

# The Effect of Currency Board Arrangements on Inflation Performance in Transition Countries before and during the Global Financial Crisis\*

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## *Abstract*

*The aim of this paper is to empirically investigate the difference in inflation performances between European countries that adopted a currency board arrangement (CBA) in the early stage of transition and countries with other monetary regimes. The sample consists of 25 transition countries for the period 1998-2015. Before the Global Financial Crisis (GFC) the main objective of most central banks was the maintenance of low inflation rates and many studies investigated which regime was the best for keeping inflation rates at low levels. A CBA, as very rigid monetary regime, proved to be beneficial for fulfilling this goal. However, during and after the GFC central banks around the world tried to offset deflationary pressures and those that implemented a CBA have been unable to do so by implementing expansionary measures. Therefore, the question about CBA performance during and after the crisis is raised and has not been previously investigated and this paper aims to fill this gap. The results indicate that the effect of CBA on inflation has been negative, yet even larger during and after the GFC, which makes the desirability of this regime in these circumstances questionable.*

## **1. Introduction**

A currency board is an arrangement under which a country fixes its nominal exchange rate to some foreign currency and maintains 100 percent backing of its monetary base with foreign exchange. Under an orthodox currency board arrangement a central bank cannot implement a discretionary monetary policy using traditional monetary policy instruments. These rules are typically embedded in law and therefore can be changed only if the law is altered, which makes the currency board a “tougher” and more credible regime than other monetary regimes with a fixed exchange rate. Currency board arrangements (CBA hereafter) were introduced in some countries in the process of transition to a market economy to assist with the achievement and maintenance of monetary stability. The increased credibility of central banks induced by currency boards is expected to decrease inflationary expectations and consequently to lower inflation. However, this effect is not straightforward since it depends on residents’ trust in their local monetary authority and their expectations regarding future developments.

Previous studies find evidence supporting the beneficial effect of CBA on inflation (Anastassova, 1999; Ghosh et al., 2000; Wolf et al., 2008). However, none of

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these studies controlled for dynamics, which is argued to be important in the inflation literature. Moreover, all of these studies treated a CBA only as an exchange rate regime, while it is more appropriate to treat it as a monetary framework since, besides defining the type of exchange rate regime, it also defines a monetary rule (Kuttner and Posen, 2001; Rose, 2011 and Dabrowski et al., 2015). This paper therefore estimates the effect of CBA on inflation performance in transition countries taking inflation inertia into account and treating the CBA as a monetary framework.

Even when the expected negative effect of CBA on inflation exists, its desirability during a contractionary crisis is questionable. In the recent Global Financial Crisis (GFC hereafter) most countries had a problem with deflationary pressures and many central banks directed their policies towards offsetting those pressures. Studies which investigated the effect of different exchange rate regimes on macroeconomic performance during the GFC did not find any significant difference in the effect of exchange rate regimes on economic outcomes (Rose, 2011; Dabrowski et al, 2015). However, when analysing performance by monetary policy framework, Dabrowski et al.'s (2015) analysis suggests that the option of depreciation cum international reserve depletion outperformed other policy responses. Since countries with a CBA faced with the GFC had a weaker ability to fight deflationary pressures, the stabilizing effect of CBA in "normal times" is likely to be reversed. Therefore, the second aim of this paper is to investigate the effect of CBA on inflation performance after the outbreak of the GFC.

The following section provides a review of studies that investigate the effect of a CBA on inflation. Section 3 analyses the main trends in those transition countries included in the empirical analysis, concentrating on the period 1998-2015. Section 4 elaborates inflation determinants and specifies the model. Section 5 investigates the effect of a CBA in transition countries on inflation performance over this period. Subsequently, the empirical analysis is extended to investigate whether the effect on inflation differs with the strictness of the CBA. The conclusions of the empirical analyses and their implications for policymakers are examined in Section 6.

## **2. Theoretical Background and Empirical Evidence**

The prediction of orthodox economic theory is that countries with a fixed exchange rate regime will have a lower inflation rate, *ceteris paribus*, than countries with a flexible exchange rate regime, since pegs are likely to lower inflationary expectations (the "confidence effect") and the rate of money growth (the "discipline effect"). This prediction has been confirmed by many studies (e.g. Levy-Yeyati and Sturzenegger, 2001; De Grauwe and Schnable, 2004; Domac et al., 2004), although the size of the effect differs depending on the level of development of the countries observed and exchange rate regime (hereafter ERR) classification used. As a type of pegged ERR (usually classified as a "hard" peg), CBAs are expected to reduce inflation even more than other pegged ERRs, due to the greater credibility of the monetary authority under a CBA (Wolf et al., 2008; Begović et al., 2016). In particular, in a world of free capital movements other fixed exchange rate regimes can alter the exchange rate parity. Moreover, the abolition of a CBA is more difficult than the abolition of other pegged ERRs and there is no time-inconsistency problem in CBA countries. Consequently, the inflation rate is expected to be lower and more stable in

the CBA countries than in countries with other pegged ERRs. This feature of a CBA is considered beneficial in “normal times”, but in the crisis, when other countries are implementing expansionary measures to stimulate prices and growth, this feature might be considered to be an impediment to growth.

It has been argued that for small developing countries it is desirable to fix the exchange rate due to issues of monetary credibility that arise in the context of a separate currency (Gudmundsson, 2006). Hanke and Schuler (1994) argue that a currency board transmits the relative credibility of the reserve country's central bank to the currency board country and that it can “import” the monetary policy of a “good” central bank. This is argued to be an especially advantageous strategy when (i) a monetary union with the currency that the small country is pegging to is the preferred exit strategy (Gudmundsson, 2006) and (ii) the aim is to trade more with the pegging currency country, which is one of the reasons that those European countries with a CBA maintained that regime until Eurozone accession (Estonia and Lithuania, which became EMU members, and Bulgaria and Bosnia and Herzegovina (BH) which are moving in that direction). Another reason for a small country to opt for a regime such as a CBA is that maintaining a central bank with its own monetary policy is costly, which will weigh more heavily on a small economy (Rose, 2011). Moreover, for a small and open economy the cost of not using the exchange rate as an instrument is not that much important, since these countries are international price-takers. In countries where the potential for political bias is high then a currency board may be more easily protected from political pressures than a “typical” central bank (Hanke and Schuler, 1994).

There are many studies estimating the effects of different ERRs on inflation, some of which include a CBA, together with dollarization (and in some cases a conventional pegged arrangement) as a type of a “hard” peg (De Grauwe and Schnabl, 2004; Bleaney and Francisco, 2007; Ghosh et al., 2011). The few studies that focus on CBAs, estimate their effects by comparing different countries with different ERRs (the “comparison” approach) or by observing one country during the periods before and during the CBA (the “experimental” approach). A limitation of studies using the former approach is that relatively few observations are related to countries with a CBA. On the other hand, the “experimental” (time-series) approach requires data for a long period. Moreover, Kwan and Lui (1999) argued that variability in the data between two periods is needed in order to empirically capture the effect of the regime. Since our focus is on transition countries, data limitations preclude an experimental approach; hence the following literature review focuses on studies that use the comparison approach.

Anastassova (1999) uses panel data analysis of 22 countries for the period 1984-1997 and estimates the effect of a CBA on inflation by dividing the sample into three groups: the first consists of six CBA countries; the second of five countries with a similar-to-CBA regime; and the third of eleven countries with a pegged ERR or crawling band. According to the results, the CBA countries had lower inflation than other pegged ERRs countries (and countries with regimes similar to CBA). When the CBA dummy is split between “strong” (more rigid) and “weak” (less rigid) CBAs the results indicate the stronger impact of a “strong” CBA on inflation. However, there are some limitations in the analysis presented in this paper. First, it is not clear what the comparison group for the “strong” and “weak” CBA dummies is (all other countries

from the sample, countries with regime similar to CBA or other pegged ERRs). Moreover, by controlling only for money supply and openness, the author fails to control for other potentially important variables, such as the degree of central bank independence and GDP growth. A further important limitation is that the potential endogeneity of the regime choice is not controlled. Moreover, the observed period after the adoption of CBA is quite short (being only a year for some countries, such as Bulgaria) and Bosnia and Herzegovina is not included in the sample, due to unavailability of data. Finally, diagnostic tests of the empirical analysis are not reported and the author does not control for dynamics.

Ghosh et al. (1998) analyse the effect of different ERRs on inflation in all IMF member countries for the period 1970-1996. They include money supply growth, openness, GDP growth and a measure of the central bank's independence in the inflation regression as controls. Additionally, annual dummies are added to control for global inflation shocks. Since they argue that countries prone to low inflation are more likely to adopt a CBA, Ghosh et al. treated the resulting potential endogeneity issue by first estimating a probit model in a two-stage procedure using the fitted values as instruments. Their results suggest that the average inflation rate under a CBA was about 4 percentage points lower than the inflation rate in other pegged exchange rate countries. However, there are a few limitations of this study. Firstly, they fail to control for country-specific factors. Secondly, since the period they covered in their analysis does not include any significant economic disruptions, the authors acknowledge that currency board arrangements may perform better than they would in a more unstable period. Moreover, their sample contains a relatively small number of CBA countries and only a short period after the introduction of most CBAs. Finally, these authors do not report diagnostic tests. A similar group of authors (Ghosh et al., 2000) conducted a similar analysis, extended for a robustness check, in which the fiscal balance, nominal exchange rate variability, institutional quality index were included in the inflation regression. These additional controls did not alter the negative relationship and significance of the CBA's effect on inflation.

Besides the controls that were used in Gosh et al. (2000), Wolf et al.'s (2008) inflation equation includes a 'central bank's governor turnover' variable, which is a further proxy for central bank independence and terms of trade shocks. GDP growth, money growth rate and fiscal balance are instrumented by their lagged values, to control for their potential endogeneity. The results again indicate that, on average, the CBA countries had lower inflation than countries with other pegged or flexible ERRs. The results are robust after excluding the first few years following the adoption (to control for the potential "contamination"), inclusion of fixed effects and accounting for the possible endogeneity of the regime choice. Additionally, Wolf et al. (2008) tested the success (defined as the ability to maintain inflation below its pre-stabilisation rate after three years) and durability (defined as the ability to maintain inflation below its initial post-stabilisation rate after three years) of the positive effects of CBA on inflation performance compared to other ERRs. They found that the levels of "success" and "durability" were considerably higher for CBA countries than countries with other ERRs. They also estimated that CBAs have been more successful in lowering inflation in countries that started with high inflation.

The previous three studies did not note what type of ERR classification (*de jure* or *de facto*) they used to classify the countries into a specific group. Moreover, they

treated a CBA only as an ERR, not a monetary regime/framework. Although it is defined as an ERR in the IMF classification, a CBA is also a monetary regime which incorporates monetary rules and the level of monetary discretion (for more details see Kuttner and Posen, 2001 and Nenovsky, 2009) and therefore it is important to compare it with other monetary regimes. Moreover, since periods included in these studies did not include the GFC they were not able to identify the effect of CBAs during the global crisis. Finally, none of the above studies controlled for potential inflation hysteresis by using dynamic estimators. To overcome these limitations, this study addresses each of these issues.

### 3. Choice of Sample and Sample Specifics

To estimate the effect of a CBA on inflation, panel data from a sample comprising 25 transition countries from the Central, South-Eastern Europe and the former Soviet Union<sup>1</sup> for the years 1998-2015 are used. The main reason for not including the period prior 1998 is a data constraint. Since there is no data on the EBRD indicator for the Czech Republic for the years after 2008, and data on the general government balance for Serbia in 1998 and 1999 and on openness for Hungary and Lithuania for 2009 are missing, the panel is unbalanced. Data for all countries and all years for certain variables are not always available from the same source. For most countries the data used are those from international databases, such as the IMF's and the World Bank's databases, but for some countries national statistics had to be consulted. Data sources for the variables used in each regression will be discussed and analysed within the appropriate sub-sections.

It has been argued that transition (and developing) countries should be treated separately from developed countries, since they have specific features (such as lack of policy makers' credibility, limited access to international markets, high default risk, weak and underdeveloped institutions) and are going through the process of transition towards a market-oriented economy, which is likely to affect macroeconomic variables significantly (Domac et al., 2004; Barlow, 2010; Frankel, 2010). Moreover, most of the countries in this sample changed their monetary and/or ERRs as a part of the transition process (Domac et al., 2004). Four of these countries (Bosnia and Herzegovina, Bulgaria, Estonia and Lithuania) introduced a CBA, largely as a means of re-establishing macroeconomic stability. Before reporting our formal modelling we describe and comment on inflation trends in transition countries from two perspectives: (i) according to differences in monetary policy and exchange rate regimes; (ii) according to the EBRD classification of transition economies.

#### **Inflation Trends According to Different Monetary and Exchange Rate Regimes**

After the collapse of the planned economies, the transition countries followed different paths when it comes to their chosen monetary and exchange rate regimes. However, as noted in Nenovsky (2009), some trends can be captured. Nenovsky differentiates between two types: (I) the "fixed-start" type, which includes countries that started with a fixed exchange rate regime and a strict control of money supply and

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<sup>1</sup> Since Serbia and Montenegro separated in 2006 there is a lack of data for Montenegro and therefore it is excluded from the sample. Moreover, due to a lack of data Turkmenistan and Uzbekistan are also excluded from the sample.

subsequently moved to a floating exchange rate regime, inflation targeting or kept their strict regimes; and (II) the “floating start” type. The latter starting with a floating rate and later on introduced rigorous monetary regimes or kept their floating rate regimes.

Nenovsky focused on European transition countries in his classification, but Asian transition countries included in our sample could be classified in the second group. However, the first type could be divided into three groups: (i) countries which opted for a strict regime and kept it through time: Bosnia and Herzegovina, Lithuania, Estonia and Bulgaria (although Bulgaria started with floating, it soon switched to a CBA in 1997) through introducing a CBA (with Estonia and Lithuania later switching to the euro); Montenegro and Kosovo through euroisation (these two countries are not included in our sample due to lack of data, as these countries gained their independence in 2006 and 2008, respectively); (ii) Croatia, Latvia, Slovenia and the Slovak Republic, which opted for a more discretionary regime but *de facto* maintained their rates. Within the first type there is a group of countries that started with a strict regime and moved towards a more flexible/discretionary one, such as inflation targeting (iii): the Czech Republic, Poland and Hungary. Within the second group Albania, Macedonia, Romania and Serbia started with a floating rate and kept it, introducing *de facto* crawling and later *de facto* peg to euro (Romania introduced inflation targeting in 2005). Nenovsky (2009) argues that the countries in the first group were more successful in handling the process of transition.

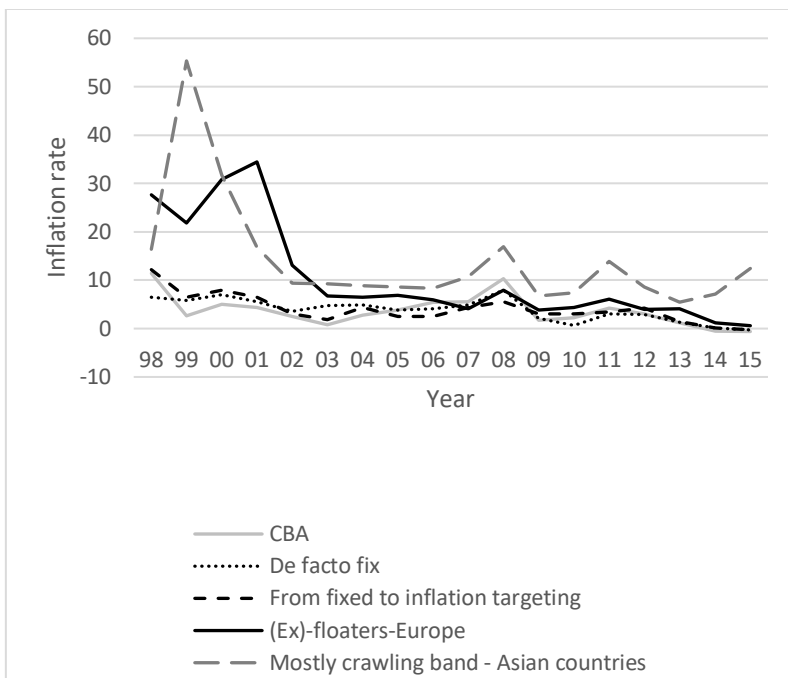
Since no CIS country has run a hard peg none could be classified as the first type. Instead, they correspond more to the second type. Tajikistan and Moldova moved from freely floating to *de facto* crawling. Most Asian ex-soviet member states opted for a *de facto* crawling peg (to the US dollar): Armenia, Azarbaijan (managed floating from 2015), Kazakhstan, Kyrgyz, Georgia, Russia, and the Ukraine (floating since 2014). Belarus changed its regime five times during the observed period.<sup>2</sup> Although this classifies all CIS countries as the second type, we observe them separately from the European “floating-start” type countries, since European transition countries *de facto* try not to deviate much from the euro on their way to the EU/EMU integration. Dabrowski (2013) argues that the worst inflation performance among Asian transition countries was by the non-credible peggers (which were not even classified as pegs in *de facto* classifications) such as Belarus and Ukraine or countries experimenting with various forms of a crawling peg/band depreciation, i.e., Uzbekistan, Tajikistan and Russia.

If we make five distinctive groups – CBA; *de facto* fixers; fixers that switched to inflation targeting; floaters that switched to more rigid regimes; and mostly crawling bands (CIS countries) – we can see that the last two performed the worst with respect to inflation (Figure 1). Among all five groups, CBA countries recorded the lowest inflation in 10 of the 18 years in our sample period (Figures 1 and 2).

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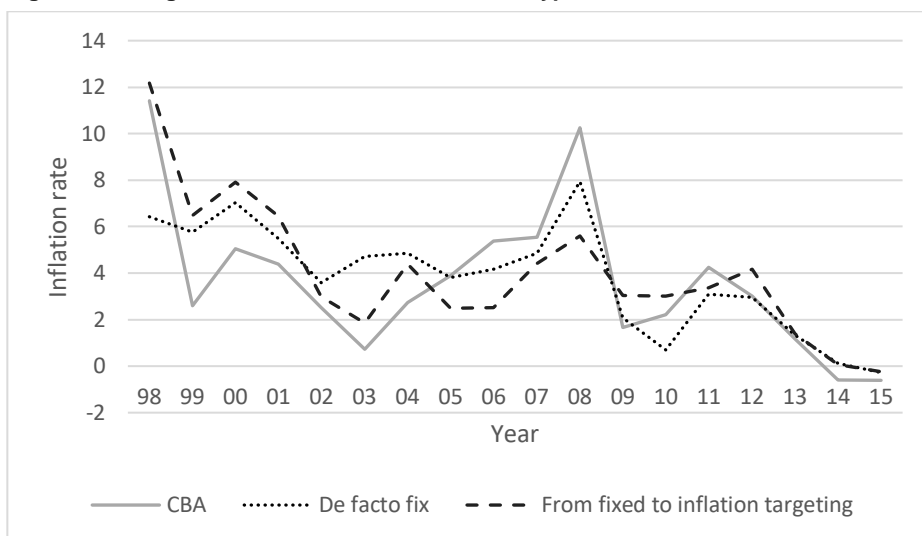
<sup>2</sup> Ilzetski et al. (2017) give a historical *de facto* classification of regimes for all these countries.

**Figure 1 Average Inflation Rate across Different Types of Regimes**



Source: Chart based on data from World Development Indicator.

**Figure 2 Average Inflation Rate across Different Types of "Fixers"**



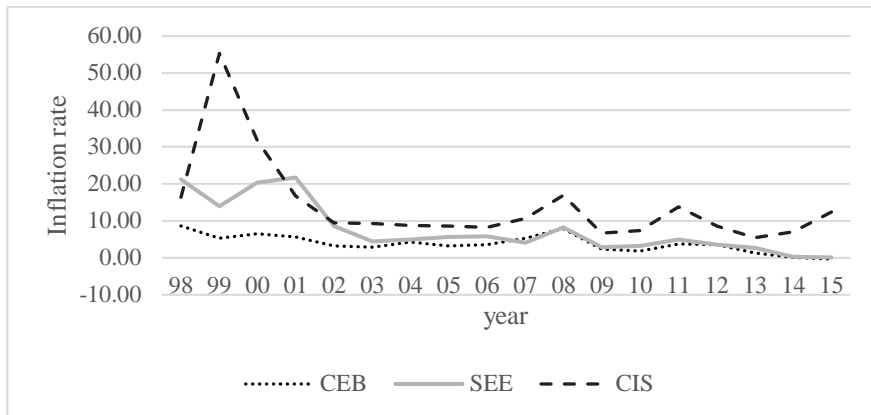
Source: Chart based on data from World Development Indicator.

### **Inflation Trends According to the EBRD Classification of Transition Economies**

Economic reform in transition countries has been achieved through stabilisation, liberalisation and privatisation processes (Barlow, 2010). Although the transition process in all countries started at the beginning of the 1990s, it did not progress at the same pace in all countries. Moreover, different countries had different pre-transition conditions and therefore their progress in transition would have been expected to differ. Therefore, these countries are typically divided into three groups, following the grouping suggested in the EBRD transition reports. The first group consists of Central Europe and the Baltic States (CEB), which includes the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. The second group is South-eastern European countries (SEE), which includes: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Romania, and Serbia. The third group is the group of Commonwealth of Independent States (CIS), which includes: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, and Ukraine.

Most of these countries experienced high inflation rates at the beginning of the transition process but managed to lower their inflation rates by the middle 1990s. This period is not included in the sample. However, as shown in Figure 3, there were some high inflation rates in the late 1990s in the CIS countries, which are likely to be the result of the Russian financial crisis in 1998 and the follow-up series of substantial currency devaluations/depreciations. The high average inflation rate for CIS countries in 1999 was mainly driven by the extremely high inflation rates in Belarus (293%) and Russia (85%). The high average rate of inflation in 1998 in SEE countries was mainly driven by high rates in Romania following the elimination of subsidies.

**Figure 3 Average Inflation rates (measured as percentage changes in consumer price index) in CEB, SEE and CIS Countries**



Source: Chart based on data from the World Development Indicator.

The inflation surge in 2001 in SEE countries was mainly reflecting the high inflation rate in Serbia (95%), which was the result of the Kosovo war in 1998-1999, and in Romania (35%). However, inflation rates stabilised after 2003 in most transition countries, only to increase again in the period immediately preceding the GFC –



generated by the expansionary monetary policy of the Fed and the weak US dollar. Inflation then returned to pre-crisis levels at the beginning of 2009. After 2011, the inflation rates generally fell (were even negative in some countries), especially in CEB and SEE countries, though this downward trend was reversed in 2013 in the CIS countries. For a comparison of inflation rates between CEB, SEE and CIS countries see Figure 3.

Relatively high inflation rates in CIS countries in 2011 mainly reflect the high inflation rate in Belarus, caused by a currency crisis (a sharp devaluation of national currency, due to political issues that undermined the trust in the central bank and the currency). The increase in inflation in CIS countries 2014 and 2015 was mostly driven by significant increases in inflation in Ukraine and Russia. These were driven mainly by territorial disputes between Ukraine and Russia in 2014. The value of the Ukraine's currency plummeted once the war began, driving up the cost of imported goods, and energy prices soared as the government cut its historically high subsidies. In Russia, international sanctions caused a collapse in the value of the Russian rouble and an increase in price levels. The next section specifies the potential determinants of inflation movements in transition countries which will be included in the regression analysis.

#### **4. Inflation Determinants in Transition Countries**

The actual and anticipated behaviour of the monetary authorities plays a crucial role in modern theories of inflation. Under more discretionary policy there is a higher possibility of time-inconsistency, which affects inflationary expectations, such that inflation is likely to be higher. Under rule-based monetary policy, and a CBA is one of the most rigid rule-based policies, the time-inconsistency problem is reduced significantly and therefore we expect it to lower inflationary expectations and inflation more than other monetary regimes. Unfortunately, we were not able to investigate the effect on inflationary expectations, since there was insufficient data (not all countries survey inflationary expectations).

The difference between the effect of a CBA and other regimes on inflation is estimated using a dummy variable identifying those countries and years where a CBA operated. The CBA variable captures what is unique to BH, Bulgaria, Estonia and Lithuania compared to all the other countries. Based on the comparison of macroeconomic variables and world development indicators, it can be concluded that the only outstanding similarity between these countries is a CBA and that there are no other characteristics common to those countries but different from those of the other countries in this sample.<sup>3</sup> There is no set of economic, political or historical characteristics that define these countries as a distinct group. Therefore, it is a reasonable presumption to believe that the CBA dummy variable is capturing the effect of CBA rather than some other set of common characteristic(s) of these countries. By including only a CBA variable the endogeneity problem between the choice of ERR and inflation is likely to be avoided. Namely, simultaneity between a CBA and

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<sup>3</sup> In addition, system GMM estimation, which is used in empirical analysis, includes group- (country-) specific fixed effect in the error term, and since initial conditions are, by definition, fixed, then initial conditions are already controlled for. If otherwise time invariant unobservable factors that might be confounded with CBA effects are controlled for, then the CBA effect can be identified.

inflation may occur, since it can be argued that countries with a greater proclivity towards low inflation may be more likely to adopt a currency board (Ghosh et al., 1998). However, periods of high inflation might explain the origins of a CBA, but not its maintenance. Since the sample period does not include a period before CBA introduction in any of these countries, it can be argued that simultaneity is not likely to be an issue, since the maintenance (and the abandonment) of a CBA is an institutional and political matter rather than determined by a countries' inflation aversion. However, it has to be noted that there is a data limitation, since we have only four countries with a CBA in our dataset, as there are no more countries which have applied this regime within transition countries. The alternative is to focus on each CBA country and observe the effects before and after, but there is insufficient time span available to conduct appropriate time series analysis.

For the inflation variable we use the logarithm of the percentage changes in the consumer price index (logs are used in order to reduce the effect of outliers) (Staehr, 2003; Barlow, 2006).<sup>4</sup> As suggested by monetary theory, a higher growth in money supply is likely to increase inflation, holding other factors constant. The positive effect of money supply growth on inflation is found in many studies (Wolf et al., 2008; Ghosh et al., 2011). In developing countries money supply growth and inflation might be considered endogenous, since a higher nominal price of goods and services increases money demand, which may put pressure on the authorities to increase money supply (Sargent and Wallace, 1981). This is not likely to be the case in many transition countries, which established more independent central banks during the early years of the stabilisation process. Moreover, since the broadest monetary aggregate is used, the increase in money demand is likely to result in increases in broad money supply, even when the central bank is not increasing the monetary base, through the credit multiplication process. Given that the effect of the monetary regime on inflation is likely to differ at different levels of money supply growth, it is important to test for the interaction between the two as well. On the other hand, real GDP growth is expected to be negatively correlated with inflation, *ceteris paribus*, since faster output growth should raise money demand and consequently decrease inflation for a given expansion of money supply (Wolf et al., 2008). However, in some studies it is argued that this relationship holds only in countries with a pegged ERR, since in countries with flexible ERRs output growth is likely to affect the exchange rate rather than inflation (Abbott and De Vita, 2011).

Beside the growth of money supply and output growth, the control variables usually included in inflation models are: fiscal balance; degree of openness; and terms of trade. A higher fiscal deficit is usually argued to increase inflation in developing countries, since in these countries a fiscal deficit is usually financed by an increase in the money supply growth (seigniorage) (Lozano, 2008). Additionally, as argued in Horvath and Kopernicka (2008), who examined inflation differentials between new-EU and EMU countries, a fiscal surplus reduces aggregate demand and therefore contributes to lower inflation. Fiscal balance as a percentage of GDP (FB) is therefore included and a negative coefficient is expected. A measure of the openness (OPEN) of

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<sup>4</sup> Average inflation has been used rather than its variability, since the central banks target and report average inflation, not its variability. Also, due to the small number of observations we wanted to preserve as many observations as possible.

an economy is usually included in the inflation regression to control for the potential disciplinary effect caused by international arbitrage (Levy-Yeyati and Stuzengger, 2001; Wolf et al., 2008; Ghosh et al., 2011), the expected effect of openness on inflation being negative, as domestic prices are more exposed to foreign competition. However, the effect might be reversed when a country is a price taker and predominantly imports high unit value goods and services. Fisher (1993) argued that the changes in terms of trade (TOT) are a major source of supply shocks for most developing countries. The commonly used measure for the terms of trade is a ratio of the export unit value index to the import unit value index. Accordingly, it is argued that when a country's terms of trade are improving (increasing) a country can afford more imports due to increased earnings from exports. These improvements are likely to increase the quantity of relatively cheaper import goods, and consequently lead to a decrease in inflation in the short-run.

Empirical studies which examine the inflation determinants in transition countries emphasise the importance of accounting for the effects of economic liberalisation, central bank independence and other institutional characteristics (Cukierman et al., 2002; Inoue, 2005; Barlow, 2010). In transition economies, there are many structural and institutional changes, which are expected to influence the inflation generating process. To account for these changes transition indicators are included in the model. Although they have some limitations, the EBRD indices, as the most widely used transition indices, are used. The aggregate EBRD index (EBRDI) indicates the overall progress in transition, assigning scores from 1 (which indicates little or no progress) to 4 (for the highest progress). Better progress in transition should result in lower inflation due to trade liberalisation (through increase in competition), privatisation (through increase in enterprises efficiency) and credit reforms (through the increase in monetary policy efficacy via raising the effectiveness of credit allocation), each of which is included in the aggregate EBRD index (Barlow, 2010).

An increase in a central bank's independence (CBI) is also argued to be a characteristic of the transition process and to influence inflation (Frankel, 2010; Maliszewski, 2000; Cukierman et al., 2002). Cukierman's CBI index (CCBI), which is usually used in similar studies, is constructed for every country by assigning points on certain features/questions assumed to affect central bank independence (such as "Who appoints the Governor?", "Limits on the level of CB credit to government", and "Provisions for dismissal of the CB governor") and by assigning certain weights to these features. Since an increase in central bank independence is associated with a decrease in the time-inconsistency problem, it is expected to lower inflationary expectations and therefore to decrease inflation. This relationship is found in many studies (Grilli et al., 1991; Cukierman et al., 2002; Panagiotidis and Triampella, 2006, as cited in Bogoev et al., 2012). The issue recognised by most of the recent studies is that the relationship between inflation and CBI is likely to be endogenous, since countries with a higher CBI are expected to have lower inflation but, on the other hand, the low inflation countries are likely to adopt more independent central banks, causing an inverse relationship between inflation and CBI.

One more potential determinant of short-run increases in inflation in transition countries is likely to be the introduction of value-added tax (VAT), which occurred in most of the countries in the sample during the early stages of transition. By 2000 VAT and excise duties were operational in virtually all transition economies with the

exception of some central Asian CIS countries, in particular Turkmenistan and Uzbekistan. Bye et al. (2003) noted that VAT reform increased the share of indirect taxation in consumer prices, and the aggregate price index of material consumption rose. A general result of all analyses conducted by Viren (2009) is that more than one half of a tax increase passes through consumer prices. None of the studies reviewed in Section 2 control for this effect. However, since it is believed that the introduction of VAT affected inflation in transition countries, a dummy variable that indicates the year of VAT introduction is included in the model. In addition, year dummies are included to control for shocks that are common for all countries such as an increase in oil prices or the onset and unfolding of the GFC. Finally, a dummy variable for EU membership is included, since countries that are EU members, and are thus expected to become Eurozone members, are trying to keep their inflation stable in order to fulfil the Maastricht criteria.

Horvath and Koprnicka (2009) examined the determinants of inflation differentials in a panel of EU countries compared to Eurozone countries. They identified the exchange rate changes, output gap, price level and fiscal deficit as important determinants of inflation differentials. In our paper, changes in the price level are the dependent variable, since we are not interested in the inflation differences between countries but in investigating how a specific monetary framework, namely CBA, affects inflation. Hence, we control for the specific regime rather than the exchange rate variability. It would also be interesting to see the effect of the Emerging Market Bond Index on inflation, even though it could easily be argued that there would be simultaneity between the two, but this variable is not included due to data limitation.<sup>5</sup>

Annual data for all variables is used. All the above specified variables with their measures, labels, and expected signs are presented in Table 1A in the Appendix. Initially the main trends in these determinants in countries with a CBA will be compared with their trends in countries with other regimes (Table 1).

**Table 1 Comparison of Average Trends in Inflation and Inflation Determinants Between Countries with a Currency Board Arrangement (CBA) and Countries with Other Regimes**

Variable	CBA				Other regimes			
	Mean	SD	Min	Max	Mean	SD	Min	Max
INF (inflation)	13.83	3.81	8.58	28.67	19.59	20.57	1.47	303.68
GDPG (GDP growth)	3.91	5.15	-14.81	15.60	4.26	4.93	-14.80	34.50
MSG (money supply growth)	16.45	13.57	-0.71	90.00	23.10	26.80	-15.17	276.00
FB (fiscal balance)	-1.53	2.76	-9.33	3.23	-2.33	3.68	-13.89	20.60
OPEN (openness)	112.05	24.22	73.80	166.86	98.99	31.88	24.17	199.68
TOT (terms of trade)	99.96	4.08	93.58	109.52	108.56	26.60	70.69	233.31
EBRDI (EBRD Transition Indicator Index)	3.48	0.50	2.28	4.06	3.31	0.51	1.56	4.06
CCBI (Central Bank Independence Index)	0.90	0.06	0.78	0.98	0.74	0.17	0.34	0.99

Notes: SD refers to standard deviation and min and max are the lowest and the highest value of the variable,

<sup>5</sup> There is no data available for the Emerging Market Bond Index for the sample countries. Moreover, alternative indicators are available only for a few countries and years from the sample.

respectively.

According to Table 1 countries with a CBA recorded, on average, lower inflation, lower GDP growth rates, lower money supply growth and lower fiscal deficits than did countries with other regimes. Furthermore, CBA countries were more open, but had less improved (decreased exports-to-imports unit value index) terms of trade compared to the countries with other regimes. CBA countries also recorded somewhat higher EBRD and CCBI indices than did countries with other regimes. The correlation matrix suggests that there are no signs of high correlation between the explanatory variables. Based on the correlation matrix (Table 2A in Appendix) we can see that there are negative correlations between inflation and the presence of a CBA, the European Bank for Reconstruction and Development's (EBRD) transition index, central bank independence, VAT introduction and EU membership; and positive correlations between inflation and GDP growth, money supply growth, fiscal balance, the degree of openness and terms of trade. Some of these signs are as expected. However, in order to identify a CBA effect, if any, we need to go beyond unconditional bivariate correlations. Accordingly, we specify a model to identify a CBA effect conditional upon all the other determinants of inflation. The results are reported and discussed in the next section.

## 5. Empirical Analysis

### 5.1 Estimation, Results and Discussion

The studies that were reviewed in Section 2 applied OLS and fixed effect estimating methods to estimate the effect of CBA on inflation. Botrić and Cota (2006) argued that since the inflation generating processes differ substantially across transition economies then it is particularly important that country specifics should be taken into account. This implies that the fixed effects (FE) estimation should be preferred over OLS. Using the FE model precludes separate estimation of the time-invariant variables, since it uses only within-group (time) variation. This is an important issue for this model, since the variable of interest (CBA) is largely unchanged during the observed period (it is 0 only for the last few years for Estonia, since its accession to the Eurozone). Moreover, recent studies of inflation emphasise the importance of modelling dynamics (Levy-Yeyati and Stuzengger, 2001; Bleaney and Fransisco, 2005; Barlow, 2010). Levy-Yeyati and Stuzengger (2001) argued that the lagged dependent variable should be included to capture the effect of past policies on current expectations, as well as to control for the possibility of backward-looking indexation. As it is likely that there is "inflation inertia" in the countries in our sample we thus use a dynamic estimator to capture this effect.<sup>6</sup> This inflation persistence is captured by inclusion of one lag of inflation ( $INF_{i,t-1}$ ) in the estimated equations (Equations 1, 2 and 3). Our baseline specification is Model 1, in which  $i$  indexes the sample countries and  $t$  indexes sample years.

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<sup>6</sup> We estimated models using OLS and FE and together with the standard serial correlation tests. In both cases, the diagnostic tests, conducted after OLS and FE estimation, suggested that serial correlation may be an issue and that, accordingly, a dynamic estimator is likely to be more appropriate. Due to the noted limitations of these estimators we do not report OLS and FE results.

$$\text{LnINF}_{i,t} = \alpha_0 + \alpha_1 \text{LnINF}_{i,t-1} + \alpha_2 \text{CBA}_{i,t} + \alpha_3 \text{CCBI}_{i,t} + \alpha_4 \text{GDPG}_{i,t} + \alpha_5 \text{MSG}_{i,t} + \alpha_7 \text{FB}_{i,t} + \alpha_8 \text{OPEN}_{i,t} + \alpha_9 \text{TOT}_{i,t} + \alpha_{10} \text{EBRDI}_{i,t} + \alpha_{11} \text{EU}_{i,t} + \alpha_{12} \text{VAT}_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

where  $\varepsilon_{i,t} = u_i + v_{i,t}$  ( $u_i$  is a group-specific effect and  $v_{i,t}$  is the idiosyncratic error) and  $\gamma_t$  is a full set of period dummies, which is essential to eliminate – or, at least attenuate – cross-country residual correlation.

We next add interaction terms: (i) between the CBA dummy and money supply growth to test for the potential difference in the effect of CBA on inflation at different levels of money supply growth; and (ii) in order to test for the effect of CBA after the beginning of the GFC, a dummy variable for the crisis/post-crisis period (2009-2015) was included and interacted with the CBA dummy.<sup>7</sup> Equation 2 is our fully specified model.

$$\text{LnINF}_{i,t} = \alpha_0 + \alpha_1 \text{LnINF}_{i,t-1} + \alpha_2 \text{CBA}_{i,t} + \alpha_3 \text{CCBI}_{i,t} + \alpha_4 \text{GDPG}_{i,t} + \alpha_5 \text{MSG}_{i,t} + \alpha_6 \text{CBA} \cdot \text{MSG} + \alpha_7 \text{CRISIS}_{i,t} + \alpha_8 \text{CBA} \cdot \text{CRISIS} + \alpha_9 \text{FB}_{i,t} + \alpha_{10} \text{OPEN}_{i,t} + \alpha_{11} \text{TOT}_{i,t} + \alpha_{12} \text{EBRDI}_{i,t} + \alpha_{13} \text{EU}_{i,t} + \alpha_{14} \text{VAT}_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (2)$$

In these dynamic models, money supply and CBI variables are included in their current values and treated as endogenous (as suggested in previous studies – see Section 4) and their lags are used as instruments. In order to estimate our dynamic models, as well as to use internal instruments for potentially endogenous variables, General Method of Moments (GMM) estimation is used. The Arellano-Bond approach (“difference” GMM; Arellano and Bond, 1991), which uses lagged values of the levels as instruments for the equations in first differences, is not appropriate, since it omits the variable of interest, which is time-invariant. Therefore, we use the Arellano-Bover/Blundell-Bond “system” GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) which builds a system of two equations: a difference equation, in which endogenous variables are instrumented by levels; and a levels equation in which instruments are provided by first differences. Additionally, system GMM is more comprehensive than difference GMM, since lagged levels (used in difference GMM) are argued to be poor instruments for first differenced variables, especially for variables that are close to a random walk, which is frequently the case with macroeconomic variables (Baum, 2006).

Equation 1 is first estimated without and then with the interaction between money supply and CBA. Due to the small sample, the minimum number of lags was used. However, even with a minimum number of lags the number of instruments exceeds the number of groups (the number of instruments for each specification are 93, 118 and 119, respectively, while the number of groups is 25 (as noted in Table 2a). Consequently, the Hansen version of the Sargan test is weak – indicated by the p-value = 1.00 – meaning that it is unable to reject the null hypothesis of instrument validity (strictly, the validity of the over-identifying instruments). However, the Sargan test is

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<sup>7</sup> Although it is not clear what is the crisis and what is the post-crisis period, and it differs from country to country, we treated 2009-2015 as a crisis/post-crisis period, since these countries struggled to increase prices (and stop deflationary pressures) in this period. Moreover, it is argued that the CESEE region was remarkably resilient to the GFC until the last quarter of 2008 (Source: <https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp114.pdf>) and that is why we observe the period from 2009.

available (reported at the end of Table 2a) and suggests that there is no problem with instrument validity when interaction terms are included. Moreover, tests reported in Table 2a for the first- (m1) and second-order autocorrelation (m2) suggest no problem with autocorrelation in the differenced residuals, which is likewise consistent with instrument validity.

**Table 2a Results from the One-Step 'System' GMM - Estimation of Equations 1 and 2**

<i>Variables</i>	<i>Equation 1</i>	<i>Equation 2</i>
<b>L1.LNINF</b>	0.411***	0.410***
Inflation (lagged)	(0.0553)	(0.0512)
<b>CBA</b>	-0.0750*	0.0644
Currency board arrangement	(0.0443)	(0.0407)
<b>1.CBA*MSG</b>		-0.00568***
CBA=1, money supply growth		(0.00144)
<b>1.CBA*1.CRISIS</b>		-0.137***
CBA=1 and crisis=1		(0.0516)
<b>GDPG</b>	-0.00418	-0.00397
GPD growth	(0.00351)	(0.00356)
<b>MSG</b>	0.00524***	0.00538***
Money supply growth	(0.00128)	(0.00121)
<b>FB</b>	0.00665	0.00562
Fiscal balance	(0.00468)	(0.00424)
<b>OPEN</b>	0.000892	0.000871
Openness	(0.000696)	(0.000688)
<b>TOT</b>	-0.000505	-0.000541
Terms of trade	(0.000667)	(0.000634)
<b>EBRDI</b>	-0.0391	-0.0363
EBRD indicator	(0.0571)	(0.0519)
<b>CCBI</b>	-0.204	-0.255
Central bank independence	(0.288)	(0.242)
<b>VAT</b>	0.193***	0.197***
Value added tax	(0.0614)	(0.0583)
<b>EU</b>	0.0245	0.0279
European Union	(0.0403)	(0.0389)
<b>CRISIS</b>		-0.215***
Global financial crisis		(0.0817)
Constant	0	1.878***
<b>TIME DUMMIES</b>	included	included
Number of observations	285	285
Number of groups	25	25
Number of instruments	93	119
Sargan (Prob > chi2)	0.038	0.120
m1+m2 (Pr > z)	0.018/0.841	0.020/0.841

Notes: \*\*\*, \*\*, \* denotes that variables are statistically significant at the 1%, 5% and 10%, respectively.

Since Equation 2 contains interaction terms, we conduct a two-stage procedure and report results from: both (i) estimation, including the constant term and the two interaction terms; and (ii) the marginal effects derived post-estimation from these regression estimates. The results in Table 2b are from the post-estimation “margins” command and these will be discussed, since regression results with interaction terms require post-estimation of marginal effects, as coefficients on interaction terms and variables which are part of interaction term cannot be interpreted in a sensible way on their own, but are a platform for calculation of marginal effects. Hence, in Table 2b there are no separate estimates for the constant term or the interaction terms. The marginal effects take into account that the CBA is part of the interaction terms (since these are included in the regression prior to the calculation of the marginal effects), even though the marginal effect of the interaction term cannot be observed separately

from the “margins” results.<sup>8</sup> To aid interpretation, the effects of interactions are presented graphically by the marginsplots below. As can be seen from the first results columns from Table 2a and Table 2b, for variables that are not interacted the direct estimates and the derived, second-stage estimates are the same. It is only for the interacted variables that we need the second-stage derived estimates.

**Table 2b Post-Estimation Results (marginal effects) after Estimation of Equations 1 and 2**

<i>Variables</i>	<i>Equation 1</i>	<i>Equation 2</i>
<b>L1.LNINF</b>	0.411***	0.410***
Inflation (lagged)	(0.0553)	(0.0512)
<b>CBA</b>	-0.0750*	-0.103**
Currency board arrangement	(0.0443)	(0.0449)
<b>GDPG</b>	-0.00418	-0.00397
GPD growth	(0.00351)	(0.00356)
<b>MSG</b>	0.00524***	0.00446***
Money supply growth	(0.00128)	(0.00112)
<b>FB</b>	0.00665	0.00562
Fiscal balance	(0.00468)	(0.00424)
<b>OPEN</b>	0.000892	0.000871
Openness	(0.000696)	(0.000688)
<b>TOT</b>	-0.000505	-0.000541
Terms of trade	(0.000667)	(0.000634)
<b>EBRDI</b>	-0.0391	-0.0363
EBRD indicator	(0.0571)	(0.0519)
<b>CCBI</b>	-0.204	-0.255
Central bank independence index	(0.288)	(0.242)
<b>VAT</b>	0.193***	0.197***
Value added tax	(0.0614)	(0.0583)
<b>EU</b>	0.0245	0.0279
European Union	(0.0403)	(0.0389)
<b>CRISIS</b>		-0.452***
Global financial crisis		(0.0716)
<b>TIME DUMMIES</b>	included	included

Notes: \*\*\*, \*\*, \* denotes that variables are statistically significant at the 1%, 5% and 10%, respectively.

Results from the one-step “system” GMM (summarised in Tables 2a and 2b) suggest that in all specifications the lagged dependent variable is highly significant and positive, indicating that inflation is persistent in these countries. Moreover, in spite of concerns over instrument validity, given the small sample size, a standard diagnostic check supports the validity of our system GMM estimates (Roodman, 2006): i.e. in each of the three models, the size of the coefficient on the lagged dependent variable from the dynamic estimation lies between the values of the coefficients from, respectively, OLS and fixed effect estimation.

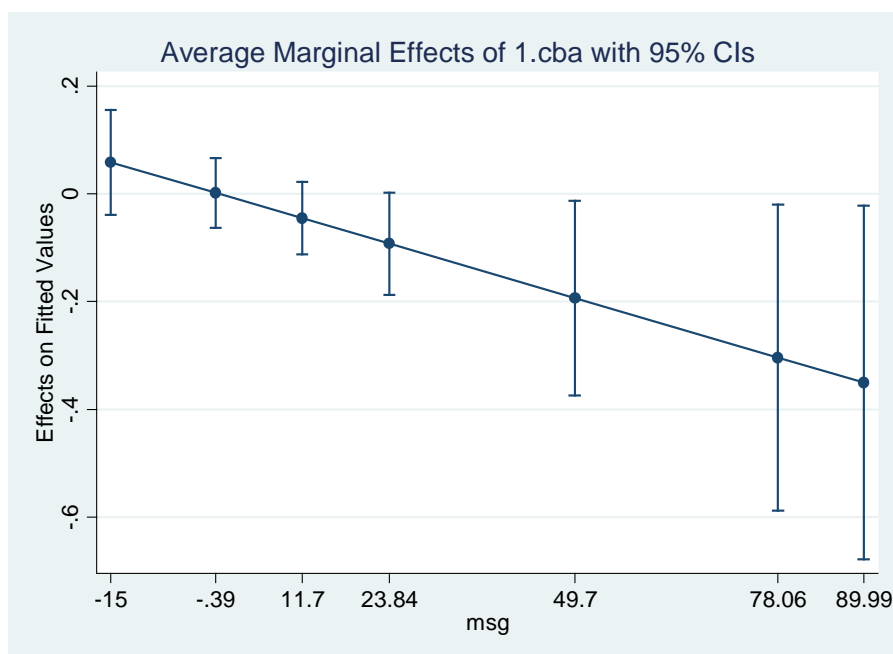
The marginal effects results suggest that the CBA has a significant and negative effect on inflation in all specifications. The effect is somewhat larger when interaction terms are included. For example, in Equation 1 the coefficient on the CBA variable suggests that countries with a CBA have, on average, a 9.79 percentage points lower

<sup>8</sup> The command “margins” (introduced in STATA11) does not report the marginal effects of the interaction terms, since, as stated in Williams (2012, p.329): ‘The value of the interaction term cannot change independently of the values of the component terms, so you cannot estimate a separate effect for the interaction.’



inflation rate than countries without a CBA,<sup>9</sup> holding other factors constant. The money supply variable is significant and positive in all specifications. The introduction of VAT also has significant and positive effect on inflation in all specifications indicating that it has a positive short-run effect on inflation. As noted above, the marginal effect of the interaction term cannot be observed separately. Therefore, the indirect or moderating effects of the interaction terms are presented in Figures 4 and 5. The marginal effect of a CBA at different levels of MSG indicate that the effect of CBA is significant when money supply growth is positive and it is more negative the higher the money supply growth (Figure 4). This suggests that the CBA tends to repress the effect of money supply growth on inflation, which is an additional argument for maintenance of a CBA.

**Figure 4 The Average Marginal Effect of CBA on Inflation Conditional on Money Supply Growth**



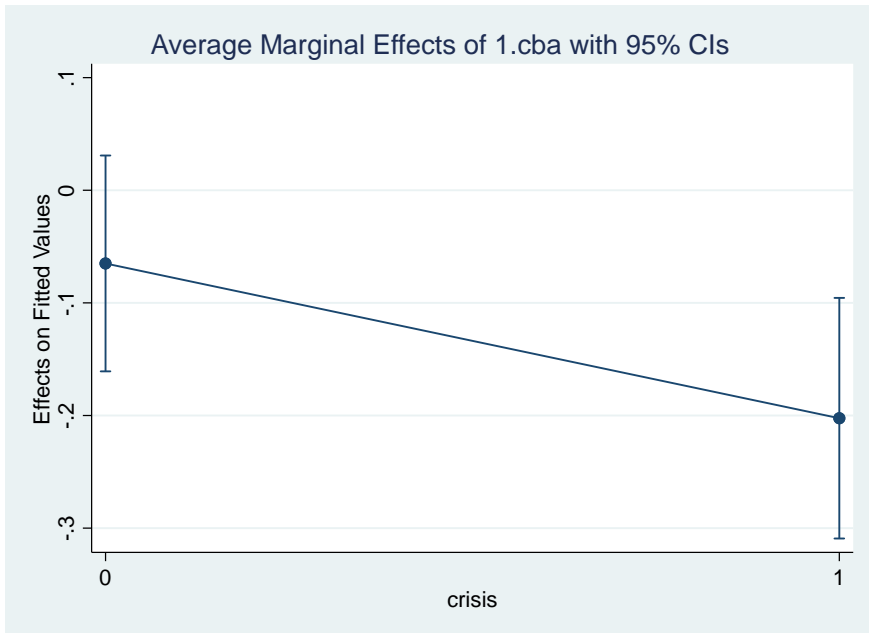
Source: Post-estimation results (marginsplot) after the Equation 2.

However, even though this effect is beneficial in “normal times”, in a crisis that depresses output the negative effect on inflation may not be desirable. The results indicate that the effect of a CBA has been even larger in the period during and after the GFC (see Figure 5) and this difference (which is estimated to be 14%) in the effect

<sup>9</sup> ‘If  $\beta$  is the coefficient on a dummy variable, say  $x_1$ , when  $\log(y)$  is the dependent variable, the exact percentage difference in the predicted  $y$  when  $x_1=1$  versus when  $x_1=0$  is  $100 \cdot [\exp(\beta_1)-1]$ ’ (Wooldridge, 2006, p. 238).

before and after crisis is estimated to be significant ( $p$ -value=0.008). Therefore, the desirability of the regime in these circumstances is questionable.<sup>10</sup>

**Figure 5 The Average Marginal Effect of CBA on Inflation Conditional on Crisis**



Source: Post-estimation results (marginsplot) after the Equation 2.

Next, any differences between CBAs with more strict rules versus those with less strict rules will be investigated, in order to check whether there is a difference in the effect of a CBA on inflation conditional on the level of strictness of the CBA.

## 5.2 Examining Differences between “Weak” and “Strong” CBAs

Currency boards in transition countries differ; some of them are stricter while others are more flexible and, therefore, would be expected to have different effects on inflation. In order to distinguish the effect of CBAs that are stricter from the more flexible ones, the CBA variable is divided into “strongCBA” and “weakCBA”. Bosnia and Herzegovina’s and Estonia’s CBAs are classified as “strong”, since they are more strict (and have a higher pre-commitment index), while the Bulgarian and Lithuanian CBAs are classified as “weak”, since they deviate significantly from the orthodox rules (and have a lower pre-commitment index). Otherwise the same specifications are

<sup>10</sup> Additionally, we estimated Equation 1 only for (subsample of) the crisis and post-crisis period (2009-2015), which is the period in which most of the countries fought with low inflation rates and tried to stimulate price growth. The results are consistent and confirm findings from the initial estimation of Equation 2 (for the whole period) which implies that the effect of CBA is even larger in the GFC. However, since there are not many observations when only the period after 2009 is observed, and the number of instruments is very high relative to the number of observations, diagnostic failures rule out system GMM estimation of the model on separate samples. Hence, we do not report these results.

estimated. Diagnostic tests do not significantly differ from those reported above. The Hansen test is again weak (indicated by p-value of 1.0) in all specifications, while the Sargan test does not reject the validity of the over-identifying instruments (Table 3a).

**Table 3a Strong and Weak CBA Specifications Estimated by ‘System’ GMM**

<i>Variables</i>	<i>Modified Equation 1<sup>1</sup></i>	<i>Modified Equation 2</i>
<b>L1.LNINF</b>	0.411***	0.417***
Inflation (lagged)	(0.0551)	(0.0529)
<b>StrongCBA</b>	-0.115**	0.0163
“Strong” currency board arrangement	(0.0549)	(0.0426)
<b>WeakCBA</b>	-0.0351	-0.0268
“Weak” currency board arrangement	(0.0385)	(0.0280)
<b>1.StrongCBA*MSG</b>		-0.00554***
StrongCBA=1, money supply growth		(0.00134)
<b>1.WeakCBA*MSG</b>		0.000471
WeakCBA=1, money supply growth		(0.00288)
<b>1.StrongCBA*1.Crisis</b>		-0.121
StrongCBA=1 and Crisis=1		(0.0944)
<b>1.WeakCBA*1.Crisis</b>		-0.0432
WeakCBA=1 and Crisis=1		(0.0503)
<b>GDPG</b>	-0.00440	-0.00438
GPD growth	(0.00345)	(0.00351)
<b>MSG</b>	0.00515***	0.00514***
Money supply growth	(0.00132)	(0.00125)
<b>FB</b>	0.00653	0.00495
Fiscal balance	(0.00463)	(0.00370)
<b>OPEN</b>	0.000944	0.000978
Openness	(0.000708)	(0.000685)
<b>TOT</b>	-0.000492	-0.000439
Terms of trade	(0.000685)	(0.000645)
<b>EBRDI</b>	-0.0468	-0.0465
EBRD indicator	(0.0578)	(0.0451)
<b>CCBI</b>	-0.199	-0.228
Central bank independence	(0.295)	(0.211)
<b>VAT</b>	0.203***	0.260***
Value added tax	(0.0564)	(0.0469)
<b>EU</b>	0.0209	0.0198
European Union	(0.0402)	(0.0342)
<b>CRISIS</b>		1.635***
Global financial crisis		(0.248)
<b>Constant</b>	0	0
Number of observations	285	285
Number of groups	25	25
Number of instruments	94	138
Sargan (Prob>chi2)	0.030	0.169
m1+m2 (Prob > chi2)	0.018/0.838	0.20/0.796

Notes: \*\*\*, \*\*, \* donates that variables are statistically significant at the 1%, 5% and 10%, respectively.

<sup>1</sup> The estimated equations are the same as Equations 1, 2 and 3, just a CBA variable is divided to StrongCBA and WeakCBA

The results summarized in Table 3a suggest that “strong” CBAs have a negative and significant effect on inflation, while the effect of “weak” CBAs is insignificant through all specifications. The coefficient on the strongCBA variable suggests that countries with a “strong” CBA have, on average, a 13.32 percentage points lower inflation rate than do countries without a CBA. When estimated by system GMM, the strongCBA variable is highly significant and negative in all specifications. The rest of the results do not change significantly, providing a supportive robustness check. According to the marginal effects of a CBA at representative values of MSG, the effect

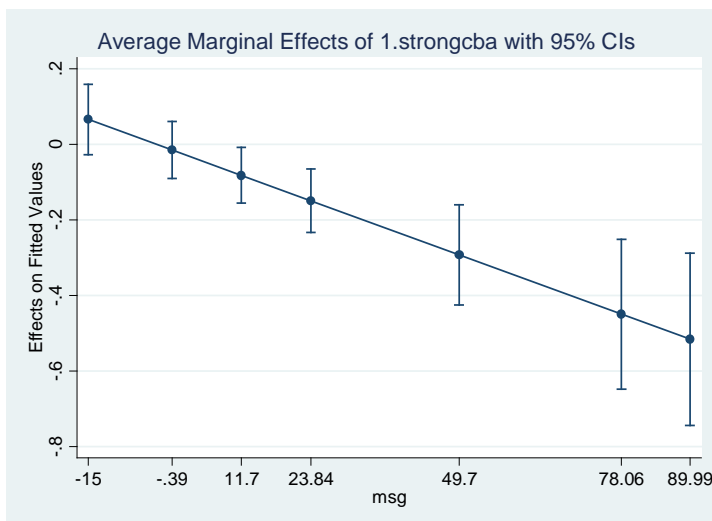
of a “strong” CBA is significant and more negative the higher the money supply growth (see Figure 6a), while the effect of a weak CBA is insignificant (see Figure 6b) and thus does not have a repressing effect on inflation when money supply growth is positive.

**Table 3b Marginal Effects After Estimation of Equations with Strong and Weak CBA Specifications Estimated by ‘System’ GMM**

<i>Variables</i>	<i>Modified Equation 1</i>	<i>Modified Equation 2</i>
<b>L1.LNINF</b>	0.411***	0.417***
Inflation (lagged)	(0.0551)	(0.0529)
<b>strongCBA</b>	-0.115**	-0.143***
“Strong” currency board arrangement	(0.0549)	(0.0423)
<b>weakCBA</b>	-0.0351	-0.0279
“Weak” currency board arrangement	(0.0385)	(0.0461)
<b>GDPG</b>	-0.00440	-0.00438
GPD growth	(0.00345)	(0.00351)
<b>MSG</b>	0.00515***	0.00473***
Money supply growth	(0.00132)	(0.00116)
<b>FB</b>	0.00653	0.00495
Fiscal balance	(0.00463)	(0.00370)
<b>OPEN</b>	0.000944	0.000978
Openness	(0.000708)	(0.000685)
<b>TOT</b>	-0.000492	-0.000439
Terms of trade	(0.000685)	(0.000645)
<b>EBRDI</b>	-0.0468	-0.0465
EBRD indicator	(0.0578)	(0.0451)
<b>CCBI</b>	-0.199	-0.228
Central bank independence index	(0.295)	(0.211)
<b>VAT</b>	0.203***	0.260***
Value added tax	(0.0564)	(0.0469)
<b>EU</b>	0.0209	0.0198
European Union	(0.0402)	(0.0342)
<b>CRISIS</b>		-0.208***
Global financial crisis		(0.0735)
<b>TIME DUMMIES</b>	included	included

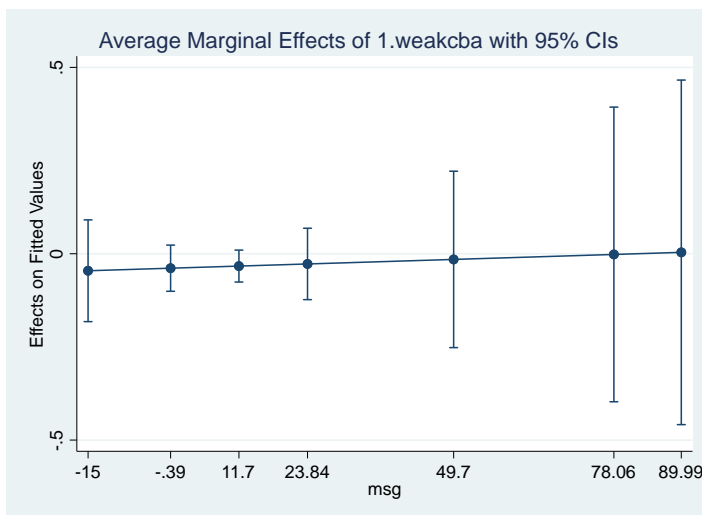
Notes: \*\*\*, \*\*, \* donates that variables are statistically significant at the 1%, 5% and 10%, respectively.

**Figure 6a The Average Marginal Effect of a “Strong” CBA on Inflation Conditional on Money Supply Growth**



Source: Post-estimation results (marginsplot) after the Equation 2 (in which strong and weak CBA's are separated).

**Figure 6b The Average Marginal Effect of a “Weak” CBA on Inflation Conditional on Money Supply Growth**

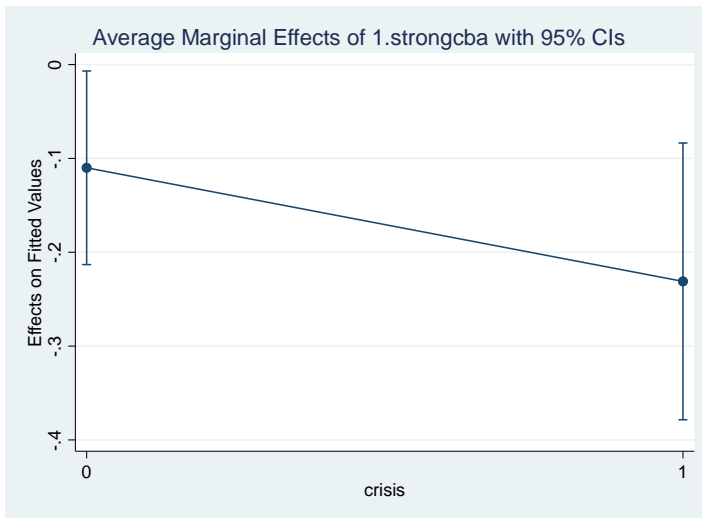


Source: Post-estimation results (marginsplot) after the Equation 2 (in which strong and weak CBA's are separated).

When interacted with the GFC dummy, a “strong” CBA has an even larger negative effect on inflation. The effect of strongCBA is negative and significant both before and after the crisis with a higher marginal effect after than before (Figure 7a),

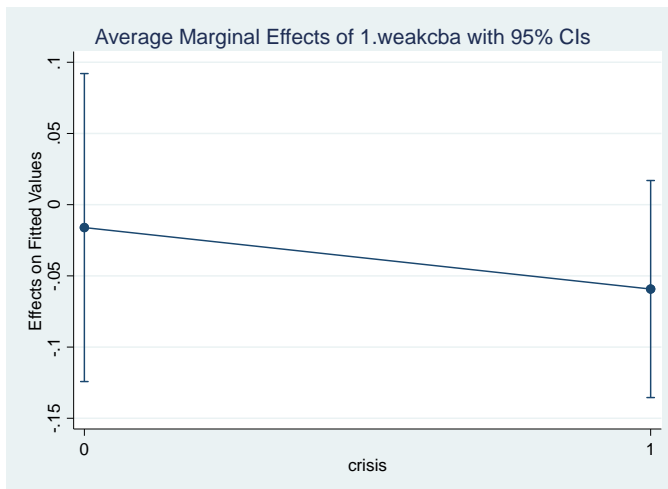
although this difference is not statistically significant at conventional levels. In contrast, the effect of a weakCBA on inflation is not statistically significant before the crisis, although it is small and of only borderline significance ( $p=0.07$ ) after the crisis.

**Figure 7a The Average Marginal Effect of a “Strong” CBA on Inflation Conditional on Crisis**



Source: Post-estimation results (marginsplot) after the Equation 2 (in which strong and weak CBA's are separated).

**Figure 7b The Average Marginal Effect of a “Weak” CBA on Inflation Conditional on Crisis**



Source: Post-estimation results (marginsplot) after the Equation 2 (in which strong and weak CBA's are separated).

## 6. Conclusion

A Currency Board Arrangement is expected to decrease inflationary expectations and consequently inflation rates due to its fixed exchange rate regime and strict rules imposed on the monetary authority. The key objective of the paper is to investigate the effect of CBA on inflation, compared with other monetary regimes, and to investigate whether this effect differs at different levels of money supply, which is part of the added value of this paper. Moreover, we also investigate whether this effect is the same in a period of crisis, which has not been investigated in previous studies. The latter is an important issue since many of these countries experienced low inflation, and even deflationary pressures, during the GFC and post-GFC periods, which undermined their recovery.

Regression analysis of the determinants of inflation in 25 transition countries between 1998 and 2015 confirms the expected negative effect of a CBA on inflation. The estimation results suggest that a country with a CBA had, on average, a 9.8 percentage points lower inflation rate than countries without a CBA, holding other factors constant. This highly significant and large effect of a CBA on inflation reduction could be used to partly justify the introduction and/or retention of CBA in the European transition countries. Additional investigation of the difference in the CBA effect at different levels of money supply growth suggests that the effect is more negative the higher the money supply growth. This suggests that the CBA tends to repress the effect of money supply growth on inflation, which is an additional argument for maintenance of a CBA. Another important finding of this paper is that the degree of strictness of the CBA appears to be important with respect to the reduction in inflation. According to the results, the “weak” CBAs (Bulgarian and Lithuanian) did not have a significant overall effect on inflation, while the “strong” CBAs (BH’s and Estonian) had a significant and negative effect through all specifications. This implies that following strict rules additionally affects inflation performance.

It is especially interesting to observe the effect during the GFC, since this feature of a CBA is not likely to be beneficial, if inflation reduction (or deflationary pressure) is at the expense of GDP or employment growth. However, according to the results, the effect of a CBA on lowering inflation was even greater during the GFC, when monetary authorities were attempting to stimulate prices and growth. These findings suggest that a CBA, while beneficial in “normal times”, is likely to be disadvantageous during a contractionary crisis.

Our further conclusions are very tentative, because the underpinning analysis requires a four-way division of our sample. We find that a weak CBA does not have a significant effect on inflation in the pre-crisis period, but has a small effect – although estimated with weak statistical significance – post-crisis. In contrast, a strong CBA has a large effect in both pre- and post-crisis periods. This might suggest that a weak CBA is not more effective than other monetary regimes at repressing inflation in “normal” times, but is mildly effective when inflation repression could be dysfunctional. Conversely, a strong CBA represses inflation irrespective of macroeconomic context and changing policy priorities.

This paper is the first to assess the effect of a CBA on inflation performance in European transition countries before and after the GFC. The deflationary effect of a CBA is usually pointed out as one of its main advantages in “normal times”, and this

paper complements previous findings that supported this rationale for its introduction. Given the results of our empirical analysis, which suggest even higher negative effects of a CBA on inflation during crisis periods than in “normal times”, the key policy implication concerns the potential need for greater flexibility of strict monetary regimes during periods of crisis. However, in order to draw final conclusions about the desirability of a CBA, and whether the CBA should be weak or strong, while taking into account its potentially varying effects in “normal times” and in crisis periods, we need to know more about CBA effects on other macroeconomic variables.



# APPENDIX

**Table A1 Inflation Regression Variables – Label, Description, Expected Sign and Data Source**

<i>Variable name</i>	<i>Label</i>	<i>Description</i>	<i>Expected sign</i>	<i>Data source</i>	<i>Notes</i>
Inflation	lnINF	Natural log of inflation (which is measured as annual percentage change in consumer price index)	Dependent variable	WDI	For BH national statistics is used; inflation in BH is measured by using the retail price index until 2007 Since some observations have negative inflation in order to calculate logs number 10 is added to all values of inflation
Countries with currency board arrangement	CBA	Dummy variable for countries with a CBA	-		
Real GDP growth	GDPG	Based on the market prices expressed in constant local currency (annual % change) Broad money supply growth which is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper (annual % change)	-	WDI	
Broad money supply growth	MSG		+	WDI	Data on broad money for Slovenia taken from various EBRD transition reports
<i>Variable name</i>	<i>Label</i>	<i>Description</i>	<i>Expected sign</i>	<i>Data source</i>	<i>Notes</i>
Fiscal balance/GDP	FB	Fiscal balance in % of GDP	-	IMF, WEO	
Openness	OPEN	The sum of exports and imports of goods and services measured as a share of gross domestic product (% of GDP)	-	WDI	
Terms of trade	TOT	Ratio of the export unit value index to the import unit value index (base year 2000)	?	WDI	
EBRD progress in transition indicator	EBRDI	Average of eight EBRD transition indicators (for liberalisation, privatisation and credit reform) (index)	-	EBRD	Available for all countries in the sample except for the Czech Republic in years 2008 and 2009, as it is considered to have completed its transition in 2007
Central bank's independence	CCBI	Updated Cukierman's index of central bank independence (index)	-	Bogoev et al., 2012	Data for period after 2012 updated based on the information provided by the IMF
Fixed exchange rate	defactoFIX	Dummy variable for countries with fixed exchange rate (de facto fixed exchange rate regime)	-	Reinhart and Rogoff (2010)	Ilizetski,
EU membership	EU	Dummy variable for EU member countries	-		
Introduction of value added tax	VAT	Dummy variable for the year of VAT introduction	+	Background paper for International Tax Dialogue Conference on the VAT, 2005	

**Table A2 Correlation Matrix**

	<i>inflation</i>	<i>cba</i>	<i>gdpq</i>	<i>msg</i>	<i>fb</i>	<i>open</i>	<i>tot</i>	<i>ebrdi</i>	<i>ccbi</i>	<i>vat</i>	<i>eu</i>
<i>inflation</i>	1.0000										
<i>cba</i>	-0.1388	1.0000									
<i>gdpq</i>	0.0772	-0.0649	1.0000								
<i>msg</i>	0.6555	-0.0988	0.3989	1.0000							
<i>fb</i>	0.1437	0.0962	0.4222	0.3313	1.0000						
<i>open</i>	0.1875	0.1360	0.0854	0.1068	0.0005	1.0000					
<i>tot</i>	0.0330	-0.1290	0.1303	0.0995	0.4739	-0.3130	1.0000				
<i>ebrdi</i>	-0.4362	0.1262	-0.2509	-0.5297	-0.3306	0.0537	-0.1403	1.0000			
<i>ccbi</i>	-0.2368	0.3327	-0.2708	-0.3391	-0.3941	0.1381	-0.3319	0.4356	1.0000		
<i>vat</i>	-0.0109	0.0773	0.0002	-0.0144	0.0906	-0.0285	-0.0214	-0.0689	-0.0557	1.0000	
<i>eu</i>	-0.1322	0.1939	-0.1627	-0.2431	-0.1379	0.3210	-0.1266	0.5517	0.3185	-0.0436	1.0000

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