

Article

Determinants of Innovation Cooperation Performance: What Do We Know and What Should We Know?

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Abstract: The involvement of firms in innovation cooperation with different partners has become a widespread phenomenon in the contemporary business landscape. Our paper provides a review of extant alliance, innovation, open innovation and inter-firm collaboration literature and organizes it based on a conceptual framework featuring three levels of analysis: (a) the dyadic level, (b) the network level, and (c) the location level. The article identifies roadmaps in each of these areas and also highlights existing gaps in the present understanding of innovation cooperation. Thereby, it outlines a research agenda by identifying key research questions and issues in the areas where further research is needed and encouraged.

Keywords: innovation cooperation performance; innovation performance; open innovation; open innovation alliances; STP; clusters

1. Introduction

Riskier and more complex product development processes, globalization of economies and the demand for increasingly innovative services and products have increased the pressure on firms to enhance their innovativeness [1–3]. Thus, firms have increasingly sought for external sources of innovation development, such as external collaborations [4–6]. The engagement of firms in a wide array of innovation cooperation forms, such as innovation alliances, has become a ubiquitous phenomenon in today's business landscape [7]. In many key industries such as computer hardware and software, telecommunications, electronics, or pharmaceuticals, innovation cooperation has become an important element of corporate strategy [8]. As a consequence, most firms are involved in multiple simultaneous cooperation types in various locations, often geographically dispersed, with various partners and are, therefore, facing the challenge to manage an entire cooperation network [9,10]. Innovation cooperation can be referred to as collaboration with external parties with a key objective of generating innovations, and ranging from wholly-owned subsidiaries, through different forms of equity and non-equity alliances, to transactions, where independent firms engage in arms-length transactions [6].

The need for cooperation on innovative projects gave rise to modern models of cooperation, involving *inter alia* the principles of Open Innovation. Chesbrough ([5], p. 43) defines “open innovation” as the paradigm stating that companies can and should use external and internal ideas, as well as internal and external paths to enter new markets. One of the first large-scale empirical studies operationalized the concept as: “an ‘open innovation’ model is using a wide range of external actors and

sources to help them achieve and sustain innovation" ([11], p. 131). A recent definition from Chesbrough and Bogers ([12], p. 17) defines "open innovation as a distributed innovation process based on purposively managed knowledge flows cross organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model" [13]. Stanko, Fisher and Bogers [14] indicate that open innovation is a topical issue which includes themes such as cooperation networks and alliances.

However, such collaborative arrangements are very complex to manage successfully [15], partly because of the difficulty of matching the goals and aspirations of autonomous organizations, often headquartered in two or more countries [16]. Such collaborations have different motives, resources and capabilities of the involved parties, varying access to knowledge, organizational structures and cultures, and degrees of competition with partners, which can affect different aspects of the performances of innovation cooperation [17–21].

Therefore, in attempt to systematize the body of existing research with regard to factors which drive the performance of innovation cooperation, we undertake a literature study which considers several levels of analysis. Specifically, we argue that apart from the dyadic level of cooperation (referring to the cooperation between two organizations), not only the increasingly popular network level of analysis, but also the location in which the cooperation takes place, must also be taken into account in order to gain a complete understanding of the performance of innovation cooperation. Our paper sets out by conveying a conceptual framework for the levels of analysis of innovation cooperation performance and outlines the methods of literature review. Subsequently, the general findings of the bibliometric analysis are presented. The paper then continues with detailed findings from each of the analytical levels. Finally, we introduce a set of detailed proposals for future research.

2. Conceptual Framework and Review Methodology

Extant research suggests that unique technological and market forces have led to an increased pursuit of cooperation with competitors, or cooptation, which might be particularly useful for innovation in high-technology contexts [22]. Yet, the existing research on the performance outcomes of innovation cooperation has led to mixed findings. Further, while firms are increasingly engaged in multiple strategic alliances, leading to the consideration of alliance portfolio as an important unit of analysis [23], the bulk of research on cooptation has focused on the dyadic level of analysis, without considering the important interdependencies among different alliances [24]. While the significance of networks has been acknowledged in several streams of innovation literature, further work is warranted to improve the management of these networks so that their potential benefits can be fully realized.

On the other hand, a lot of research on innovation cooperation has neglected the role of the location in which this cooperation is embedded [25]. There is evidence from research more in economics that location-level factors affect innovation cooperation to an equal extent as factors related to the firm and its network partners. Toselli [26] found that firm innovation is affected by knowledge sources, in that demand-pull factors affect the probability of achieving product innovation, whilst technology-push factors drive the probability of both product and process innovation. Cassiman and Veugelers [4] indicate that the R&D cooperation of firms and the rate of innovation is importantly affected by knowledge spillovers existing in a given location, as well as the ability of the firm to appropriate the returns from innovation. Furthermore, Amoroso [27] empirically studied the main drivers of undertaking a collaborative agreement with a research partner, and in a second stage investigated the effects of innovation policies and R&D cooperation on innovative intensity. He confirmed the presence of sector-level heterogeneity which might affect the probabilities to cooperate and the level of innovative production. Moreover, he indicated that the impact of public funding has a positive effect, when controlling for public financial support and innovation activities at different levels of government.

The latter findings lead to an overarching remark about location factors, in that a complex system of dependencies—political, legal, technological and institutional is supporting and developing the innovation process [28]. Christopher Freeman noticed years ago that the emergence of new ideas and their implementation into the economy is the result of a combination of economic, social and technical

changes that create the economic space of a given country [29] In this space, which Freeman called the National Innovation System, there are more or less formalized networks of cooperating companies and institutions. Indeed, as Fomina et al. [30] argue, the stability of economic development is determined by the features of the network structure in a collaborative engagement of enterprises. Therefore, it is legitimate to explore whether and how the location of companies and other institutions influence their cooperation for the development of innovation, and the performance outcomes thereof.

Economic geography has developed the concept of proximity to explain the formation of networks and clusters of innovative companies in industrial districts [31,32]. The different dimensions of proximity may explain some of the positive externalities, such as knowledge creation and transfer, as well as innovation, which are generated by companies that are co-located [33]. According to Boschma [34], proximity implies similarity between actors and organizations, including both a geographical or spatial dimension and other non-spatial dimensions. Knoblen and Oerlemans [35] note that *“the concept of proximity has been used in many different ways in the literature, this including different measures and definitions”*.

Boschma [34] identifies five types of proximity:

1. Geographical proximity, which is a spatial dimension to the physical distance between actors;
2. organizational proximity, this is when companies share the same relationships and technology;
3. social proximity, related to interactions based on trust and knowledge between stakeholders;
4. institutional proximity, based on the set of practices, laws, rules and routines that facilitate collective action; and
5. cognitive proximity, which occurs when companies share the same references and knowledge.

It can be expected that the overall proximity positively affects the repeated collaboration between two actors in a regional knowledge network. While the majority of related literature refers mostly to geographical proximity, two actors in a knowledge network can clearly demonstrate proximity although they are not geographically close. The main premise for this view is that geographical proximity is neither a necessary nor a sufficient condition for knowledge transfer and innovation. Still, for the purposes of this review, we focus primarily on the first type, i.e., geographic proximity and its impact on innovation cooperation. Geographic proximity is understood as the physical distance of two actors, and plays an important role in facilitating the other kinds of proximity [32]. Capaldo and Petruzzelli [36] prove in their research that integrating geographically distant as well as organizationally proximate knowledge in R&D alliances negatively affects innovative performance at the alliance level. Fitjar and Rodríguez-Pose [37] when studying Norwegian companies, came to the conclusion that in general, local and national linkages tend to be more closely related with innovation for firms located in areas where there is more investment in R&D. Partnerships at the national or international levels are more important for regions in which the workforce is highly educated, but also in regions with catching-up potential, where the so called “knowledgization” is important for innovativeness and in which universities act as knowledge hubs to develop human capital [38].

Erkut [39,40] makes an interesting point by demonstrating empirically that the stage of competitiveness of a given location can be associated with the effectiveness of governmental institutions, intellectual property legislation, gender equality, quick access to utilities, and the discovery of opportunities by young entrepreneurs to establish new firms. Further, Žižka et al. [41] shows empirically that the effect of cluster organizations on innovation activities depends on the industry. Contrary to the authors’ expectations, a stronger effect proved to exist in the traditional industry than in the high-tech sector.

Therefore, on the whole, we argue that in addition to the typical research on innovation cooperation at the dyadic (or bilateral level), as well as the increasingly prominent network (or portfolio) level, it is crucial to incorporate the location effects in understanding the driving forces behind innovation cooperation and its performance (see Figure 1). The proposed conceptual framework does not distinguish between innovation generated by actors nested in these different levels (from

micro to macro). Instead, it calls to integrate determinants of innovation performance which are not only rooted in a firm's or its partner's characteristics, or their cooperation design, as it has been assumed in most studies, but also in an entire innovation network and in the location in which the cooperation occurs.

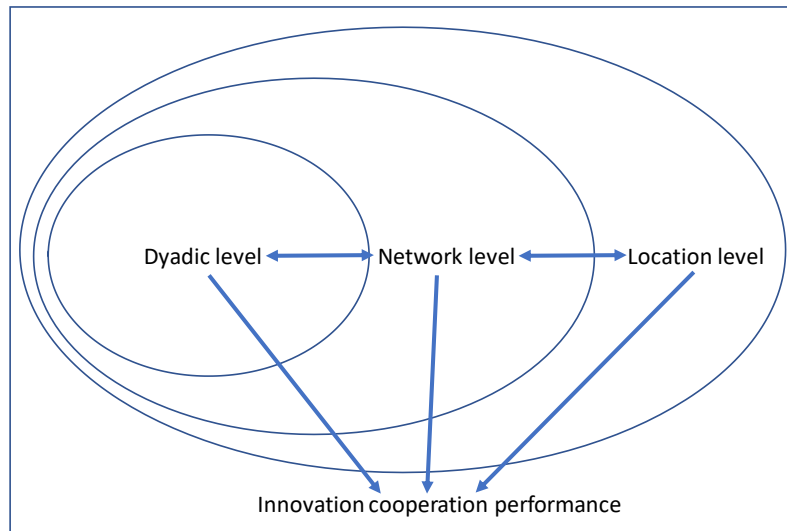


Figure 1. Conceptual framework.

3. Literature Review Results

3.1. Review Methodology

For the purpose of data collection, a keyword-driven search was undertaken in leading international journal databases (including *inter alia* EBSCO, ScienceDirect, Emerald, JSTOR, Proquest) At an initial stage, non-indexed sources, such as books, monographs, conference proceedings, were screened as well in order to identify further relevant sources. However, for the analysis of results, only indexed sources were retained in order to ensure the scientific quality of the evaluated studies. The search process involved a dedicated set of keywords, corresponding to each of the identified research levels of the conceptual framework (see Appendix A), and their different combinations. Specifically, we used the following keywords and their different combinations:

- For the location level: STP, science and technology park, clusters, proximity, geographical proximity, innovation performance, innovation, cooperation, and firm performance.
- For the network level: innovation networks, alliance portfolios, inter-firm cooperation, innovation performance, and firm performance.
- For the dyadic level: Open Innovation, Open Innovation Alliances, Innovation Cooperation, Innovation Performance, R&D Alliances, Strategic Technology Alliances, Business-Academia Alliances, Biopharma, Biopharmaceutical industry, and firm performance.

The research findings were verified for the fulfilment of the aforementioned criteria for geographic scope, authorship and original contribution. Conceptual contributions were not retained as the purpose here is to take stock of current knowledge about innovation cooperation performance and its drivers, which emerged from the analyses of business reality, rather than mere conceptualizations, and inspire future research.

Different methods of critical literature reviews in the field of international business and management have been used in order to take stock of extant research contributions, to identify the most salient features of previous works and to reflect constructively on the most promising avenues for further investigation (see e.g., Schmid and Kotulla [42]). Due to the fact that the field of international business

is highly heterogeneous in terms of theoretical approaches, levels of analysis and research designs used, the first step in the present review was a preliminary qualitative analysis of papers from specific research areas (meta-analysis cannot be used for heterogeneous operationalizations and research methods [43] which is the case of the present research sample). In line with some recent systematic review procedures [44], we tabulated the studies in a consolidated database. Thereby, detailed research topics, methods and key findings and other bibliometric attributes were coded for each contribution. In order to enable a consistent system of codes within research areas, each research area was analyzed by all three researchers to reach consensus in coding.

Furthermore, in order to provide an account on the relative relevance of each research area and its changes within the analyzed period, quantitative analysis followed [45]. The integration of content analysis (qualitative) with frequencies of the attributes concerned (quantitative) aimed at providing a possibly exhaustive and comprehensive perspective on extant scholarship and its major contributions, as well as highlighting the paths for future research. In total, a sample of 107 empirical research contributions was attained for the purpose of the present review. Appendix A demonstrates the specific areas which the identified papers represent.

3.2. Overall Findings

Taking the number of publications in different years into consideration (see Figure 2), it can be noted that the highest number of articles was published in 2015 (18 articles) (One can also note that this development coincided with the establishment of the Emerging Sources Citation index). Analyzing the entire period, a positive growing trend in the publication output can be observed. This may be the result of an interest of both researchers as well as companies in the broad topic of innovation. Another explanatory factor arguably pertains to a facilitated access of researchers to different databases, which gradually became more widespread among Polish research institutions.

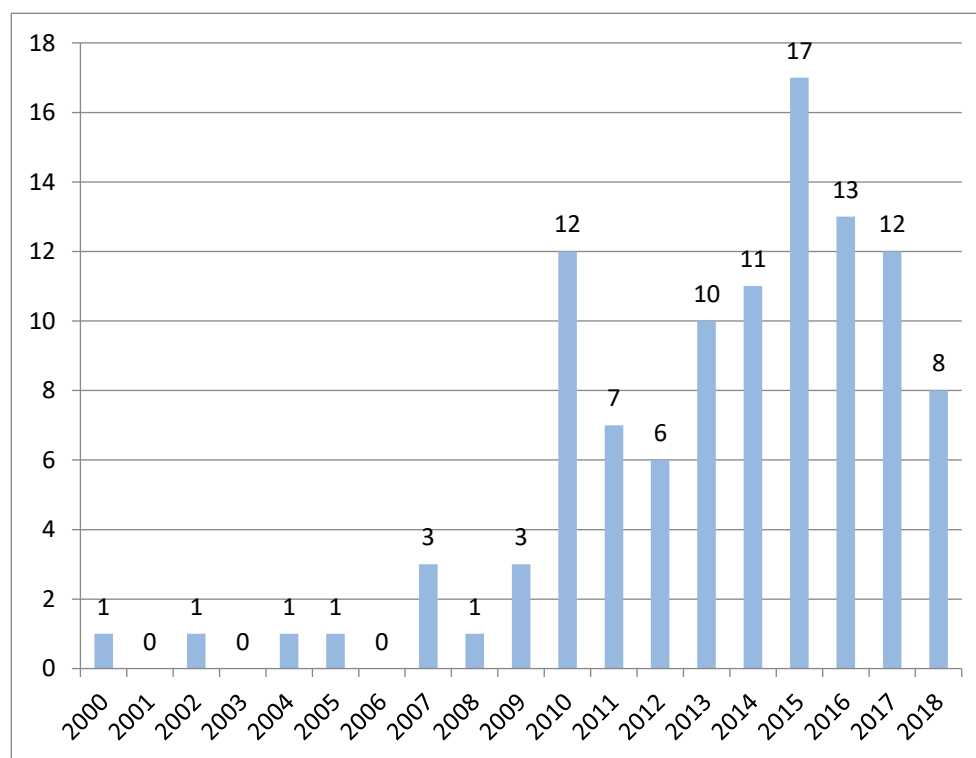


Figure 2. Evolution of the number of publications.

Taking into account the adopted methodology research was divided into three levels:

1. Location level
2. Network level
3. Dyadic level

Analyzing Figure 3, one can note that the fewest articles fall into the area concerning the location of innovation cooperation. The reason for this can be the novel approach to the topic of innovation location in the context of clusters and science and technology parks. Obviously, there are many contributions on clusters and science parks, but only a few refer strictly to innovation cooperation. Articles from the other two groups are more frequently represented since they deal with topics such as alliances, portfolio management or open innovation concepts, which are more popular than location or proximity importance. There have been more than 60 scientific journals represented in the database gathered. The most important journals in the field covered include Technovation, Strategic Management Journal, Research Policy, Journal of Product Innovation Management and The Journal of Technology Transfer.

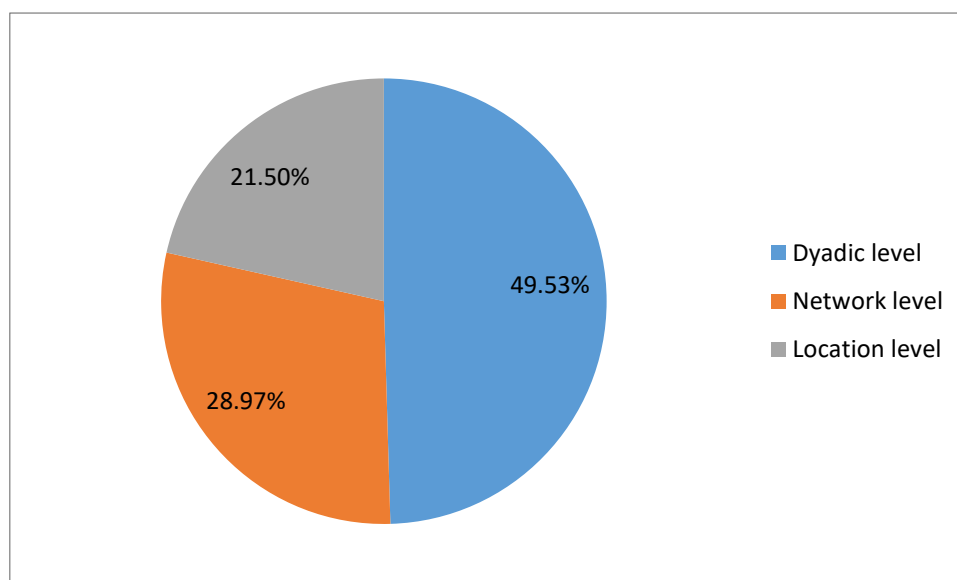


Figure 3. Relative relevance of research papers in each group analyzed (N = 107).

3.3. Findings at the Dyadic Level

The presentation and discussion of detailed findings of our review begins with the dyadic level and the factors related to the modes of organizing innovation cooperation.

3.3.1. Open Innovation and Determinants of Cooperation Form

One of the important developments in recent literature on managing innovation cooperation between firms are the open innovation alliances. Laursen and Salter [11] conducted one of the first large-scale empirical researches and explores the relationship between the openness of firms' external search strategies and their innovative performance. Their results of a large-scale sample of industrial firms in the UK showed that searching widely and deeply is curvilinearly (taking an inverted U-shape) related to performance. Overall, research has shown that cooperating with a broad network of external partners positively affects a firm's innovation performance [11].

Bianchi et al. [46] investigated the adoption of Open Innovation in the biopharmaceutical industry, evaluating organizational modes and how these modes are used with the different phases of the drug discovery and development process. They observed that firms gradually modified their innovation network by adding external partners operating outside their core areas, and that alliances play an

important role among the organizational modes implemented by firms in the sample in both Inbound and Outbound Open Innovation [46].

Michelino et al. [47], on the other hand, analyze the relationships between the openness degree of companies and their context features, R&D organization and financial performance. They find that the performance of companies has an inverted-U shape relationship with inbound practices and a clearly decreasing one with outbound ones. Yun et al. [48] found that the structure of collaboration networks has both direct and indirect effects on firms' innovative performance. Rangus et al. [49] examined how absorptive capacity and open innovation interact to impact innovation performance, reaching the conclusion that absorptive capacity mediates the relationship between open innovation and innovation performance. Likewise, Zynga et al. [50] prove that the existence of distinct routines and organizational structures can explain why some firms implement open innovation successfully. Shin et al. [51] studied technological innovation performance and found the moderating effect of absorptive capacity and potential competition by categorizing strategic alliances for R&D activities in the biotechnology industry into vertical-downstream alliances, vertical-upstream alliances, and horizontal alliances. Vertical alliances have a positive impact on technological innovation performance, while horizontal alliances have an inverted U-shaped relationship with technological innovation performance caused by the effect of competition. Bouncken [17] shows that project alliances offer firms an opportunity to increase innovation performance through the flexible combination of specialized competencies across firms.

Han et al. [18], on the other hand, investigated the economic and strategic value of open innovation alliances (OIAs), and found that allying firms realize significant positive abnormal returns when their entry into an OIA is made public. Their results also suggest that substantial excessive returns accrue to the allying firms with the belated entry of a market leading firm. They discovered also that a firm's entry into an OIA increases, rather than decreases, the market valuation of its competitors [18].

Considering the importance of innovation, it is crucial to learn more about the alternative mechanisms such as alliances and acquisitions which can be used by companies to enhance their innovation performance. Vanhaverbeke et al. [20] prove that a series of strategic alliances between the two partners increases the probability that one will ultimately acquire the other. While previous direct contacts tend to lead to an acquisition, this is not true of previous indirect contacts, which increase the probability that a link between the companies, once it is established, takes the form of a strategic alliance.

3.3.2. Characteristics of Partners, Innovation Cooperation Determinants and Performance

Regarding the resources available in cooperation, Zheng, Li and Wu [52] show that embedded resources contribute positively to capability accumulation and innovation performance. Further research supports that knowledge creation by partners mediates the effect of knowledge acquisition on innovative performance and that international alliances strengthen the effect of knowledge creation on innovative performance [53]. Lucena & Roper [54] find that a firm's absorptive capacity and ambidexterity in R&D mediate the relationship between technology alliance diversity and innovation. Further, with regard to experience, it has been found that the general alliance experience of biotechnology partners, but not of pharmaceutical firms, positively affects joint project performance [55]. Also, there is evidence that there are diminishing returns to general alliance experience, such that prior general alliance experience has a positive effect on the likelihood of alliance success that decreases as alliance experience increases. However, as Sampson [56] notes, the lack of cumulative benefits from prior experience appears to be partly due to knowledge depreciating over time, since only recent experience has a positive impact on collaborative returns.

Another stream of studies has focused on the diversity of partners in innovation cooperation. Among these, it has been shown that there is an inverted U-shaped relationship between alliance partner diversity and innovation performance and confirms the positive moderating effects of relational social capital and knowledge codifiability [57]. However, only few studies decompose this diversity further. For instance, Beers & Zand [58] indicate that functional diversity leads to a variety of knowledge intake and synergetic effects necessary to develop and commercialize novel products. Geographical diversity results in a successful adaption of existing products to different local requirements such as technical standards, market regulations, and customer preferences. Sampson [19] verified the impact of partner technological diversity and alliance organizational form on innovation performance. She observed that alliances contribute far more to firm innovation when technological diversity is moderate, rather than low or high. She also found that hierarchical organization, such as an equity joint venture, improves firm benefits from alliances with high levels of technological diversity.

Fernald et al. [59] investigated the moderating role of firms' absorptive capacity in external innovation activities of Big Pharma firms and showed that acquisitions of biotech companies have negatively affected Big Pharma firms' innovation performance on average, but these acquisitions might have a positive effect at higher levels of acquiring firms' absorptive capacity. Moreover, acquisitions of pharma companies and alliances with biotech companies only have a positive effect on innovation performance at sufficiently high levels of absorptive capacity. The moderating role of absorptive capacity implicates that a tight integration of internal R&D efforts and (unrelated) external knowledge is important to use complementarity effects [59].

Pustovrh et al. [60], in turn, claim that SMEs involved in broader types of open collaboration display higher levels of innovativeness. Rangus et al. [49] confirmed that firms which are open towards innovation are embedded in different networks, maintain regular collaborations with various partners, and, because of that, leverage their knowledge and technology in ways that can enhance their innovation performance. Garbade et al. [61] prove that alliance performance of R&D intensive SMEs is positively related to the level of complementarity, cognitive distance and tacit knowledge transfer by exchanges of human resources.

More detailed results of research at the dyadic level are presented in Table 1. You can find there not only key relationships studied, key determinants of innovation cooperation performance, but also key research gaps, which could be promising future research topics in the field of innovation cooperation performance.

Table 1. Findings at the dyadic level.

Research Area	Specific Research Focus	Key Relationships Studied	Key Determinants of Innovation Cooperation Performance	Key Research Gaps
	Alliance partner resources	Partner resources and innovation performance	<ul style="list-style-type: none"> • Embedded resources (e.g., knowledge-sharing routines and joint problem-solving arrangements) positively affect innovation performance; accessed resources have a negative effect from a certain threshold. • Interaction of star scientists with upstream alliances decreases and with downstream alliances increases innovation performance. • Large and innovative alliance partners perform better than firms without such partners. • Resource complementarity affects firm performance more strongly if partners have higher status. 	<ul style="list-style-type: none"> • Effectiveness of different governance modes of accessing resources. • Boundary conditions to effective cumulation of partner resources. • The effects of partner geographic and industrial origin on the ability to leverage resource complementarity.
Characteristics of partners in interfirm cooperation	Learning and innovation cooperation performance	Knowledge-innovation link and its moderators	<ul style="list-style-type: none"> • Interfirm cooperation and competition increase knowledge acquisition; knowledge creation mediates the knowledge-innovation performance link. • International alliance strengthens the effect of knowledge. 	<ul style="list-style-type: none"> • The effects inter-partner distance on the effect of cooperation and competition on performance
	Partner diversity and alliances performance	Partner diversity-performance link and its moderators	<ul style="list-style-type: none"> • Inverted U-shaped relationship between alliance partner diversity and innovation performance (positive moderating effects of relational social capital and knowledge codifiability) 	<ul style="list-style-type: none"> • The effect of cultural diversity on performance.
	Prior alliance experience	Prior experience and performance	<ul style="list-style-type: none"> • Collaborative benefits are enhanced with prior alliance experience, but more extensive experience does not enhance outcomes. • Previous ties with a partner are associated with later stages of R&D in a new alliance. 	<ul style="list-style-type: none"> • The depreciation of knowledge over time and factors affecting it.

Table 1. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Determinants of Innovation Cooperation Performance	Key Research Gaps
Determinants of cooperation form	Determinants of alliance type	Technological innovation performance in different types of alliances (horizontal, vertical, hybrid, specialized, project alliances)	<ul style="list-style-type: none"> Vertical alliances have a positive impact on technological innovation performance, while horizontal alliances have an inverted U-shaped relationship with technological innovation performance caused by the effect of competition. R&D intensity of biotechnology firms has a moderating effect of increasing the impact of vertical-upstream alliances on technological innovation performance. Exploitation shows greater innovation performance in hybrid alliances than in alliances specialized in exploitation when the alliances result in radical, product innovations (i.e., the introduction of products or services new to the market). Structure of collaboration networks has both direct and indirect effects on firms' innovative performance. Alliances contribute far more to firm innovation when technological diversity is moderate, rather than low or high. Hierarchical organization, such as an equity joint venture, improves firm benefits from alliances with high levels of technological diversity, alliance organizational form likely influences partner ability and incentives to share information, which affects performance. Project alliances offer firms an opportunity to increase innovation performance through the flexible combination of specialized competencies across firms. 	<ul style="list-style-type: none"> The effects of strategic alliances on technological innovation performance from a greater variety of perspectives by verifying various indices. Investigate when hybrid alliances achieve a better innovation performance than specialized alliances. Investigate the innovative performance of hybrid alliances focusing on different types of firms. Investigate the mode of innovation cooperation and explore the effects of both formal and informal relationship networks on stock returns and risk. Investigate the choice between strategic alliances and acquisitions to enhance the innovation performance of the firm. Investigate the important relation between the management of project alliances and their performance.
Innovation cooperation determinants and performance	Determinants of alliance performance	Impact of different alliance characteristics and different modes of innovation cooperation on the performance	<ul style="list-style-type: none"> Alliance performance is positively related to the level of complementarity, the cognitive distance and tacit knowledge transfer by the human resources exchanges. Innovation alliances show greater synergy creation, and ultimately a higher level of innovation performance. 	<ul style="list-style-type: none"> Choosing one cooperation mode over another, and the consequences thereof for the innovation output and the financial implications.

Table 1. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Determinants of Innovation Cooperation Performance	Key Research Gaps
Open Innovation	Open Innovation and firm performance	<p>Impact of Open Innovation on innovation performance taking into consideration:</p> <ul style="list-style-type: none"> relationship between the openness of firms' external search strategies and their innovative performance organisational modes of Open Innovation Alliances economic and strategic value of Open Innovation Alliances relationships between the openness degree of companies and their context features, R&D organization and financial performance absorptive capacity technological innovation performance. 	<ul style="list-style-type: none"> Searching widely and deeply is curvilinearly related to innovative performance. Cooperating with a broad network of external partners positively affects a firm's innovation performance. Alliances play an important role among the organisational modes implemented by firms in both Inbound and Outbound Open Innovation. Interacting with a broad network of external partners positively affects a firm's innovation and financial performance. Distinct routines and organizational structures can explain why some firms implement open innovation successfully. Performances of companies have an inverted-U shape trend versus inbound practices and a fundamentally decreasing trend versus outbound ones. Absorptive capacity mediates the relationship between open innovation and innovation performance. Both scope and depth of openness have a positive effect on the company's innovation performance. SMEs which engage in broader types of open collaboration display higher levels of innovativeness. Allying firms realize significant positive abnormal returns when their entry into an Open Innovation Alliance (OIA) is made public. Positive abnormal stock returns will accrue to firms that participate in an OIA. Announcement of the entry of a market leader company into an existing OIA will result in positive abnormal returns for current OIA member firms. Announcement of OIAs will result in positive abnormal stock returns for the rival firms that compete with the firms participating in OIAs. Firms that are open towards innovation are embedded in different networks, maintain regular collaborations with various partners, and, because of that leverage their knowledge and technology in ways that can enhance their innovation performance. 	<ul style="list-style-type: none"> Effects of strategic alliances on innovation performance from a greater variety of perspectives taking into consideration various measures. Including performance measures to verify the impact of Open Innovation on social innovation objectives such as sustainability or climate change. Investigate if participation in an Open Innovation Alliances increases the future financial performance and strategic positioning of the focal company. Open Innovation in SMEs, management of innovation and innovation performance. SMEs innovativeness, Open Innovation in transition or post-transition economies – like Central and Eastern Europe.

3.4. Findings at the Network Level

3.4.1. Alliance Portfolios

Moving from the dyadic to the network level can sensitize managers to the importance of understanding how social structure influences firm performance [62]. Within a relatively well-developed research strand devoted to alliance portfolios has first of all addressed the role of diversity in networks of innovation cooperation [63–65]. Zouaghi, Garcia & Garcia [63] explored the value of diversity in cooperation networks on innovation performance, finding a curvilinear relationship in line with other studies, suggesting that companies collaborating with different external partners show higher innovation performance, but only up to a certain point. This relationship has been explored for different moderators. *Inter alia*, it is more accentuated in high-tech industries and dependent on firms' R&D human capital. Likewise, Collins & Riley [66] found that it is moderated by alliance portfolio characteristics, such as partner reciprocity. Oerlemans, Knoben and Pretorius [67] show that the said relationship is positively moderated by the presence of technology management tools. Conversely, Martinez, Zouaghi & Garcia [68] find that R&D human capital plays an important role in innovation novelty by partially mediating the relationship between alliance partner diversity and firm innovation performance. Likewise, Caner & Tyler [69] showed that the R&D intensity of firms' alliance portfolios is positively related to their new product introductions. Also, the study by Lin et al. [70] supports the notion that the firms' absorptive capacity affects the ability to innovate through R&D alliances. Finally, Piening, Salge & Schäfer [71] indicate MNCs equipped with strong internal R&D capabilities and human capital to better translate alliance portfolio diversity into superior innovative performance than domestic firms. On the other hand, there is evidence that the relationship between diversity and performance is positively moderated by network centrality and learning speed [72].

Rogbeer et al. [73] determined the impact of the macro-design of a firm's alliance portfolio on its open-innovation effectiveness. They took into consideration three elements of macro-design: international, technological, and partner diversity, to affect the breadth of knowledge sourcing, which is an important aspect of open-innovation effectiveness. They found a U-shaped relationship between knowledge-sourcing breadth and international diversity, and also that technological diversity has no impact on knowledge-sourcing breadth. Additionally, when companies try to find valuable knowledge, partner diversity has a negative effect on knowledge-sourcing breadth [73].

Golonka [74], in turn, analyzed links among firms' cooperation strategies, the complexity of their alliance portfolios, and their innovativeness in the context of the ICT industry in emerging markets. Alliance portfolio formation has been perceived as a major element influencing firms' performance as well as innovativeness. The results suggest that a proactive, market-focused cooperation strategy positively affects the complexity of alliance portfolios and might increase firms' innovativeness [74].

De Leeuw, Lokshin, & Duysters [75] further point out that the inverted U-shaped relationship holds for alliance productivity and radical innovative performance, while there is a linear positive relationship with incremental innovative performance. Moreover, the results suggest that a lower level of diversity is needed to achieve an optimal level of productivity compared to radical innovative performance, whereas for incremental innovative performance, a higher level of portfolio diversity appears to deliver the highest performance. Phelps [65] demonstrated that technological diversity of a firm's alliance partners increases its exploratory innovation. In a similar vein, Marhold, Kim and Kang [64] found an inverted U-shape relationship between the diversity of alliance partners' industrial background and innovation performance, and a negative interaction of partner diversity and the diversity of the alliance objectives. Subramanian & Soh [76] explored the configuration of an alliance portfolio that links to recombinant innovation and showed that the technological diversity of a firm's alliance portfolio has a positive impact on the breadth of recombinant innovation produced by the firm. However, there have been virtually no related research into different types of alliance experiences, which would show different effects of explorative and exploitative experience, but also experience with different collaboration modes and different geographic locations.

While a number of moderating variables have indeed been studied, the results may differ for different dimensions of diversity. For instance, Jiang, Tao, Sartoro [77] developed a comprehensive alliance portfolio diversity construct embracing partner, functional, and governance diversity. They found that alliance portfolios with greater organizational and functional diversity were related to higher firm performance, while industry diversity had a relationship with firm performance. However, it still remains rather vague how different diversities of partner and alliance characteristics interact and affect firm performance. Moreover, while the inverted U-shaped curve may hold for productivity and radical innovative performance, it has been found to be positive for incremental innovative performance, hence the relationship is complex and may depend on the specific aspects of innovative performance. Not least, while the effects on the innovation outputs may be positive *per se*, the translation into financial performance is not evident, as we still know relatively little about the cost side of managing innovation relationships.

Quite strikingly, only Lavie & Miller [10] studied alliance portfolio internationalization, finding that as the level of internationalization increases, financial performance is expected to initially decline, then improve, and finally decline again. Also, among the reviewed studies, only Li [78] dealt with the choice between bilateral and multilateral alliances, finding that there is a curvilinear relationship between market uncertainty and new ventures' formation of multilateral R&D alliances. Moreover, considering the organizational complexity involved in multilateral alliances, he argued that chain-based multilateral R&D alliances generate more value for their venture partners than net-based ones and that equity-based governance structures can alleviate the negative effect of net-based exchange relationship and improve value creation.

Apart from the international complexity, we still know relatively little about the organizational moderators of the relationship between alliance breadth or diversity, such as HRM practices and integration techniques. Quite notably, while formal governance structures are often used for such projects, the choice of formal or informal governance modes for portfolios is still a white spot on the research map.

As far as other characteristics of network partners go, Stuart [79] found that sales growth and innovation rates are higher for organizations with large and innovative alliance partners. Lin, Yang & Arya [80] on the other hand noted that having alliance partners with high resource complementarity will boost firm performance when those partners also have high network status. At the level of management-related factors, Liu et al. [81] show that motivation-based alliance control approaches, including proper allocation of alliance control rights, sustained strengthening of alliance members' continuity expectation, and enhancement of mutual relationship and friendship among alliance members, are more effective than process or outcome control approaches for improving alliance performance.

Finally, one of the rare research topics is the institutional differences between partners. Notably, Filiou & Golesorkhi [82] explored the contribution of the institutional perspective in understanding firm innovation returns from international alliances. They argued that formal and informal national institutions are of different nature, and give rise to explicit and tacit differences respectively between alliance partners. They found that the effect of informal institutional differences is sigmoid (S-shaped), with innovation performance slightly increasing first, then improving further and finally reaching a plateau with the increase of the informal institutional difference. Conversely, the effect of formal institutional differences was found to follow an inverted U-shape.

3.4.2. Network Design

A smaller number of studies dealt with the structure of network and the relative position of partners therein. In general, the related findings support the notion that companies tend to select partners with tighter organizational coupling for architectural innovation than for modular innovation. In across-firm settings, tighter organizational coupling among partners increases innovation performance for modular innovation (conversely for architectural innovation). Moreover, brokerage positions and network sparseness produce positive effects on firm innovation.

More detailed results of research at the network level are presented in Table 2. One can find there not only key relationships studied and key determinants of innovation cooperation performance, but also key research gaps, which could be promising future research topics in the field of innovation cooperation performance.

Table 2. Findings at the network level.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
Alliance portfolios	Portfolio diversity and performance	The effect of alliance portfolio diversity on firm innovation performance and the moderating effects thereon.	<ul style="list-style-type: none"> • Inverted U-shaped relationship between alliance portfolio diversity (technological/industrial) and innovation performance, moderated by: <ul style="list-style-type: none"> - use of technology management tools (+) - diversity of alliance objectives (–) - high-tech industry (+) - explorative alliance experience (positive)—weakens for prior ties with partners - multinationality of the company (positive), if supported with R&D capabilities and human capital - network centrality, network density, learning speed, reciprocity of norms, or network embeddedness (positive) - status similarity between partners (–) • Organizational diversity has a positive J-shaped relationship with firm performance. • Functional diversity is positively and governance diversity is negatively associated with performance. • R&D human capital mediates between alliance partner diversity and firm innovation performance. • Absorptive capacity and ambidexterity in R&D mediate the technology alliance diversity- innovation link. 	<ul style="list-style-type: none"> • Interactions between different diversities of partners and alliance characteristics. • Role played by training and integration. • Role of prior alliances (exploration and exploitation) for diversity. • Extent of (in)formal structures. • Cost side of innovation alliance networks. • Managerial overconfidence and inertia in designing organizational networks. • Effects for different types of innovation performance and for economic performance.
	Determinants of alliance portfolio management	The impact of the macro-design of a firm's alliance portfolio (international, technological, partner diversity) on its open-innovation effectivenessLinks among firms' cooperation strategies, the complexity of their alliance portfolios, and their innovativeness.	<ul style="list-style-type: none"> • U-shaped relationship between knowledge-sourcing breadth and international diversity. • Technological diversity has no impact on knowledge-sourcing breadth but the partner diversity has a negative effect on knowledge-sourcing breadth • Alliance portfolio formation has been perceived as a major element influencing firms' performance as well as innovativeness. • Proactive, market-focused cooperation strategy (proactively searching for and selecting "strangers" from the market as potential partners) positively affects the complexity of alliance portfolios (specifically: functional, geographic, governance complexity, as well as a number of ties) and might increase firms' innovativeness. 	<ul style="list-style-type: none"> • Impact of complexity of firm's alliance portfolio, as well as firm's innovativeness on firm's performance. • The interplay among different dimensions of diversity and complexity of alliance portfolios as well as other configurational aspects.

Table 2. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
	Coopetition	Coopetition in the portfolio and innovation performance.	<ul style="list-style-type: none"> Moderate to high levels of balanced-strong coopetition in alliance portfolio have a positive impact on the firm's innovation performance (positively moderated by experience) Cooperation with competitors has an inverted U-shaped relationship with successful product innovation. Technological capability and collaboration with universities or research institutes negatively moderate the relationship between co-opetition and product innovation success. 	<ul style="list-style-type: none"> Factors at the level of firm capabilities and experience which moderate the effect of coopetition. The role of economic, geographic, institutional and cultural distances.
Alliance portfolios	Portfolio internationalization	Partner distance and performance	<ul style="list-style-type: none"> Cooperation with proximate foreign partners may face declining performance as it increases its API; at moderate API levels performance improves. 	<ul style="list-style-type: none"> Interplay between subsidiaries and alliances as a means for international expansion. Interaction between geographic complexity and alliance diversity.
	Alliance networks and performance	Network position and performance	<ul style="list-style-type: none"> Unanticipated product alliance activity is associated with lower idiosyncratic risk and with lower stock returns. Unanticipated network centrality of the focal firm and the unanticipated density of ties in its extended network significantly moderate the effects of product alliance activity. 	<ul style="list-style-type: none"> Effects of incremental vs. radical innovation on idiosyncratic risk. Moderation of innovation type in the relationship between product alliance activity and stock returns.
	antecedents of multilateral alliances	relationship between market uncertainty and likelihood of forming multilateral R&D alliances	<ul style="list-style-type: none"> Inverted U-shaped relationship between market uncertainty and likelihood of forming multilateral R&D alliances. Social capital held by top management team and ventures' technological capabilities affect new ventures' formation of multilateral R&D alliances. 	<ul style="list-style-type: none"> Decision process and the comparison of new ventures between bilateral and multilateral R&D alliances. The motivations of ventures' formation of multilateral R&D alliances.

Table 2. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
	alliance portfolio R&D intensity	R&D intensity and new product introductions	<ul style="list-style-type: none"> R&D intensity of alliance portfolios (proportion of R&D alliances) is positively related to new product introductions (stronger in pharmaceutical than biotechnology sector; and moderated in an inverted-U manner by technological distance) 	<ul style="list-style-type: none"> Diversity of different types of alliances in the portfolio (objectives, activities, level of firm's involvement therein) Changes in the portfolio R&D intensity over time and their antecedents
	Partner types	Partner types and performance	<ul style="list-style-type: none"> For spin-offs, partnering with larger firms enhances innovation performance. Corporate spin-offs outperform public research spin-offs. 	<ul style="list-style-type: none"> Behaviour of young technology spin-offs in choosing partners and the consequences thereof.
Network design	relative position in network	Network structure and knowledge benefits	<ul style="list-style-type: none"> Knowledge benefits from intrafirm and interfirm network are affected by the amount of non-redundant contacts, structural holes in the network. Organizational coupling among firms enhances performance 	<ul style="list-style-type: none"> Impact of multiple types of interfirm networks on knowledge transfer and interfirm learning.

3.5. Findings at the Location Level

Proximity is often associated with clusters, which were also the subject of our analysis in the innovation cooperation context. Economic geography has developed the concept of proximity to explain the formation of networks and clusters of innovation in industrial districts. We argue that the concept of science and technology parks (STPs) needs to be added to this analysis, as they are seldom discussed in terms of innovation cooperation and its performance. Porter [83] proposed to understand clusters as “*geographic concentrations of interconnected companies and institutions in a particular field, linked for common and complementary elements*”. Probably the broadest definition of science and technology park has been created by UNESCO [84]. The term “*science and technology park*” encompasses any kind of high-tech cluster such as: technopolis, science park, science city, cyber park, hi tech (industrial) park, innovation centre, R&D park, university research park, research and technology park, science and technology park, science city, science town, technology park, technology incubator, technopole, and technology business incubator.

3.5.1. Clusters and STPs

Nestle and his research team [85] proved that agglomeration effects, next to the open innovation approach, significantly contribute to the degree of network activities of companies in a cluster region. Being a member of a cluster and knowing each other results in increased trust, which enables a transfer of knowledge. We can find also similar results when it comes to the STPs literature. Vásquez-Urriago et al. [86] analyzed previous studies on STPs which show that the location in a park promotes cooperation for innovation. They demonstrated that STPs are important for fostering innovation cooperation. Intangible outputs from cooperation are higher for park-located firms for the key reason that their location facilitates the development of more diverse cooperative relationships. Žižka et al. [41] compared innovation performance of companies which are members of high-tech and traditional clusters. It turned out that companies from the textile industry, described as a traditional cluster, benefited to a larger extent from being a cluster member than companies from high-tech clusters. The explanation of the results is that the knowledge of technology companies is often their competitive advantage, which they do not want to share with others. These results are in line with another research focus, namely the cooperation effect, both when it comes to the institutional environment and importance of proximity. Superior effects in terms of innovation performance are more relevant in the case of technological rather than non-technological innovations [87]. Finally, Daniluk [88] proved that companies assess the existing level of cooperation with business environment institutions as low in regions considered to be less developed.

Díez-Vial and Montoro-Sánchez [89] explored how technological knowledge flows from universities may increase innovation by firms located in a science park. They proved that companies which obtain knowledge from universities mainly through formal agreements and informal interactions, tend to increase their innovative capacity. However, physical proximity to the university does not automatically create knowledge spillovers from the institution. Similar results were obtained by Motohashi [90] who found that companies that have their internal innovations grounded in their own competitive advantage show better innovation performance, while formal R&D collaboration with the university plays only a marginal role. However, they benefit from informal interactions with faculty members and access to students.

3.5.2. Importance of Proximity and Networks

The importance of business-university cooperation was analyzed not only in the context of STPs and clusters, but also in the context of the proximity of companies. Abramovsky and Simpson [91] examined whether firms locate their R&D labs in proximity to university research departments, and whether those that do are more likely to cooperate with, or source information from universities in the course of their innovative activities. They found out that pharmaceutical companies that locate their R&D facilities near to the world-class rated chemistry research departments benefit from knowledge spill-overs. Hewitt-Dundas [92] also proved that there are significant differences between those firms that cooperate with local universities and those that cooperate with non-local universities. In instances where business's innovation process is more open, the probability of cooperating with universities for innovation increases.

3.5.3. Institutional Environment

The study of Zeng and his team [93] implies that there are significant positive relationships between inter-firm cooperation, however, the cooperation with government agencies and universities does not significantly affect the innovation performance of SMEs. These results are in line with suggestions from other studies which show that universities and research institutions have relevance but less than could be expected in creating innovation among companies [94,95]. Also, Schøtt & Jensen [96] prove that institutional support does not significantly affect quantity of networking, but enhances quality of networking.

More detailed results of research at location level are presented in Table 3. One can find not only the key relationships studied and key determinants of innovation cooperation performance but also the key research gaps, which can be promising future research topics in the field of innovation cooperation performance.

Table 3. Findings at the location level.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
Institutional environment	Access to knowledge	The relationship between innovation and external knowledge links.	<ul style="list-style-type: none"> • Different types of innovations do rely on different kinds of knowledge inputs, sources and links. • More advanced innovations are supported by cooperation with universities and research institutions. 	<ul style="list-style-type: none"> • Research on political tools supporting the development of innovation networks.
	Cooperation effects	Cooperation in the context of innovation creation between companies and other institutions.	<ul style="list-style-type: none"> • The development of cooperation with business environment institutions may be regionally determined. • Companies assess the existing level of cooperation with business environment institutions as low in regions considered to be less developed. • Institutional support does not significantly affect quantity of networking, but enhances quality of networking. • Alliances in countries with norms characteristic of collectivist cultures give more to their participants in terms of knowledge transfer. 	<ul style="list-style-type: none"> • Institutional interactions between alliance form and innovation. • Impact on networking for innovation from the degree of consistency among institutional elements.
Importance of proximity and networks	Knowledge transfer	Knowledge flows.	<ul style="list-style-type: none"> • The propensity of firms to introduce innovation by linking with partners at different geographical scales varies depending on the characteristics of the region where the firm is located. • In general, local and national linkages tend to be more closely related to innovation for firms located in areas where is more investment in R&D. • On the other hand, integrating geographically distant as well as organizationally proximate knowledge in R&D alliances can negatively affects innovative performance at the alliance level. 	<ul style="list-style-type: none"> • Deepening knowledge of the similarities and differences between various modes of cooperation (alliances, networks). • Conditions under which the different modes may be more or less conducive to innovation.

Table 3. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
	Regional networks	The influence of regional networks on innovation performance.	<ul style="list-style-type: none"> • Geographical proximity influences the acceleration of the technological progress and transfer of technologies between the companies. • It is more effective in high-tech industries and highly developed countries. 	<ul style="list-style-type: none"> • Comparative analysis of regional networks from developed and developing countries. • Analysis of the national innovation systems of developed and developing countries and their impact on innovation performance of companies
	Business-university cooperation	Spatially mediated knowledge transfer from university research.	<ul style="list-style-type: none"> • Innovative companies that do locate near to relevant research departments are more likely to engage with universities. • Businesses faced with a lack of information on technology may approach universities as a source of information. 	<ul style="list-style-type: none"> • Identification of who benefits more from such cooperation • What type of information gathered from universities are crucial to develop innovation • Is it applicable only with high-tech firms
	Cooperation effects	Cooperation between companies and its effects.	<ul style="list-style-type: none"> • Best effects in terms of innovation performance is more relevant in the case of technological innovation unlike non-technological innovations. • Business cooperation levels are lower in micro-enterprises. • When active cooperation in innovative activities takes place among product market competitors, one observes an indirect negative impact on innovation and productivity. 	<ul style="list-style-type: none"> • Examine other types of business cooperation that firms seek out with buyers, suppliers, competitors and institutions of research and development.

Table 3. Cont.

Research Area	Specific Research Focus	Key Relationships Studied	Key Findings on the Determinants of Innovation Cooperation Performance	Key Research Gaps
Clusters and STPs	Business-university cooperation	Cooperation between clusters or science parks and universities in terms of knowledge transfer.	<ul style="list-style-type: none"> Firms that have developed cooperation agreements with universities and other research institutions are more able to exploit on-park knowledge. Such companies tend to increase their innovative capacity. Physical proximity to the university does not automatically create knowledge spillovers from the university. 	<ul style="list-style-type: none"> Does differences in the culture and norms developed among firms conditions their willingness and capacity to transfer knowledge from universities. Do central firms in science and technology parks access more knowledge.
	Innovation performance	The impact of parks and clusters on innovative activity.	<ul style="list-style-type: none"> Intangible outputs from cooperation are higher for park firms because location facilitates the development of more diverse cooperative relationships. The innovation cooperation performance is more effective in traditional industries clusters in comparison to those from high-tech. 	<ul style="list-style-type: none"> Analyzing the performance of firms that were born in the parks (the incubated firms). Collaboration patterns of firms located in an STP or clusters.
	Open Innovation	Open innovation processes between clustered firms	<ul style="list-style-type: none"> Agglomeration effects strongly contribute to the degree of network activities of firms in a cluster region, It enhances trust between residing companies. Spill-over effects due to positive agglomeration effects might intensify the interaction between cluster members in terms of cooperation. 	<ul style="list-style-type: none"> Cross cultural samples that comprise cluster initiatives in different regions.

4. Directions for Future Research and Practical Implications

To summarize, the above-mentioned research results do not conclusively determine whether an appropriate type of cooperation has a positive effect on innovation cooperation, or whether the openness of a firm (open innovation) has a positive effect on innovation performance. Our review of extant research demonstrates that the studied relationships are highly complex and subject to a number of moderating and mediating variables. This opens a fertile ground for future research efforts which are presented with reference to different levels of analysis discussed earlier in this review, as well as their interactions (see Tables 1–3 for the identified gaps in more detail).

4.1. Dyadic Level

The heterogenous findings of extant research might be the result of different performance measures (innovative performance, financial performance, firm performance, R&D performance, absorptive capacity, joint patents) used in the research, as well as different approaches to investigating these phenomena, mainly in Biopharma and ICT industries. Future studies should verify the effects of strategic alliances on innovation performance from a greater variety of perspectives taking into consideration various measures [51]. It could also be interesting to consider including performance measures to capture the impact of open innovation on social innovation objectives, such as sustainability or climate change [97], rather than merely financial aspects or innovation understood as patent outputs. Moreover, it will be useful to learn more about the alternative mechanisms, such as alliances and acquisitions, which can be used by companies to enhance their innovation performance, measure how differences in financial characteristics of firms impact their choice between strategic alliances and acquisitions, as well as to investigate the important relationship between the management of project alliances and their performance.

With regard to learning modes in inter-firm cooperation, authors like Colombo et al. [98] found that exploitation exhibits greater innovation performance in hybrid alliances than in alliances specialized in exploitation when the alliances result in radical product innovations (i.e., the introduction of products or services new to the market). Yet, more research is also needed to investigate when hybrid alliances achieve a better innovation performance than specialized alliances. Future studies could investigate the innovative performance of hybrid alliances focusing on different types of firms and check under which circumstances results can be generalized. Particularly, one can expect that hybrid alliances might achieve better innovation performance than specialized alliances whenever the knowledge transferred between exploring and exploiting agents is complex and there is little common ground between the partners.

With regard to the mode of innovation cooperation, predominant attention has been paid to formal arrangements (e.g., Reference [99]). Yet, many firms engage in informal ties that provide similar informational advantages and may improve firm performance. Data limitations have arguably hindered exploration of informal alliances by existing research, but it can be only hoped that future research finds a way to explore the effects of both formal and informal relationship networks on stock returns and risk. It will be also useful to validate whether participation in Open Innovation Alliances indeed increases the future financial performance and strategic positioning of the focal company.

Moreover, most of the research covered only one country or industry, hence the results may not be applicable in other countries and industries. Existing research has focused on open innovation practices in developed economies, with limited focus on less developed countries, such as the transition economies, like Central and Eastern Europe countries [49]. We can find some interesting research focused on open innovation, innovation cooperation or innovation performance in the CEE [6,49,60,100,101], but these few studies are unfortunately focused on a particular country. Taking into account the biopharmaceutical industry in the CEE region with high potential of clinical trials could be an interesting research gap for future studies, including both business–university alliances [102,103] and innovation cooperation developed in clusters or STPs as well as open innovation alliances in the model of open innovation.

Further, it is also important to focus on research not only on large companies, but also on SMEs [60,104–107]. SMEs do not gain from open innovation as much as large firms, that is why we cannot easily compare the successful open innovation examples from multinational corporations with small firms. It is important to verify the exact conditions under which SMEs can successfully implement an open innovation in future research [108], as well as antecedents of SME innovativeness in transition or post-transition countries (where companies face more external and institutional obstacles to innovation). Having more countries in a sample will make it possible to conduct comparative studies, which could bring important insights to the innovation cooperation performance analysis in future.

At the level of methodology, a comparative design can be also relevant to understanding why different modes of innovation cooperation can lead to different performance outcomes. Currently, little is known about the antecedents of choosing one cooperation mode over another, and the consequences thereof for the innovation output and the financial performance. These managerial choices could be analyzed along the criteria of openness (open vs. closed innovation design), capital involvement (capital-related vs. contractual modes of cooperation), or the specific governance modes (structured or formalized alliances vs. less hierarchical modes of cooperation, related more to project work). Such analyses have significant practical value as they can provide support for managers to make appropriate decisions to the design of innovation cooperation.

4.2. Network Level

Among the reviewed studies devoted to innovation cooperation networks, the study of Marhold, Kim and Kang [64] is one of the few to consider the actual objectives of an alliance. Future research on alliance portfolios should pay more attention to their objectives at the level of their construction, as well as at the level of single alliances.

Moreover, as indicated in the previous sections, future research can further increase our understanding about the interaction between different diversities in terms of partner and alliance characteristics on firm performance by considering other definitions of alliance portfolio diversity, some of which have been studied, although in different contexts, in prior studies. In particular, such forms of alliance portfolio diversities as the diversity of geographical locations and partner profiles, deserve more research efforts. Further, one of the implications of the study by Lavie and Miller [10] is that alliance portfolio internationalization can complement subsidiary-based internationalization of firms. Firms may need to coordinate their activities across wholly owned subsidiaries and alliances in foreign countries to identify optimal modes and levels of internationalization. Thus, it seems warranted to further analyze the interplay between subsidiaries and alliances as a means for international expansion. Moreover, it may be influential for the management of an innovation cooperation network, where the units responsible for coordination are located, how they are integrated with other parts of the network, and how these design characteristics translate into both innovation performance and the economic outcomes thereof. In contemporary business reality, a vast number of innovation-related cooperation projects occur in a cross-border context, in various formal and informal forms. Therefore, research into the success factors and design characteristics of such collaboration, with an explicit attention paid to the challenges of different types of distance, such as geographic, cultural, technological, or institutional, can be highly inspiring for managers.

With regard to the type of innovation, there is evidence that incremental innovation has no effect on idiosyncratic risk, but breakthrough innovation increases it. Additional research is needed to reconcile these disparate conclusions. Scholars might explore how innovation type (incremental versus radical) moderates the product alliance activity/stock risk relationship. It is conceivable that a product alliance activity is more appropriate for radical innovation, as it mitigates innovation risks, but it is unfavorable for incremental innovation. Likewise, explaining the moderating role of innovation type in the relationship between product alliance activity and stock returns could also increase our knowledge of the impact of product alliance activity on shareholder value.

Not least, it can be expected that a firm's alliance experience still plays an important role in addressing the challenges of knowledge recombination in its alliance portfolio. While alliance experience has its benefits, future studies can examine if explorative alliance experience with the same portfolio partners would indeed lead to knowledge recombination exhaustion. Further work is required to identify those firms with prior experience who do and do not have alliance experience to see if such dedicated resources do offer a means for developing organizational memory and the important coordination function. Thereby, as indicated in the preceding sections of this paper, researchers should distinguish between different types of experience, particularly experience with exploration or exploitation alliances. Finally, further studies of the effects of experience on collaborative benefits in alliances not involving R&D would be a useful extension to this work. There are some reasons to expect that experience matters more in R&D alliances. Not least, one can expect that experience can also have potentially adverse influences due to the possible overconfidence of managers in their choices of cooperation design, partner selection, execution control, etc. A study of the effects of experience on managerial behavior and the resulting performance would therefore be a promising avenue for further research. Such research is of utmost practical relevance as managers tend to rely on 'simple rules' which can draw upon past experience, not necessarily leading to optimal decisions.

4.3. Location Level

The location-specific context of innovation cooperation in performance analyses has several interesting topics to be covered. Location, proximity, clusters or STPs are topics strongly connected to the institutional environment, and therefore, an interesting issue would be to examine what political tools are used to support innovation networks and which of those give the best results in terms of innovation cooperation performance. It is possible to compare National or Regional Innovation Systems and choose a model which works best. Some of the abovementioned authors raised the issue of comparability of the outcomes obtained across different countries or industries. It is possible that some of results are country-specific, so it would be valuable to examine some research concepts in other countries. Future studies might gather cross-cultural samples that comprise cluster initiatives from different sectors or STPs in different regions and countries to control potential cultural side effects.

At a practical level, geographic proximity accelerates technological progress and the transfer of technologies and knowledge between firms. It is worth mentioning that this type of grouping, whether in the form of clusters, STPs or business networks, has been found to be more effective in high-tech industries and highly developed countries. Hence, both states and firms should be committed to improve the effectiveness of knowledge transfer in emerging markets and post-transformation economies. An explicit consideration to the location context of innovation cooperation inevitably brings cluster organizations to the forefront, as they can be instrumental in developing interfirm networks, or identifying new demand trends. They can be crucial not only in fostering innovation processes, but also generating new internationalization opportunities, which can further augment the firms' competitiveness. In order for the collaboration institutions to work more effectively, however, it may be worthwhile organizing training and workshops devoted to the use of open innovation support tools (such as IP mapping or legal aspects of collaboration), so that firms, particularly from knowledge-sensitive sectors, can overcome their behavioural barriers to entering such cooperation.

When it comes to the business–university cooperation it would be worth examining not only the positive or negative effects of cooperation for companies, but also the effects of such cooperation for universities. Another question is what types of information gathered from universities are crucial to develop innovation in firms and in which industries cooperation between companies and universities brings the biggest benefits. In order to achieve sustainable development, it is important that clusters have an effective access to scientists and mobility of researchers between companies or from universities to companies is possible [104–106].

With regard to the practical implications of business–academia cooperation, pharma–university alliances can significantly increase the likelihood of creating better medical therapy for patients. In addition to partnerships within the industry, pharmaceutical companies establish relationships with universities or research institutes as well as more often cross-industry alliances and public-private partnerships. This cooperation enables a number of innovative projects and allows significant synergy effects given the significant pressures on innovativeness and shortening lifecycles. Biopharmaceutical companies involved in innovation cooperation with academic institutions, especially in the model of open innovation alliances, can also significantly reduce the risk and cost of research, use the resources, competencies, technology and knowledge from partners, and thus easier respond to changes in the environment, and most of all, quickly launch new biotechnology or pharmaceutical products.

4.4. Interactions between Levels

As performance drivers are rooted in various levels simultaneously, future research should consider interactions between variables at different levels. For instance, a fruitful area of research is the possible influence of firms' network-level cooperation strategies on the dyadic interactions in an individual innovation cooperation. If the composition of a partner firm's cooperation network influences its evaluation of an individual cooperation, the firm's networking strategy will also influence its objectives in and motivations for collaboration in the individual cooperation. After the formation of an innovation cooperation, changes in the partner firm's network composition may alter its motivation and bring instability to the single cooperation project. Moreover, the other partner firm may react to these changes and adjust its own strategy. Thus, dyadic interactions become more complicated when innovation collaborations are managed at the network level. These dynamics and how they influence the outcome of an individual alliance need to be better understood.

Furthermore, the important role of a cooperation management function suggests the need to further investigate the process and structure of innovation cooperation management. A significant issue is when and to what extent innovation collaborations should be supported by formal organizational structures, especially considering the economic and organizational cost of establishing such functions which affect performance outcomes. As innovation cooperation activities continue to increase and cooperation management functions emerge, this issue deserves more research.

Not least, as Zheng, Li & Wu [52] point out, owing to the complex economic and social environments in international economies, one should be cautious to generalize the conclusions of research across different economic environments. Thus, researchers may examine the effects of network resources in different contexts, such as different governance structures. It will be particularly interesting to test whether the relationships found in domestic or single-country research which has prevailed, continue to hold true in different situations. Also, more studies seem needed to investigate the interactions between external environmental characteristics and internal resources.

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Appendix A. Overview of Specific Research Areas and Research Focus

Table A1. Overview of specific research areas and research focus.

Level of Analysis	Research Area	Research Focus	# of Articles
Dyadic level	Characteristics of partners in inter-firm cooperation	Alliance partner resources	4
		Learning and innovation cooperation performance	1
		Partner diversity and alliances performance	1
		Prior alliance experience	1
	Determinants of cooperation form	Alliance network technological diversity	1
		Alliances vs. acquisitions	1
		Determinants of alliance type	2
		Determinants of cooperation form	1
		Governance form determinants	1
		Innovation performance	1
		OIA and value co-creation	1
		Potential absorptive capacity	1
	Innovation cooperation determinants and performance	Technological complexity and alliance complexity	1
		Alliance characteristics and performance	1
		Alliance performance determinants	1
		Business-university cooperation	1
		Determinants of alliance performance	2
		Exploration and exploitation	1
		Innovation cooperation	1
	Prior experience and performance	1	
	Open innovation	Vertical-downstream and vertical-upstream alliances	1
		Business-university cooperation	2
		Determinants of cooperation form	2
Inbound open innovation and firm performance		1	
Innovation and financial performance		1	
Innovation cooperation		7	
Innovation networks		1	
Innovation performance		5	
Knowledge transfer		2	
Measuring Open Innovation		2	
Network management and innovation performance		1	
Open innovation modes		1	
Organisational modes	1		
Potential absorptive capacity	1		
Network level	Alliance portfolios	Portfolio diversity and performance	16
		Coopetition	2
		Portfolio internationalization	1
		Alliance networks and performance	3
		Antecedents of multilateral alliances	1
		Alliance portfolio R&D intensity	3
	Partner types	1	
Network design	Relative position in network	4	

Table A1. Cont.

Level of Analysis	Research Area	Research Focus	# of Articles
	Clusters and STPs	Business-university cooperation	4
		Innovation performance	3
		Open innovation	1
Location level	Importance of proximity and networks	Business-university cooperation	2
		Cooperation effects	4
		Knowledge transfer	2
		Regional networks	3
	Institutional environment	Access and transfer of knowledge	1
		Cooperation effects	3

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