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## Article

# Forging innovation cooperation in Central and Eastern Europe: Unveiling the location role in biopharmaceutical industry

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# Forging innovation cooperation in Central and Eastern Europe: Unveiling the location role in biopharmaceutical industry

Łukasz Puślecki

## ABSTRACT

**Objective:** The article aims to verify the development of innovation cooperation in the biopharmaceutical (biotech, pharma) industry in Central and Eastern Europe (CEE) taking into account the directions of innovation cooperation. I will try to verify the importance of location in innovation cooperation in the biopharmaceutical industry in the CEE region, mainly if the frequency of cooperation within research and development (R&D) alliances with CEE partners is higher than with non-CEE partners.

**Research Design & Methods:** This is one of the first quantitative primary research articles in the world focused on innovation cooperation in the biopharmaceutical industry in the CEE region (covering 18 CEE countries), in the years 2015-2017. I conducted an online survey and collected data from January 2019 to March 2020 (a long-lasting process). The sampling procedure was non-random (purposeful selection with snowballing technique). To verify the directions of cooperation within R&D alliances in the biopharmaceutical industry, I investigated 241 R&D alliances conducted by 107 companies from the CEE region in the years 2015-2017.

**Findings:** The results show that the frequency of cooperation within R&D alliances with CEE partners was higher than with non-CEE partners (for selected partners and sectors). Moreover, according to the analysis of 241 R&D alliances, I observed the same results, i.e. companies from the CEE region – taking into account the direction of innovation cooperation – are more willing to develop R&D alliances with partners from the CEE region (including partners from the domestic market) than with partners outside the CEE region (North America, Western Europe, Asia) in the biopharmaceutical industry.

**Implications & Recommendations:** In the difficult times of the Covid-19 pandemic, companies should be more open to cooperation and use local potential and local partners to develop better therapies for patients. With more flexible modes of cooperation, it is possible to deliver new solutions and better patient treatment to the market faster, which is particularly germane to responses to the current Covid-19 pandemic, and potential future pandemics.

**Contribution & Value Added:** The involvement of all partners, both from the local and regional level, from business and academia, in the innovation cooperation positively impacts the innovation cooperation performance. The identified directions of innovation cooperation in CEE countries may contribute to the development of innovation cooperation in the CEE countries in the future and greater exploitation of the innovation and educational potential of the biopharmaceutical industry in the domestic market and the entire CEE region (clinical trials, clusters, science and technology parks, academia, institutions).

**Article type:** research article

**Keywords:** R&D alliances; innovation cooperation; biopharmaceutical industry; business-academia cooperation; location; Central and Eastern Europe; CEE

**JEL codes:** F23, L25, M16, O32

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## INTRODUCTION

Considering the past 30 years, R&D cooperation is a fundamental component of innovation strategies. The economic and management literature offers numerous insightful publications on R&D cooperation among companies considering various forms of collaboration, such as technology transfer, technology exchange, R&D arrangements, and joint ventures (Casson, 1987; Contractor & Lorange, 1988; Piowar-Sulej & Podsiadły, 2022; Miłoś, 2021). We can categorize technological agreements based on the nature of relationships between companies, ranging from one-directional arrangements to those with stronger organizational ties, like joint ventures and research corporations. On the other end of the spectrum, there are agreements with fewer organizational dependencies, such as contractual arrangements like technology exchange agreements or joint R&D agreements. These differing forms of technological cooperation can have varying effects on technology sharing, competitiveness levels, organizational dynamics, and potential economic outcomes for the participating companies (Contractor & Lorange, 1988; Hagedoorn, 1990; Hagedoorn, Link & Vonortas, 2000; Gomes-Casseres, Hagedoorn & Jaffe, 2006; Puślecki, 2010; Wybieralski, 2015).

Technological cooperation serves as a crucial channel for knowledge diffusion in both the public and private sectors (Androniceanu et al., 2022). Companies have been increasingly utilizing global strategic partnerships to bolster their competitive positions. Moreover, R&D alliances enable partners to improve core competencies and skills, acquire new technologies, share the risks involved in developing new technologies, and access emerging markets (Puślecki, 2010; Wybieralski, 2015; Androniceanu, 2023). Consequently, such collaborations lead to improved innovation cooperation performance (Jaklič *et al.*, 2014; Trąpczyński, Puślecki & Staszków, 2018; Tvaronaviciene & Burinskas, 2021).

The article aims mainly to verify the development of innovation cooperation in the biopharmaceutical (biotech, pharma) industry in Central and Eastern Europe (CEE) taking into account the directions of innovation cooperation. I will verify the importance of location in innovation cooperation in the biopharmaceutical industry in the CEE region, mainly if the frequency of cooperation within R&D alliances with CEE partners is higher than with non-CEE partners. This is one of the first quantitative primary research articles in the world focused on innovation cooperation in the biopharmaceutical industry in the CEE region (covering 18 countries), in the years 2015-2017. To verify the directions of cooperation within R&D alliances in the biopharmaceutical industry, I investigated 241 R&D alliances conducted by 107 companies from the CEE region between 2015-2017.

Biopharmaceutical companies (operating in the biotech and pharma industry) try to implement various forms of cooperation within the industry with universities or research institutes, institutions, and more often cross-industry alliances that may help share the costs of R&D investment and minimize the risk (Gomes-Casseres, 2014; Puślecki, 2015, 2016). This cooperation is very important in combating Covid-19 pandemic quicker, preparing for the potential future pandemics (Bourla, 2022; Gorynia, 2023; Puślecki, 2021; Puślecki *et al.*, 2022), and building innovation resilience to rapid changes in the environment as a condition for continuity of innovation (Jaklič, Puślecki & Trąpczyński, 2023; Nowiński, Rymarczyk & Starzyk, 2022; Puślecki *et al.*, 2022; Gorynia, 2023).

The article draws on issues addressed in innovation theory (Schumpeter, 1934, 1939, 1942) and it is embedded in the biopharmaceutical industry, thus constituting a kind of meso-economic study (Gorynia, 1995). I studied one of the economic mesosystems, the biopharmaceutical industry, *i.e.* the mid-level system, narrowing the focus to innovation cooperation. The thread of cooperation central to this study is also widely discussed within the framework of economic systems regulation theory (Weresa, 2022). Moreover, although, the article focuses mainly on the innovation thread, the study made it possible to determine how a given way of regulating the behaviour of firms through R&D alliances can contribute to the innovation of these partners, which ultimately translates into the competitiveness of the economy. It is also important to take a broader view of innovation cooperation and firm performance not just in one country but in the CEE region (Jaklič *et al.*, 2014; Wach, 2020; Barłózewski & Trąpczyński, 2021; Gorynia & Trąpczyński, 2017, 2022).

The post-transition countries of CEE have seen a significant increase in foreign direct investment (Trąpczyński *et al.*, 2016; Gorynia *et al.*, 2019, 2022), the location of new companies, and new service centres (BPO/ITO/SSC) for foreign entities, particularly in the last 15 years. The CEE region is an emerging and dynamic market that offers many business opportunities. Central and Eastern Europe offers significant growth opportunities and more competitive business costs than established EU markets. This makes the region an attractive location for international companies to trade and invest, often through strategic alliances, including R&D alliances. Noteworthy, the CEE region is less represented when it comes to research in the field of, for example, international business than *e.g.* Western Europe (Schuh, 2012, 2021; Schuh & Rossmann, 2009; Puślecki & Trąpczyński, 2014; Puślecki, Trąpczyński & Staszaków, 2016; Trąpczyński, Puślecki & Jarosiński, 2016; Jaklič *et al.*, 2020; Schuh, Trąpczyński & Puślecki, 2024; Jaklič, Puślecki & Trąpczyński, 2023).

The article is structured as follows. Firstly, I will present the literature review regarding the R&D alliances and the role of location in the development of innovation cooperation and use it to formulate hypotheses on the example of the biopharmaceutical industry. Subsequently, I will present the methodology of my empirical data collection, the findings both for innovation cooperation in the CEE region in the biopharmaceutical industry, and the direction of cooperation, taking into account the role of location. In the final part of the article, I will discuss the findings, limitations, and implications and indicate future research potential.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

We may describe strategic alliances as a specialized form of collaboration between at least two parties, which may be competitors or partners operating in the same or related sectors. Above all, these alliances aim to achieve common goals by utilizing available resources while maintaining the autonomy of each partner. These alliances cover various fields and areas not explicitly covered by the partnership agreement (Gomes-Casseres, 1996; Gulati & Singh, 1998; Das, 2005; Duyster & Hagedoorn, 2000; Puślecki, 2010; Wybieralski, 2015).

The partners involved in strategic alliances typically comprise two firms, but they can also involve research institutes, universities, government institutions, or non-profit organizations (Baum *et al.*, 2000; Puślecki & Staszaków, 2015; Puślecki, 2015, 2016). Partners implement strategic technology alliances primarily through joint ventures, equity alliances (where two or more partners form a separate entity), or non-equity alliances within R&D cooperation agreements (Bartolacci *et al.*, 2022). The R&D alliances are characterized as innovation-based partnerships formed by multiple participants who pool their resources and coordinate their activities to achieve a common objective and where R&D activities play a significant role (Hagedoorn, 2002). These alliances appear in the literature under various terms, such as strategic technology partnering, strategic technology alliances, technological cooperative agreements, technological alliances, innovation cooperation, or cooperative R&D (Duysters & Hagedoorn, 2000; Puślecki, 2010; Wybieralski, 2015; Narula & Martínez-Noya, 2015; Martínez-Noya & Narula, 2018). We can consider technological alliances as strategic when they enhance the long-term market perspectives of at least one company involved in the cooperation. Furthermore, technological partnerships entail cooperation that involves some degree of innovative activity or the exchange of technology between partners (Hagedoorn, 1990, 1993, 2002; Duysters & Hagedoorn, 2000). The diverse definitions of R&D alliances across the economic, international business, and management literature reflect the multidisciplinary nature of the subject (Narula & Martínez-Noya, 2015; Martínez-Noya & Narula, 2018).

The R&D alliances offer various advantages to partners engaged in innovation cooperation. These advantages include access to complementary resources necessary for improving products or processes or developing new ones, the opportunity to explore new markets, cost reduction, risk mitigation, increased flexibility in partner selection, and faster time-to-market (Narula & Duning, 1998; Duysters & Hagedoorn, 2000; Hagedoorn, Link & Vonortas, 2000; Sakakibara, 2002; Nowak, 2021; Tomášková & Kaňovská, 2022). Analysing the growth and development of R&D alliances (Puślecki, 2010, 2012; Wybieralski, 2015), existing literature explains their formation through two main perspectives (Narula

& Dunning, 1998; Martínez-Noya & Narula, 2018). The first perspective is transaction cost theory, which considers the economization aspect (Williamson, 1975; Hennart, 1988; Pisano & Teece, 1989). The second perspective takes a strategic approach and involves various other theoretical frameworks, such as the resource-based theory of the firm (Barney, 1991; Das & Teng, 2000; Wernerfelt, 1984), organizational learning and knowledge-based view (Kogut & Zander, 1993), social network theory (Gulati, 1995; Powell & Grodal, 2005), and the dynamic capabilities approach (Teece, Pisano & Shuen, 1997; Zollo & Winter, 2002).

Recent literature regarding R&D alliances (Martínez-Noya & Narula, 2018) highlights that alliances are not solely motivated by cost minimization but are also influenced by value-enhancing factors, such as market growth and inter-firm learning through alliances. Firms establish R&D alliances to strengthen their organizational and technological capabilities (Das & Teng, 2000) and create value by leveraging existing assets, developing new or improved products and innovation capabilities, acquiring complementary resources, and entering new markets (Gulati, 1998; Sakakibara, 2002; Martínez-Noya & Narula, 2018). These strategic considerations are particularly important in emerging technological sectors like the biopharmaceutical industry.

The diversity of fields of cooperation (new, developed, and advanced technologies), the dynamic and turbulent environment (*e.g.* exacerbated by the COVID-19 pandemic), high uncertainty and the complexity of alliance management require from companies a both broader range of skills and competencies and resources and partners from different locations and levels (Hagedoorn, 1993; Granstrand, Patel & Pavitt, 1997; Gulati, 1998; Leiblein & Miller, 2003; Mol, 2005; Nicholls-Nixon & Woo, 2003; Świadek *et al.*, 2022; Puślecki, 2010, 2021; Puślecki *et al.*, 2022; Quinn, 2000; Martínez-Noya & Narula, 2018; Wybieralski, 2015). This situation has prompted companies to adopt a portfolio of R&D alliances for accessing complementary capabilities and resources from different partners and locations (Hamel, 1991; Hong & Snell, 2013; 2014; Howard *et al.*, 2016).

Currently, scholars consider both transactions cost minimization and value-enhancing motives as complementary to each other in forming R&D alliances. Many studies in the literature combine both approaches. Very few alliances are distinctly driven by one motivation over the other (Lai & Chang, 2010; Martínez-Noya & Narula, 2018).

Considering the establishment of R&D alliances, certain scenarios may arise, in which the decision on the location happens made beforehand. For instance, some firms may seek to form alliances with partners in specific locations to gain location-specific advantages through their alliance partner (Henisz, 2000; Santangelo, Meyer & Jindra, 2016; Trąpczyński, Puślecki & Staszków, 2018). Once the desired location is determined, the company then selects the appropriate partner from the available alternatives in that location. On the other hand, in some cases, the focus is on choosing the type of partner based on their technological capabilities, regardless of the location (Martínez-Noya & Narula, 2018).

Previous literature indicates a preference for geographically close partners in addition to a preference for known partners (Narula & Martínez-Noya, 2015). Due to information asymmetry, firms forging R&D alliances encounter high information costs, leading to significant search and evaluation costs for potential alliance partners and exposing them to the risk of adverse selection (Reuer & Lahiri, 2014). Opting for a spatially close partner offers the advantage of better control, which is crucial in R&D alliances to mitigate the risk of knowledge loss (Li *et al.*, 2008). Because of that, R&D alliance formation tends to decrease with increasing geographical distance (Reuer & Lahiri, 2014). According to Capaldo and Petruzzelli (2014) who conducted a study on knowledge-creating R&D alliances, the geographical distance between the allied firms and their membership in the same business group negatively impacts alliances' innovation performance. However, their study highlighted that the presence of direct and indirect prior linkages between the exchange partners mitigates the negative effect of geographical distance on R&D alliance formation. Direct prior linkages result from past collaborations, while indirect linkages are established through common partners. These prior linkages help reduce information asymmetry and the risk of adverse selection, as they provide better information about a potential partner's actual capabilities and resources (Zaheer, Hernandez & Banerjee, 2010; Martínez-Noya & Narula, 2018).

Another area of research examines whether R&D alliances can act as substitutes or complements for co-location in specific regions. Results of previous studies show that firms may co-locate with

other companies to internalize location-specific advantages and boost firm innovation or avoid co-location to reduce the risk of unintentional knowledge leakage (Alcácer, 2006; Narula & Santangelo, 2009, 2012). Because R&D is a knowledge-based activity, it is often tied to location (Cantwell & Santangelo, 1999), certain locations can offer expertise or capabilities in specific technological fields. Establishing R&D activities in foreign locations can be costly and time-consuming, making alliances with partners in those economies a more attractive option for accessing external resources and technological expertise (Cantwell & Santangelo, 1999; Puślecki, 2010; Wybieralski, 2015; Trąpczyński, Puślecki & Staszaków, 2018; Martínez-Noya & Narula, 2018).

Through international R&D alliances, firms can exploit country-specific advantages possessed by their cooperating partners, making them a tool for leveraging the comparative advantages of foreign countries (Gomes-Cessaes, Hagedoorn & Jaffe, 2006). Furthermore, it will be interesting to explore how firms from emerging countries may differ in their R&D decisions and alliance choices in comparison to firms from developed countries, considering factors like risk perception shaped by the country of origin (Narula & Sadowski, 2002; García-Canal & Guillén, 2008; Awate *et al.*, 2015). Moreover, analysing how firms from developed countries engage in innovation cooperation with firms from emerging countries, including CEE countries, presents an interesting avenue for investigation (Trąpczyński, Puślecki & Staszaków, 2018; Martínez-Noya & Narula, 2018; Puślecki, Trąpczyński & Staszaków, 2016; Puślecki & Trąpczyński, 2014; Schuh, Trąpczyński & Puślecki, 2024; Jaklič *et al.*, 2014, 2020; Jaklič, Puślecki & Trąpczyński, 2023).

The development of innovation collaboration with different partners has become a common phenomenon in contemporary business (Jaklič *et al.*, 2014; Puślecki, 2015, 2016, 2021; Szczepańska-Woszczyzna & Gatnar, 2022; Samoilikova *et al.*, 2023). Trąpczyński, Puślecki, and Staszaków (2018) conducted a review of the existing literature on international business, alliances, inter-firm collaboration, innovation, open innovation, which allowed them to develop the determinants of innovation cooperation performance based on a conceptual framework with three levels of analysis: (a) dyadic level, (b) network level, and (c) location level. They identified roadmaps in each of these areas and presented existing gaps in the current understanding of innovation cooperation. They argue that in addition to the dyadic level of collaboration (collaboration between two organisations), not only the network level of analysis, but also the location in which the cooperation takes place should also be taken into consideration to have a full understanding of the performance of innovation cooperation. It is important to include location effects to better understand the driving forces behind innovation cooperation and its outcomes. Their presented conceptual framework does not distinguish between innovations generated by actors nested at these different levels (from micro to macro). Trąpczyński, Puślecki, and Staszaków call for an integration of the determinants of innovation outcomes, which are rooted not only in the characteristics of the firm or its partner, or in their collaborative design, as presented in most studies, but also in the innovation network as a whole and in the place where the cooperation takes place (Trąpczyński, Puślecki & Staszaków, 2018).

Considering the abovementioned aspects, I developed three hypotheses:

- H1:** The frequency of cooperation in the biopharmaceutical industry in the CEE region within R&D alliances with CEE partners is higher than with non-CEE partners.
- H2:** The increase in the frequency of collaboration within R&D alliances in the biopharmaceutical industry in the CEE region is significantly associated with an increase in a firm's R&D alliance success rate.
- H3:** The companies from the CEE region in the biopharmaceutical industry are more willing to develop R&D alliances with partners from the CEE region rather than with partners outside the CEE region (non-CEE) taking into account the direction of innovation cooperation.

## RESEARCH METHODOLOGY

In this research, I used the quantitative method. I conducted an online survey (including an online questionnaire) regarding innovation cooperation in the biopharmaceutical industry in the CEE region

in the years 2015-2017. I collected data from January 2019 to March 2020 (a long process of 15 months) from 20 CEE countries. The sampling procedure was non-random (purposeful selection with snowballing technique). I used LinkedIn platform to distribute the questionnaire (contact with over 400 managers from the CEE region), data obtained from the database AMADEUS (Bureau van Dijk Electronic Publishing), industry portals, *e.g.* Pharmaboardroom, direct email and telephone contact with companies. Moreover, I used pharma and biotech associations to request the distribution of the questionnaire. *i.e.* within EFPIA (European Federation of Pharmaceutical Industries and Associations) Belgium and EFPIA representatives in the CEE countries, INFARMA (The Employers' Union of Innovative Pharmaceutical Companies, Poland), Farmacja Polska (Poland), and organisations preparing industry events like CEBIOFORUM and CEHE (Central European Healthcare Expo), in which I received support from the partners from the academia in the CEE region within the Academy of International Business – Central and Eastern Europe Chapter (AIB-CEE) for distribution of the questionnaire in CEE countries. Thanks to all these efforts, I could distribute the questionnaire to approximately 2000 companies and stakeholders in the biopharmaceutical industry in 20 CEE countries (biotechnology, pharmaceutical, biopharmaceutical companies, national and international industry associations). The return rate of the questionnaires used for the analysis was *ca.* 5%, which amounts to 187 (return rate of 9.5%) and of which 107 companies from 18 CEE countries (approx. 5% of the surveyed population) responded to all the questions required in the questionnaire. Due to the small sample size ( $n=107$ ), I could not generalise the results obtained from the quantitative studies conducted for the whole population. Noteworthy, it is one of the first quantitative primary research articles in the world focused on innovation cooperation in the biopharmaceutical industry in the CEE region in the years 2015-2017 (covering 18 CEE countries). Therefore, we may treat the study results as exploratory. Moreover, the results are based on unique primary data (which is not so usual in the innovation cooperation analysis in the previous studies as a lot of studies were based on secondary data and used for instance Community Innovation Survey (CIS)).

To verify hypotheses **H1** and **H2**, I analysed the innovation cooperation in the biopharmaceutical industry of 107 companies in the years 2015-2017 in the CEE region. To verify hypothesis **H3**, I analysed 241 R&D alliances conducted by 107 companies from the CEE region in the years 2015-2017. To verify hypotheses, I used descriptive statistics and conducted a student's t-test analysis and a series of Pearson correlation analyses. The next section will present the results.

## RESULTS AND DISCUSSION

### Innovation cooperation with CEE and non-CEE partners in the biopharmaceutical industry in the CEE region

To verify the hypothesis assuming that companies in the biopharmaceutical industry in the CEE region are more likely to indicate the implementation of R&D alliances with CEE partners than with non-CEE partners, I performed a Student's t-test analysis. It showed the validity of the hypothesis,  $t(106; N = 107) = 5.78; p < 0.001$ . Table 1 presents the obtained results.

**Table 1. Frequencies of identification of CEE and non-CEE partners in R&D alliances**

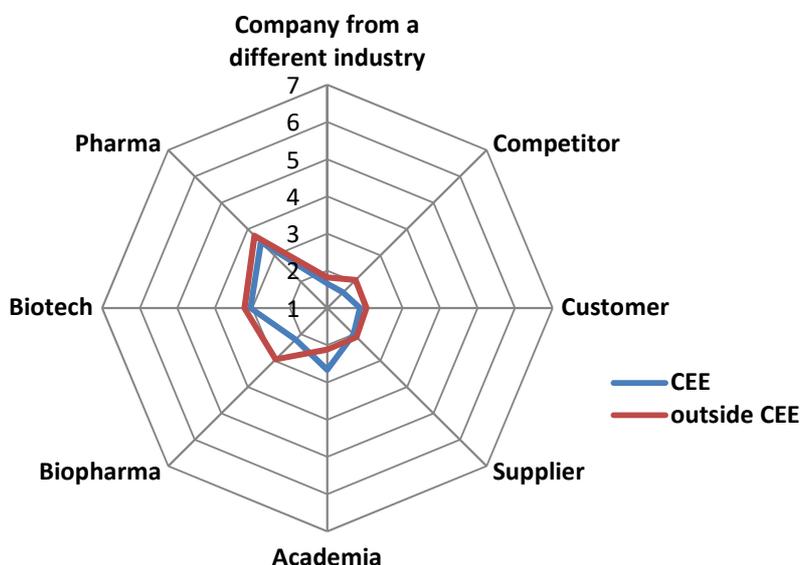
Category	CEE partners (R&D alliances)	outside CEE partners (R&D alliances)
Number of indications (%)	97 (90.65%)	59 (55.14%)
Number of no indications (%)	10 (9.35%)	48 (44.86%)

Source: own elaboration.

Biopharmaceutical companies were more likely to indicate the implementation of R&D alliances with CEE partners (including domestic partners) than with non-CEE partners.

Considering the data presented in Figure 1, we may observe that the frequency of innovation cooperation with partners from CEE ( $n=97$ ) and non-CEE ( $n=59$ ) countries within R&D alliances in the biopharmaceutical industry in Central and Eastern European (CEE) countries was relatively low. The

average indications of companies collaborating with CEE and non-CEE partners oscillated between ‘very rarely’ and ‘rarely’ for customers, suppliers, companies from a different industry and competitors. Innovation cooperation with universities and research institutions within the framework of R&D alliances with CEE partners occurred ‘rarely’ and outside CEE ‘very rarely’. In terms of R&D collaborations, companies ‘occasionally’ collaborated with pharmaceutical partners (both CEE and non-CEE partners) and ‘rarely’ with biopharmaceutical and biotech partners.



**Figure 1. Frequency of collaboration with CEE and non-CEE partners in research and development (R&D) alliances in the biopharmaceutical industry in the CEE region**

Note: scale of 1-7, where: 1 – never, 2 – very rarely, 3 – rarely, 4 – occasionally, 5 – often, 6 – very often, 7 – most often (in 80% of cases). CEE n=97, outside CEE n=59.

Source: own elaboration.

To verify hypothesis **H1** that the frequency of cooperation within R&D alliances with CEE partners is higher than with non-CEE partners, I performed a Student’s t-test analysis. This analysis showed that there were no significant differences between the two groups of partners,  $t(47; N = 48) = 0.41; ni$ . Table 2 presents the obtained results.

**Table 2. Descriptive statistics for the variables ‘frequency of collaboration with CEE partners (R&D alliances)’ and ‘frequency of collaboration with non-CEE partners (R&D alliances)’**

Variable	M	N	SD	SE
Frequency of cooperation with CEE partners (R&D alliances)	2.52	48	0.73	0.10
Frequency of cooperation with partners outside CEE (R&D alliances)	2.48	48	0.92	0.13

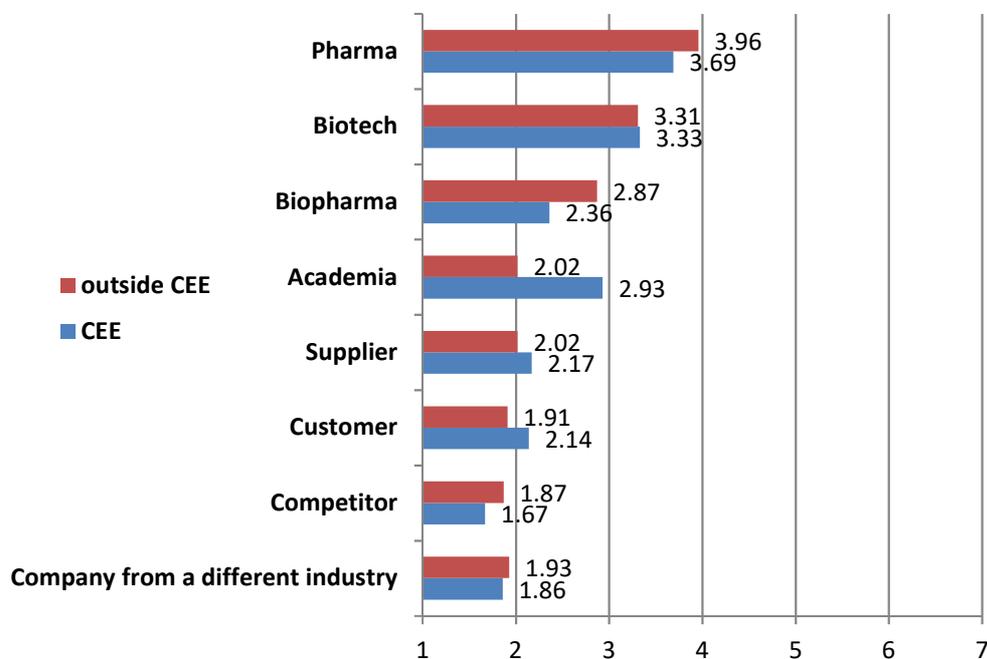
Source: own elaboration.

I conducted a series of Student’s t analyses ( $N = 48$ ) to verify hypothesis **H1** that the frequency of collaboration in R&D alliances with CEE partners is higher than that with non-CEE partners for selected sectors and partners. The results indicated that the hypothesis was valid for the selected partners: academia, supplier, customer, and sector: biotech. Figure 2 presents differences in the frequency of cooperation with CEE and non-CEE partners by sector and partner.

To verify hypothesis **H2** that the increase in the frequency of collaboration within research and development (R&D) alliances is significantly associated with an increase in a firm’s R&D alliance success rate (SRA – success rate of alliances,<sup>1</sup> the percentage of R&D alliances in which partners achieved initial goals between 2015 and 2017) – while taking into account location of the partner/partners – I conducted a series of Pearson correlation analyses. The analyses showed that an increase in the frequency of R&D

<sup>1</sup> Definition of SRA based on De Man and Duysters, 2007; De Man, Duysters, and Neyes, 2009; De Man *et al.*, 2012.

alliance collaboration was significantly associated with an increase in the success rate of a company's R&D alliances with international partners,  $r = 0.44$ ;  $p < 0.001$ , partners outside CEE (non-CEE),  $r = 0.41$ ;  $p < 0.001$  and domestic partners,  $r = 0.39$ ;  $p < 0.001$ . These correlations were of moderate strength. Finally, an increase in the frequency of R&D alliance collaboration was significantly associated with an increase in the success rate of a company's R&D alliances with partners from Central and Eastern Europe (CEE),  $r = 0.29$ ;  $p < 0.05$ , while the strength of the correlation was weak. Table 3 shows the obtained results.



**Figure 2. Differences in frequency of cooperation in R&D alliances between CEE and non-CEE partners (comparisons by partner and sector)**

Note: scale of 1–7, where: 1 – never, 2 – very rarely, 3 – rarely, 4 – occasionally, 5 – often, 6 – very often, 7 – most often (in 80% of cases). (CEE  $n=97$ , outside CEE  $n=59$ )

Source: own elaboration.

**Table 3. Relationship between the frequency of collaboration in research and development (R&D) alliances and the success rate of a company's R&D alliances with selected partners**

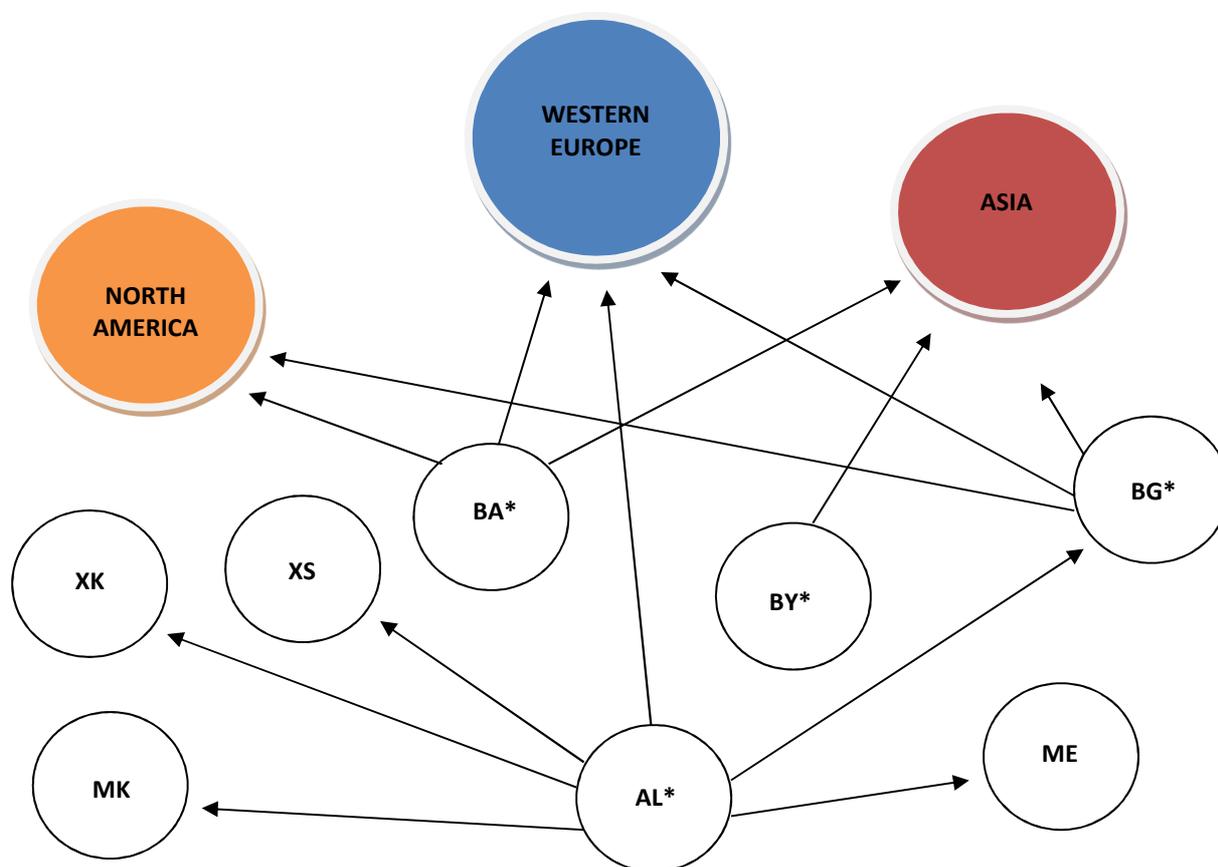
The success rate of R&D alliances with		Frequency of cooperation in research and development (R&D) alliances
National partners (domestic) <sup>a</sup>	$r$	0.388
	$p$	0.000***
International partners <sup>b</sup>	$r$	0.435
	$p$	0.000***
CEE partners <sup>c</sup>	$r$	0.290
	$p$	0.023*
Non-CEE partners <sup>d</sup>	$r$	0.406
	$p$	0.000***

Note: <sup>a</sup> –  $N = 106$ ; <sup>b</sup> –  $N = 83$ ; <sup>c</sup> –  $N = 60$ ; <sup>d</sup> –  $N = 73$ ; \* –  $p < 0.05$ ; \*\* –  $p < 0.01$ ; \*\*\* –  $p < 0.001$ .

Source: own elaboration.

Considering the implemented research and development (R&D) alliances in the biopharmaceutical industry, it is worth analysing the directions of innovation cooperation within the framework of international alliances implemented by companies from CEE countries. To verify hypothesis **H3** that the companies from the CEE region in the biopharmaceutical are more willing to develop R&D alliances with partners from the CEE region rather than with partners outside the CEE region (non-CEE) taking into account the direction of innovation cooperation, I analysed 241 R&D alliances conducted by 107 companies, implemented between 2015 and 2017. The following figures present the

individual directions of innovation cooperation for R&D alliances. Regarding partners from non-CEE countries, I grouped foreign partners into North America, Western Europe, and Asia. Given the larger number of R&D alliances implemented (241), I presented the results for the different country groups. I used abbreviations for countries to present the results more clearly. Moreover, the figures highlight companies that reported research and development (R&D) alliances with domestic partners in addition to international innovation collaborations.



**Figure 3. Directions of innovation cooperation within international research and development (R&D) alliances in the biopharmaceutical industry in the Central and Eastern European countries in 2015-2017:**

**Albania, Belarus, Bosnia and Herzegovina, Bulgaria**

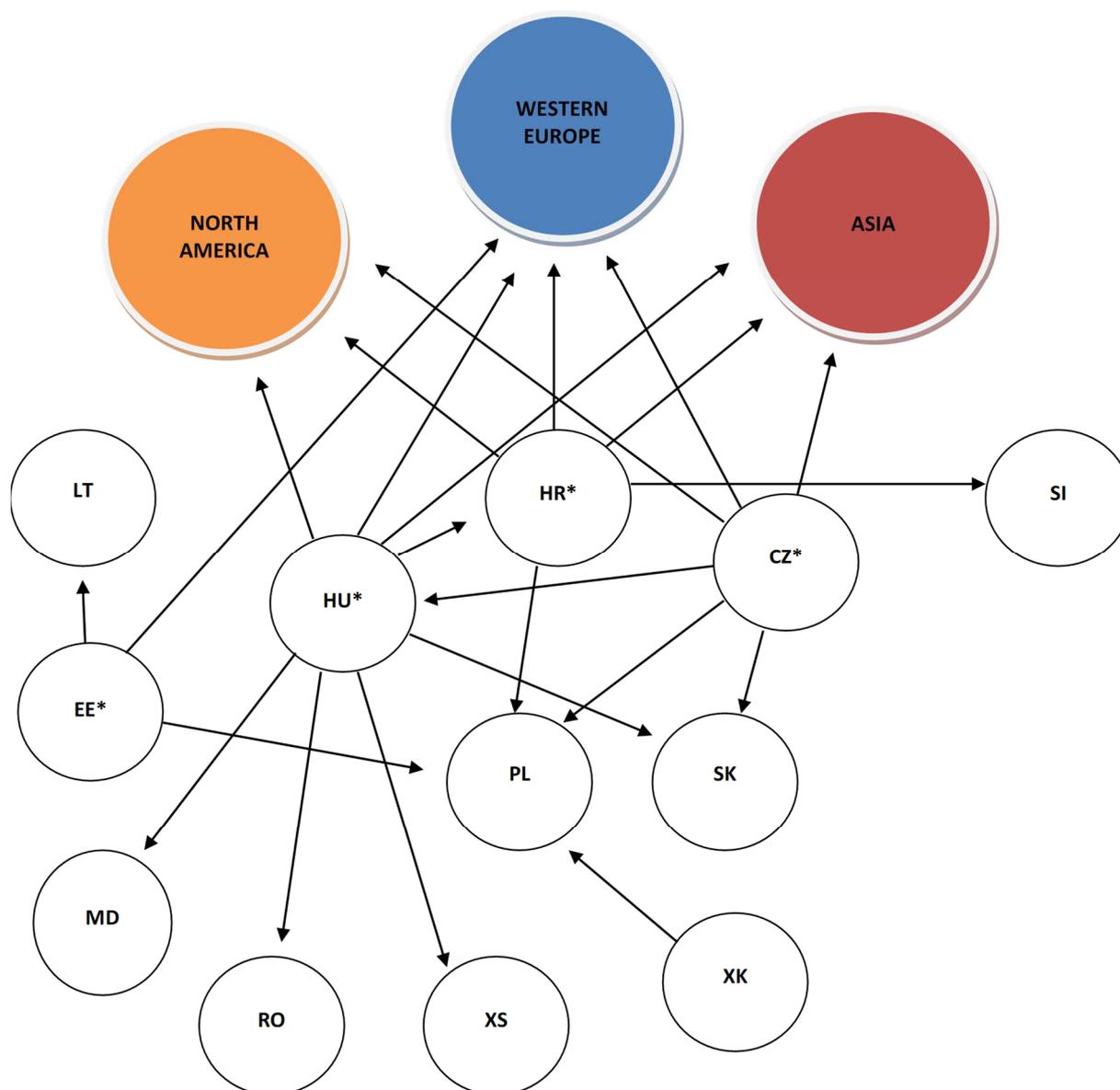
Note: \* innovation cooperation within the framework of research and development (R&D) alliances also with domestic partners.

Source: own elaboration.

Within the framework of R&D alliances, companies from Albania (AL), Belarus (BY), Bosnia and Herzegovina (BA), and Bulgaria (BG) (all CEE countries) (Figure 3) implemented international innovation cooperation in the biopharmaceutical industry between 2015 and 2017 with partners from Western Europe (five alliances), North America (four alliances), and Asia (four alliances). Furthermore, companies from Albania (AL), Belarus (BY), Bosnia and Herzegovina (BA), and Bulgaria (BG) also pursued innovation cooperation with domestic partners. A company from Albania (AL) also conducted international cooperation within the framework of R&D alliances with partners from CEE – Bulgaria (BG), Montenegro (ME), Kosovo (XK), Macedonia (MK), and Serbia (XS). In total, between 2015 and 2017, companies from Albania (AL), Belarus (BY), Bosnia and Herzegovina (BA), and Bulgaria (BG) conducted innovation cooperation within 29 R&D alliances in the biopharmaceutical industry.

Within the framework of research and development (R&D) alliances, companies from the CEE countries of Croatia (HR), the Czech Republic (CZ), Estonia (EE), and Hungary (HU) (Figure 4) most frequently implemented international innovation cooperation in the biopharmaceutical industry in 2015-2017 with partners from Western Europe (24 alliances), North America (seven alliances), and

Asia (four alliances). Moreover, companies from Croatia (HR), the Czech Republic (CZ), Estonia (EE), and Hungary (HU) also pursued innovation cooperation with domestic partners. Companies from Croatia realised international cooperation within R&D alliances with CEE partners from Poland (PL) and Slovenia (SI), companies from Estonia (EE) – with partners from Poland (PL) and Lithuania (LT), and from Hungary (HU) – with partners from Croatia (HR), Moldova (MD), Romania (RO), Serbia (XS), and Slovakia (SK). Companies from the Czech Republic (CZ) pursued international cooperation with partners from Hungary (HU), Poland (PL), and Slovakia (SK), and from Kosovo (XK) – with partners from Poland (PL). In total, between 2015 and 2017, companies from Croatia (HR), the Czech Republic (CZ), Estonia (EE), Hungary (HU), and Kosovo (XK) implemented innovation cooperation within 97 R&D alliances in the biopharmaceutical industry.

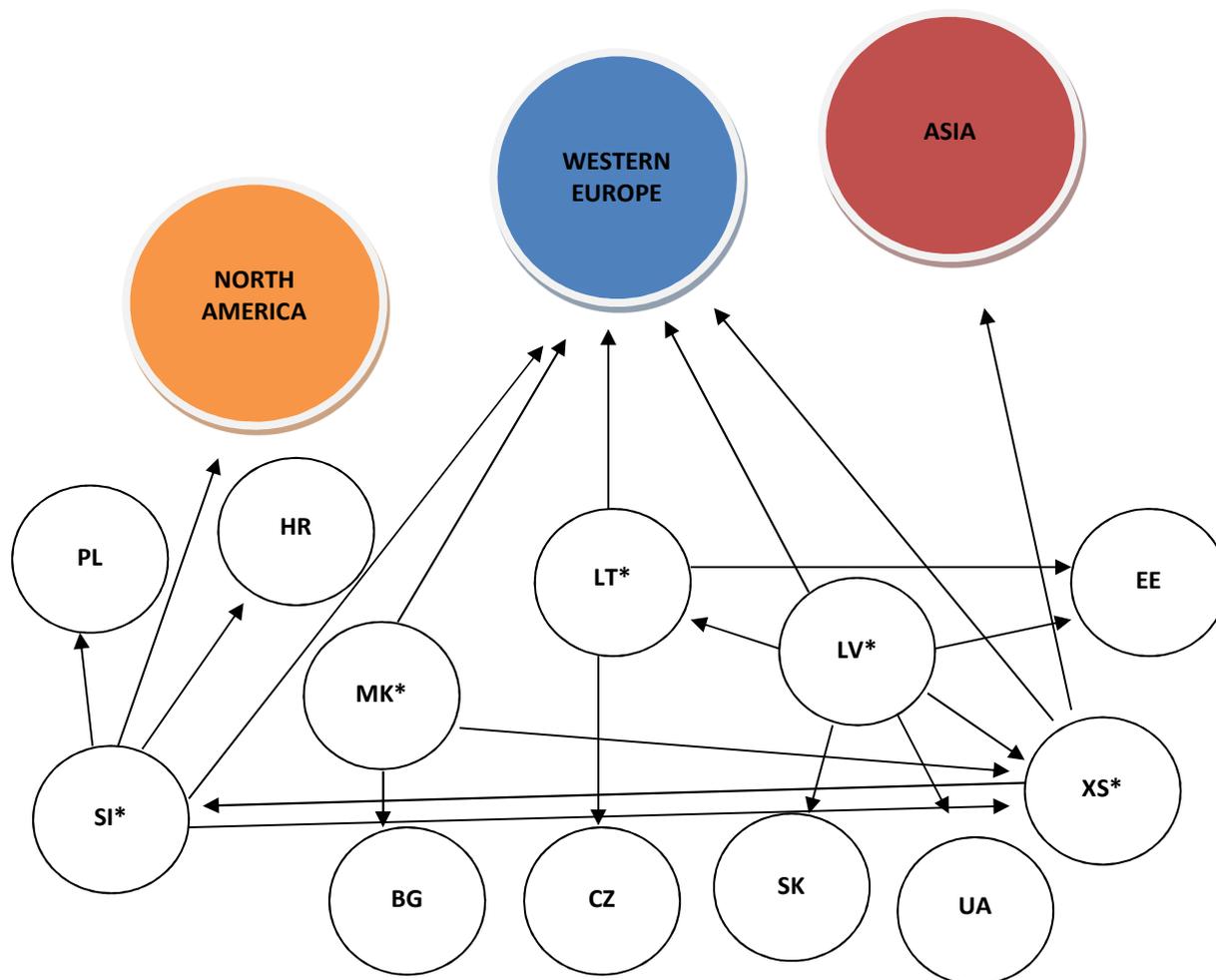


**Figure 4. Directions of innovation cooperation within international R&D alliances in the biopharmaceutical industry in the CEE countries in 2015-2017: Croatia, Czech Republic, Estonia, Hungary, Kosovo**

Note: \* innovation cooperation within the framework of research and development (R&D) alliances also with domestic partners.

Source: own elaboration.

Within the framework of R&D alliances, companies from the CEE countries of Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) (Figure 5) implemented international innovation cooperation in the biopharmaceutical industry in 2015-2017 with partners from Western Europe (seven alliances), North America (one alliance), and Asia (one alliance). Furthermore, companies from Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) also pursued innovation cooperation with domestic partners. Companies from Latvia (LV) cooperated internationally within R&D alliances with CEE partners from Estonia (EE), Lithuania (LT), Serbia (XS), Slovakia (SK), and Slovenia (SI), while companies from Lithuania (LT) – with partners from Estonia (EE) and the Czech Republic (CZ). Companies from Macedonia (MK) cooperated internationally with partners from Bulgaria (BG) and Serbia (XS), and companies from Serbia (XS) – with partners from Slovenia (SI). Companies from Slovenia (SI) pursued international cooperation with partners from Hungary (HU), Poland (PL), and Serbia (XS). In total, between 2015 and 2017, companies from Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) conducted innovation cooperation within 33 R&D alliances in the biopharmaceutical industry.



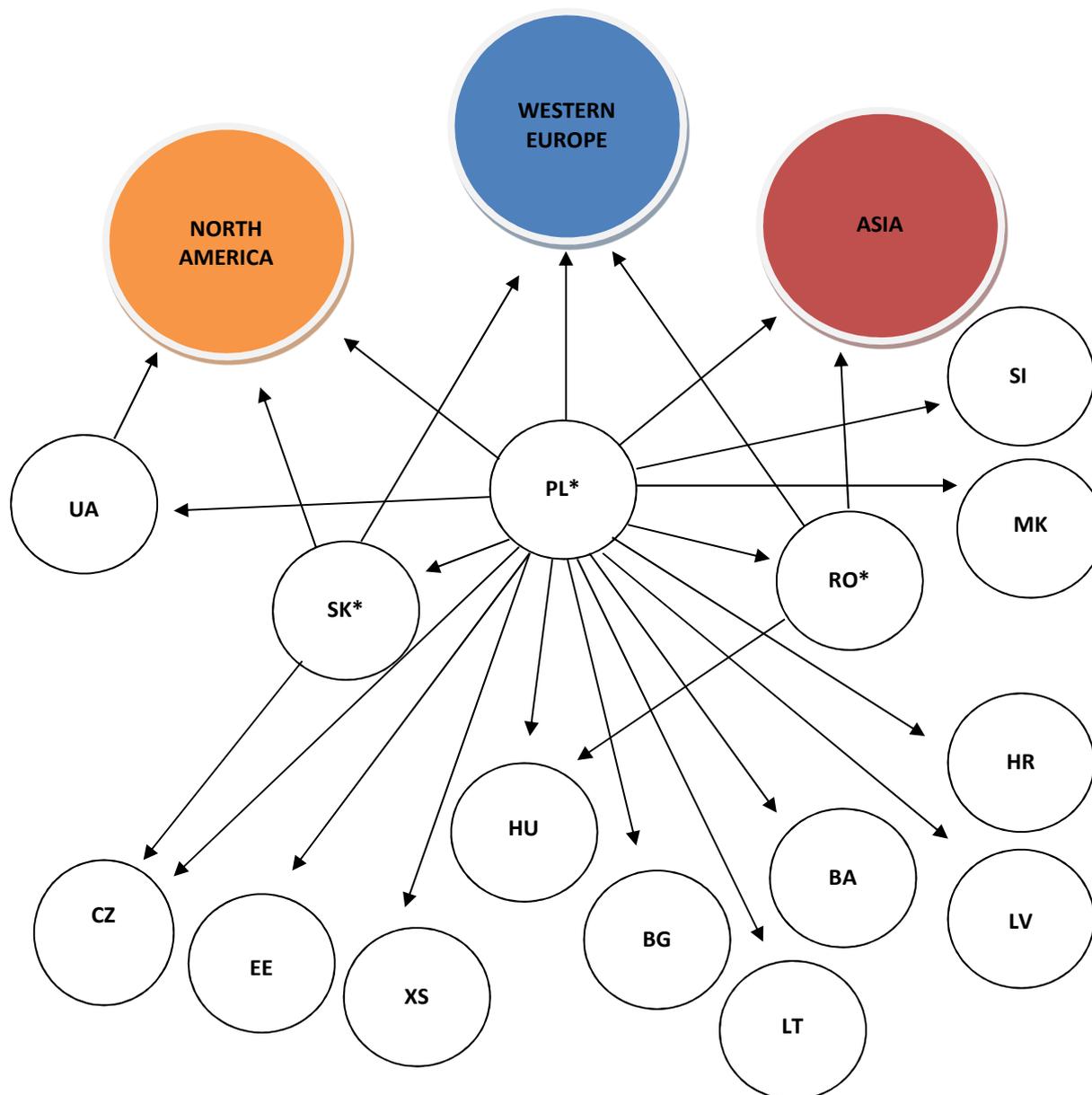
**Figure 5. Directions of innovation cooperation within international R&D alliances in the biopharmaceutical industry in the CEE countries in 2015-2017: Lithuania, Latvia, Macedonia, Serbia, Slovenia**

Note: \* innovation cooperation within the framework of research and development (R&D) alliances also with domestic partners.

Source: own elaboration.

Within the framework of R&D alliances, companies from the CEE countries of Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) (Figure 5) implemented international innovation cooperation in the biopharmaceutical industry in 2015-2017 with partners from Western Europe (seven alliances), North America (one alliance), and Asia (one alliance). Furthermore, companies from Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) also pursued

innovation cooperation with domestic partners. Companies from Latvia (LV) cooperated internationally within R&D alliances with CEE partners from Estonia (EE), Lithuania (LT), Serbia (XS), Slovakia (SK), and Slovenia (SI), while companies from Lithuania (LT) – with partners from Estonia (EE) and the Czech Republic (CZ). Companies from Macedonia (MK) cooperated internationally with partners from Bulgaria (BG) and Serbia (XS), and companies from Serbia (XS) – with partners from Slovenia (SI). Companies from Slovenia (SI) pursued international cooperation with partners from Hungary (HU), Poland (PL), and Serbia (XS). In total, between 2015 and 2017, companies from Lithuania (LT), Latvia (LV), Macedonia (MK), Serbia (XS), and Slovenia (SI) conducted innovation cooperation within 33 R&D alliances in the biopharmaceutical industry.



**Figure 6. Directions of innovation cooperation within international R&D alliances in the biopharmaceutical industry in the CEE countries in 2015-2017: Poland, Romania, Slovakia, Ukraine**

Note: \* innovation cooperation within the framework of research and development (R&D) alliances also with domestic partners.

Source: own elaboration.

Within the framework of R&D alliances, companies from the CEE countries of Poland (PL), Romania (RO), Slovakia (SK), and Ukraine (UA) (Figure 6) most frequently implemented international innovation

cooperation in the biopharmaceutical industry in 2015-2017 with partners from Western Europe (15 alliances), North America (nine alliances), and Asia (four alliances). Moreover, companies from Poland (PL), Romania (RO), and Slovakia (SK) also pursued innovation cooperation with domestic partners. Companies from Poland (PL) implemented international cooperation within R&D alliances with CEE partners from Bulgaria (BG), Bosnia and Herzegovina (BA), Croatia (HR), the Czech Republic (CZ), Estonia (EE), Hungary (HU), Lithuania (LT), Latvia (LV), Macedonia (MK), Romania (RO), Serbia (XS), Slovakia (SK), Slovenia (SI), and Ukraine (UA). Companies from Romania (RO) conducted international cooperation with partners from Hungary (HU), and companies from Slovakia (SK) – with partners from the Czech Republic (CZ). In total, between 2015 and 2017, companies from Poland (PL), Romania (RO), Slovakia (SK), and Ukraine (UA) conducted innovation cooperation within 82 R&D alliances in the biopharmaceutical industry.

Between 2015 and 2017, CEE companies pursued international innovation collaborations in the biopharmaceutical industry through 89 R&D alliances with non-CEE partners, including 51 alliances with Western European partners, 21 alliances with North American partners, and 17 alliances with Asian partners. Furthermore, companies pursued innovation cooperation in 152 R&D alliances with CEE partners (including 93 alliances with domestic partners and 59 alliances with international partners from CEE countries). The countries most involved in innovation cooperation were Poland with 56 R&D alliances (including 22 alliances with non-CEE partners, 18 with domestic partners, and 16 with partners from CEE countries), Hungary with 40 alliances (including 15 alliances with non-CEE partners, 17 with domestic partners, and 8 with partners from CEE countries), from the Czech Republic with 36 alliances (including 15 with partners from outside CEE, 13 with domestic partners and 8 with partners from CEE countries), Romania with 18 alliances, and Croatia and Bulgaria with 16 alliances. In total, companies from CEE countries pursued 241 R&D alliances in the biopharmaceutical industry in innovation cooperation between 2015 and 2017.

Considering the direction of innovation cooperation within R&D alliances of CEE companies in the biopharmaceutical industry, we can observe that the CEE companies are more willing to develop cooperation with CEE and domestic partners (easier to cooperate due to closer location) than with non-CEE partners. Thus, I can confirm that the partner's location is an important determinant in the development of innovation cooperation in the CEE region. The reason for that can be the specifics of the CEE region, in which the companies are still not so open to international cooperation, especially in the biopharmaceutical industry, and prefer to develop cooperation with local and domestic partners. Moreover, we can still observe a lot of barriers in innovation cooperation between companies, as well as in business-academia cooperation in the CEE region, which include: lack of trust, language barriers, problems with knowledge transfer (both on company/institutional level), the problem with mentality in the CEE (the difficult experience. of communism), the problem with opening-up to the cooperation of business representatives with universities, lack of funds for the development of innovation cooperation (public/private) with business and academia, and the overall low frequency of innovation cooperation with different partners (also identified in this research).

## CONCLUSIONS

The main aim of this study was to verify the importance of location in innovation cooperation in the biopharmaceutical industry in the CEE region, taking into account the frequency of cooperation within R&D alliances with CEE partners and with non-CEE partners, as well as the directions of cooperation within R&D alliances. As it was one of the first such studies presented in the literature, we may treat the study results as exploratory. To verify the directions of cooperation within R&D alliances in the biopharmaceutical industry, I investigated 241 R&D alliances conducted by 107 companies from the CEE region in the years 2015-2017. The results showed that the frequency of cooperation within R&D alliances with CEE partners was higher than with non-CEE partners (for selected partners: academia, supplier, customer, and sectors: biotech), as well as the number of indications. Moreover, according to the analysis of 241 R&D alliances, I also observed that the companies from the CEE region are more willing to develop R&D alliances with partners from the CEE region (including partners from the domestic market) than with partners outside the CEE region (North America, Western Europe, Asia) in

the biopharmaceutical industry. Comparing the results with the previous literature while taking into account R&D alliances in the biopharmaceutical industry in the CEE region, I can confirm a preference for geographically close partners (domestic or in the CEE region) in addition to a preference for known partners (Li *et al.*, 2008; Reuer & Lahiri, 2014, Narula & Martínez-Noya, 2015; Martínez-Noya & Narula, 2018). However, the frequency of innovation cooperation in the CEE region is low.

Noteworthy, taking into account the success rate of alliances (SRA) (% of R&D alliances in which initial goals were achieved between 2015 and 2017), the CEE companies had a better success rate within R&D alliances with domestic partners (n=48) – around 54% than with international partners (n=48) – around 47%, and non-CEE partners (n=48) – around 43%. I observed the lowest success rate of R&D alliances (SRA) for the CEE companies with partners from the CEE region (n=48) – around 37%. Taking that into consideration, we can see that CEE companies have better SRA for international R&D alliances with international and non-CEE partners than with CEE partners. On the other hand, the CEE companies try to use local potential in the development of innovation cooperation in the biopharmaceutical industry in domestic markets. We could observe it very well especially during the Covid-19 pandemic (Puślecki *et al.*, 2022). An example includes the ‘ECMO for Wielkopolska Programme’ implemented in the Wielkopolska Region in Poland. Moreover, in the last two years, we have observed the development of governmental initiatives, *e.g.* Warsaw Health Innovation HUB (WHIH) in Poland, which aims to integrate innovative companies from the biopharmaceutical industry with research institutions and universities, as well as state institutions such as ABM (Medical Research Agency) (Schuh, Trąpczyński & Puślecki, 2024).

As in any scientific study, it is important to mention the problems and limitations associated with the implementation of the study. Among the main problems and limitations, we may indicate:

- the difficulty in obtaining companies to participate in primary research in the 18 CEE countries and the extended time of data collection: the primary quantitative survey took a total of 15 months;
- in primary research, the CEE companies were reluctant to agree to participate in the survey, explaining it with lack of time for such activities and the confidentiality of the information provided (due to the specific nature of the biopharmaceutical industry) along with the requirement to share data on innovation cooperation;
- the small sample size (n=107) with a varying number of entities in individual CEE countries (no equal groups), which may have blurred the phenomenon of innovation cooperation, which is why I analysed the entire CEE region rather than individual countries. Comparisons between countries are still possible and could be a new very interesting research avenue;
- the small sample size (n=107): I cannot generalise the results obtained from the quantitative studies conducted for the whole population.

In these difficult times of the Covid-19 pandemic, companies, especially in the biopharmaceutical industry, should be more open to innovation cooperation (Wilks, Porthmann, 2012; Chesbrough, 2020; Puślecki, 2021; Bourla, 2022) and use more flexible models (Puślecki, 2012; Wilks & Prothmann, 2012). Moreover, they should use local potential and local partners in the development of better therapies for patients (Puślecki, 2021; Puślecki *et al.*, 2022). Over 80% of companies (n=107) from the biopharmaceutical industry from 18 CEE countries conducted mainly R&D non-equity alliances (which provide greater flexibility in the selection and possible change of partners and also enable a faster change/exchange of technology than traditional equity alliances) in the development of innovation cooperation in years 2015-2017. With more flexible modes of cooperation, companies can deliver new solutions and better patient treatment to the market faster, which is particularly germane to responses to the current Covid-19 pandemic and potential future pandemics.

Involving all partners from the local, regional, and national levels, both from business and academia in the innovation cooperation can positively impact the innovation cooperation performance (Trąpczyński, Puślecki & Staszaków, 2018). The identified directions of innovation cooperation in CEE countries may contribute to the development of innovation cooperation in CEE countries in the future and greater exploitation of the innovation and educational potential of the biopharmaceutical industry in the

entire CEE region (clinical trials, clusters, science and technology parks, academia, institutions) (Staszków, Puślecki & Trąpczyński, 2017; Drelich-Skulska & Jankowiak, 2019; Puślecki, 2021; Puślecki *et al.*, 2022).

Given the potential research and new research areas, it is certainly worthwhile to conduct further research in the CEE countries on the innovation cooperation in the development of new medical technologies and devices (Digital Health, MedHealth) (especially during the Covid-19 pandemic), the use of modern medical simulation (translational simulation, translational innovation) and technologies (virtual reality, augmented reality, big data, blockchain, artificial intelligence, collaborative AI, machine learning, deep learning, cloud computing) in the development of new therapies and treatments for patients (Śliwiński & Puślecki, 2022; Puślecki *et al.*, 2022), the exploitation of the potential of clinical trials in the CEE region, and cooperation in the management of patient and drug data (storage, processing and recombination of data aiming to develop new drugs and therapies proposals for patients). It is also worth comparing the development of such collaboration in the CEE region with other emerging regions, *e.g.* Middle East and North Africa (MENA; Alhajaj & Moonesar, 2023; Kumar *et al.*, 2022a, b; Moonesar & Dass, 2021).

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