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Unravelling Open Innovation Determinants and Firm Performance Relationships in CEE and SEE Countries

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Dear Reviewers,
Thank you very much for your useful comments and suggestions, which contributed to improving this paper.
We carefully went through all your suggestions and highlighted with red color the changes in the manuscript.
Respectfully,
The authors

Referee: 1
Recommendation: Minor Revision

-Discussion Depth and Contextualization:
The discussion section of the manuscript still lacks the desired depth and reflection within the broader context of existing findings. While you adequately discuss the effects, the current narrative seems somewhat boilerplate and could benefit from a more nuanced exploration of how your results compare, contrast, or contribute to existing literature. It would be beneficial to explicitly connect your findings to relevant theoretical frameworks and/or empirical studies in the field. This will enhance the scholarly impact of your work and provide a more comprehensive understanding for readers.

Response: *Following your suggestions, the discussion section is completely rewritten, and we focused the discussion on the following points:*

- *Open innovation is reshaping industries but presents challenges (Christensen et al., 2005; Bacon et al., 2020; Caputo et al., 2016; Madanaguli et al., 2023).*
- *Our study aligns with previous research, showing the positive impact of innovation on firm performance (Ahn et al., 2013; Almirall and Casadesus-Masanell, 2010; Oltra et al., 2018).*
- *R&D investment and employee education positively influence firm performance (Kmecová-Vokoun, 2020; Krishnan et al., 2009; Dayan et al., 2023; Ramadani et al., 2017).*
- *Technology licensing, collaboration with large firms, and direct exports also boost firm performance (Callarisa-Fiol et al., 2023; Ramadani et al., 2019; Porter, 1980; Gulati, 1998).*
- *Structural Equation Modeling identifies key factors such as R&D, knowledge, and coopetition as positively associated with firm performance (Feser, 2022; Xie et al., 2022).*
- *Our study acknowledges the complexity of open innovation challenges and emphasizes adaptability for resilience in SEE and CEE regions (Kmecová-Vokoun, 2020; Krishnan et al., 2009; Dayan et al., 2023; Ramadani et al., 2017).*

More details are provided in the respective section in the manuscript.

-Future Research Suggestions:

The future research section remains somewhat narrow as it primarily focuses on the limitations arising from your statistical analysis. I recommend expanding this section to outline broader avenues for future research based on the insights gained from your study. Consider addressing not only the statistical limitations but also potential gaps in the literature that your study identifies. Providing a more comprehensive roadmap for future research will contribute to the significance and practical implications of your work.

Response: *We agree with your observations, and hence added to these sections, focusing the future research directions on the following points:*

- *Conduct macro-level analyses focusing on the SEE and CEE regions to understand unique challenges and opportunities.*
- *Investigate the dynamics and impact of collaborative networks on innovation outcomes.*
- *Develop innovative strategies to navigate 'coopetition' and assess the impact of technology licensing from foreign-owned companies.*
- *Conduct cross-industry comparative studies to identify industry-specific challenges and success factors.*
- *Integrate ethical considerations, such as intellectual property rights and data privacy, into open innovation practices.*
- *Examine how open innovation contributes to organizational resilience and agility in the face of external shocks.*
- *Analyze negative outcomes and common pitfalls to gain a comprehensive understanding of challenges in open innovation.*

-Professional Academic Proofreading:
While the overall language quality has improved, there are still instances where the language appears less precise or not entirely correct. It is advisable to engage a professional academic proofreader to ensure the linguistic accuracy and coherence of the manuscript. This step is crucial to maintain the high standards expected in academic publications and to enhance the overall readability of the paper.

Response: *A professional and native speaker was engaged for proofreading the paper.*

In summary, your manuscript has undergone substantial improvements, and I commend your responsiveness to previous feedback. Addressing the outlined points will further refine your contribution and elevate the paper's quality.

Referee: 2
Recommendation: Minor Revision

1) The discussion needs stronger reflection.

Response: *Following your suggestions, the discussion section is completely rewritten, and we focused the discussion on the following points:*

- *Open innovation is reshaping industries but presents challenges (Christensen et al., 2005; Bacon et al., 2020; Caputo et al., 2016; Madanaguli et al., 2023).*
- *Our study aligns with previous research, showing the positive impact of innovation on firm performance (Ahn et al., 2013; Almirall and Casadesus-Masanell, 2010; Oltra et al., 2018).*
- *R&D investment and employee education positively influence firm performance (Kmecová-Vokoun, 2020; Krishnan et al., 2009; Dayan et al., 2023; Ramadani et al., 2017).*
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- *Our study acknowledges the complexity of open innovation challenges and emphasizes adaptability for resilience in SEE and CEE regions (Kmecová-Vokoun, 2020; Krishnan et al., 2009; Dayan et al., 2023; Ramadani et al., 2017).*

More details are provided in the respective section in the manuscript.

2) Future research needs a further outlook for the actual topic, open innovation in Central Eastern European Countries.

Response: *We agree with your observations, and hence added to these sections, focusing the future research directions on the following points:*

- *Conduct macro-level analyses focusing on the SEE and CEE regions to understand unique challenges and opportunities.*
- *Investigate the dynamics and impact of collaborative networks on innovation outcomes.*
- *Develop innovative strategies to navigate 'coopetition' and assess the impact of technology licensing from foreign-owned companies.*
- *Conduct cross-industry comparative studies to identify industry-specific challenges and success factors.*
- *Integrate ethical considerations, such as intellectual property rights and data privacy, into open innovation practices.*
- *Examine how open innovation contributes to organizational resilience and agility in the face of external shocks.*
- *Analyze negative outcomes and common pitfalls to gain a comprehensive understanding of challenges in open innovation.*

3) Professional proofreading is necessary.

Response: *A professional and native speaker was engaged for proofreading the paper.*

4) Please consider reading these papers and including them if found suitable:

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https://doi.org/10.1186/s13731-023-00340-w
https://doi.org/10.1016/j.jik.2022.100275

Response: *We are grateful for these supportive references and cited them into our manuscript where fitting.*

Unravelling Open Innovation Determinants and Firm Performance Relationships in CEE and SEE Countries

Abstract:

Purpose – Open innovation, by now one of the major concepts for the analysis of innovation, is seen as a methodology for collaboratively designing and implementing solutions by engaging stakeholders in an iterative and inclusive service design process. This paper aims to empirically investigate open innovation capacities, defined as a cooperative, knowledge-sharing innovation ecosystem, and to explore how it can lead to improved performance of firms in Central and Eastern European (CEE) and Southeastern European (SEE) countries.

Design/methodology/approach – The study builds on the World Bank/EBRD's Business Environment Enterprise Performance Survey (BEEPS) dataset for 2009, 2013, and 2019. Primarily, the research model was estimated using log-transformed ordinary least squares (OLS). Taking into consideration that this method might produce substantial bias, yielding misleading inferences, this study is fitting Poisson pseudo maximum likelihood estimators with robust standard errors and instrumental variable/ generalized method of moments estimation (IV/GMM) approach for comparative results. Secondarily, the research model was tested using structural equation modelling (SEM) to investigate the relationship between five OI capacities and firm performance.

Findings – The findings indicate that there is a significant positive relationship between most open innovation capacities and firm performance, except for innovation, which did not show a statistically significant relationship with firm performance. Specifically, R&D, knowledge, and coopetition are statistically significant and positively associated with firm performance, whereas transformation is statistically significant but negatively associated with firm performance. The IV/GMM estimations' findings support the view that the firm performance is significantly affected by open innovation capacities, together with some control variables such as size, age, foreign ownership, and year dummy to have a significant impact on firm performance.

Originality/value –This paper fills an identified gap in the literature by investigating the impact of open innovation on firm performance executed in the specific CEE and SEE country context.

Keywords: Innovation, Open Innovation, Firm Performance, Skilled Workers, SEM, BEEPS

Article Type: Research paper

1 Introduction

Recently, the concept of open innovation (OI) has been recognized as one of the major frameworks for the analysis of firms' innovation and its contribution to competitive advantage and overall performance (Rexhepi *et al.*, 2019; Rondi *et al.,* 2021). The importance of open innovation among scholars, practitioners, and policymakers was raised by Chesbrough's (2003) work, which was based on "the collaboration between people and external entities in organizations, with the use of the benchmarking technique, and that helps us to identify the relationship between the two concepts" (Oliveira *et al.*, 2021, p.13), and "valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well" (Chesbrough, 2003, p.43).

This paper aims to explore the concept of OI, as a cooperative, knowledge-sharing innovation ecosystem, and explore how it can lead to enhanced innovation activity and improved performance of firms. This exploration is important because OI is such a vital process for many companies, especially the smaller companies in CEE and SEE economies with insufficient resources to finance innovation activities by themselves (López-Muñoz *et al.,* 2023). Studies on OIs in CEE and SEE countries are scarce, especially those related to open innovation and firm performance. These regions may face disparities in innovation capabilities compared to more developed economies. Investigating open innovation capacities allows for a nuanced understanding of the existing innovation gaps and provides insights into how these gaps can be bridged through collaborative and open approaches. Therefore, this paper tries to add new findings to the literature and contribute to creating a more sustainable ground for further research in this field, focused on CEE and SEE countries.

This study measures the impact of R&D (R&D intensity, invest in R&D, and R&D to sales), knowledge (% of employees with university degrees, foreign ownership, and technology in foreign companies), innovation (innovation activities including product and process innovation, innovation in logistics and international market) coopetition (Competitors for the main product/service in the main market, part of large companies, direct export), and transformation (patents, trademarks, etc.), as determinants of open innovation concept, on the firm performance in CEE and SEE countries.

This paper contributes to a dual capacity. Firstly, it offers an enriched depiction of Open Innovations (OIs) in Central and Eastern European (CEE) and South-East

European (SEE) countries, shedding light on the diverse factors influencing OI development and their subsequent impact on firm performance. The findings aim to assist firms in these regions in refining their strategies and establishing a stronger competitive position both domestically and internationally. This involves the provision of broader and higher-quality products and services, leading to increased profits and reduced costs associated with marketing and investments in research and development (R&D). It is noteworthy that OI, as a process of innovation accessible to citizens, companies, and private organizations, facilitates quicker problem-solving (Sandoval-Almazan and Millán-Vargas, 2023). Secondly, to experimentally investigate the concept of open innovation in SEE and CEE, this paper employs sophisticated research methods. The research model is primarily estimated using log-transformed ordinary least squares (OLS), with an acknowledgment of potential biases, leading to the use of Poisson pseudo maximum likelihood estimators with robust standard errors and instrumental variable/generalized method of moments estimation (IV/GMM) approach for comparative results. Additionally, the research model undergoes testing through structural equation modelling (SEM) to explore the relationship between five OI capacities and firm performance.

The paper is structured as follows: Section two examines the extant literature about open innovation, CEE and SEE open innovation studies, and open innovation and firm performance. Section three constitutes the methodology section, including a description of methods and used data on open innovation in CEE and SEE countries. Section four discusses the findings. The conclusion section discusses the implications, limitations, and further research avenues.

2 Literature review

2.1 Open innovation: general insights

Innovations (or precisely, closed innovations) are usually seen as a product that derives from inside the organizations and produces a competitive advantage. Research has shown that this way of exploring innovation has many boundaries, even though researchers have identified several ways in which business strategies can influence innovation activities (Bashir *et al.,* 2020; Kennedy *et al.,* 2017; Rexhepi, 2020). Thus, they recommend new sources of innovation, which will come from outside the

organization known as open innovation. The new approach toward the source of innovation has become increasingly popular amongst researchers.

The organization functions as an open system, exerting influence on society while also being influenced by it. In this dynamic relationship, organizations not only generate benefits for others but also derive benefits from external sources. Collaboration with external entities, particularly in the realms of creativity and innovation, is crucial for organizations (Brodny and Tutak, 2021, Rexhepi *et al*., 2019). The concept of open innovation, introduced by Henry Chesbrough (2003), emphasizes the exchange of ideas between different organizations for innovation.

Open innovation is innovative modeling that suggests that organizations can use external and internal resources to advance products to increase their performance (Angrisani *et al*., 2023; Moiseev *et al*., 2023). Open innovation challenges the traditional vertically integrated model prevalent in the twentieth century, suggesting that innovation can stem not only from internal sources but also from external ones. Initially developed by a small group of innovation practitioners primarily active in high-tech industries, the concept of open innovation has now gained widespread attention and implementation as an innovation practice (Gassmann *et al*. 2010).

OI has emerged as a paradigm shift that challenges the assumption that firms should solely rely on internal ideas and pathways to market (Chesbrough, 2003). Instead, OI emphasizes the deliberate inflows and outflows of knowledge to drive internal innovation and expand external markets for innovation utilization (Chesbrough *et al.,* 2006). Additionally, open innovation is seen as a methodology for collaboratively designing and implementing solutions by engaging stakeholders in an iterative and inclusive service design process (Carayannis and Campbell, 2011). However, while the definition of open innovation has evolved over the years, Chesbrough's definition remains influential (Chesbrough 2003; Kraus *et al*., 2020; Parveen *et al*., 2015).

2.2 Open innovation and firm performance

The OI concept is considered a new approach and a complementary strategy for increasing the firms' development and performance (Madanaguli *et al*., 2023). This approach is focused on "finding proper strategies and business models, e.g., IPR systems and strategies; industrial R&D models and strategies; compatibility of the business model with those of suppliers, customers, competitors, complementors;

cooperation with universities and other R&D institutions; to reap the benefits of 'de-verticalization', or vertical specialization" (Karo and Kattel, 2010, p.13) and contribute to profit increase and firms' competitive advantages.

The impact of OI on the firms' performance depends on several factors, such as firms' ecosystem and culture, employees' knowledge, reward policies, or intellectual property rights (Hlušková, 2021). Those firms that operate in an entrepreneurial ecosystem characterized by more openness are more likely to increase the OI concept adoption (Alassaf *et al.*, 2020; Surya *et al.*, 2021). Firms that employ well-educated workers and design a motivational reward policy create a better environment for innovation, including OI (Oliveira *et al.*, 2021). Further, countries with strong intellectual property rights have positive impacts on the development of the OI concept (Battisti *et al.*, 2015; Dodourova and Bevis, 2014).

Ahn *et al.* (2013), using the Korean Innovation Survey (KIS) 2008 data and Structural Equation Modelling (SEM) found that generally, the OI capacities have a significant impact on the financial performance, sales, and profits of the firms, but some factors might have a negative impact and imply delayed effects. Almirall and Casadesus-Masanell (2010) found that firms with a higher openness can achieve better performance, predominantly in a dynamic environment where firms can change their partners freely. Oltra *et al.* (2018) found that inbound practices (cooperating with partners on R&D), outbound practices (licensing payments, indirect marketing, and technical benefits) and have a positive impact on firm performance, emphasizing that coupled practices (innovation networks and participation in clusters) have the highest impact. Mazzola *et al.* (2012) have studied the impact of OI modes on the firms' financial and innovation performance. Their findings show that OI has positive and negative impacts on performance, respectively, acquisition, alliance, co-patenting, and licensing-out have a significant impact on the firms' innovation and financial performance, while public funding, university collaboration, and R&D alliance have an insignificant impact. Some OI modes have an impact on the innovation performance only, such as government collaboration, licensing, and supplier collaboration, while external technology commercialization has an impact only on the firm's financial performance. Similarly, Brunswicker and Vanhaverbeke (2015) found that not all OI modes have a positive impact on the firm's innovation performance. Zhou et al. (2018) found that both inbound and outbound OI have an impact on innovative performance. Rass et al. (2013) concluded that OI's implementation strengthens the firm's social

capital, which contributes positively to firm performance. Zhang et al. (2018) measured the moderation effect of human capital on the open innovation-performance relationship and generally found that the higher employees' education level implies a positive effect of open innovation on the firm performance, but not in all firms, because in production-oriented firms, this effect was negative.

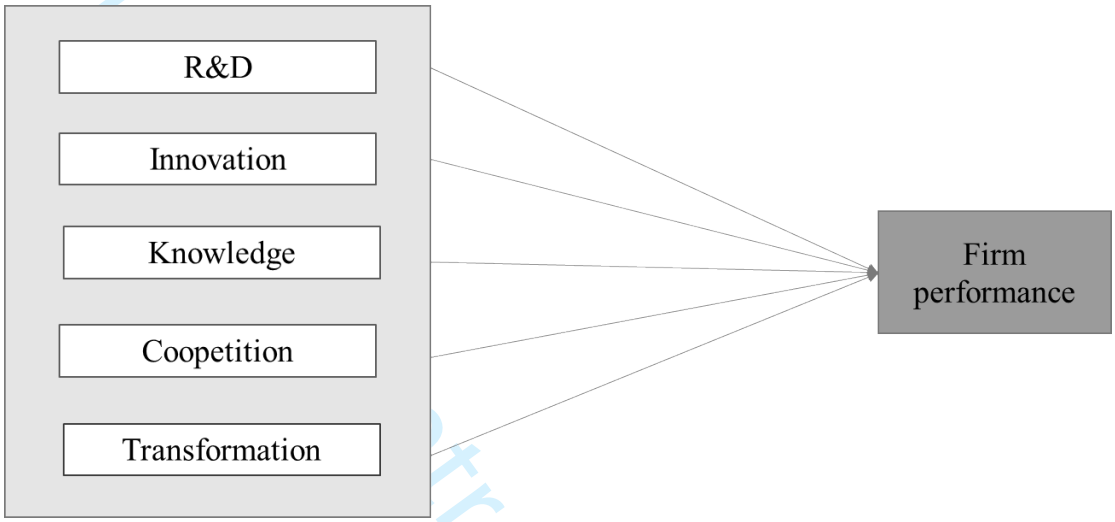

Figure 1. Conceptual research model

Whereas the open innovation variable presents the number of open innovation practices that are employed by the firm such as external R&D spending, external knowledge acquisition, innovation collaboration with domestic partners for product innovation, innovation collaboration with international partners both for product innovation, collaboration with domestic partners for process innovation and collaboration with international partners for process innovation. Specifically, in this study, the focus is on R&D, innovation, knowledge, coopetition, and transformation. The conceptual model is presented in Figure 1.

2.2.1 R&D and firm performance

Research and development (R&D) is proven to be strongly related to the overall firm performance (Ramadani *et al.,* 2019). The impact of research and development activities on firm performance has been of considerable interest to scholars (Falk, 2012). Much early research has shown a positive relationship between research and development strategy and intensity and firm performance including sales (Krishnan *et al.*, 2009;). Agency theory, leading edge, and administrative/life cycle perspectives all

show the same results. Firms with high levels of R&D intensity and investment will show better performance compared to those with lower levels of R&D intensity and investment. These firms also have higher salaries, bonuses, and greater relative eligibility for long-term incentive payments (Gentry and Shen, 2013). However, firms still show different performances. The firm's performance differs within years, usually lower in the years of more intensive investment, but higher in the years after, also the firm size, the larger the firm size, the greater the use of resources for R&D (Chen *et al.*, 2019; Leung and Sharma, 2021). Some other factors determine the R&D performance like the absorptive capacity of the firms, budget, marketing strategies, use of contracted R&D, internationalization, etc. (Booltink and Saka-Helmhout, 2018; Lin *et al.*, 2006; Veugelers, 1997). Some of the main challenges in this context have been: (1) Have the firms invested enough in R&D spending? (2) Have the firms allocated enough resources to the commercialization of the firm's technology assets? (3) Do investments in R&D and commercialization pay off in terms of bottom-line finance performance? (Lin *et al.*, 2006).

H1: *R&D has a positive significant impact on firm performance.*

2.2.2. Knowledge and firm performance

Most extant research has established that knowledge has a significant impact on firm performance (Ramadani *et al.*, 2017), and is the most relevant source of creating a competitive advantage for firms (Rexhepi, 2015). Alavi and Leidner (2001) consider that the sustainability of a firm's competitive advantage depends on its capability to manage the existing knowledge effectively and to create new knowledge constantly. This has become widely recognized and accepted in the business community, which has led researchers and policymakers within the last few decades, to further increase the interest in all forms and dimensions of knowledge (Pathirage *et al.*, 2007). Levels of knowledge and absorptive capacity are very much related to employee competencies which are related mainly to the level of education and experience; thus, organizations must preserve and develop skills (Attia *et al.*, 2014; Ripollés and Blesa, 2023), manage knowledge sharing (Salehzadeh *et al.*, 2017), increase the level of education (Bakan *et al.*, 2011), etc. Firms nowadays also have understood that the generation of new knowledge is considered not only an internal process (Arora *et al.*, 2001). This means that the level of knowledge does not depend only on internal capabilities to generate new knowledge, but also on the level of gaining new knowledge from other local and

foreign ownership firms, which usually bring new know-how and technology (Ramadani *et al.*, 2017; Rexhepi and Berisha, 2017). Stojčić et al. (2018) suggest that employees who have shown to have specific skills positively impact the firm performance. Consequently, increasing the absorptive capacity will lead to a more sustainable competitive advantage for the firms.

H2: *Knowledge has a positive significant impact on firm performance.*

2.2.3. Innovation and firm performance

Prior research has shown significant positive effects of innovation on firm performance (Damanpour *et al.*, 2009; Fernandes *et al.*, 2013; Hashi and Stojcic, 2013; Sok and O'Cass, 2011; Subramanian and Nilakanta, 1996; Damanpour, 2009). Similar results have been seen in all four types of innovations - product, services, process, and organizational innovations (Ramadani *et al.*, 2017; Suhag *et al.*, 2017). Concentration on innovation and innovative capacity will lead to the possibility of firms possessing more patents, which will create possibilities of having a more sustainable competitive advantage (Rexhepi *et al.*, 2013). Price *et al.*, (2013) noted "that firms that engage in developing innovative products and services are positioned to compete more successfully through the development of new products and processes, before competitors in first-mover advantage, increasing market share, return on investment (ROI), and overall firm success" (p.1). Innovation has been related to the presence in international markets (Bitzer and Görg, 2009). Competitors' pressure, even though it has led to difficulties in the effectiveness of the global logistics and supply chains, has influenced organizations to innovate their strategies in logistics which has led firms to increase their performance (Cheon *et al.*, 2018; Zhu and Sarkis, 2010). Recently, research has also shown a significant positive relationship between innovation and business sustainability. Firms, while transforming resources into new products and services sometimes concentrate mainly on financial gains, consequently neglecting the adverse effects on the environment and society (Al-Abrrow *et al.*, 2021). New dimensions of research are appearing mainly related to green innovation, eco-innovation, and sustainable innovation, followed by green intellectual capital and green supply chain management practices (Becker and Egger, 2013; Suki *et al.*, 2022).

H3: *Innovation has a positive significant impact on firm performance*

2.2.4. Coopetition and firm performance

Competition is a complex process that has shown different results when it comes to organizational performance. Nickell (1996), based on an analysis of around 670 UK companies, found that competition, as measured by increased numbers of competitors, is associated with a significantly higher rate of total factor productivity growth. Coopetition, defined as the simultaneous cooperation and competition between rival firms, has emerged as a compelling strategy for leveraging complementary resources effectively. Despite its advantages, the paradoxical nature of coopetition presents firms with cognitive and behavioral dilemmas, leading to tension, opportunistic behavior, and knowledge leakage in their relationships. Recognized as one of the most complex organizational phenomena, coopetition poses challenges and risks. However, companies across industries are increasingly adopting coopetition as a strategic business practice to unlock synergistic benefits. Research on coopetition has gained significant attention, with literature reviews analyzing the period until 2015 and subsequent studies revealing a surge in publications between 2015 and 2020. These studies address gaps in understanding, covering diverse topics such as the role of coopetition for small businesses, behavioral aspects of managing coopetition, and intra-firm coopetition among internal teams (Gernsheimer, *et al.*, 2021). Recent research provides new insights, advancing academic discussions and offering practical implications for firms to navigate the complexities and reap the benefits of coopetition. Bowen and Wiersema (2005) found that increased foreign-based competition is a statistically significant factor in increasing firm performance. One very important issue regarding competitors' pressure is that they may lead to non-ethical behavior of firms. One interesting experiment in academia proved that poor performers significantly increase their cheating behavior under competition which may be a face-saving strategy or an attempt to retain a chance of winning (Schwieren and Weichselbaumer, 2008). Thus, an increased number of competitors and competitors' strengths, means increased pressure on firms for more coopetition in local and international markets. In most cases, coopetition can be expected a significant positive impact on firms (Bitzer and Görg, 2009; Cheon *et al.*, 2018; Rexhepi *et al.*, 2015; 2018; Ritala, 2008).

H4: *Coopetition has a positive significant impact on firm performance*

2.2.5. Transformation and firm performance

According to Lichtenthaler and Lichtenthaler (2009), from the perspective of open innovation, transformation includes the ability of firms to keep knowledge inside (through patents, trademarks, trade secrets, etc.) and gain benefits from their innovative products, services, and processes, respectively: Kknowledge is transformed if firms maintain knowledge over time and reactivate it subsequently" (p.1320). Huang *et al.* (2015) define transformation as "the capacity of an organization to transform and produce output from absorbed knowledge" (p. 843), while Ahn et al. (2013) and Huang et al. (2015) suggest for transformation to have a positive impact on firms' performance.

H5: *Transformation has a positive significant impact on firm performance.*

2.3 Open innovation in CEE and SEE countries

The extent of studies about open innovation in the CEE and SEE countries is fragmented and limited. There are several studies conducted about innovations in general (Abazi-Alili *et al.*, 2016; Gërguri-Rashiti *et al.*, 2017; Kadriu *et al.*, 2018); Krasniqi and Kutllovci, 2008; Ramadani *et al.*, 2019), but very few about OIs (Lesáková *et al.* 2018; Prokop *et al.*, 2019; Rexhepi-Mahmutaj and Krasniqi, 2019), especially in SEE countries (Rexhepi, 2020). This might be because these countries are not very involved in these collaborations and open innovations are very rare. Such a situation creates disparities between countries and regions (Ramadani *et al.*, 2013). In this context, Vanhaverbeke (2008) noted that "there exist huge differences in the knowledge capabilities of regions depending on the presence and the level of global competitiveness of clusters and regional innovation systems. Since the effectiveness of open innovation strategies of companies is strongly related to the presence of regional innovation systems, these regional differences can also explain why some regions are much more successful in attracting multinationals ensuring a steady flow of workers and entrepreneurs" (p.216).

Some OI-related studies in CEE countries are mostly focused on specific innovation types, sectors, and regions. Kmecová-Vokoun (2020) conducted a study on OI eco-innovations in the Czech Republic and found that these activities have a positive effect on the R&D intensity of SMEs. Lesáková *et al.* (2018) found that SMEs in Slovakia and their partnership with external companies in innovation have a low impact on the firm performance. In Poland, Dziurski-Sopińska (2020) found that the OI concept is used by both, high-tech and non-high-tech related industries. Dries et al.

(2014) found that Hungarian firms use the OI approach much more in the first stages of the innovation process and less during the later stages. Prokop et al. (2019) found that generally in CEE countries, the triple-helix approach (cooperation between industry, universities, and government) as a good base for OI is not well-developed, with some exceptions, for example, the machinery industry in the Czech Republic has a good collaboration with universities (Stejskal *et al.*, 2016). Klasová et al. (2019) found that Slovak universities like more stable and easier funds, such are the public ones, rather than generating funds from the cooperation with the industry. The same results were found in Poland by Lisowska-Stanisławski (2015). Urbaníková et al. (2020) focused their study on Slovakian family businesses and concluded that 74.5% of family businesses did not cooperate with schools, 22.5% plan to collaborate with universities, 21.3% have cooperated with other firms on innovation development, and 9.2% plan to cooperate with high-schools and universities in the future.

Regarding the SEE countries, studies on open innovation are extremely rare. For some of the SEE countries (e.g., Albania, Bosnia and Herzegovina, Kosovo, and North Macedonia), up to this moment, there could not be found any single thoughtful and comprehensive study about OI; for these countries, all studies were focused on innovations in general, but none specifically on OI. For other countries in the region, there are some but only a few studies available. Olaru et al. (2015) concluded that if the firms in Romania capitalize the external innovation resources, they may increase their innovation processes performance. Lukic (2014) conducted a study with Serbian ICT firms and found that they are more involved in inbound OI practices, such as networking with other organizations, involvement of consumers in generating, evaluating, and testing new ideas, and licensing external IP rights. Stratan and Perchinskaya (2018) suggest that to OI be developed in Moldova, the following points are necessary: internationalization of education and the scientific sphere, information accessibility, promotion of innovations and innovative values, external methodological support, and consultations.

3 Methodology

Based on the developed theoretical framework, this paper empirically investigates the relationship between open innovation capacities and firm performance using the World Bank/EBRD's Business Environment Enterprise Performance Survey (BEEPS) dataset

for 2009, 2013, and 2019. The major advantage of this dataset is that it provides a large number of comparable observations for all TEs constituting the pooled data. The BEEPS questionnaire consists of questions that allow us to specify the variables that are used in the theoretical framework followed here. This richness of information enables a holistic exploration of factors influencing open innovation capacities, contributing to a more robust and nuanced analysis. BEEPS incorporates firm-level data, allowing for a granular analysis at the organizational level. This is particularly valuable for understanding how open innovation capacities vary among different firms within the CEE and SEE countries.

The model to be estimated can be written as follows:

$$LNLP_{it} = \beta_0 + \beta_1 innov\_act_{it} + \beta_2 Inv\_RnD_{it} + \beta_3 size_{it} + \beta_4 Age_{it} + \beta_5 Age\_sq_{it} + \beta_6 Direct\_Exports_{it} + \beta_7 FRGNowner_{it} + \beta_8 Tech\_FRGN\_com_{it} + \beta_9 Innov\_logistics_{it} + \beta_{10} International\_mrk_{it} + \beta_{11} part\_of\_LF_{it} + \beta_{12} knowledge_{it} + \beta_{13} Patent_{it} + \beta_{14} Competitors_{it} + \beta_{15} y2013_{it} + \beta_{16} y2019_{it} + u_{it} \quad (1)$$

The dependent variable of the model is firm performance measured by the logarithmic values of labor productivity (LNLP). The model contains time dummies: y2013 (equal to one for the year 2013), and y2019 (equal to one for the year 2019) whereas the year 2009 is the base group.

Until recently most studies applied ordinary least squares (OLS) to investigate this relationship. As an alternative to log-linear regressions, this paper also fits a Poisson pseudo maximum likelihood (PPML) regression using the Huber-White-Sandwich linearized estimator of variance for comparative estimates. Furthermore, the IV technique (only fixed-effect and fixed-effect with variance–covariance matrix) will be used to estimate the relationship, in order to provide fixed-effect results for the pooled data. The VCE option is common to most estimation commands. It specifies how to estimate the variance–covariance matrix (VCE) corresponding to the parameter estimates. The standard errors reported in the table of parameter estimates are the square root of the variances (diagonal elements) of the VCE. The VCE option is provided for the fixed-effect regression models for the pooled data already set. The results will further be compared with the results of the IV/GMM technique for the treatment of endogeneity.

Furthermore, the paper extends the empirical investigation by applying Structural Equation Modelling (SEM) (Pundziene *et al.*, 2022). SEM with Smart PLS

4.0 and Partial Least Squares was used to evaluate the structural model (Ringle *et al.,* 2022).

The explanatory variables used in the research model include a range of firm characteristics. An inclusive list of potential explanatory variables identified in the literature and their expected signs are presented in Table 1.

Table 1. Description of the explanatory variables

Variable Name	Variable Definition /Unit of measurement	Expected Sign
Innov_act	Dummy variable = 1 if the firm introduced product and process innovation three years before the survey	+
Size	Number of permanent, full-time employees of this firm at the end of last fiscal year (natural logarithm)	+/-
Invest in R&D	Dummy variable = 1 if the company invested in research and development in the last 3 years	+
Direct_exports	% of establishment sales as direct exports	+
Foreign ownership	Percent of the firms owned by private foreign individuals, companies, or organizations	+/-
Knowledge	Percent of employees with a university degree at the end of fiscal year	+
Age	Years since the firm began its operations in this country (natural logarithm)	+
Agesq	Firm's experience–year since establishment squared	-
Tech_FRGN_com	Dummy variable =1 if the company uses technology licensed from a foreign-owned company at present	+
Patent	Dummy variable = 1 if the company applied for a patent/trademark over the last three years	+
Productivity	Turnover per employee (natural logarithm)	
Innov_logistics	Dummy variable = 1 if there are new or improved logistical or business support processes	+
International_mrk	Dummy variable = 1 if the main product or service is sold mostly to nations outside the country where the establishment is located	+
Part of a Large Firm	Dummy variable = 1 if the establishment is part of a large firm	+

Here we provide the descriptive statistics of the pooled data in the years 2009, 2013, and 2019. Two separate tables, Tables 2(a) and 2(b) are generated to show the descriptive statistics for different types of variables: (i) continuous and (ii) dichotomous, respectively.

Table 2(a). Descriptive statistics of continuous variables

Variables	Year	Obs.	Mean	Std. Dev.	Min	Max
Size (number of employees)	2009	4,970	105.7139	429.5514	0	18208
	2013	5,454	55.1443	252.944	1	9850
	2019	8,340	82.15743	243.1726	1	11382
Age (years since establishment)	2009	4,938	27.30174	16.10265	11	194
	2013	5,458	22.77409	12.24504	6	168
	2019	8,404	20.37292	13.61803	2	205
Direct Exports (% of establishment's sales exported directly)	2009	5,008	11.47404	26.05415	0	100
	2013	5,422	10.01402	24.50956	0	100
	2019	8,309	14.67481	28.95524	0	100
Foreign Owner (% owned by private foreign individuals,	2009	4,964	10.20165	28.57173	0	100
	2013	5,444	8.01194	25.72605	0	100
	2019	8,367	9.132903	27.59889	0	100

companies or organizations)						
Knowledge (% employees with a university degree)	2009	5,031	14.38939	20.39637	0	100
	2013	5,508	19.10349	24.78976	0	100
	2019	3,585	17.54644	21.43693	0	100
Productivity (Sales per employee)	2009	4,123	4256957	35500000	0	1740000000
	2013	4,618	44300000	2380000000	0	160000000000
	2019	7,345	10400000	312000000	100	19600000000
Competitors (Competitors for the main product/service in the main market)	2009	1,111	18.24842	61.98219	0	1400
	2013	4,801	76.8694	153.7849	0	1000
	2019	8,378	12.25997	103.9703	0	5000

The average size of the companies in the sample is varying on average from 55 to 106 employees. The average firm receives 11 – 15 percent of its sales from direct exporting. Firms have been established mostly 20 to 27 years ago (the late nineties). For companies surveyed in 2009, on average 14 percent of the employees have a university degree, and this percentage increases to 20 percent by 2013.

Table 2(b). Descriptive statistics of dichotomous variables

Dummy variables	Year	Obs.	Yes	No
dInnov_act	2009	5,031	56.39	43.61
	2013	5,508	41.36	58.64
	2019	8,462	39.33	60.67
dInvestR&D	2009	5,031	29.24	70.76
	2013	5,508	12.49	87.51
	2019	8,462	19.77	80.23
dTech_FRGN_com	2009	1,700	23.76	76.24
	2013	5,440	15.86	84.14
	2019	8,383	16.93	83.07
dPatent	2009	5,031	25.10	74.90
	2013	5,508	4.74	95.26
	2019	8,462	6.96	93.04
dInnov_logistics	2009	5,031	2.42	97.58
	2013	5,508	12.49	87.51
	2019	8,462	5.72	94.28
dInternational_mrk	2009	5,031	9.14	90.86
	2013	5,508	11.76	88.24
	2019	8,462	18.46	81.54

Considering innovation activities, 56 percent of the companies have indicated that they introduced a new product and/or process in 2009, and the number of innovative firms has decreased by 17 percent by 2019.

3.1. Performance model regression results

Primarily the research model was estimated using log-transformed ordinary least squares (OLS). Taking into consideration that this method might produce substantial

bias, yielding misleading inferences, this study is fitting Poisson pseudo maximum likelihood estimators with robust standard errors. Specifically, we fit a Poisson regression using the Huber-White-Sandwich linearized estimator of variance, as an alternative to logarithmic linear regressions, without taking the natural log of the dependent variable. Furthermore, we employ the instrumental variable/generalized method of moments estimation (IV/GMM) model to deal with the problem of endogeneity[1] that arises in the literature on the relationship between open innovation activities and firm performance. To deal with the endogeneity of labor productivity and open innovation, we will use instrumental variables (IV), by finding instruments that satisfy the two key assumptions (i) the instrumental variable must be uncorrelated with the error term but (ii) must be correlated with the independent variable. The instruments considered are the R&D investment and knowledge. Both appear to be valid instruments and satisfy the test of redundancy. Table 3 displays the regression coefficients and corresponding p-values of the performance model.

[1] Endogeneity appears in equations where there is correlation between an independent variable and the disturbance term.

Table 3. The performance models: (i) OLS and PPML (ii) IV (only FE and FE with VCE), and (iii) IV/GMM regression results

	OLS	PPML	FE	FE with vce (cluster country)	IV/GMM regression
Independent Variables	*Coeff. / p-values*	*Coeff. / p-values*	*Coeff. / p-values*	*Coeff. / p-values*	*Coeff. / p-values*
Innov_act	0.529***	0.0497***	0.334***	0.334**	2.646
	(0.117)	(0.0107)	(0.107)	(0.129)	(2.334)
Inv_RnD	0.664***	0.0597***	0.438***	0.438***	-0.131
	(0.156)	(0.0125)	(0.142)	(0.117)	(0.602)
size	0.000214	1.80e-05	2.13e-05	2.13e-05	-6.04e-05
	(0.000206)	(1.90e-05)	(0.000186)	(0.000249)	(0.000281)
Age	0.0224**	0.00211***	0.0424***	0.0424**	0.0414***
	(0.00877)	(0.000792)	(0.00804)	(0.0152)	(0.00810)
Age_sq	-0.000124	-1.18e-05*	-0.000269***	-0.000269**	-0.000270***
	(8.18e-05)	(7.15e-06)	(7.44e-05)	(0.000126)	(7.24e-05)
Direct_Exports	0.00823**	0.000725**	0.00299	0.00299	
	(0.00368)	(0.000283)	(0.00334)	(0.00307)	
FRGNowner	0.00943***	0.000829***	0.00862***	0.00862***	0.00823***
	(0.00218)	(0.000165)	(0.00198)	(0.00174)	(0.00195)
Tech_FRGN_com	-0.445***	-0.0411***	-0.206	-0.206*	-0.419*
	(0.146)	(0.0133)	(0.133)	(0.116)	(0.252)
Innov_logistics	-0.0137	-0.000992	0.0841	0.0841	-0.648
	(0.177)	(0.0154)	(0.162)	(0.272)	(0.755)
International_mrk	0.253	0.0231	0.114	0.114	0.112
	(0.287)	(0.0224)	(0.260)	(0.365)	(0.240)
part_of_LF	0.957***	0.0843***	0.444**	0.444***	0.368*
	(0.196)	(0.0160)	(0.179)	(0.126)	(0.189)
knowledge	0.00748***	0.000696***	0.00983***	0.00983*	0.00845***
	(0.00229)	(0.000215)	(0.00212)	(0.00469)	(0.00267)
Patent	-0.0415	-0.00362	0.271	0.271	-0.154
	(0.224)	(0.0182)	(0.203)	(0.250)	(0.483)
Competitors	0.00120***	0.000104***	0.000545	0.000545**	0.000542*
	(0.000368)	(3.02e-05)	(0.000335)	(0.000255)	(0.000312)
y2013	0.501	0.0462	0.608**	0.608	0.938**
	(0.313)	(0.0289)	(0.283)	(0.680)	(0.466)
y2019	0.536*	0.0489*	1.201***	1.201*	1.598***
	(0.308)	(0.0280)	(0.280)	(0.636)	(0.512)
Constant	8.996***	2.211***	8.482***	8.482***	
	(0.351)	(0.0322)	(0.320)	(0.655)	
Observations	8,249	8,249	8,249	8,249	8,249
R-squared	0.026		0.024	0.024	0.031
Number of a1			17	17	17

Note: Standard errors in parentheses, and *** p<0.01, ** p<0.05, * p<0.1

Before moving to the interpretation of the coefficients, the tests of all instruments of the semi-logarithmic performance regression are discussed. These results indicate that we have insufficient evidence to reject the null hypothesis that the

model has the correct functional form at a 5% level of significance. The diagnostic tests suggest that there is insufficient evidence to accept the null hypothesis that the residuals have a normal distribution. And there is insufficient evidence to reject the null hypothesis of homoscedasticity in the model.

The F-test of the validity of instruments employed shows to be insignificant (less than ten) when the 'invest in R&D' variable is employed.[2] For these specifications of the estimated regressions, the instruments show to be strong, and thus we reject the null hypothesis of weak instruments.

The GMM estimation technique offers the Hansen J statistic, which is another test for the validity of the instruments. It tests the joint hypothesis of the correct model specification and the orthogonality conditions. In both specifications Hansen J confirms the validity of instruments i.e., we fail to reject the null hypothesis of over-identification of all instruments. The tests for the robustness of the performance models and the validity of the instruments show that they are robust and that their instruments meet the validity criteria. After considering the diagnostics of the model we can continue with the interpretation of the coefficients (Table 3).

The interpreted coefficients are statistically significant at a 1% level of significance, offering evidence that the Ho hypothesis, (β_{it} =0) can be rejected for these cases. According to chi2 statistics, the explanatory variables are jointly significant (since Prob>chi2 = 0.000) at a 1% level of significance, therefore the null hypothesis that all regressors are jointly insignificant may be rejected.

3.2. Structural Equation Modelling (SEM)

SEM with Smart PLS 4.0 and Partial Least Squares was used to evaluate the structural model (Ringle *et al.,* 2022). Items on five capacities were individually summed to construct each latent variable. As the number of estimated variables decreases by adopting summed scales, simple path analyses can be conducted to see the total effects of OI capacities on firm performance. Key model fit indices and path estimates are summarized in Figure 2.

[2] Generally, the value of the F- statistic is required to be over 10 to suggest sufficiently strong instruments (Cragg and Donald, 1993; Staiger and Stock, 1997).

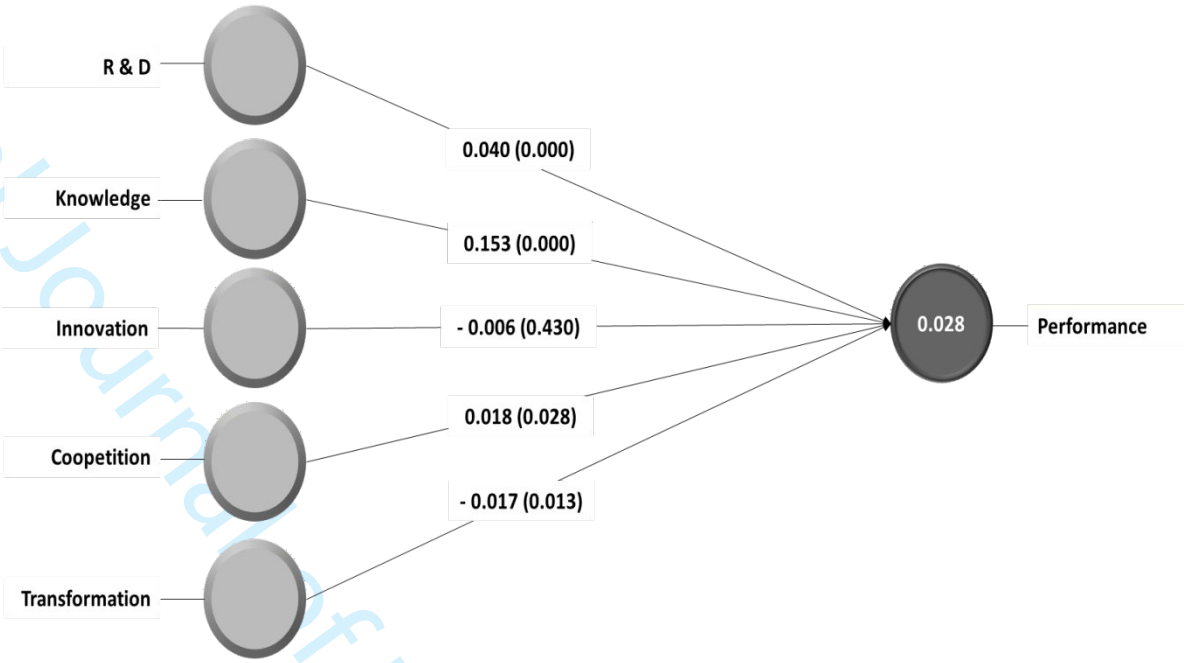

Figure 2. SEM Results

Considering the SEM results (Figure 2), all path coefficients are statistically significant at the 0.05 level. The bootstrapping technique with 5000 sub-samples as an approach was utilized to test the provided hypotheses and to evaluate the structural model by examining beta, R^2, and t-values (Hair *et al.,* 2017). Table 4 reveals the obtained results of the hypotheses.

Table 4. Hypotheses testing

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
R&D → performance	0.04	0.04	0.007	5.911	0.000
Knowledge → performance	0.153	0.153	0.007	20.575	0.000
Innovation → performance	-0.006	-0.006	0.008	0.789	0.430
Coopetition → performance	0.018	0.018	0.008	2.207	0.028
Transformation→performance	-0.017	-0.017	0.007	2.481	0.013

4 Findings

To empirically investigate the open innovation concept in the context of SEE and CEE, this paper employs sophisticated research methods. Three different estimation techniques are applied to empirically estimate the productivity model: (i) semi-logarithmic OLS regression; (ii) Poisson pseudo maximum likelihood estimators with robust standard errors; and (iii) the IV/GMM model. This methodological diversity

strengthens the robustness of the findings. Additionally, the paper incorporates the testing of the research model using Structural Equation Modelling (SEM) to unravel the intricate relationship between five OI capacities and firm performance. This multifaceted approach not only enriches the discussion but also contributes to a more comprehensive understanding of the dynamics and implications of open innovation in the specified geographical contexts.

The regression results are consistent across the three estimation techniques (five models applied) reported in Table 3, except for IV/GMM where we find some insignificant effect of the variables. The main point to notice is that the Poisson estimated coefficients are similar to the ones generated with OLS. They all show that performance is statistically dependent on innovation activities and firm characteristics.

The results of the four regression results show the positive and statistically significant coefficient of innovation at a 1% level of significance, except for the IV/GMM where innovation is statistically insignificant. This methodological specification indicates companies undertaking innovation are 33.4 percentage points more likely to have better performance compared to their counterparts. In the instrumental variable (IV) model, the innovation variable is instrumented with the investment in R&D and knowledge. The results show a positive and statistically significant impact of the instrumented variable innovation on firm performance.

The variable *invest in R&D* in the regression analysis appears to have a positive and significant relationship with firm performance, which is in accordance with the research conducted by Kmecová-Vokoun (2020) in the Czech Republic. The coefficient of the invest in *R&D* variable is statistically significant at a 1% level of significance, indicating that companies investing in R&D are 43.8 percentage points more likely to have better performance compared to their counterparts. The coefficient *knowledge* measured as the level of education of the employees as the share of employees with university degrees is significant and positively related to the firms' performance.

The IV model appears to have positive and significant coefficients for foreign ownership indicating that private foreign firms are performing better than domestic-owned firms. The variable indicating if the company uses technology licensed from a foreign-owned company has contradictory results differing on the method used, i.e., it becomes negative and statistically significant when the IV is employed.

The results of the OLS and IV/GMM performance models show an insignificant coefficient on the independent variable *patent.* The regression results also show a

statistically insignificant coefficient of *innovation in logistics* even at a 10 percent level of significance. The same results are shown for providing new products and services to the international market. The findings align with the conclusions drawn by Ramadani et al. (2019). The variable *competitors* is positive and statistically significant at a 5% level of significance, implying that those firms that function in more competitive environments are better-performing ones. The regression results also show a positive and statistically significant coefficient of *being part of a large firm* at 1% level of significance. The results indicate that companies that collaborate with large companies are more likely to have better performance compared to their counterparts. The regression results show a positive significant impact of direct export on performance as well.

Considering the SEM results, we tested the proposed hypotheses and concluded that three OI capacities, R&D, knowledge, and coopetition are statistically significant and positively associated with firm performance. Innovation does not have a statistically significant impact on firm performance, whereas transformation is statistically significant but negatively associated with firm performance.

H_1 assessed whether *R&D* has a significant impact on firm performance. The findings revealed that R&D shows to have a significant positive impact on firm performance (beta= 0.04, t=5.911, p<0.000).

H_2 assessed whether *knowledge* has a positive significant impact on firm performance. The findings revealed that knowledge (*absorptive capacity*) shows to have a significant positive impact on firm performance (beta=0.153, t=20.575, p<0.000).

H_4 assessed whether *coopetition* has a positive significant impact on firm performance. The findings revealed that coopetition showed to have a positive significant effect at a 5% level of significance on firm performance (beta=0.018, t=2.207, p<0.028).

H_3 and H_5 assessed whether *innovation* and *transformation* have a positive significant impact on firm performance. The findings revealed that innovation did not show to have a statistically significant impact on firm performance (beta=-0.006, t=0.789, p<0.430). Moreover, based on the results, the transformation was shown to have a negative effect on performance, with an effect (beta=-0.017, t=2.481, p<0.013).

5. Discussion

Open innovation has emerged as a transformative catalyst, reshaping entire industries (Chesbrough, 2024; Christensen et al., 2005), exerting a profound influence on the competitive business landscape (Bacon *et al.,* 2020; Ramadani *et al.,* 2018), and creating significant opportunities for companies adept at efficiently practicing open innovation (Caputo *et al.,* 2016; Chaudhary *et al.,* 2022). However, amid these promises, open innovation is not impervious to challenges (Madanaguli *et al.,* 2023; Majchrzak *et al.,* 2023).

Our study aligns seamlessly with the research conducted by Ahn et al. (2013), Almirall and Casadesus-Masanell (2010), and Oltra et al. (2018), reinforcing the consistently positive impact of innovation activities on firm performance. This resonance strengthens the argument that fostering innovation remains a universal driver of business success (Ahn et al., 2013; Almirall and Casadesus-Masanell, 2010; Dabić et al., 2023; Oltra et al., 2018), particularly in the dynamic SEE and CEE regions.

The significance of investment in R&D in our study finds robust support in the works of Kmecová-Vokoun (2020), Krishnan et al. (2009), and Kraus et al. (2022). These studies substantiate the enduring positive relationship between R&D investments and firm performance, underlining the pivotal role of continuous research and development endeavors (Kmecová-Vokoun, 2020; Krishnan *et al.,* 2009; Kraus *et al.,* 2022) within the SEE and CEE context.

The observed positive association between firm performance and knowledge, measured through employee education levels, resonates with the findings of Dayan et al. (2023) and Ramadani et al. (2017). These studies reinforce the universal idea that maintaining a knowledgeable workforce contributes significantly to organizational success, extending the applicability of these principles to the unique dynamics of SEE and CEE markets (Dayan *et al.,* 2023; Ramadani *et al.,* 2017).

The nuanced impact of technology licensing from a foreign-owned company on firm performance aligns intricately with the findings of Callarisa-Fiol et al. (2023). This underscores the intricate nature of international collaborations and their diverse effects on performance within the SEE and CEE regions. The insignificant coefficients for patents, innovation in logistics, and international market expansion also align with the nuanced and context-specific nature of these factors, echoing previous research by Abazi-Ali et al. (2016) and Ramadani et al. (2019).

Our study concurs with the notion that a competitive environment acts as a driving force for organizational improvement, aligning with the broader literature on organizational competitiveness (Ramadani *et al.,* 2019). Furthermore, the identification of collaboration with large firms and direct exports as positive influencers of firm performance corresponds seamlessly with existing literature emphasizing the benefits of strategic partnerships and international market engagement (Ramadani *et al.,* 2018). The phenomenon of OI, spanning from idea generation to scalability and involving process-related challenges (Madanaguli *et al*., 2023), introduces strategic complexities, especially during the transition from collaboration to 'coopetition' (Corbo *et al*., 2023; Xue *et al*., 2023). This phase is characterized by intricacies and ambiguities, and as organizations navigate this challenging terrain, the shadows of potential failures loom (Bamel *et al.,* 2023; Cricelli *et al.,* 2023).

The multifaceted lens becomes indispensable as we delve into the complexities of open innovation, considering the significance of organizational culture, the challenges within collaborative networks, and the imperative of adaptability for resilience. The identified pathways offer a nuanced perspective, aligning with the broader discourse on the intricacies and multifaceted nature of open innovation challenges and successes (Antonio *et al.,* 2023; Meyer *et al.*, 2023).

The interconnectedness of the challenges highlighted here, such as the significance of a collaborative culture, the dynamics of collaborative networks, and the adaptability required for resilience, echoes the intricate landscape of open innovation as discussed in the literature. In our Structural Equation Modeling (SEM) analysis, three out of five open innovation dimensions—R&D, knowledge, and coopetition—are identified as statistically significant and positively associated with firm performance. This aligns seamlessly with recent studies by Feser (2022) and Xie et al. (2022), affirming the crucial role of these capacities in shaping organizational success specifically within the dynamic SEE and CEE regions.

Building on the insights generated in the discussion above, our analytical exploration of the pathways takes root in this understanding. Moreover, our exploration aligns with the acknowledgment of potential failures and the need for organizations to navigate these challenges strategically (Antonio *et al.,* 2023; Bamel *et al.,* 2023; Chesbrough, 2024). As we embark on this analytical journey, we recognize the interconnected nature of these challenges and their implications for organizational resilience in the dynamic context of open innovation within SEE and CEE.

6 Conclusions

This paper aims to empirically investigate open innovation capacities, defined as a cooperative, knowledge-sharing innovation ecosystem, and explore how it can lead to improved performance of firms in Central and Eastern European (CEE) and Southeastern European (SEE) countries. Some important conclusions can be generated from the empirical results of this study. The results of the regressions differ slightly depending on the method used, but there is sufficient evidence to support the significant positive open innovation capacities-performance relationship. Summarizing these findings, the paper concludes that the improved performance of firms in the transition period is due to factors such as innovation, R&D investment, knowledge, foreign ownership, patents, coopetition, etc. The first estimation findings support the view that firm productivity is significantly affected by open innovation capacities, together with some control variables such as firm characteristics. (IV/GMM estimations appear to have insignificant coefficients for some of the estimates). Other variables such as size, age, foreign ownership, and year dummy too have a significant impact on firm performance. SEM results confirm that R&D, knowledge, and coopetition have positive effect on firm performance.

6.1 Theoretical and practical implications

Based on the learnings of the investigated open innovation capacities-firm performance relationship, theoretical and practical implications can be identified for scholars and practitioners. The study investigated the effect of open innovation capacities such as R&D, knowledge, innovation, transformation, and coopetition on firm performance. This analysis provides an enriched portrayal of OI in CEE and SEE countries and the different factors that drive the development of OI and how they impact the firm's performance.

In this paper, sophisticated research methods are used. For the empirical analysis, three different estimation techniques were applied to the pooled BEEPS dataset in order to deal with endogeneity, heteroskedasticity, and autocorrelation problems. We treat both open innovation and performance as endogenous variables. Primarily, the research model was estimated using log-transformed ordinary least squares (OLS). Taking into consideration that this method might produce substantial

bias, yielding misleading inferences this study is fitting Poisson Pseudo Maximum likelihood estimators with robust standard errors and instrumental variable/ generalized method of moments estimation (IV/GMM) approach for comparative results. Secondarily the research model was tested using Structural Equation Modelling (SEM) to investigate the relationship between five OI capacities and firm performance.

As managerial implications, firms in these regions are encouraged to strategically embrace open innovation, fostering a culture of collaboration and knowledge-sharing. Investments in R&D, enhancement of employee knowledge through education, and strategic coopetition initiatives are highlighted as pivotal strategies. The findings underscore the significance of navigating competitive environments, leveraging collaboration with large firms, and exploring global market expansion. Caution is advised in approaching transformative changes, emphasizing the need for careful planning and adaptation. Policymakers are urged to consider these insights for shaping policies that support innovation and contribute to a conducive environment for firms in CEE and SEE countries.

This research not only contributes to the academic understanding of open innovation but also provides actionable guidance for businesses and policymakers. By integrating these practical implications, firms can position themselves for sustained success in the evolving global business landscape, capitalizing on the opportunities presented by open innovation and fostering a culture of continuous improvement and adaptation.

6.2 Limitations and future research directions

Limitations of any research in this area are partly conceptual and partly data-related. Data limitations, of course, were the main limitations of this research. The paper relied on BEEPS 2009, 2013, and 2019 pooled data survey, as the panel component could not be used as the questions were not quite the same in more recent rounds compared with earlier rounds. This limitation was due to the availability of relevant variables and questions that enabled us to create the open innovation variable.

Furthermore, because of these data limitations, we were unable to employ a CDM-type model and have had to examine the relationship between open innovation and firm performance by following studies applying singe-equation models (Damijan, *et al.*, 2008; Ramadani, *et al.*, 2017).

Notwithstanding the advantages, pooled data sets have their limitations, too. As listed by Baltagi (2005), first the design and the data collection are more problematic, then there are some distortions of measurement error[3] and it is moreover usually difficult to get long time-series dimensions for the micro panel data (they have high costs and the computational difficulty for limited dependent variable pooled data models increases by increasing the time span). Another limitation that should be mentioned is the selectivity problems which include self-selectivity and non-response issues.[4]

We used secondary data rather than conducting an own survey to employ SEM, and therefore the variables were not initially tailored to the purposes of this study. We attempted to choose appropriate and relevant variables but inevitably there were scale mismatches. Some variables measure objective figures while others measure the subjective extent of the respondent's feelings.

Future research agendas in open innovation should encompass a macro-level analysis, investigating broader systemic and environmental dimensions, particularly in the SEE and CEE regions. Context-specific exploration is crucial to understand unique challenges and opportunities in these dynamic regions. Longitudinal studies could offer insights into the evolution of open innovation practices and their sustained impact on firm performance over time.

Exploration of the dynamics of collaborative networks, focusing on their evolution, adaptation, and impact on innovation outcomes, is essential. Innovative strategies for adapting to 'coopetition' and in-depth analysis of the nuanced impact of technology licensing from foreign-owned companies deserve further attention. Cross-industry comparative studies could identify industry-specific challenges and success factors in open innovation.

Integrating ethical considerations, such as intellectual property rights and data privacy, into open innovation practices is increasingly important. Exploring how open innovation contributes to organizational resilience and agility in the face of external shocks should be a focal point. Additionally, a more in-depth analysis of negative outcomes and the identification of common pitfalls could contribute to a comprehensive

[3] Measurement errors may arise because of faulty responses due to unclear questions, memory errors, deliberate distortion of responses (e.g., prestige bias), inappropriate informants, miss-recording of responses and interviewer effects.

[4] When the individual refuses to participate in the survey or refuses to answer particular questions. This problem occurs in cross-section studies, but it becomes aggravated in panel surveys.

understanding of challenges in open innovation. Overall, addressing these research avenues will enhance our understanding and responsible implementation of open innovation, especially in diverse regional contexts like SEE and CEE.

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