within a single quarter via changes in LI alone. The speed of adjustment towards the long-run equilibrium is much faster when compared to the loading coefficient of 0.141 reported in Table 4.9a, but, again, the two numbers cannot be directly comparable as the latter is related to the system of equations that allows for the interaction between the variables. Note that the ARDL-ECM, being implemented by an OLS estimation, will provide biased and inconsistent estimates in Table A4.19 if an omitted variable is correlated with IIP, which is suspected (Section 4.4). Given all, the ARDL-ECM only supports the VECM results in a sense that potentially disequilibrating relationship between LI and IIP in the VECM (Table 4.10) indeed does not imply that there is no cointegration between the variables. The great variation in the speed of the short-run adjustment in LI between the models is an indicator of an omitted variable and there is no evidence that the ARDL-ECM estimates are more accurate.

The cointegrating vectors that arise from the models (ARDL-ECM or VECM) require normalization so that the adjustment and cointegrating vectors can be given plausible economic interpretations (Rossana, 2004). The choice of normalizing variable should produce long-run relationships consistent with economic theory. From that perspective, normalizing the VECM and ARDL-ECM on the measure of systemic risk, rather than the level of real economic activity seems plausible; the extrapolated expectations of the future increase in the underlying economic activity is generally seen as one of the causes of financial instability. Nevertheless, as one would expect a feedback effect from the level of systemic risk to the level of real economic activity, the ARDL Bounds Testing methodology was applied in the case when IIP is the variable on which the ARDL-ECM is normalized. In other words, it tests for the possibility that the ECM is normalized on a “wrong variable”. As the Bounds test (Table A4.26 below) based on the estimate of the ARDL normalized on IIP (Table A4.25 below) indicate, the null hypothesis of no cointegration is accepted (note that the lower and upper bounds are the same as related to Table A4.21). In other words, the VECM and ARDL-ECM should be normalized on LI as the IIP should be regarded as the forcing variable.

Table A4. 25: The estimation output for the unrestricted ECM; IIP normalizing variable

Dependent Variable: D(LOG(IIP))				
Method: Least Squares				
Sample (adjusted): 2003Q3 2010Q4				
Included observations: 30 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.095	1.453	2.818	0.012
D(LOG(IIP(-1)))	0.260	0.243	1.071	0.300
D(LOG(LI(-1)))	-0.010	0.036	-0.279	0.784
LOG(IIP(-1))	-0.968	0.332	-2.915	0.010
LOG(LI(-1))	0.003	0.030	0.101	0.921
USDEUR	0.122	0.112	1.091	0.291
INFLOW2006(-1)	0.034	0.066	0.512	0.616
INFLOW2008(-1)	-0.052	0.036	-1.435	0.171
S1(-1)	0.085	0.027	3.183	0.006
S2(-1)	0.066	0.027	2.456	0.026
S3(-1)	0.068	0.027	2.514	0.023
TREND(-1)	0.023	0.009	2.647	0.018
SHOCKLEVEL(-1)	0.277	0.232	1.192	0.251
SHOCKTREND(-1)	-0.015	0.010	-1.603	0.129
R-squared	0.790	Mean dependent var		0.019
Adjusted R-squared	0.620	S.D. dependent var		0.060
S.E. of regression	0.037	Akaike info criterion		-3.440
Sum squared resid	0.022	Schwarz criterion		-2.786
Log likelihood	65.602	Hannan-Quinn criter.		-3.231
F-statistic	4.640	Durbin-Watson stat		2.106
Prob(F-statistic)	0.002			

Table A4. 26: The Wald Test for restrictions in coefficients; IIP normalizing variable

Test Statistic	Value	df	Probability
F-statistic	4.257	(2, 16)	0.033
Chi-square	8.514	2	0.014
Null Hypothesis: C(4)=C(5)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		-0.968	0.332
C(5)		0.003	0.030
Restrictions are linear in coefficients.			

The VECM results (set of Tables 4.8) suggest that, in the long run, the availability of domestic sources of long-term funding has no effect on the level of the risk of a currency crisis. In other words, the banking sector related inflows of foreign funding (that significantly influence the level of LI) are weakly related to trends in long-term deposits of residents. If LTDOMFUND was wrongly omitted from the VECM (as a consequence of the small sample), that could be one of the reasons for failing to identify the error correction mechanism in the VECM. In order to test this hypothesis, the ARDL-ECM was estimated with all three initial endogenous variables included: LI, IIP and LTDOMFUND. As Bounds test (Table A4.28 below) based on the estimate of the ARDL normalized on LI (Table A4.27 below) indicate, the null hypothesis of no cointegration is accepted.

Table A4. 27: The estimation output for the unrestricted ECM with all three endogenous variables

Dependent Variable: D(LOG(LI))
Method: Least Squares
Sample (adjusted): 2003Q3 2010Q4
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-18.328	12.517	-1.464	0.165
D(LOG(LI(-1)))	-0.243	0.338	-0.718	0.484
D(LOG(IIP(-1)))	-1.533	2.072	-0.740	0.472
D(LTDOMFUND(-1))	0.026	0.050	0.528	0.606
LOG(LI(-1))	-0.755	0.269	-2.808	0.014
LOG(IIP(-1))	3.891	2.847	1.367	0.193
LTDOMFUND(-1)	0.040	0.041	0.985	0.342
USDEUR	-1.024	1.175	-0.872	0.398
INFLOW2006(-1)	-1.265	0.582	-2.176	0.047
INFLOW2008(-1)	0.643	0.415	1.548	0.144
S1(-1)	0.025	0.221	0.114	0.911
S2(-1)	-0.313	0.243	-1.290	0.218
S3(-1)	-0.207	0.227	-0.912	0.377
TREND(-1)	-0.124	0.078	-1.595	0.133
SHOCKLEVEL(-1)	1.709	1.980	0.863	0.403
SHOCKTREND(-1)	-0.015	0.079	-0.187	0.855

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R-squared	0.687	Mean dependent var	-0.010
Adjusted R-squared	0.352	S.D. dependent var	0.381
S.E. of regression	0.306	Akaike info criterion	0.775
Sum squared resid	1.313	Schwarz criterion	1.523
Log likelihood	4.368	Hannan-Quinn criter.	1.015
F-statistic	2.052	Durbin-Watson stat	2.014
Prob(F-statistic)	0.094		

Table A4. 28: The Wald Test for restrictions in coefficients; IIP normalizing variable

Test Statistic	Value	df	Probability
F-statistic	2.919	(3, 14)	0.071
Chi-square	8.758	3	0.033
Null Hypothesis: C(5)=C(6)=C(7)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(5)		-0.755	0.269
C(6)		3.891	2.847
C(7)		0.040	0.041
Restrictions are linear in coefficients.			

The test was repeated for normalization on IIP and LTDOMFUND, but no cointegration was detected. A possible explanation why removing a variable from the cointegrating vector (and the ARDL-ECM) resulted in detecting a cointegrating relationship (granted, without the error correction mechanism in the case of the VECM) is the effect of an inclusion of a variable that has no stable linear relationship with other variables (LTDOMFUND). As tests for cointegration search only for stable linear relationships among economic variables, a failure to find cointegration among the variables suggests that it is possible that the long-run relationship among them is not stable (Dickey et al., 1991). In other words, it is possible that the variables in question in the long run arbitrarily wander away from each other. However, unlike the case of stationary regressions, when an "irrelevant" variable is added to the cointegrating regression, its coefficient does not converge to zero and neither do other coefficients to the same limits as before, but all of them, generally, to some other element of the cointegrating space (Davidson, 1997). Therefore, it is possible that because of a non-linear relationship between the variables, one of them is regarded as "irrelevant" by the model (both the VECM and ARDL-ECM). For example, the growth of domestic deposits will mirror trends in the real economic activity, and a significant fraction of domestic demand for long-term loans will be funded domestically. However, as both banks and their clients start to extrapolate their expectations of future positive trends based on the past, the demand for long-term loans (especially by the households) will increase. Given the requirements regarding maturity harmonization of banks' assets and liabilities, in a small open economy such as BH that demand is generally funded by a cross-border flow of funds. In these periods, LTDOMFUND changes much faster than LI, as all foreign currency loans and deposits affect the level of LI. Therefore, as the hedge funding phase of the Minsky cycle matures and moves towards the Ponzi stage, the long-run relationship between the availability of foreign sources of funding and the level of systemic risk becomes less stable and more non-linear.

Appendix 5.1: Poor management in banks and other microeconomic deficiencies: the role of banking supervision

In theory, an efficient banking supervision should be able to swiftly recognize and sanction imprudent behaviour of banks, thus significantly reducing the risk of banking crises. However, as will be illustrated in this Appendix, the efficiency of banking supervision may be difficult to evaluate.

In the context of poor management and other microeconomic deficiencies, there may be significant differences between the operational and systemic risks from the supervisory point of view. The operational risks are more specific for an individual bank, since fraudulent activities or poor managerial decisions are often hard to detect before they materialize. These pose a systemic risk only if the troubled bank is too big to fail or if there is a high level of inter-linkages between the banks. In order to minimize the effects of a single macroeconomic shock on the stability of the banking system, the vast majority of national supervisors have clear guidance regarding banking sector concentration or and significant exposures. Unfortunately, as illustrated it is the case in BH, there may be situations when decisions of another government agency are in a collision with the best banking supervision practices. However, as long as the vulnerabilities are domestic it is reasonable to argue that more efficient banking-supervision would reduce the probability of a banking crisis.

Increased cross-border capital mobility and complexity of financial instruments since the 1990s resulted in a sharp rise in both cross-border and domestic vulnerabilities (Section 1.3). The undermining of supervisory regulations through the process of financial liberalization made banking systems more sensitive to shocks originating abroad. The build-up in risks abroad is extremely difficult to detect since, as research such as Kaminsky and Reinhart (2001) suggests, the financial channels of crisis contagion are becoming more important when compared to more traditional trade channels of contagion. For this reason, even if international supervisory standards are largely harmonized, the presence of the large internationally active financial institutions makes consolidated supervision hard or even irrelevant from the host country perspective (Herring, 2007 and Sorsa et al., 2007). Similarly, the process of financial innovation results in a removal of a part of banking activities from regulatory oversight (Calomiris, 2009). Given that the value of the underlying commodity in the complex financial instruments depends on a number of assumptions, these constructions eventually may become so fragile that even the smallest shock can collapse their value, spilling the crisis across the markets. Again, as in the case of financial liberalization, it is almost impossible see the fine line that distinguishes between those activities that enhance banking sector efficiency and those that increase its fragility. For all these reasons, it is reasonable to claim that banking crises in some cases are predictable since they are a direct consequence of deliberate actions. On the other hand, although there may be a suspicion that the vulnerability of the banking sector is increasing due to insufficient supervision, quantification of these effects is generally impossible. From the financial stability point of view, the most that can be done in such a complex environment is identification of the systemic vulnerabilities and monitoring the factors that increase it, thus reducing the probability of a systemic crisis (see the discussion in Section 2.3).

As previously concluded, one may argue that more efficient domestic supervision, by reducing the endogenous banking system risk, reduces the probability of banking crisis. This claim is conditional on coordinated actions between the supervisory agency and other government bodies. Banking supervision in BH has its limitations that are mainly reflected in the sub-state level of banking supervision, a unique case in the world, and a significant delay in the implementation of the internationally adopted supervisory standards. It is common to find in place regulatory guidelines that discourage the creation of “too big to fail” banks that pose a significant systemic risk. However, the supervisors’ work is sometimes additionally burdened by the lack of coordination between them and other regulators. The BH Council of Competition has approved bank mergers that resulted in a significant increase in concentration creating “too big to fail” banks. The largest merger occurred in March 2008 when concentration in the banking market, as measured by the Herfindahl-Hirschman Index for assets, increased by 131.4 points. For the sake of comparison, for the U.S. Department of Justice an increase of 100 points in a concentrated market presumptively raise antitrust concerns. When the merger occurred, the BH banking sector was approaching the upper end of the scale that represents a moderately concentrated market. In such an environment, it is not safe to assume that the on-site supervision would detect every case of fraudulent activities or poor managerial decisions. Even reckless behaviour is difficult to distinguish from normal operations under the given market conditions. Therefore, unless there are some serious deviations in bank’s policies from those of its peers, one cannot with certainty tell whether a bank is significantly more risk-loving than the rest of the system.

Appendix 5.2: The estimation output for the deterministic trend in private credit to GDP ratio that accounts for both the changes in the intercept and slope

Table A5. 1: The estimation output for the deterministic trend in private credit to GDP ratio

Dependent Variable: PCGDP
Method: Least Squares
Sample: 1998 2010
Included observations: 13

	Coefficient	Std. Error	t-Statistic	Prob.
C	20.745	1.733	11.969	0.000
TIME	-2.091	0.780	-2.681	0.025
DT2001	8.434	0.985	8.562	0.000
DU2008	-14.594	2.301	-6.343	0.000

R-squared	0.988	Mean dependent var	35.151
Adjusted R-squared	0.984	S.D. dependent var	16.558
S.E. of regression	2.115	Akaike info criterion	4.584
Sum squared resid	40.262	Schwarz criterion	4.758
Log likelihood	-25.794	Hannan-Quinn criter.	4.548
F-statistic	242.128	Durbin-Watson stat	2.961
Prob(F-statistic)	0.000		

Appendix 5.3: The macroeconomic and banking-sector specific variables with distinctly different patterns at various stages of the credit cycle

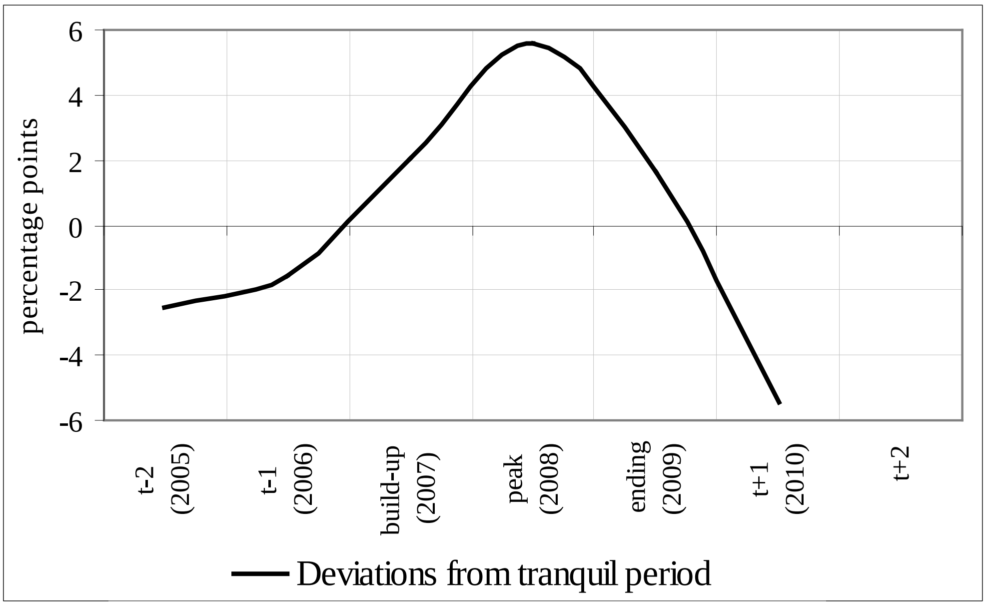
Gourinchas et al. (1999) identified the following variables as those that exhibit distinctly different patterns at various stages of the credit cycle.

> Between t-2 and the build-up phase, output is significantly above its potential compared to tranquil periods.

The gap between actual and potential GDP is estimated as deviations from trend calculated with a HP filter. As in the case of all the following macroeconomic variables, the average deviations in the tranquil period are then subtracted from the average deviations for each of the identified segments of a credit cycle. These deviations are presented in the set of figures in this Appendix and are used to illustrate by how much is the observed variable in each stage of a credit boom cycle above or below its average for the periods when there is no excessive lending.

Figure A5. 1: Deviations in GDP gap from tranquil periods, BH

Source: CBBH, own calculations.



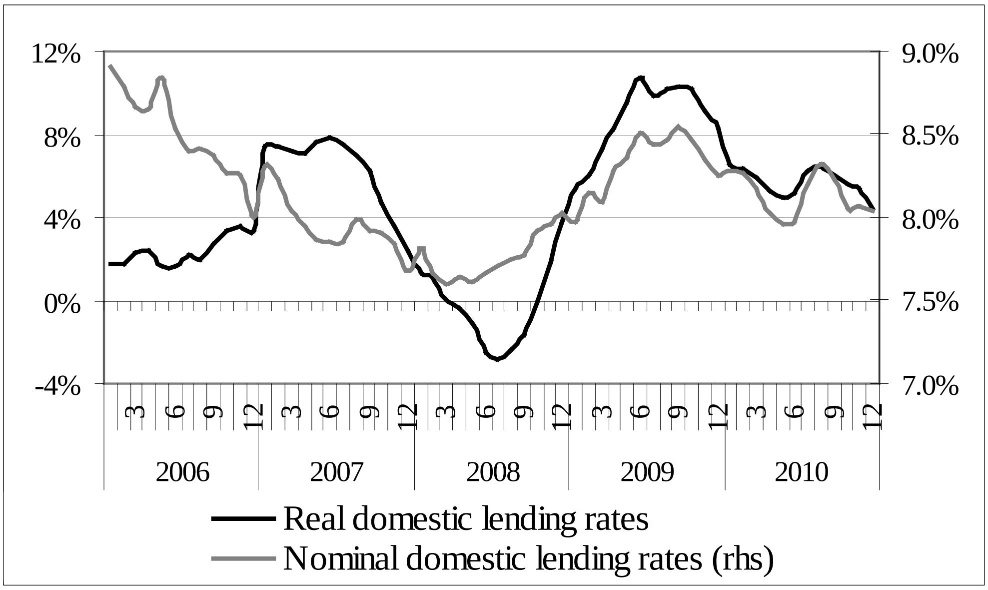
In the case of BH the GDP gap in the build-up phase and during the peak is significantly above its trend in tranquil periods. In the peak year, the output gap is almost 6 percentage points wider when compared to the tranquil periods. As theory suggests, the lending booms promote boom-boost cycles, with the end of a lending boom coinciding with a sharp contraction in the economic activity and real GDP falls below its long-term trend.

The domestic real interest rate rises by 665 basis points during the lending build-up. This increase is very economically significant.

In the case of BH, it is very likely that this Gourinchas et al. (1999) finding does not hold. Testing for it by replicating the same approach is the case of GDP is not possible since the BH interest rates series does not cover periods prior to 2002. Furthermore, the consumer price index (CPI; 2005=100) is only available for the periods after 2004. Prior to 2005, the retail price index (RPI) was used as a measure of inflation. Judging by Figure A5.2a below, it is possible that domestic real interest rates rose significantly during 2007 when compared to the tranquil periods, but due to the mentioned limitations in the availability of data, it is not possible to regard this with certainty.

Figure A5. 2a: Real and nominal domestic lending interest rates

Source: CBBH, own calculations.

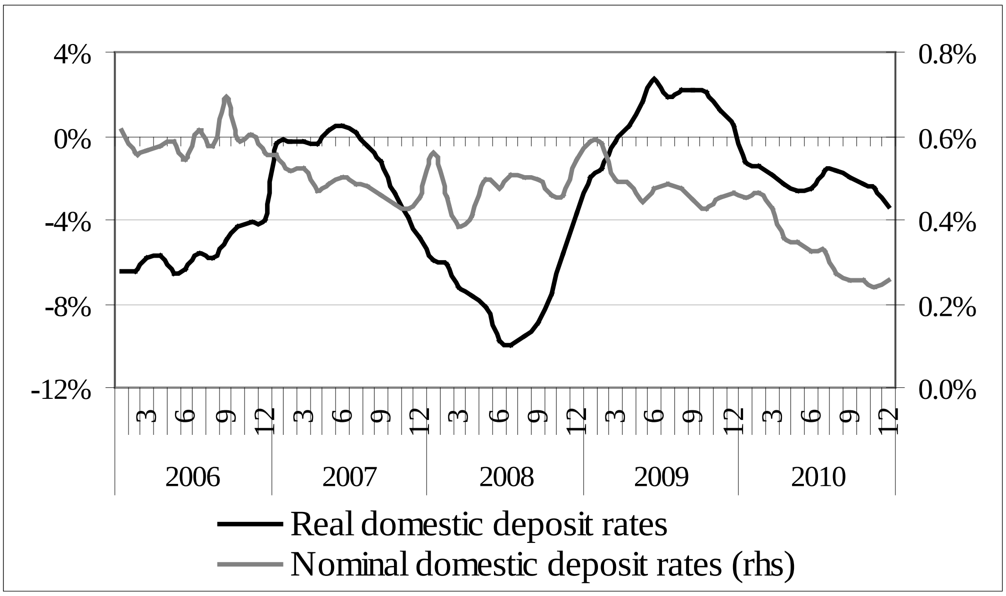


A possible reason why changes in domestic real interest rates may be not be important in detecting a forthcoming crisis in the case of BH is the over-reliance on the external sources of financing. Figure A5.2b below indicates that real domestic deposit rate (weighted average for the system as a whole) was so low in the period 2005 – 2010 that, with an exception of a brief episode in 2007 and 2009 (the latter being a consequence of the liquidity freeze in international financial markets), that domestic depositors were actually paying banks to deposit funds in the periods of credit expansion. This is a consequence of the maturity mismatch between banks' assets and liabilities (Section

1.3) and indicates that foreign interest rates might play a more prominent role in explaining changes in the SI.

Figure A5. 2b: Real and nominal domestic deposit interest rates

Source: CBBH, own calculations.

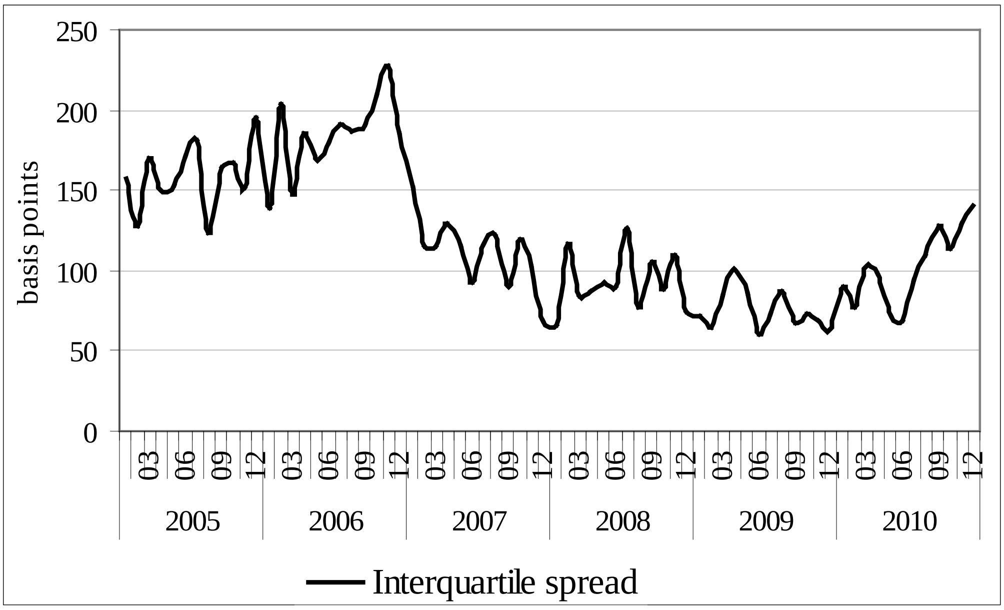


In support of this argument, one of the three market-based indicators of forthcoming crises according to Honohan (1997), namely a much higher interest rate paid by a bank on long-term deposits when compared to the rest of the banking system, will be examined. Macroeconomic epidemics, discussed in the sub-section 5.2.3, assume that it takes reckless behaviour or some other microeconomic deficiencies to create a lending boom out of credit expansion. In the case of BH, market-based indicators play no significant role in signalling microeconomic deficiencies and an individual bank's distress.

Although maturity transformation of liquid liabilities to illiquid assets is the core of banking operations, it makes banks subject to self-fulfilling runs (Diamond and Dybvig, 1983 and Chang and Velasco, 2000). Whenever a bank is willing to pay an interest rate on long-term deposits well above the market average, it signals that a significantly higher fraction of its client's deposits are tied up in illiquid assets. Figure A5.3 illustrates the interquartile spread of the interest rate paid on long-term deposits of households in the period January 2005-December 2010. Honohan (1997) suggest that a gap exceeding 200 bp between the third and the first quartile signals forthcoming banking problems.

Figure A5. 3: The interquartile spread of the nominal interest rate on the long-term deposits of households

Source: CBBH, own calculations.



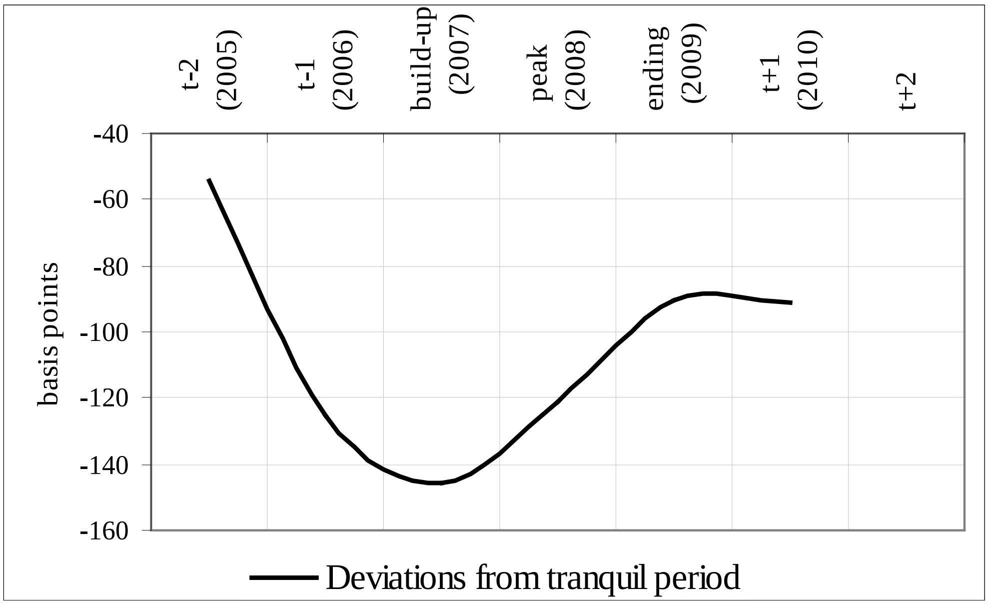
This indicator is, at best, inconclusive. The first reason is that there was no banking crisis in BH, so it is impossible to tell with certainty whether this rule of thumb holds in the case of BH or not. However, there is a plausible explanation for the shape of the curve. The only time that the spread is exceeding the 200 bp threshold is at the end of 2006. The euro changeover caused a permanent shift in the distribution of domestic sector holdings of cash versus deposits, which provided banks with resources to intensify their credit activity (Cotarrelli et al., 2003). Increasing domestic demand for long-term loans resulted in a pursuit of long-term sources of financing especially with the new foreign entrants to the market. As an illustration, two banks from the example in Section 5.2, B10 and B18, were paying up to two percentage points above the average market interest rates on time and savings deposits of households with maturity exceeding one year in the first years of the credit expansion. In the mid-2000s, the period of a strong increase in domestic demand for loans overlapped with a period of excess liquidity in international markets. The most active banks in the domestic market, foreign banks, had no incentive to pay high domestic deposit rates when they could borrow funds internationally either from the mother bank or other non-residents at lower rates. From the beginning of 2007 through to mid-2010, the majority of BH banks were offering interest rates on deposits of households with maturity over a year within a percentage point range. When the bank run occurred in October 2008 there was no need for an increase in long-term domestic deposit rates; the withdrawn deposits were returned to banks within a month, but demand for loans contracted sharply due to a slowdown in economic activity. Therefore, this indicator should not be used as a signal of a forthcoming crisis. On the one hand, the interquartile spread did imply increased competition in the market for loans through the end of 2006, indicating possible vulnerability in the banking system. In an attempt to increase their client base, both Banks B10 and B18 were found to be paying above the average market interest rates on time and savings deposits of households in the period 2003 through 2006. The aim of such an activity was to attract as much long-term funds as possible before they turned to borrowing internationally. In the same period they increased their cumulative share of total loans from 23.1 to 31.3%. In a sense, country and period specifics muted domestic market-based indicators so they no longer could provide a reliable signal of forthcoming turbulence.

> The spread between domestic lending and deposit rates decreases significantly in t+1.

The trend in domestic spread is again related to the interquartile spread of the interest rate on the long-term deposits of households (Figure A5.4). Regardless of the stage of a possible credit boom cycle, in the case of BH this spread is always below the levels recorded during tranquil periods.

Figure A5. 4: Deviations in spread of domestic rates from tranquil periods, BH

Source: CBBH, own calculations.



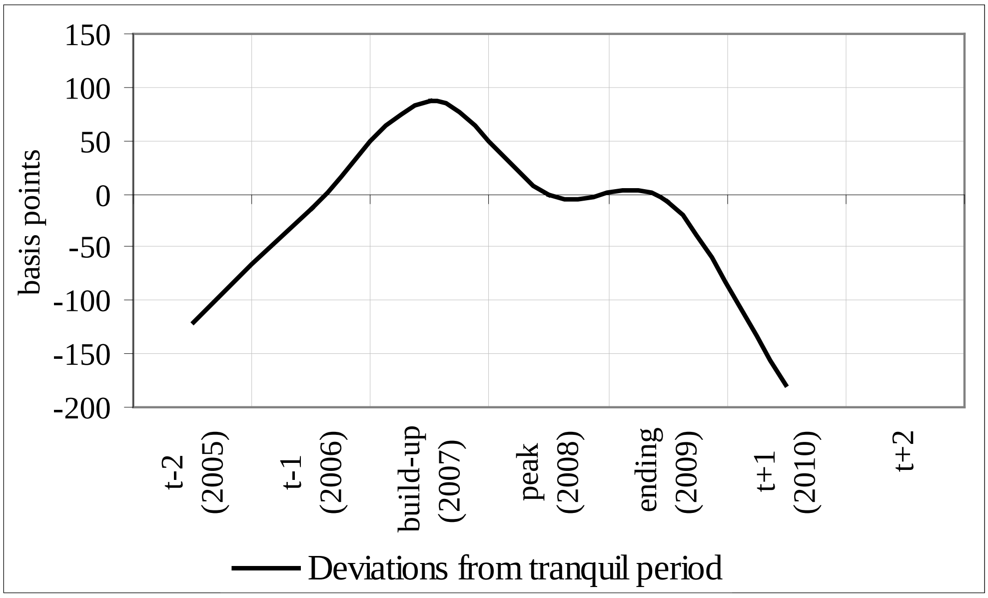
In the periods t-2 through the build-up the spread is substantially reduced, Figure A5.4, mostly due to reduction in active lending rates of the banks. Once the peak is reached the spread starts to increase. Keeping in mind the country specifics, an explanation for such trend is intuitive. With stronger economic activity, the banks tend to overestimate the creditworthiness of their clients that is reflected in lowering lending rates. Domestic deposit rates are sticky since the long-term domestic lending is financed by borrowing externally. An increasing spread in domestic interest rates in the peak year may occur either because the foreign sources of funding were reduced, which results in an increase in domestic passive deposit rates or the investment projects were perceived as more risky which pushed the lending rates up.

The international real interest rate increases significantly in the build-up period.

Gourinchas et al. (1999) do not specifically mention which international real interest rate was used. In Appendix B of the study it was only mentioned that the source was the World Bank (WB) World tables. When the indicator was replicated in order to investigate whether the variable is of importance in the case of BH, the European 12 month money market interest rate deflated by the HICP, was used.

Figure A5. 5: Deviations in foreign real interest rate from tranquil periods

Source: Eurostat (12 months money market rate and HICP), own calculations.



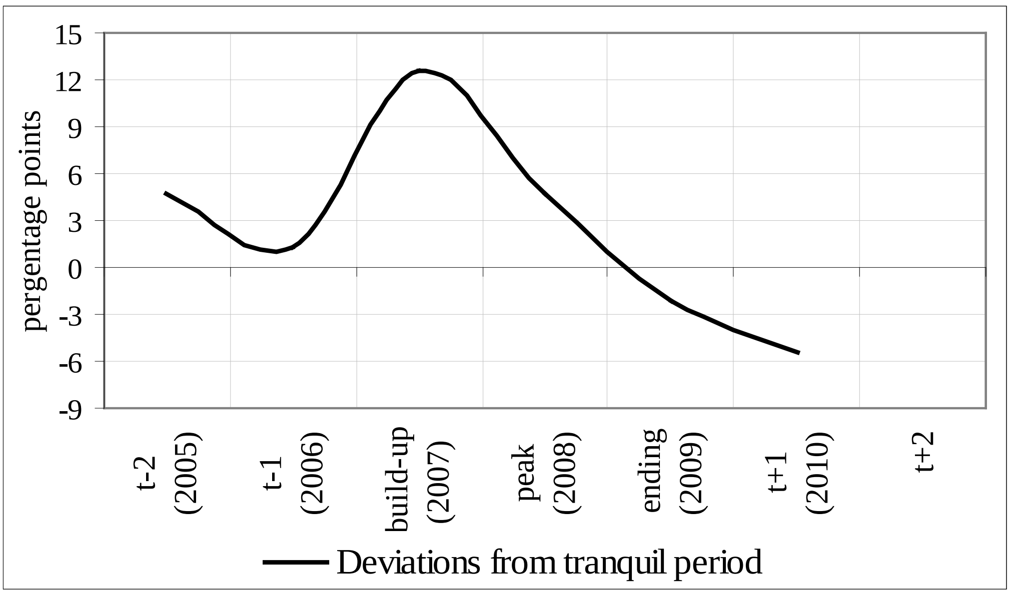
An increase in deviations in the foreign real interest rate in the build-up phase when compared to tranquil periods indicates reduced liquidity in international markets. In the case of BH, the build-up phase occurred in 2007, a year in which significant increases in interbank market rates occurred as a consequence of the global financial crisis.

Investment to GDP rises significantly above the tranquil periods in between t-2 and the build-up period and declines subsequently.

BH data is in line with the findings of Gourinchas et al. (1999). There is an increased variability, measured by the standard deviation of the each episode average, in the periods t-2 and t-1, but these are the years in which major privatization projects, such as one of the telecom companies, occurred. Overall, investments tend to rise above the levels recorded in tranquil periods in the years preceding the peak year. In the case of BH the investments are largely determined by the changes in foreign liabilities of domestic commercial banks.

Figure A5. 6: Deviations in investment as a % of GDP from tranquil periods, BH

Source: CBBH, own calculations.



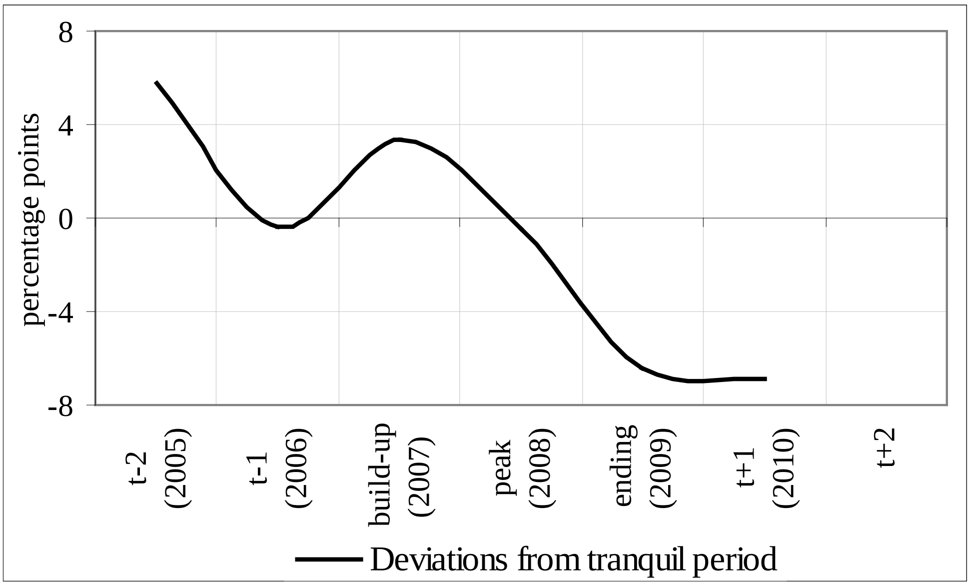
The effect of investment is already indirectly taken into account through the SI (Section 3.5) and it should not enter the model as an explanatory variable. Investments in the banking sector can be in the form of capital injections, loans from the non-residents and deposits of the non-residents. Additional capitalization will increase the buffer against the shocks making the banking system more resilient, which will be represented by a reduction in the SI. Part of the loans from the non-residents, the subordinated and hybrid loans (Table A1.5, p. 333), will also increase the level of capital. Loans from the non-residents and deposits of the non-residents will finance increased demand for loans. In the case of BH, the periods of significant foreign investment inflows coincided with the periods of an increased economic activity and higher level of fragility.

> Private capital inflows increase significantly during the build-up phase and peak year. This surge is subsequently reversed during the ending phase.

As argued by Gourinchas et al. (1999) a surge of foreign capital, mainly to the banking sector, is experienced in the build-up phase, followed by a significant outflow in the periods after the peak.

Figure A5. 7: Deviations in capital inflows from tranquil periods, BH

Source: CBBH, own calculations.



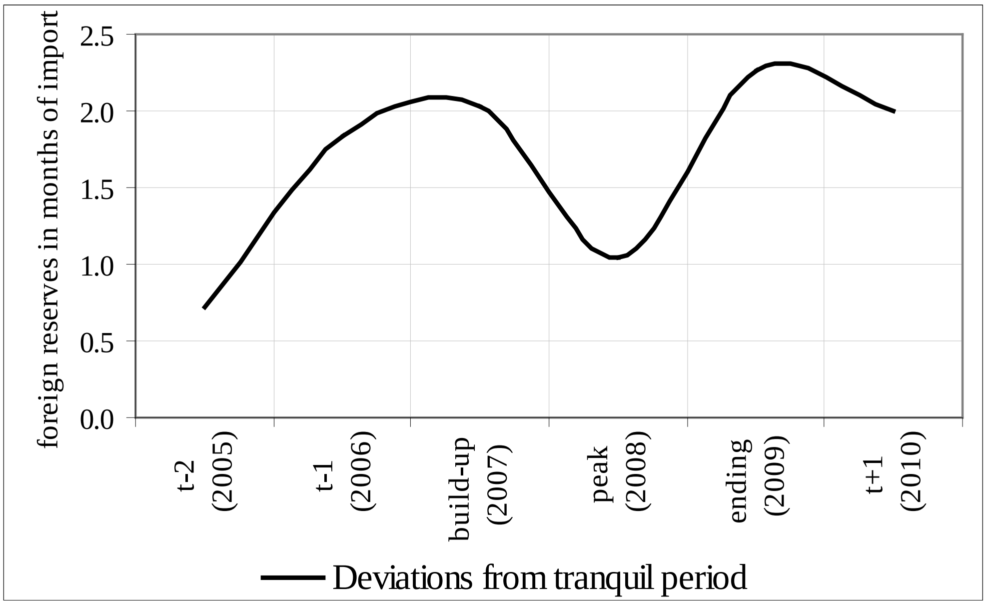
The effect of this variable is also already taken into account through the SI (Section 3.5) and the difference between domestic and foreign interest rates. The effect of private capital inflows to the SI is the same as the effect of total investments.

International reserves are 0.6 months of imports above the tranquil period average in t-2.

In the case of BH, foreign reserves expressed in months of imports are above the tranquil period average through the whole sample.

Figure A5. 8: Deviations in foreign reserves from tranquil periods, BH

Source: CBBH, own calculations.



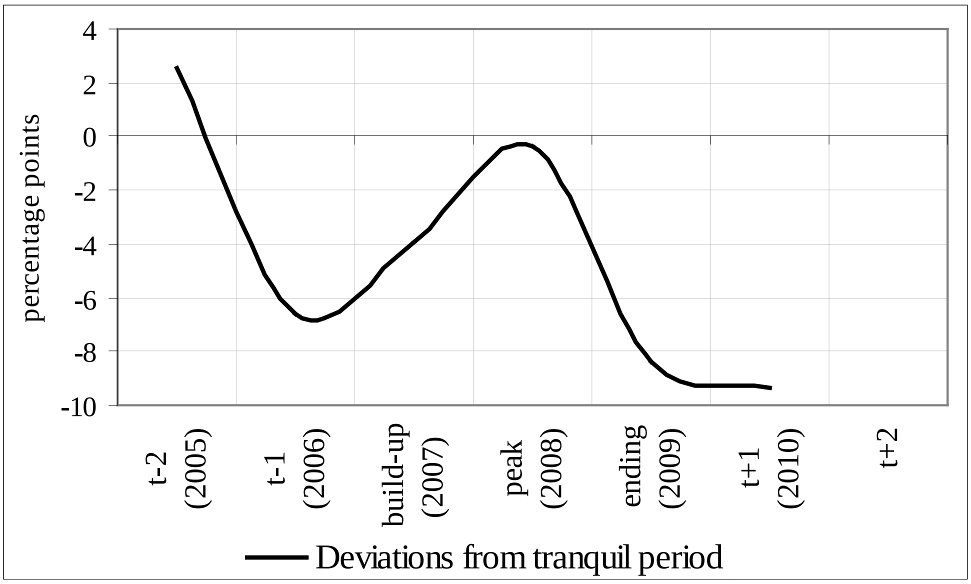
This is a reflection of the country specifics. In the periods through the build-up phase foreign reserves were growing faster than imports. There were three reasons for this: an inflow of privatization-related funds; a favourable international investment climate in the pre-2007 years; and a strong inflow of foreign investment to the banking sector. In 2008, a bank run occurred and the banks also reduced their lending activities. This strong increase in the trend in the ending period of the cycle is a consequence of a significant reduction in imports and the SBA with the IMF.

There is a large and significant current account deficit during the build-up phase and the peak year.

Figure below indicates an increase in the current account deficit in the build-up phase and the peak year, but the deficit is always below the levels recorded during the tranquil periods.

Figure A5. 9: Deviations in current account deficit from tranquil periods, BH

Source: CBBH, own calculations.



Country specific factors could again be credited for this trend. In the tranquil period in BH, the current account deficit was financed mostly by remittances. In the build-up phase and the peak year the current account deficit was mostly financed by foreign investment (Section 1.3). In the ending period and the year t+1, which corresponds to the years 2009 and 2010 in our sample, the current account deficit was significantly reduced with respect to the tranquil periods, primarily due to weakening domestic demand.

Appendix 5.4: Testing for the presence of a unit root in the solvency index

The Augmented Dickey-Fuller test indicates that the null hypothesis of a unit root in SI in levels should not be rejected (Table A5.2a). The same test indicates that the variable is the first difference stationary (Table A5.2b). In both cases the lag length is set automatically.

Table A5. 2a: The Augmented Dickey-Fuller test, levels

Null Hypothesis: SI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.375	0.846
Test critical values:	1% level	-4.324	
	5% level	-3.581	
	10% level	-3.225	

*MacKinnon (1996) one-sided p-values.

Table A5. 2b: The Augmented Dickey-Fuller test, 1st difference

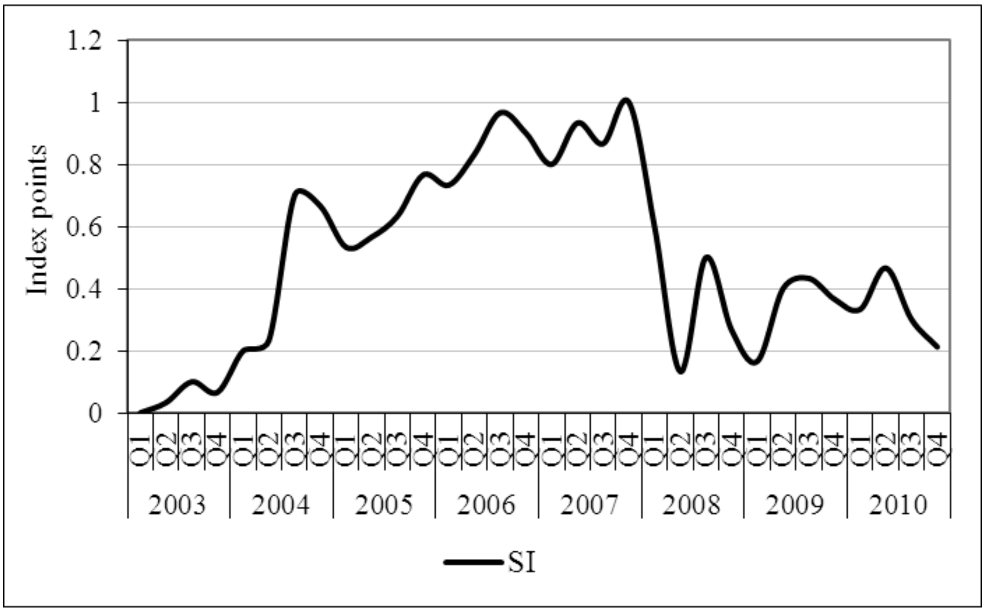
Null Hypothesis: D(SI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.370	0.000
Test critical values:	1% level	-4.324	
	5% level	-3.581	
	10% level	-3.225	

*MacKinnon (1996) one-sided p-values.

Inspecting the variable by eye (Figure A5.10), one cannot rule out the possibility that the SI is trend stationary once the structural break is removed.

Figure A5. 10: The solvency index (SI)



There is a clear break in Q1 2008. However, the cause of it is not something that could be characterised as a structural break, like the legislation and macroeconomic policies or any outstanding macroeconomic shocks. The reason for this perception of a sharp decline in the solvency risk of the system is a significant increase in the items of the banks' supplementary capital, *Subordinated debts* and *General reserves for losses on loans from classification A* (both items represented in Table A1.5 (p.333). The SI indicates the magnitude of a shock that would deplete the net capital of the banking system. The shock is expressed in terms of deterioration in the quality of assets. The size of the shock based on which the index is constructed of 0.25, for example, indicates that it would take a reclassification of 25% of A category classified loans into lower categories to result in an insolvency of the banking system. Contrary to what the level of the SI suggests (Figure A5.10), 2007 was a pre-crisis year with strong economic activity (real GDP was growing annually at 6.1%, preceded by the annual growth of 6.0 in 2008 and followed by the annual growth of 5.6% in 2008) and perceived by the general public as a rather riskless year. The latter is supported by the significant banking sector related inflows of foreign funds, which also affected the level of the banking sector capital, at the beginning of 2008.

The significant increases in the above two items of the supplementary capital in one quarter indicate that the expectations of both the banks' and the clients' regarding future trends were very optimistic. However, this increase in capital made the system, at least temporarily, more stable since it would take a larger shock to deplete the banks' capital.

The structural break that is known to occur is a significant change in the banks' lending policies in the second quarter of 2008. Because of the large disturbances in international financial markets, banks increased domestic lending rates mirroring the increase in the cost of internationally borrowed funds. This and the worsening in the macroeconomic environment resulted in both a reduction in demand for loans and an increase in non-performing loans, both affecting the level of the net capital, primarily of the item 2.3 in Table A1.5. Thus, the test for the presence of the unit root process in the SI after the structural break was taken into account will be performed assuming there was a structural break in Q2 2008. The following table displays the results of the unit root test assuming the structural breaks. The changes in both the intercept and slope are allowed for. Perron (1998) trend model is Model C, which is of the form:

$$Y_t = \mu_1 + \beta t + (\mu_2 - \mu_1)DU_t + (\beta_2 - \beta_1)DT_t + \varepsilon_t \qquad \text{(A5.1)}$$

where DU=1 if t> Q2 2008 and zero otherwise and DT=0 prior to and in Q2 2008 and the value *t* set to 22, period Q2 2008 being the twenty second observation in the sample.

Table A5. 3: Test for the unit root assuming an intercept and slope change in the deterministic trend

Dependent Variable: D(SI)
Method: Least Squares
Sample (adjusted): 2003Q2 2010Q4
Included observations: 31 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
SI(-1)	-0.0548	0.0618	-0.8867	0.3828
DU08Q2	0.1341	0.1300	1.0313	0.3112
DT08Q2	-0.0196	0.0208	-0.9416	0.3544
R-squared	0.0579	Mean dependent var		0.0068
Adjusted R-squared	-0.0094	S.D. dependent var		0.1879
S.E. of regression	0.1888	Akaike info criterion		-0.4041
Sum squared resid	0.9984	Schwarz criterion		-0.2654
Log likelihood	9.2642	Hannan-Quinn criter.		-0.3589
Durbin-Watson stat	2.0935			

A low t-statistic of the lagged dependant variable indicates that we cannot reject the null hypothesis of the unit root in the SI. In other words, the dependent variable is difference stationary.

Appendix 5.5: Testing for the appropriate VAR specification

Table A5. 4a: The VAR specification, diagnostics: 1 endogenous and 1 exogenous lags

Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

	VAR (1,1), intercept only	VAR (1,1), intercept and trend	VAR (1,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.5539	0.3674	0.0042
Doornik (1996), LMF test for autocorrelation, 2 lags	0.0337	0.0193	0.1454
Doornik (1996), LMF test for autocorrelation, 3 lags	0.0235	0.0108	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994), joint test for non-normality	0.0940	0.0780	0.9039
Lütkepohl (1993), joint test for non-normality	0.2330	0.2806	0.9380

Table A5. 4b: The VAR specification, diagnostics: 2 endogenous and 1 exogenous lags

	VAR (2,1), intercept only	VAR (2,1), intercept and trend	VAR (2,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.8049	0.6513	0.1267
Doornik (1996), LMF test for autocorrelation, 2 lags	0.2900	0.3849	-
Doornik (1996), LMF test for autocorrelation, 3 lags	-	-	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994), joint test for non-normality	0.9795	0.9431	0.7718
Lütkepohl (1993), joint test for non-normaility	0.9642	0.8922	0.6163
Jarque-Bera test, u1	0.8187	0.6875	0.4024
Jarque-Bera test, u2	0.6881	0.7163	0.6225
Jarque-Bera test, u3	0.8811	0.8035	0.4660
Multivariate ARCH-LM test	(1): 0.2574 / (2): 0.1872 (3): 0.2864 / (4): 0.2826	(1): 0.0450 / (2): 0.0328 (3): 0.0809 / (4): 0.3194	(1): 0.0447 / (2): 0.0457 (3): 0.0799 / (4): 0.3599
ARCH-LM test, u1	(1): 0.7578 / (2): 0.7523 (3): 0.7433 / (4): 0.6169	(1): 0.0149 / (2): 0.0446 (3): 0.0647 / (4): 0.0176	(1): 0.6593 / (2): 0.4162 (3): 0.5148 / (4): 0.4138
ARCH-LM test, u2	(1): 0.5723 / (2): 0.8829 (3): 0.5283 / (4): 0.5751	(1): 0.9147 / (2): 0.9462 (3): 0.7518 / (4): 0.6695	(1): 0.9642 / (2): 0.7117 (3): 0.7371 / (4): 0.8618
ARCH-LM test, u3	(1): 0.0752 / (2): 0.0442 (3): 0.0964 / (4): 0.1098	(1): 0.0929 / (2): 0.0539 (3): 0.1129 / (4): 0.1052	(1): 0.2126 / (2): 0.1132 (3): 0.2296 / (4): 0.2607

Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

Appendix 5.6: Diagnostics and estimation output for the full VECM

Table A5. 5: The full VECM, diagnostics

Note:
For Doornik (1996) p-value of LM statistics is reported.
For Doornik& Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value of Chi^2 is reported.
For Multivariate ARCH-LM test p-value of Chi^2 is reported.
For ARCH-LM test p-value of F statistic is reported.

	1 lag	2 lags	3 lags	4 lags
Doornik (1996), LM test for autocorrelation	0.260	0.728	0.130	0.111
Doornik & Hansen (1994), joint test for non-normality	0.120	0.120	0.120	0.120
Lütkepohl (1993), joint test for non-normaility	0.820	0.820	0.820	0.820
Jarque-Bera test, u1	0.589	0.589	0.589	0.589
Jarque-Bera test, u2	0.803	0.803	0.803	0.803
Jarque-Bera test, u3	0.014	0.014	0.014	0.014
Multivariate ARCH-LM test	0.966	0.571	0.550	0.348
ARCH-LM test, u1	0.433	0.734	0.558	0.546
ARCH-LM test, u2	0.122	0.169	0.340	0.501
ARCH-LM test, u3	0.907	0.780	0.867	0.897

Set of Tables A5. 6: The full VECM, estimation output

VEC REPRESENTATION
endogenous variables: SI_log, IIP_log, LTDOMFUND
exogenous variables: UNEMP, USDEUR_log
deterministic variables: merger, inflow2008, bankrun, shocklevel, shocktrend,
CONST, S1, S2, S3, TREND
endogenous lags (diffs): 1
exogenous lags: 1
sample range: [2003 Q3, 2010 Q4], T = 30
estimation procedure: Two stage. 1st=Johansen approach, 2nd=OLS

Legend:

Variable 1	Coefficient
	{p - Value}
	[t - Value]

Table A5. 6a: Loading coefficients

	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
ec1(t-1)	-0.275 {0.000} [-7.765]	-0.022 {0.000} [-3.674]	-0.260 {0.152} [-1.433]

Table A5. 6b: Estimated cointegration relation

	ec1(t-1)
SI_log(t-1)	1 {0.000} [0.000]
IIP_log(t-1)	14.652 {0.001} [3.381]
LTDOMFUND(t-1)	0.425 {0.000} [8.478]
merger(t-1)	-1.932 {0.001} [-3.427]
inflow2008(t-1)	0.178 {0.855} [0.183]
bankrun(t-1)	-0.266 {0.785} [-0.273]
shocklevel(t-1)	-15.494 {0.000} [-4.001]
shocktrend(t-1)	0.691 {0.000} [4.404]
CONST	-84.663 {0.000} [-4.352]
S1(t-1)	-0.529 {0.228} [-1.207]
S2(t-1)	-2.681 {0.000} [-5.536]
S3(t-1)	-1.336 {0.000} [-3.686]
TREND(t-1)	-0.541 {0.000} [-4.332]

Table A5. 6c: Lagged endogenous term

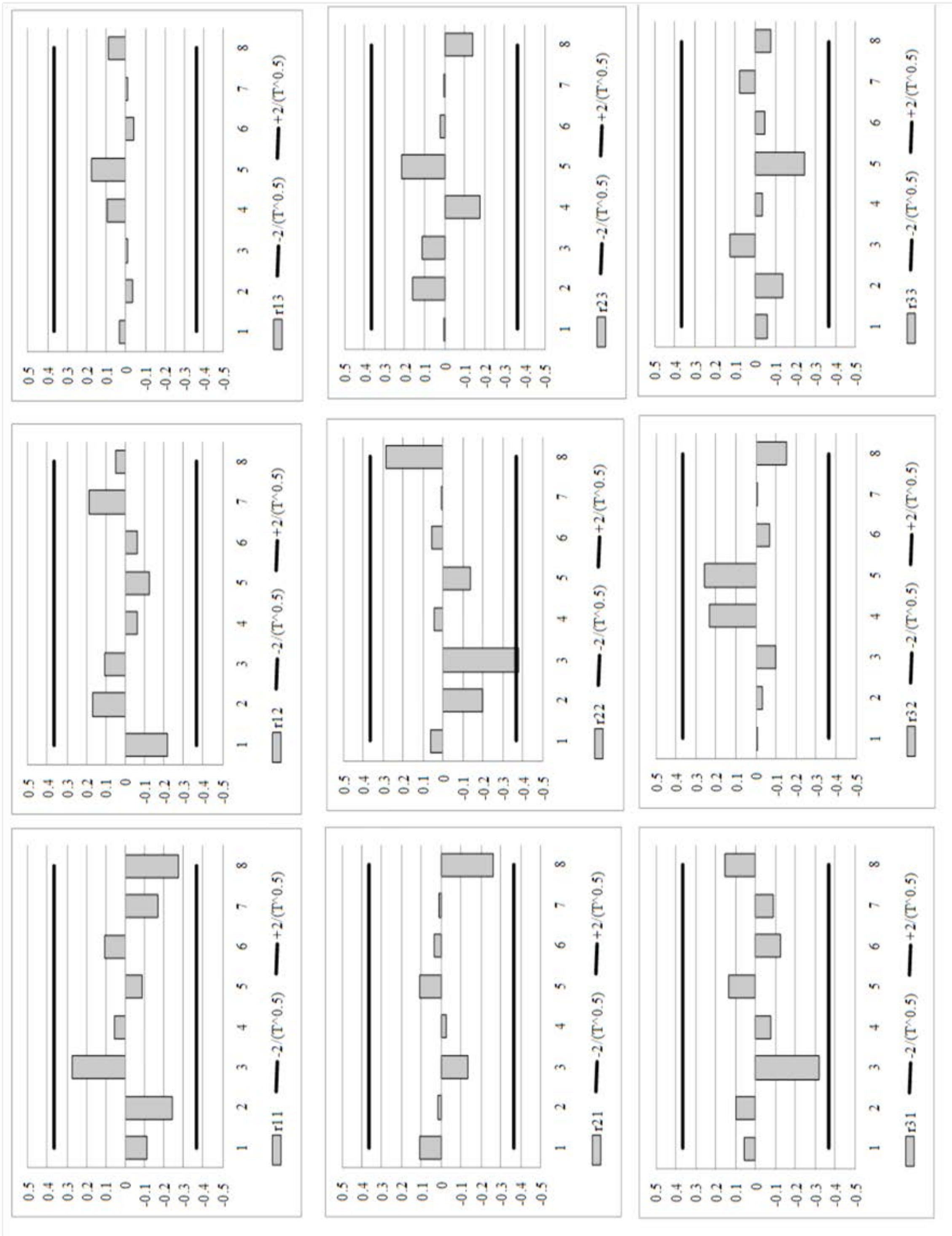
	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
d(SI_log)(t-1)	-0.474 {0.000} [-4.784]	0.002 {0.901} [0.125]	0.199 {0.695} [0.392]
d(IIP_log)(t-1)	0.250 {0.781} [0.278]	-0.294 {0.051} [-1.955]	-1.535 {0.738} [-0.334]
d(LTDOMFUND)(t-1)	0.203 {0.000} [5.830]	0.013 {0.031} [2.162]	0.328 {0.066} [1.841]

Table A5. 6d: Current and lagged exogenous terms

	d(SI_log)	d(IIP_log)	d(LTDOMFUND)
UNEMP(t)	0.248 {0.031} [2.157]	0.001 {0.953} [0.059]	-0.13 {0.826} [-0.220]
USDEUR_log(t)	-4.488 {0.001} [-3.281]	0.185 {0.419} [0.808]	20.815 {0.003} [2.971]
UNEMP(t-1)	-0.247 {0.034} [-2.114]	-0.002 {0.915} [-0.107]	0.116 {0.846} [0.194]
USDEUR_log(t-1)	4.148 {0.001} [3.256]	0.007 {0.973} [0.034]	-18.834 {0.004} [-2.887]

Appendix 5.7: The cross-correlation of the residuals of the restricted VECM

Figure A5. 11: The cross-correlation of the residuals in the final model



Appendix 5.8: The EC terms

Figure A5. 12a: The EC term based on equation (4.3)

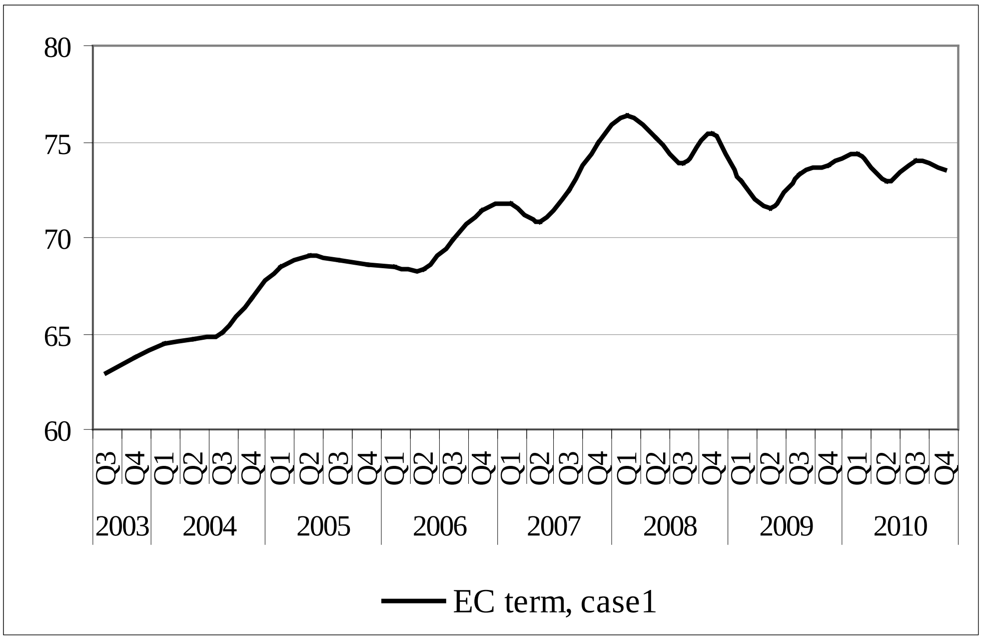


Figure A5. 12b: The EC term based on equation (4.4)

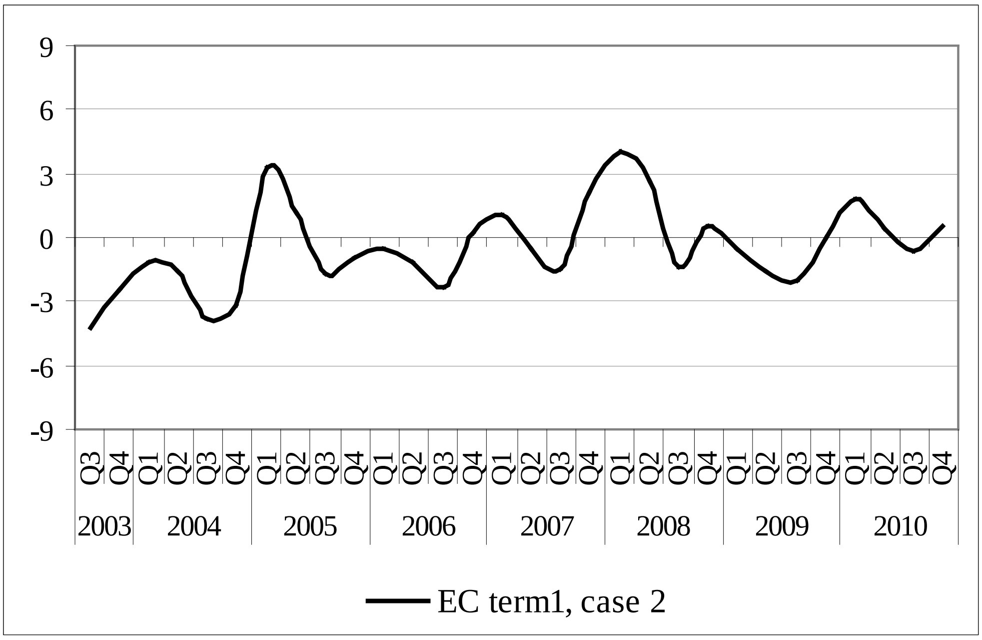
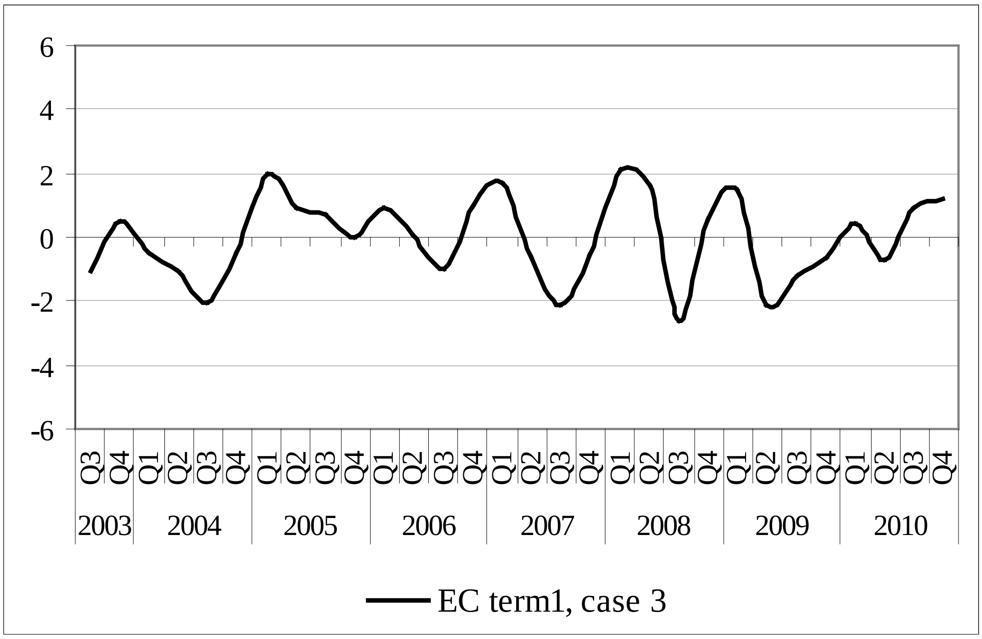


Figure A5. 12c: The EC term based on equation (4.5)



Appendix 5.9: The VECM with GDP instead of IIP and UNEMP

When the identical procedure from the chosen model is applied to the VECM in which the index of industrial production and unemployment are replaced by the GDP, the diagnostic tests (Tables A5.7a and A5.7b below) suggest that the appropriate specification of VAR is two lags with intercept, trend and seasonal dummies included. Note that the VAR specification is identical to that of the final model, the one with IIP and UNEMP.

Table A5. 7a: The VAR (1,1) specification for a model with GDP, diagnostics

	VAR (1,1), intercept only	VAR (1,1), intercept and trend	VAR (1,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.9571	0.8370	0.7307
Doornik (1996), LMF test for autocorrelation, 2 lags	0.1489	0.0807	0.0747
Doornik (1996), LMF test for autocorrelation, 3 lags	0.0293	0.1038	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-
Doornik & Hansen (1994), joint test for non-normality	0.0533	0.0154	0.4181
Lütkepohl (1993), joint test for non-normaility	0.0040	0.0020	0.3511
Jarque-Bera test, u1	0.5355	0.1957	0.2419
Jarque-Bera test, u2	0.8003	0.6234	0.5310
Jarque-Bera test, u3	0.0066	0.0066	0.4086

CONTINUED ON THE FOLLOWING PAGE

Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik & Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

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Multivariate ARCH-LM test	(1): 0.0918 / (2): 0.0767 (3): 0.3312 / (4): 0.2700	(1): 0.0024 / (2): 0.0275 (3): 0.2000 / (4): 0.3099	(1): 0.7810 / (2): 0.8203 (3): 0.5750 / (4): 0.4565
ARCH-LM test, u1	(1): 0.2810 / (2): 0.5778 (3): 0.7159 / (4): 0.2263	(1): 0.6329 / (2): 0.8212 (3): 0.8332 / (4): 0.7665	(1): 0.7087 / (2): 0.3601 (3): 0.5618 / (4): 0.4928
ARCH-LM test, u2	(1): 0.4769 / (2): 0.0806 (3): 0.1843 / (4): 0.3080	(1): 0.2500 / (2): 0.0092 (3): 0.0157 / (4): 0.0453	(1): 0.7019 / (2): 0.9127 (3): 0.9523 / (4): 0.7642
ARCH-LM test, u3	(1): 0.5741 / (2): 0.6132 (3): 0.7250 / (4): 0.7497	(1): 0.5738 / (2): 0.6125 (3): 0.7243 / (4): 0.7489	(1): 0.7276 / (2): 0.8348 (3): 0.7959 / (4): 0.7257

Table A5. 7b: The VAR (2,1) specification for a model with GDP, diagnostics

	VAR (1,1), intercept only	VAR (1,1), intercept and trend	VAR (1,1), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.3369	0.1390	0.1900
Doornik (1996), LMF test for autocorrelation, 2 lags	0.2726	0.0449	-
Doornik (1996), LMF test for autocorrelation, 3 lags	-	-	-
Doornik (1996), LMF test for autocorrelation, 4 lags	-	-	-

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Note:
The residuals were tested up to four lags.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik& Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM test.

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Doornik & Hansen (1994), joint test for non-normality	0.9165	0.4241	0.9462
Lütkepohl (1993), joint test for non-normaility	0.9588	0.3923	0.9391
Jarque-Bera test, u1	0.7029	0.0738	0.7076
Jarque-Bera test, u2	0.7052	0.8487	0.6281
Jarque-Bera test, u3	0.5519	0.6291	0.7759
Multivariate ARCH-LM test	(1): 0.1148 / (2): 0.3477 (3): 0.5263 / (4): 0.3400	(1): 0.0704 / (2): 0.0506 (3): 0.1935 / (4): 0.2471	(1): 0.1094 / (2): 0.1490 (3): 0.1966 / (4): 0.3241
ARCH-LM test, u1	(1): 0.1787 / (2): 0.4608 (3): 0.4557 / (4): 0.2227	(1): 0.7321 / (2): 0.8509 (3): 0.7354 / (4): 0.6486	(1): 0.6940 / (2): 0.4279 (3): 0.5321 / (4): 0.5377
ARCH-LM test, u2	(1): 0.8359 / (2): 0.9333 (3): 0.9447 / (4): 0.8876	(1): 0.1276 / (2): 0.2381 (3): 0.3560 / (4): 0.4677	(1): 0.6715 / (2): 0.5056 (3): 0.6544 / (4): 0.7368
ARCH-LM test, u3	(1): 0.8377 / (2): 0.9615 (3): 0.9270 / (4): 0.8896	(1): 0.9839 / (2): 0.8702 (3): 0.9421 / (4): 0.9350	(1): 0.1838 / (2): 0.2687 (3): 0.1424 / (4): 0.2082

The results of Johansen Trace test and Saikkonen and Lütkepohl test are, at best, inconclusive (Table A5.8) as they suggest from zero to more than a single cointegrating relationship.

Table A5. 8: The cointegration tests for a model with GDP

Note:
Break date in Johansen Trace Test is set to Q1 2009. The break is assumed in levels and trend jointly and ignored in "orthogonal trend". MERGER and INFLOW2008 were not restricted to long run.
Saikkonen and Lütkepohl test does not have an option to set the break dates. Instead, it allows for including series that will account for changes in deterministic trend. In this case, the variables included are: INFLOW2008, SHOCKLEVEL and SHOCKTREND. Note that inclusion of SHOCKLEVEL and SHOCKTREND have the same effect as the introduction of the break in Q1

Test	Included	Null hypothesis	Test value	p-value	Critical values		
					90%	95%	99%
Johansen Trace Test	- Constant	r = 0	50.69	0.00	38.91	41.69	47.25
		r = 1	25.75	0.04	22.83	25.09	29.73
	- Constant - Trend	r = 0	58.66	0.03	52.79	56.35	63.43
		r = 1	33.86	0.07	32.31	35.21	41.10
	- Orthogonal trend	r = 0	42.89	0.00	27.16	29.80	35.21
		r = 1	20.58	0.01	13.42	15.41	19.62
Saikkonen and Lütkepohl Test	- Constant	r = 0	30.62	0.01	21.76	24.16	29.11
		r = 1	13.40	0.03	10.47	12.26	16.10
	- Constant - Trend	r = 0	19.59	0.42	26.07	28.52	33.50
		r = 1	5.44	0.83	13.88	15.76	19.71
	- Orthogonal trend	r = 0	21.69	0.04	18.67	20.96	25.71
		r = 1	11.53	0.02	8.18	9.84	13.48

In fact, as indicated in Table A5.9 below, the cointegration tests results do not suggest that one should assume the cointegration even between the SI and GDP.

Table A5. 9: The tests of cointegration between the SI and GDP

Test	Included	Null hypothesis	Test value	p-value	Critical values		
					90%	95%	99%
Johansen Trace Test	- Constant	r = 0	30.15	0.01	22.83	25.04	29.56
		r = 1	7.29	0.32	10.76	12.59	16.53
	- Constant - Trend	r = 0	49.83	0.00	32.85	35.76	41.67
		r = 1	9.11	0.54	15.89	18.09	22.70
	- Orthogonal trend	r = 0	6.73	0.61	13.42	15.41	19.62
		r = 1					
Saikkonen and Lütkepohl Test	- Constant	r = 0	10.52	0.10	10.47	12.26	16.10
		r = 1	0.03	0.90	2.98	4.13	6.93
	- Constant - Trend	r = 0	5.87	0.79	13.88	15.76	19.71
		r = 1	0.26	0.97	5.47	6.79	9.73
	- Orthogonal trend	r = 0	8.17	0.10	8.18	9.84	13.48
		r = 1					

Note is the same as under Table A5.8.

Appendix 5.10: The ARDL Bounds Testing methodology for the solvency index

The ARDL Bounds Testing methodology introduced in Appendix 4.8 will be employed as a robustness check in the case of the VECM normalized on SI as well. As in the case of LI, only the VECM equation with change in the level of systemic risk (ΔSI_t) as the dependant variable will be considered.

Step 1: Ensuring that none of the variables are I(2)

The unit root tests were conducted in Section 4.4 and it was demonstrated that none of the variables is I(2) as that would invalidate the methodology.

Step 2: Formulating the “unrestricted” ECM

Based on the Set of Tables 5.7a through 5.7d, the estimation of the unrestricted ECM (equation (A4.9) in Appendix 4.8) is reported in Table A5.10 below.

Table A5. 10: The estimation output for the unrestricted ECM

Dependent Variable: D(LOG(SI))
Method: Least Squares
Sample (adjusted): 2003Q3 2010Q4
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	24.267	7.108	3.414	0.006
D(LOG(SI(-1)))	-0.570	0.117	-4.856	0.001
D(LTDOMFUND(-1))	-0.003	0.053	-0.060	0.953
LOG(SI(-1))	-0.649	0.144	-4.504	0.001
LOG(IIP(-1))	-4.325	1.884	-2.296	0.042
LTDOMFUND(-1)	-0.034	0.047	-0.720	0.487
UNEMP	0.259	0.146	1.774	0.104
LOG(USDEUR)	-4.038	1.483	-2.723	0.020
UNEMP(-1)	-0.372	0.141	-2.639	0.023
LOG(USDEUR(-1))	5.008	1.505	3.328	0.007
MERGER(-1)	0.903	0.310	2.916	0.014
INFLOW2008(-1)	-2.459	0.659	-3.732	0.003
BANKRUN(-1)	-2.137	0.561	-3.810	0.003

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S1(-1)	-0.208	0.198	-1.048	0.317
S2(-1)	0.245	0.158	1.553	0.149
S3(-1)	0.080	0.141	0.566	0.583
TREND(-1)	0.198	0.049	4.084	0.002
SHOCKLEVEL(-1)	3.737	2.385	1.567	0.146
SHOCKTREND(-1)	-0.235	0.088	-2.684	0.021

R-squared	0.950	Mean dependent var	0.062
Adjusted R-squared	0.868	S.D. dependent var	0.591
S.E. of regression	0.215	Akaike info criterion	0.025
Sum squared resid	0.507	Schwarz criterion	0.912
Log likelihood	18.625	Hannan-Quinn criter.	0.309
F-statistic	11.566	Durbin-Watson stat	2.850
Prob(F-statistic)	0.000		

Step 3: Determining the appropriate lag structure for the model in Step 2

In principle, one should test for the appropriate lag structure when building a model. However, as the sample size was the limiting factor in testing for the appropriateness of including the AR component higher than one, the first lag was used under the assumption that an inappropriate lag length would be detected by the tests for serial correlation.

Step 4: Ensuring that the errors of this model are serially independent

The results of the tests for serial correlation up to four lags are reported in the table below. With the probability for all four lags exceeding 5%, one may assume that the serial correlation of the residuals should not invalidate the procedure.

Table A5. 11: The Breusch-Godfrey Serial Correlation LM Test

	F-statistic		Probability
1 lag	3.766	F(1,10)	0.067
2 lags	3.567	F(2,9)	0.072
3 lags	3.016	F(3,8)	0.094
4 lags	2.025	F(4,7)	0.195

Step 5: Ensuring that the model is “dynamically stable”

With a coefficient on the lagged dependant variable of -0.570 (Table A5.10), the model can be considered as dynamically stable as the stationarity condition, $|-0.570| < 1$, holds.

Step 6: Performing a "Bounds Test"

In this step one needs to obtain the F-statistic associated with the Wald test for the joint significance of the coefficients next to LOG(SI(-1)), LOG(IIP(-1)) and LTDOMFUND(-1) in Table A5.10 and interpret it in the context of the Bounds Test tables of critical values reported in Pesaran et al. (2001). The value of our F-statistic is 8.54 (Table A5.12 below).

Table A5. 12: The Wald Test for restrictions in coefficients

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	8.540	(3, 11)	0.003
Chi-square	25.620	3	0.000

Null Hypothesis: C(4)=C(5)=C(6)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.649	0.144
C(5)	-4.325	1.884
C(6)	-0.034	0.047

Restrictions are linear in coefficients.

With k=2 (there are k+1 = 3 potentially cointegrating variables in our model), the relevant Bounds Test table of critical values is Table CI (v) on p.301 of Pesaran et al. (2001) as both an intercept and linear trend are included in the model. The lower and upper bounds for the F-test statistic at the 10%, 5%, and 1% significance levels are $[4.19, 5.06]$, $[4.87, 5.85]$ and $[6.34, 7.52]$ respectively. As the value of our F-statistic exceeds the upper bound at all significance levels, one may conclude that there is evidence of a long-run relationship between SI, IIP and LTDOMFUND. The lower and upper bounds for the Narayan (2005) F-test statistic at the 10%, 5%, and 1% significance levels for 30 observations and k=2 are $[4.58, 5.60]$, $[5.55, 6.75]$ and $[7.98, 9.41]$ respectively. This time the test is inconclusive at 1%, so one should, even if the unit root tests were not conducted in Section 4.4, assume that all three variables are I(1) and that they are coinetgrated.

Step 7: Estimating the long-run multipliers

From the unrestricted ECM (Table A5.10), the long-run multipliers between SI and IIP and SI and LTDOMFUND are $-\left(\frac{-4.325}{-0.649}\right) = -6.66$ and $-\left(\frac{-0.034}{0.649}\right) = -0.05$ respectively.

The multipliers are consistent with the coefficients reported in Table 5.7b. It is confirmed once more that real economic activity favours more financially stable systems. The long-run multiplier of LTDOMFUND, also in line with the VECM estimates, indicates that an over-reliance on the foreign sources of financing tends to increase the risk of a banking crisis. Similar to the case of LI (Appendix 4.8), the estimated coefficients are smaller when compared to the VECM, but, as already emphasized, these estimates of the long-run relationship were not expected to be identical in size as the VECM is a system and the ARDL-ECM is a single equation estimate. Note, however, that they are much more similar when compared to Appendix 4.8. A possible explanation could be that omitted variables are not as serious an issue as they were in the cases of the VECM normalized on LI and the ARDL-ECM with LI as the dependant variable. Every model is a simplification of reality and, as such, is bound to suffer from omitted variable bias to a certain degree. However, as the VECM was, overall, equilibrating (indicating that the omitted variable bias is less of a concern when compared to the VECM normalized on LI), the ARDL-ECM will provide less biased and more consistent estimates in Table A5.10.

Step 8: Estimating a long-run "levels model" and measuring short-run dynamic effects

By estimating the levels model by OLS and constructing the residuals series, one can fit a restricted ECM (Table A5.13).

Table A5. 13: The restricted ECM estimation output

Dependent Variable: D(LOG(SI))
Sample (adjusted): 2003Q3 2010Q4
Included observations: 30 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	5.082	3.100	1.640	0.116
D(LOG(SI(-1)))	-0.384	0.172	-2.233	0.037
D(LOG(IIP(-1)))	0.759	1.484	0.512	0.614
D(LTDOMFUND(-1))	0.116	0.060	1.942	0.066
UNEMP	0.034	0.124	0.271	0.789
LOG(USDEUR)	-5.203	2.303	-2.259	0.035
UNEMP(-1)	-0.116	0.121	-0.964	0.346
LOG(USDEUR(-1))	-0.232	2.166	-0.107	0.916
RES_SI(-1)	-0.549	0.192	-2.855	0.010

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R-squared	0.545	Mean dependent var	0.062
Adjusted R-squared	0.371	S.D. dependent var	0.591
S.E. of regression	0.468	Akaike info criterion	1.564
Sum squared resid	4.604	Schwarz criterion	1.984
Log likelihood	-14.453	Hannan-Quinn criter.	1.698
F-statistic	3.141	Durbin-Watson stat	1.646
Prob(F-statistic)	0.017		

Given the established cointegrating relationship between SI, IIP and LTDOMFUND, one would expect both a negative and statistically significant coefficient next to lagged residuals from the levels model. The sign of the coefficient next to the error-correction term indicates that there is an adjustment mechanism in place, as the Granger Representation Theorem suggests there should be. The magnitude of RES_SI(-1) implies that SI adjusts in the very next quarter to neutralize 54.9% of any disequilibrium between the three variables. The speed of adjustment towards the long-run equilibrium is faster when compared to the loading coefficient of -0.317 reported in Table 5.7a underlying the case that in the ARDL-ECM the short-term adjustment is occurring via adjustment in SI alone, but also indicating that omitted variable is not as serious an issue as the coefficients are more similar in size than was the case with LI.

Appendix 6.1: Diagnostics of the VAR specifications with 1 endogenous lag

Table A6. 1a: The VAR specification, diagnostics: 1 endogenous and 0 exogenous lag

Note:
One exogenous lag and 2 maximum exogenous lags assumed in all 6 cases.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik& Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM

	VAR (1 lag), intercept only	VAR (1 lag), intercept and trend	VAR (1 lag), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.1366	0.3516	0.2700
Doornik (1996), LMF test for autocorrelation, 2 lags	Not tested for higher number of lags, like multivarite and univariate ARCH-LM tests, due to detected non-normality of residuals.		0.1023
Doornik (1996), LMF test for autocorrelation, 3 lags			-
Doornik (1996), LMF test for autocorrelation, 4 lags			-
Doornik & Hansen (1994), joint test for non-normality	0.0649	0.0289	0.9881
Lütkepohl (1993), joint test for non-normaility	0.0810	0.0172	0.9968
Jarque-Bera test, u1	0.6246	0.5561	0.8128
Jarque-Bera test, u2	0.5010	0.8667	0.8689
Jarque-Bera test, u3	0.2704	0.0251	0.8581
Jarque-Bera test, u4	0.0024	0.0128	0.7522
Multivariate ARCH-LM test	(1): 0.1589 / (2): (3): - / (4): -	(1): 0.4895 / (2): (3): - / (4): -	(1): 0.8339 / (2): 0.2541 (3): - / (4): -
ARCH-LM test, u1	(1): 0.0006 / (2): - (3): - / (4): -	(1): 0.0056 / (2): - (3): - / (4): -	(1): 0.0183 / (2): 0.0425 (3): 0.0958 / (4): 0.0061
ARCH-LM test, u2	(1): 0.3444 / (2): - (3): - / (4): -	(1): 0.0553 / (2): - (3): - / (4): -	(1): 0.1345 / (2): 0.1425 (3): 0.0292 / (4): 0.0754
ARCH-LM test, u3	(1): 0.2820 / (2): - (3): - / (4): -	(1): 0.9842 / (2): - (3): - / (4): -	(1): 0.9377 / (2): 0.9453 (3): 0.5511 / (4): 0.5791

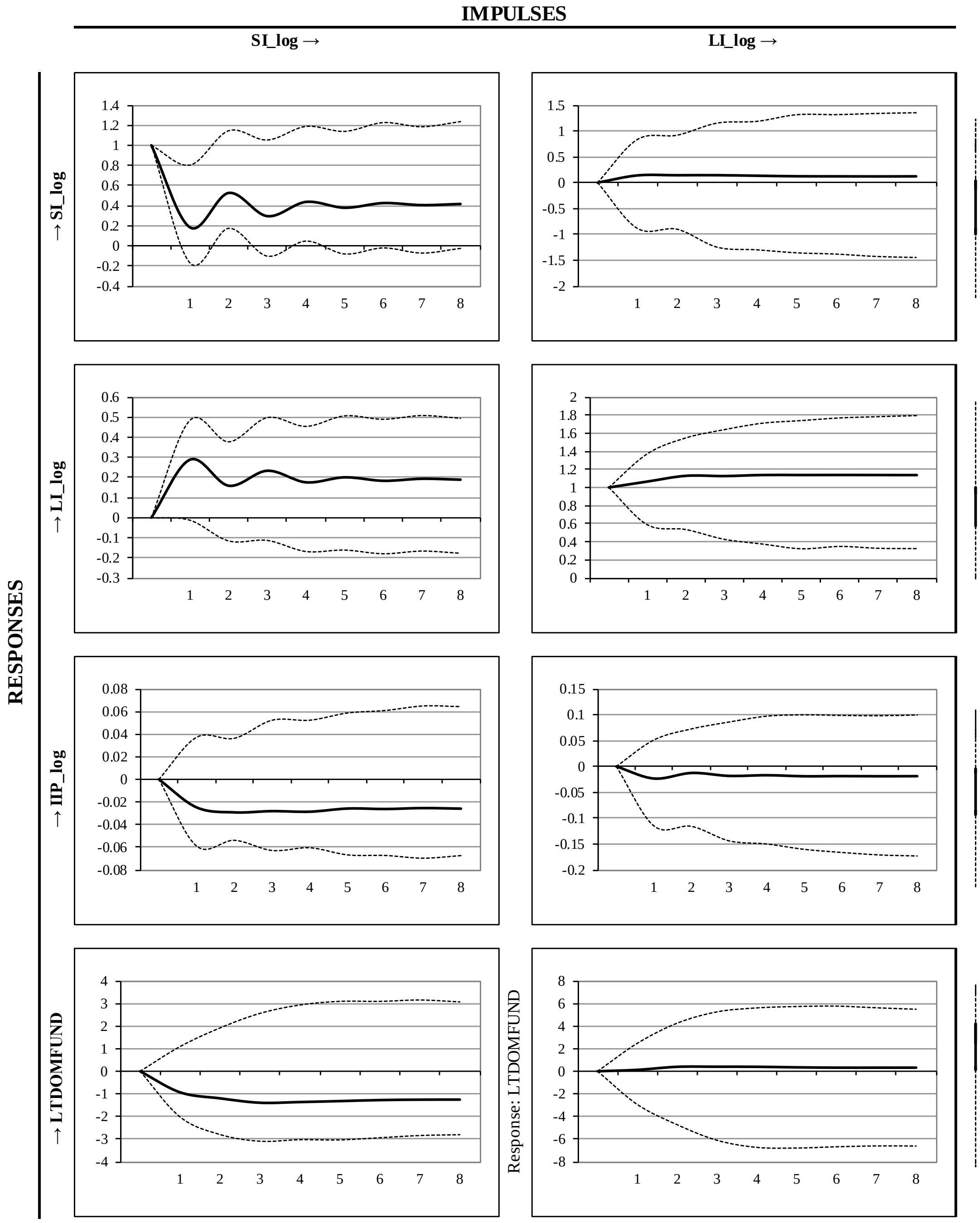
Table A6. 1b: The VAR specification, diagnostics: 1 endogenous and 1 exogenous lag

Note:
One exogenous lag and 2 maximum exogenous lags assumed in all 6 cases.
For Doornik (1996) LMF test for autocorrelation with F-approximation p-value is reported.
For Doornik& Hansen (1994) p-value for joint test statistic is reported.
For Lütkepohl (1993) p-value for joint test statistic is reported.
For Jarque-Bera p-value Chi^2 is reported.
For Multivariate ARCH-LM test p-value Chi^2 is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
For ARCH-LM test p-value of F statistic is reported. Each reported value corresponds to lags 1 through 4 in the LM test.
"-" Insufficient degrees of freedom for the F-correction in the case of Doornik LMF test or insufficient number of observations to perform the test in the case of Multivariate ARCH-LM

	VAR (1 lag), intercept only	VAR (1 lag), intercept and trend	VAR (1 lag), intercept, trend and seasonal dummies
Doornik (1996), LMF test for autocorrelation, 1 lag	0.0029	0.0579	0.0067
Doornik (1996), LMF test for autocorrelation, 2 lags	Not tested for higher number of lags, like multivarite and univariate ARCH-LM tests, due to detected non-normality of residuals.		
Doornik (1996), LMF test for autocorrelation, 3 lags			
Doornik (1996), LMF test for autocorrelation, 4 lags			
Doornik & Hansen (1994), joint test for non-normality	0.0000	0.0000	0.7348
Lütkepohl (1993), joint test for non-normaility	0.0000	0.0000	0.0842
Jarque-Bera test, u1	0.5428	0.4685	0.8093
Jarque-Bera test, u2	0.0001	0.0035	0.0902
Jarque-Bera test, u3	0.6309	0.0682	0.8354
Jarque-Bera test, u4	0.0010	0.0004	0.8658
Multivariate ARCH-LM test	(1): 0.0639 / (2): - (3): - / (4): -	(1): 0.1881 / (2): - (3): - / (4): -	(1): 0.1132 / (2): - (3): - / (4): -
ARCH-LM test, u1	(1): 0.0003 / (2): - (3): - / (4): -	(1): 0.0020 / (2): - (3): - / (4): -	(1): 0.0183 / (2): - (3): - / (4): -
ARCH-LM test, u2	(1): 0.0466 / (2): - (3): - / (4): -	(1): 0.0200 / (2): - (3): - / (4): -	(1): 0.0187 / (2): - (3): - / (4): -
	(1): 0.5837 / (2): -	(1): 0.8882 / (2): -	(1): 0.7222 / (2): -

Appendix 6.2: VECM Forecast Error Impulse Responses; 95% Efron Percentile CI (B=2000 h=8, seed=5000)

Set of Figures A6. 1a: Plots of responses to impulses



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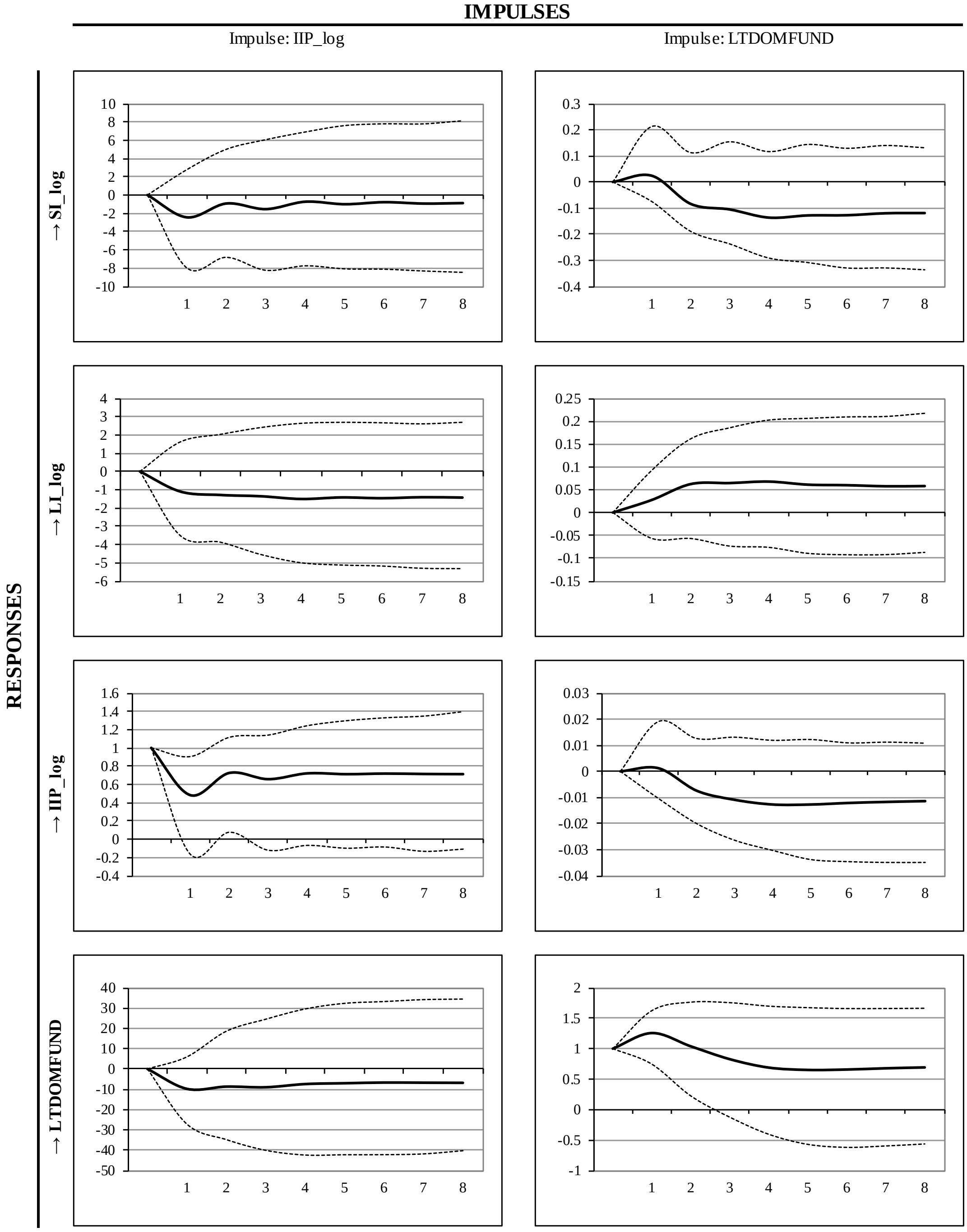
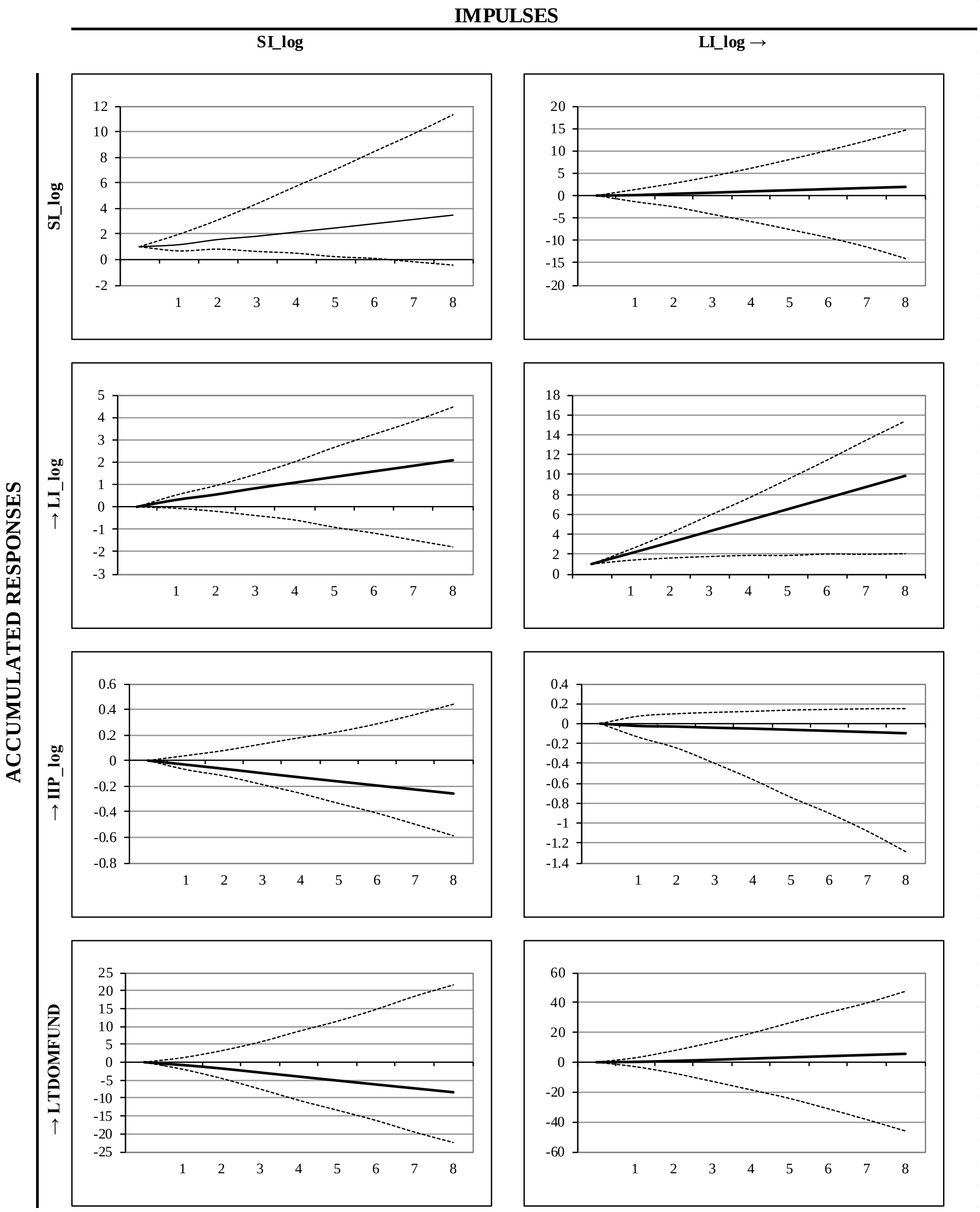
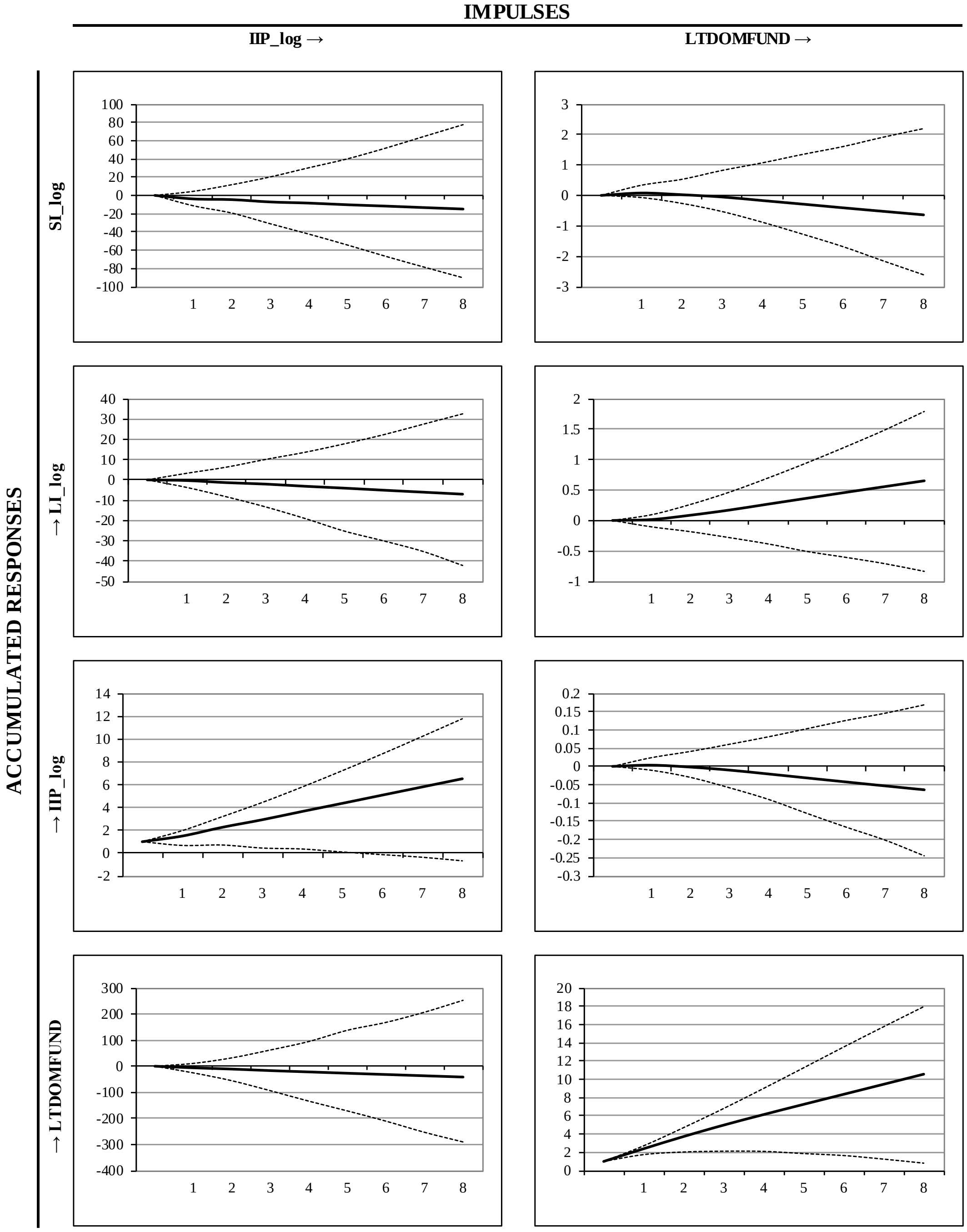

IMPULSES
Impulse: IIP_log
Impulse: LTDOMFUND
RESPONSES
→ SI_log
→ LI_log
→ IIP_log
→ LTDOMFUND

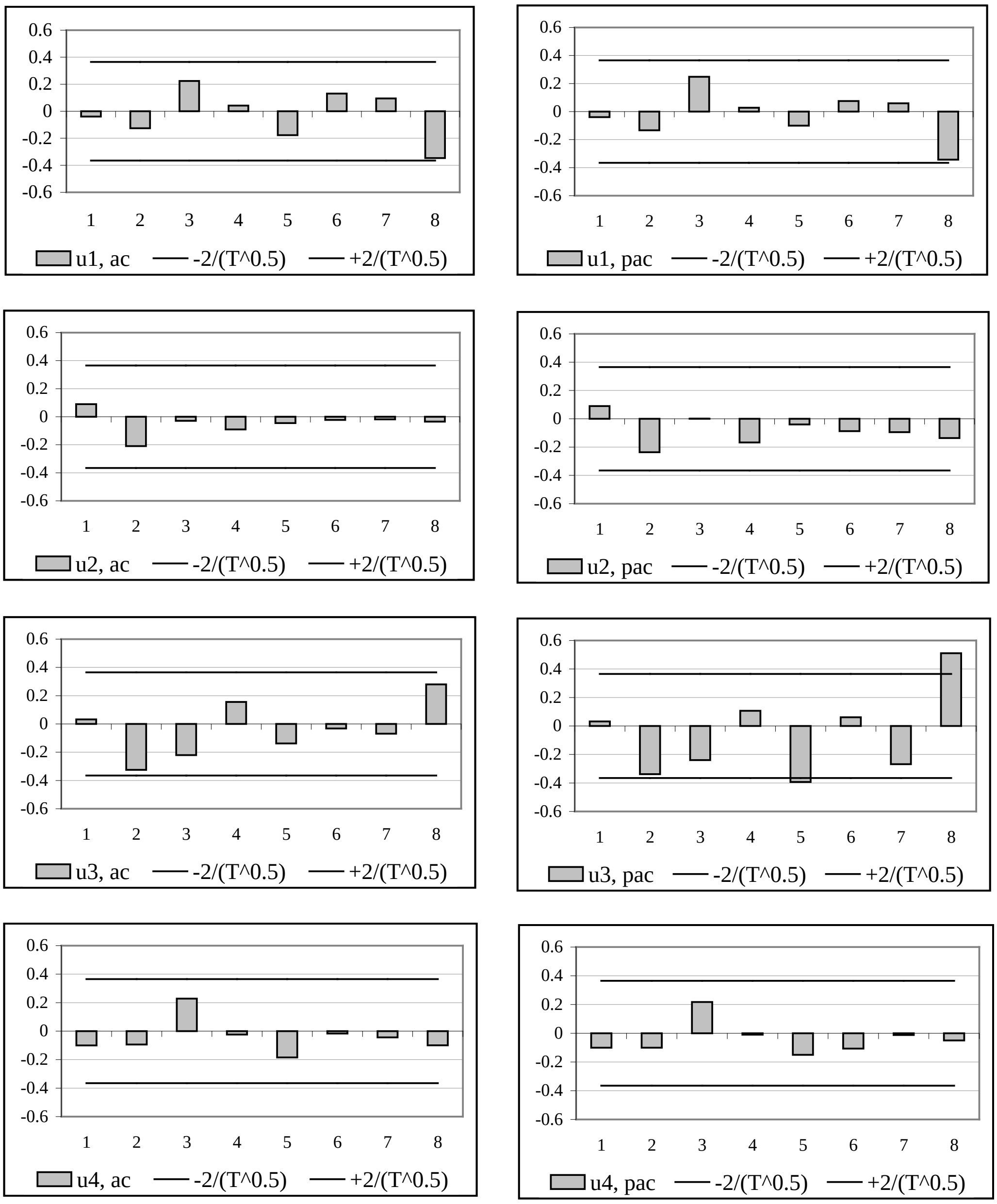
Figure A6. 1b: Plots of accumulated responses to impulses




IMPULSES
IIP_log →
LTDOMFUND →
ACCUMULATED RESPONSES
SI_log
→ LI_log
→ IIP_log
→ LTDOMFUND

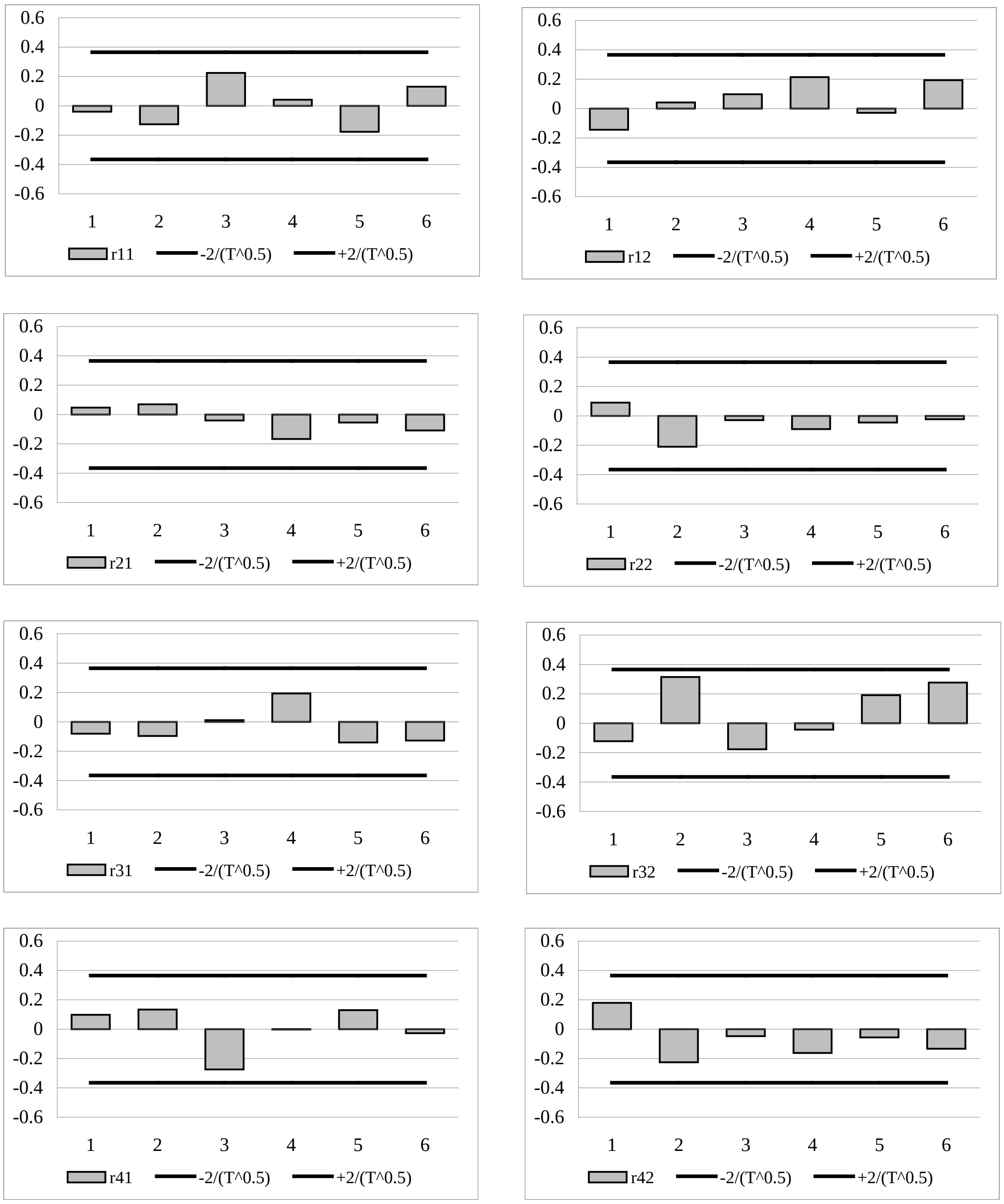
Appendix 6.3: The auto and partial correlation functions of the residuals from the four VECM equations

Set of Figures A6. 2: ACF and PACF of the residuals



Appendix 6.4: The cross-correlogram of the residuals from the four VECM equations

Set of Figures A6. 3: The cross-correlograms



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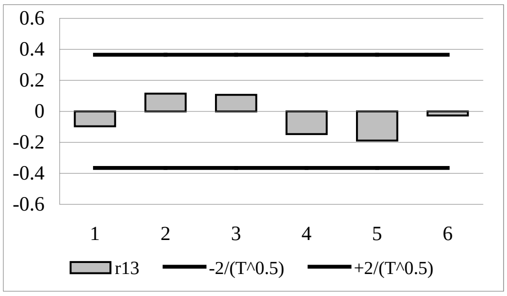

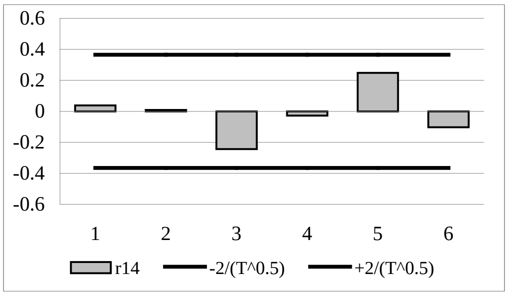

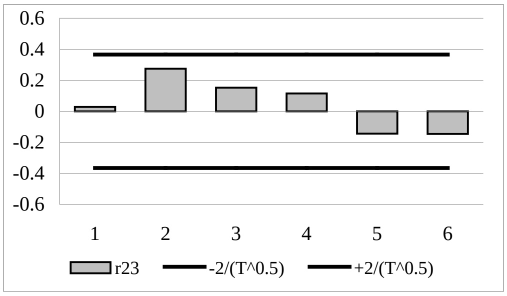

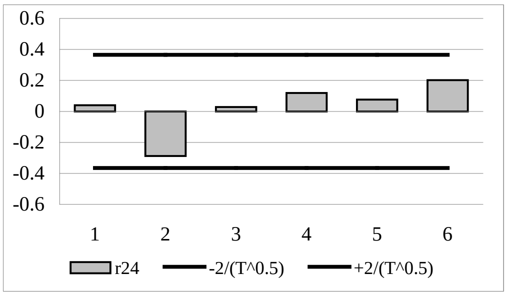

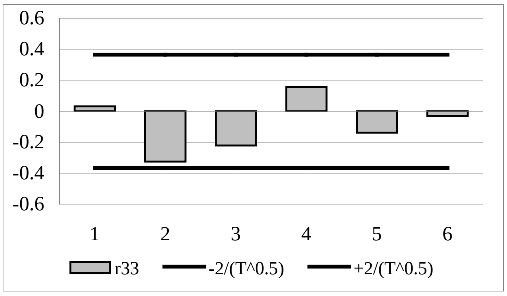

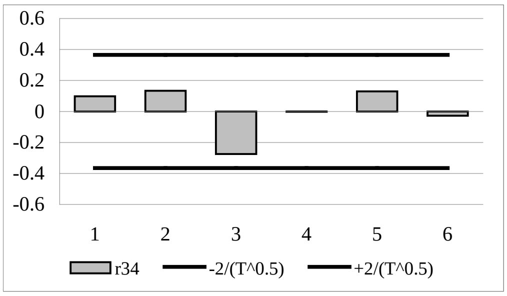

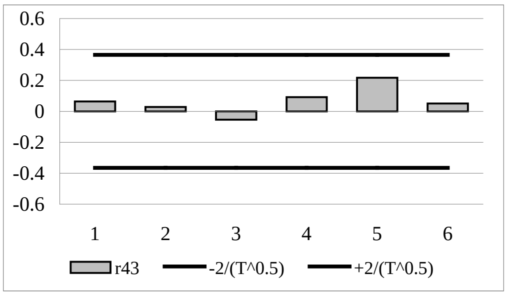

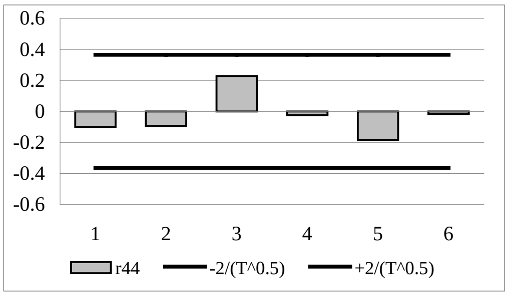

Appendix 6.5: The plots of the error correction term with the short-term dynamics

Figure A6. 4a: The EC term with the short-term dynamics, positive shock

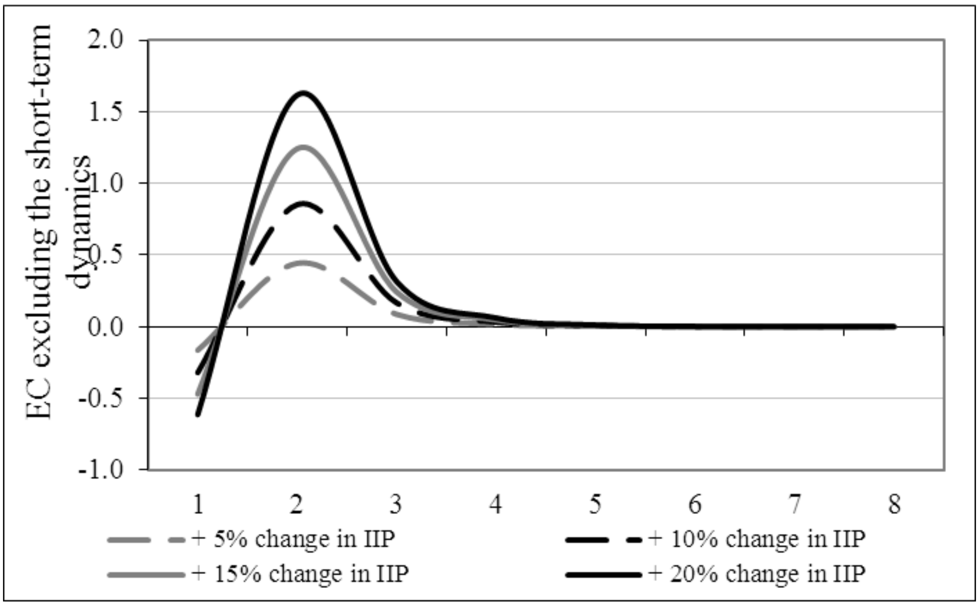

Figure A6. 4b: The EC term with the short-term dynamics, negative shock