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Article

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Innovation through Collaboration[1]

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Abstract

What types of market cooperation are essential for developing innovations? Is collaboration with other enterprises, clients or competitors worth it? Actual research and public debate reveal the range of the issue, whereas the subject of policies motivating private entities to create innovations is key for the national and international programs for boosting innovativeness of economies. The aim of the paper is to review the sphere of relevance of different types of market collaboration for innovativeness and to verify as well as compare their importance in European countries empirically, by applying econometric techniques. The results suggest the positive effect of cooperation on various kinds of innovation activities.

Keywords: *innovations, market cooperation, innovation strategy, innovation policy*

JEL Classification: D22, O31, O32

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Introduction

What are the relevant forms of cooperation between a firm and other enterprises, suppliers, clients, competitors, academia or government in terms of creating innovations? We ask the question with a link to institutional setting of the market.

Innovators may undertake different strategies of developing innovations. Entities may create innovations by themselves, by buying semi-products and technology and basing on some kind of cooperation. There are different types of

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[1] The views, thoughts, and opinions expressed in the text belong solely to the authors, and not necessarily to the authors' employer, organization, committee or other group or individual.

cooperation that may be present on the market. Sometimes it is beneficial to collaborate with other enterprises from the same capital group, with clients, suppliers or even competitors. It may occur that establishing a cooperation with higher education institutions or research institutions, is beneficial.

Although there is a broad literature addressing the subject of collaboration for developing innovations, our study brings a value added to the actual research discussion over public policies regarding innovations, as well as attitude towards market competition. Namely, numerous available studies analyzing the relevance of collaboration are narrowed to single countries or specific regional groups of countries. Another point is that these studies, discussed in the following section of this paper, to a large extent refer to onefold forms of cooperation between organizations. In addition, the existing literature leads, to some degree, to conflicting conclusions. Our paper deals with both theoretical and empirical dimensions of the issue of market cooperation of innovative firms. We refer to the existing literature on the issue and then we check the expectations empirically, focusing on European states. In particular, we draw on the significance of cooperation with different types of partners with regard to the efficiency in developing innovations. We analyze the determinants of creation of innovations in European firms with a particular interest in the abovementioned collaboration factors. The novelty of our study is twofold. We use the most actual version of the Eurostat Common Innovation Survey (2014 edition) that provides data representing various forms of cooperation or cooperation partners, as well as multiple types of innovations in 15 European countries. Moreover, we apply econometric techniques allowing for addressing the potential endogeneity and the complexity of the relationships between different types of innovations.

The paper is structured as follows. The next section covers the relevance of collaboration in the context of innovations, as well as refers to other determinants of innovativeness of entities. Then, we present our quantitative methodology. Section 3 contains the description of our results and discussion. Finally, the last part concludes the study.

1. Literature Review

1.1. Collaboration for Innovations

Interorganizational collaboration is perceived as an advance for innovative performance of firms. It is also a mean of industrial response to dynamically changing economic and technology conditions in a global scope. However, the actual empirical literature regarding the subject is much less popular in comparison

with the issue of public support for innovations. A positive relationship between interorganizational collaboration and innovative performance is generally confirmed. Innovation-oriented collaboration is sometimes even treated as a substitute for the internal R&D (De Marchi, 2012). The spillover effects in a cooperative research are high enough to overwhelm potential negative effects of R&D engagement via free riding, and to provide incentives to invest more in R&D (Czarnitzki, Ebersberger and Fier, 2007). It is found that firms which engage in R&D and collaborate with other entities, are attempting to introduce higher level innovations, i.e. 'new to the market' (Tether, 2002). The strength of such a relationship is dependent on the type of the partner for collaboration – different types of partnerships lead to various results (Faems, Van Looy and Debackere, 2005). It is even stated that collaboration with other firms is critical for processing innovations (Von Stamm, 2004).

It is expected that most firms would utilize various types of R&D collaboration partners simultaneously. Empirical results prove that R&D collaboration with customers and universities have a positive effect on product innovation. At the same time, R&D collaborations with suppliers and competitors have an inverted-U shape relationship with product innovation (Kang and Kang, 2010). There are researches that state insignificance of collaboration with customers in terms of development of innovations and a negative impact of collaboration with competitors (Un, Cuervo-Cazurra and Asakawa, 2010). Such a negative impact occurs only in a short-time perspective and is not a common phenomenon. Findings prove that cooperation with suppliers is more effective for developing innovations that collaboration with customers (Tu, Hwang and Wong, 2014). However, there are analyzes that prove empirically that both non-competitive and competitive collaborations in R&D have a positive effect on firm's innovativeness (Huang and Yu, 2011).

Linkages between firms serve as tools for sharing knowledge, combine skills and perform scale economies in research. As a result, they are expected to raise innovative performance. The ability to set up alliances and work together with market partners motivates firms to integrate and conduct mutual operations for increased effectiveness in case of radical or incremental innovation (Soosay, Hyland and Ferrer, 2008). Moreover, industry collaboration is a kind of an information corridor for knowledge spillovers. Thanks to networks of firms, technological breakthroughs are spread. There are factors listed as determinants of different partners of a firm: technical capital (patents), physical capital (ownership of supporting assets) and social capital (embeddedness in the industry network) (Ahuja, 1996). Firms not only establish alliances to deal with uncertainty and facilitate innovations. Their behavior within partnership is crucial for handling

technology shocks (Schilling, 2015). However, market competition has a negative impact on effects of technological collaboration. This interaction is positively moderated by sectoral technological intensity (Wu, 2012).

An interesting point with regard to market collaboration is about diffusion of coopetition (Min, Fung So and Jeong, 2019). Collaboration between large entities (market leaders) leads to subsequent collaboration between other firms. Thus, it creates more mutual benefits (positive externalities) that generate innovation (Gnyawali and Park, 2011). Another way of collaboration for innovations is by establishing clusters.

Dense local clustering stimulates transmission of information in the network by fostering cooperation and communication. The higher the technology intensity of the industry is, the greater is the necessity of entities to collaborate for developing innovations (Koschatzky and Sternberg, 2010). Cluster connections mitigate the distance between firms (Schilling and Phelps, 2007). Enterprises may share the costs and risks of innovative undertakings through collaboration in clusters. Collaboration between market leaders is found to be key in innovation adoption, if technological indivisibilities are the issue (Sandee and Rietveld, 2010). Empirical research reveal that interregional collaboration provides firms with vital access to basic research, production expertise and finance. Most of the collaborative links are found to be national or international rather than local (Rees, 2005). It is proved that local and nonlocal collaborations between firms are statistically indistinguishable from each other with regard to their relevance. Anyway, they are a significant motor of innovations (He and Wong, 2012). What is crucial, knowledge spillovers, thanks to collaboration in R&D, occur rather as networks phenomena than processes between the local firm and individual partners. Collaboration is significant for the presence of foreign innovation partners in the network (Lööf, 2008). However, in some analyzes, the role of R&D in regional innovation seems to remain unclear (Fritsch, 2004).

Firms may collaborate with so-called innovation intermediaries, which are entities, agents, or brokers in the innovation process between parties (Lichtenthaler, 2013; Kanda et al., 2018). Such intermediaries may be i.a. consulting bodies or Internet marketplaces and others. Firms are able to reduce transaction costs in technology markets by collaborating with intermediaries. Studies reveal that collaboration with extra-regional agents is more important for innovation than co-operation with local partners (Fitjar and Rodriguez-Pose, 2013).

With reference to internal organizational structure, it may be stated that the innovation potential of organizations is boosted by a proper access to knowledge and team collaboration of engaged specialists (Gressgård, 2011; Olaisen and Revang, 2017). In addition, collaborative space within a firm may serve as

a stimulator for innovations, by developing a shared vision of a compelling challenge, having an easy access to information and creating trust and participation (Wycoff and Snead, 1999).

A relevant partner for developing innovations may be a university or some another academic or research center. The role of university-industry collaboration is diverse with regard to early-stage, emergent and mature industries. Universities are a sort of source of knowledge for entities pursuing radical innovations (Belderbos, Carree and Lokshin, 2004). Collaborative projects conducted with emerging industries (entities) is rather a result of call from academic sector or public need for projects (Freitas, Marques and de Paula e Silva, 2013). The significance of the impact of academic research for local (regional) innovation is mediated by geographical proximity and by networks that stem out from industry-university alliance (Ponds, Van Oort and Frenken, 2010).

An interesting mean of collaboration for developing innovations is open collaboration (Radziwon and Bogers, 2019). Open collaboration is perceived as a robust engine for innovation. Open collaboration is proved to perform even in harsh environments, with regard to market competition or free-riding. The following factors are crucial in terms of development of open collaboration: the cooperativeness of participants, the diversity of their needs, and the degree to which the goods are rival (Levine and Prietula, 2013).

1.2. Other Determinants of Firms' Innovativeness

The level of development of financial sector is relevant for innovativeness of firms. Banks provide credits and loans for private entities for R&D, and equity markets assure additional sources of financing (Bouis et al., 2011; Hsu et al., 2014). Industries that are high-tech intensive and relatively more dependent on external financing, are usually more developed in countries with strong equity markets (Hsu et al., 2014). Anyhow, the influence of financial sector on the economy is ambiguous, especially in the context of the recent global financial crisis (Cecchetti and Kharroubi, 2015; Levine, 1997).

Openness of the economy is another factor shaping evolvement of innovations (Dotta and Munyo, 2019). The degree of openness of the economy is usually approximated by intensiveness of export or import penetration, and shares of export and import in GDP (Laursen and Salter, 2005; Bouis et al., 2011; Bessanini et al., 2001; Almeida and Fernandes, 2008). Openness of the economy makes economic growth faster in short and medium-term perspectives, but this impact is not always noticeably strong (Harrison, 1996). The essence of this impact may be tied with international investments in the country or volume of trade (Edwards, 1998).

Some of the most popular institutional frames of business activity are product market regulation or employment market legislation (Aloisi and De Stefano, 2020). Bouis et al. (2011) state and prove that countries with rigorous product market regulations and employment protection legislation are accompanied by relatively lower total factor productivity, what leads to slower economic growth. Intellectual property protection in many circumstances also has an influence on the total factor productivity (Bouis et al., 2011). However, the issue of intellectual property protection relevance for economic growth is an research lacuna, as non-linear relationships between intellectual property protection and total factor productivity have to be empirically verified.

The state has a variety of instruments that could be applied to make selected assets captured by innovative firms or to make them transferred there from less productive entities. This kind of a policy is considered as more effective than creating a range of subsidies for innovators (Acemoglu et al., 2013). But sometimes government support is anticipated (Gonzales et al., 2005).

Tax allowances are proved to have an influence on the level of funds put in commercial R&D (Mansfield and Switzer, 1985; Mansfield, 1986; Warwick and Nolan, 2014). All in all, conclusions about the relevance of tax regulation in this context are rather ambiguous (OECD, 2014). It is proved that in the perspective of economic crises or downturns, tax policies should keep on providing incentives to fostering innovations (Palazzi, 2011).

Labor market regulations are relevant from the perspective of innovators, as they determine the proportion of profit division between the employer and employees due to the costs of labor (Cingano et al., 2010; Saint-Paul, 2002). With respect to strong employment protection legislation, bargaining power of employees is relatively high, what is crucial when the hold-up problem occurs. It is also proved that stringent dismissal laws enhance innovation, mostly in innovation-intensive industries (Acharya et al., 2013).

Too strong rights of creditors may discourage entrepreneurs from investing in innovations and R&D. Then, the risk of innovative commercial activity is very high, as the innovator may suffer from harsh obligations due to potential insolvency or bankruptcy (Acharya and Subramanian, 2009).

Stability of laws and predictability of execution of legal rules is significant for developing innovations (Nunn, 2007). It also attracts international investors and influences positively spread of innovations. An effective legal system is a credible commitment for a state, which also serves as a support in pursuance of business obligations (Andrews et al., 2015).

Successful innovations may be also a result of social capital and interactions between entities present on the market (Landry et al., 2002; Ceci et al., 2020).

Accumulation of knowledge, organizational learning, creation of innovations, their spread and commercialization may be dependent on social networking (Lawson and Lorenz, 1999; Suorsa, 2010; Melnikas, 2008). Knowledge diffusion and interrelationships between firms, academic institutions, and the society are crucial there (Jensen et al., 2007; Love and Roper, 1999).

The state may be involved in active policies for boosting innovativeness. Active pro-innovation policies are considered as a response to structural problems and a mean of making innovative commercial activity more popular (Jaumotte and Pain, 2005; Lin and Chen, 2019). Implementation of those policies may mean promoting commercialization of innovative ideas or collaboration between commercial entities and academic sector. One of the most essential characteristics of such support for firms is the coordination of institutions involved in the whole pro-innovative process (OECD, 2014).

Public grants, subsidies and other forms of accountable financial support are usually more adequate for big firms and corporations, i.a. due to their ability to deal with administrative requirements (EC, 2014). Grants and subsidies may serve as a key support for developing innovations, but they may cause bureaucratic issues that may be a serious barrier to small firms.

Legal regulations, in turn are helpful especially for small and medium entities (EC, 2014). The available literature confirms that regulatory ease of doing business, tax allowances and other institutional rules are more important for small and medium firms than larger ones. It occurs due to better capabilities of corporations to adapt to institutional environment, also in global perspective. In addition, the outcomes of grants and subsidies are rather easier than legal systems or non-refundable donations to evaluate.

Although the literature review proposed in this text is focused on the internal factors supporting innovativeness, there are also another relevant instruments that refer to political stability, trade and international agreements (Felbermayr and Yalcin, 2013). Importantly, factors like executive leadership or organizations' characteristics also matter for innovativeness (Shin and Choi, 2019).

2. Methodology

2.1. Database and Variables

In our empirical analysis we exploit the firm level data coming from the Community Innovation Survey (CIS) (Scientific Use File version) – a survey concerning innovation activity of enterprises in a number of European countries. It is performed in waves with two years' frequency by a number of European

Union member states, Norway and Iceland. In our study we use the CIS 2014 wave containing the data collected in 2014. The database after deleting the observations with missing dependent variables consists of observations for 98,809 enterprises form 15 countries. Such size of the database assures the representativeness of the sample and increases the credibility of obtained empirical results.

Table 1 shows the list of countries covered in the analysis with the number of enterprises representing each country. The majority of enterprises has a place of residence in one of three countries – Spain, Bulgaria and Romania. States included in the sample differ in terms of social and economic development. Therefore, we are able to account for various environments in which an enterprise may operate.

T a b l e 1

Countries Included in the Analysis

	Number of enterprises included in the dataset
Bulgaria	14,255
Cyprus	1,346
Czech Republic	5,198
Germany	6,282
Estonia	1,760
Greece	2,507
Spain	30,333
Croatia	3,265
Hungary	6,817
Lithuania	2,421
Latvia	1,501
Norway	5,045
Portugal	7,083
Romania	8,206
Slovakia	2,790

Source: Authors' own calculations.

In order to assess the innovativeness of the enterprise we focus on the different types of innovation events represented by five variables:

- a binary variable *innovation good* – takes the value 1, if the enterprise introduced onto the market a new or significantly improved good,
- a binary variable *innovation service* – takes the value 1, if the enterprise introduced onto the market a new or significantly improved service,
- a binary variable *innovation method of production* – takes the value 1, if the enterprise introduced onto the market a new or significantly improved method of production,
- a binary variable *innovation distribution system* – takes the value 1, if the enterprise introduced onto the market a new or significantly improved logistic, delivery or distribution system,

• a binary variable *innovation supporting activities* – takes the value 1, if the enterprise introduced onto the market a new or significantly improved supporting activities.

Such approach encompassing a variety of product and process innovations enables us to deepen the analysis concerning the magnitude of influence of cooperation on the probability of occurrence of various types of innovation activities.

The CIS database includes information concerning innovation cooperation for product or process innovation that the enterprise undertook in a given year. We account for the occurrence of such event with a binary variable *cooperation* (value 1 if a given firm entered into cooperation arrangements on innovation activities in a given year). What is more, we deepen our analysis by accounting for the type of the firm's most valuable co-operation partner. The types lying within the scope of our research are: other enterprises within enterprise group (*other_enterprise*), suppliers of equipment (*suppliers*), clients or customers from the private sector (*clients private*), clients or customers from the public sector (*clients public*), competitors or other firms (*competitors*), consultants and commercial labs (*consultants*), universities or other higher education institutions (*universities*), government, public or private research institutes (*government*). The aforementioned variables are binary – they take the value one, if a given entity is firm's most important co-operation partner.

In the model we include a set of control variables related to firm's characteristics and economic conditions in a resident country of the enterprise.

These are:

• size of the enterprise expressed by the number of employees (less than 50 *size 0*, between 50 and 249 *size 50*, 250 – 499 *size 250*, more than 500 *size 500*). The larger the firm is, the higher should be the probability that it will engage into innovations,

• largest market in terms of turnover between 2010 and 2012 – possible values *local/regional*, *national*, *other European Union or associated countries*, *all other countries*,

• whether a firm incurred any expenses on innovation activities in 2014 (*rd expenditures*) – binary variable taking value 1, if firm incurred such expenses,

• public support received by the firm from the following sources: from local or regional authorities (*local funding*), from central government (*government funding*), from the EU (*eu funding*) and from EU's Framework Programme (*eu framework funding*). These are all binary variables taking the value 1 if the firm received public support from the given source.

T a b l e 2
Descriptive Statistics

		Frequency	Percentage
innovation good	0	83,316	84.32
	1	15,493	15.68
innovation service	0	89,284	90.36
	1	9,525	9.64
innovation method of production	0	84,981	86.01
	1	13,828	13.99
innovation distribution system	0	92,999	94.12
	1	5,810	5.88
innovation supporting activities	0	86,376	87.42
	1	12,433	12.58
most valuable cooperation partner	other_enterprise	2,605	6.89
	suppliers	3,166	8.37
	clients private	1,525	4.03
	clients public	192	0.51
	competitors	652	1.72
	consultants	821	2.17
	universities	1,730	4.57
	government	1,583	4.18
	missing	25,561	67.56
size 0	0	39,895	40.38
	1	58,914	59.62
size 50	0	69,003	69.83
	1	29,806	30.17
size 250	0	91,990	93.10
	1	6,819	6.90
size500	0	95,539	96.69
	1	3,270	3.31
% of employees with degree	0%	23,112	23.39
	1% to 4%	14,155	14.33
	5% to 9%	12,842	13.00
	10% to 24%	20,673	20.92
	25% to 49%	12,018	12.16
	50% to 74%	7,527	7.62
	75% to 100%	8,482	8.58
group	0	63,453	67.64
	1	30,352	32.36
largest market:	local/regional	26,168	26.48
	national	25,408	25.72
	other European Union or associated countries	12,810	12.96
	all other countries	3,231	3.27
local funding	0	94,975	96.12
	1	3,834	3.88
government funding	0	90,594	91.69
	1	8,215	8.31
eu funding	0	94,346	95.48
	1	4,463	4.52
eu framework funding	0	97,252	98.42
	1	1,557	1.58
cooperation	0	23,259	64.16
	1	12,994	35.84
rd_expenditures	0	28,723	29.07
	1	70,086	70.93

Source: Authors' own calculations.

Table 2 presents descriptive statistics of all variables used in the model. Basing on statistics included in the table, we conclude that our sample consists on average of small firms (with less than 50 employees), not being part of the enterprise group, but being part of cooperation arrangements. The prevailing majority of enterprises from the sample have not introduced any product of their innovation activities. However, about 71% of firms incurred expenses on innovation. What is more, about 36% of enterprises entered into cooperation arrangements on innovation activities. The highest percentage of firms (around 8%) reported supplier as the most valuable cooperation partner. In our paper we aim to test whether presence of cooperation arrangements and type of most valuable cooperation partner contributes to the outcome of innovation activities.

2.2. Empirical Strategy

The main goal of our study is to verify the relevance of cooperation arrangements and different types of cooperation partners on the probability of innovation occurrence.

The econometric strategy used in the study is as follows. In order to account for selection bias related to CIS methodology we base our empirical design on CDM model approach developed by Crépon, Duguet and Mairesse relating innovation input to innovation output (Crépon et al., 1998). The CIS focus is on innovativeness, therefore while some general questions are posed to all firms, eventually only innovative firms are kept in the sample.

CDM approach allows to control for selectivity and simultaneity problems in the data. The classical CDM model consists of three consecutive stages. At first stage, enterprise decides whether to engage in an innovation project and what amount of resources to devote to carry it. Secondly, enterprise uses chosen resources to obtain innovations. Finally, the model accounts for the influence of successful innovations on the enterprise's profitability or productivity.

The focus of our paper is on the influence of collaboration arrangements on the probability of occurrence of various types of innovation activities, therefore we limit our empirical design to the first two stages of CDM model. Model consists of two steps – probit model with *rd expenditures* as dependent variable and generalized structural equation probit model using a predicted values of *rd expenditures* from the first step as independent variable.

In selection equation we account on firm's engagement into innovation activities. In order to proxy the above we account on whether enterprise's expenditures on innovation activities in 2014 were greater than 0 (*rd expenditures*). Therefore, our dependent variable in the selection equation is:

$$rd\ expenditures_i = 1,\ \ if\ \ firm\ incurred\ any\ expenses\ on\ R\ \&\ D\ in\ 2014$$
$$rd\ expenditures_i = 0,\ \ otherwise$$

What is more, in this equation we employ the following set of control variables: being part of cooperation arrangements on innovation activities, the percentage of employees with a university degree, membership in the enterprise group, largest market in terms of turnover, size of an enterprise and reception of public funding. The outcome equation in our model is related to the introduction of innovations. In order to measure successful innovations authors using CMD models refer to dummy variables describing the introduction of innovations (Hall et al., 2009; Griffith et al., 2006) or the number of patent applications and share of innovative sales (Crépon et al., 1998; Marin, 2014).We follow the first approach and use binary variables representing various type of innovation activities carried by the firm. These are introduction onto the market a new or significantly improved good, service, method of production, distribution system or supporting activities. We use the following set of control variables: presence of cooperation arrangement, membership in the enterprise group, the percentage of employees with a university degree, largest market in terms of turnover, reception of public funding and size of an enterprise, and predicted values of *rd expenditures* calculated in the first step.

In our empirical specification we account for the fact that the development of different types of process innovation may have an impact on the introduction of a new or significantly improved good or service. In order to control the aforementioned endogeneity, we estimate a generalized structural equation probit model taking the following functional form:

$$\left\{\begin{array}{l} goods\ or\ service\ innovation_i = \alpha_i + production\ innovation_i + \\ distribution\ innovation_i + \ cooperation_i + firm\ characteristics_i + \\ + \ country\ fixed\ effects_i + \varepsilon_i \\ production\ innovation_i = \alpha_i + cooperation_i + firm\ characteristics_i + \\ + \ country\ fixed\ effects_i + \varepsilon_i \\ distribution\ innovation_i = \alpha_i + cooperation_i + firm\ characteristics_i + \\ + \ country\ fixed\ effects_i + \varepsilon_i \end{array}\right\}$$

To test the influence of the type of the most valuable cooperation partner on the innovation output we propose a probit model. We estimate regression in the following form:

$$\begin{aligned} innovation\ type_i = \alpha_i + most\ valuable\ cooperation\ partner_i + \\ + firm\ characteristics_i + country_i + \varepsilon_i \end{aligned}$$

We account for the following set of control variables: the percentage of employees with a university degree, membership in the enterprise group, largest market in terms of turnover, size of an enterprise, predicted values of *rd expenditures* calculated in the first step and reception of public funding.

3. Results and Discussion

Table 3 presents the outcomes of probit estimation calculating the probability the firm bear expenses to R&D probability. We predict the latent *rd expenditure* variable and use it as an input to the second stage of our study i.e. generalized structural equation probit model.

T a b l e 3

Selection Equation – Results of Probit Regression

Variable name	
cooperation arrangement	0.528* *24.65*
group	0.043* *2.14*
% of employees with degree	0.073* *14.39*
local funding	0.492* *13.09*
government funding	0.556* *20.61*
eu funding	0.032 *0.85*
eu framework funding	0.598* *6.65*
largest market: national (local as base level)	0.624* *9.43*
largest market: other European Union or associated countries (local as base level)	0.896* *13.73*
largest market: all other countries (local as base level)	0.969* *13.73*
size 500 (size 0 as base level)	0.461* *10.66*
size 250 (size 0 as base level)	0.174* *5.00*
size 50 (size 0 as base level)	0.099* *5.02*
constant	–1.275* *–17.54*
log-likelihood	–14,775.28
number of observations	34,387

Notes: Values of z statistics in *italics*. Coefficients significant at 5% level are marked with an *.

Source: Authors' own calculations.

Table 4 presents the outcomes of generalized structural equation probit model.

T a b l e 4
Results of Generalized Structural Equation Probit Estimation. Country Fixed Effects and Robust Estimator of Variance Included

	inpdgd	***inpspd***	***inpslg***	***inpdsv***	***inpspd***	***inpslg***
inpspd	0.382* *25.35*			0.233* *14.32*		
inpslg	0.110* *5.56*			0.434* *21.61*		
cooperation arrangement	0.306* *9.37*	0.368* *11.36*	0.297* *7.67*	0.265* *7.58*	0.368* *11.36*	0.297* *7.67*
predicted probability of r&d investment	0.524* *2.69*	0.635* *3.28*	0.480* *2.07*	0.158 *0.76*	0.635* *3.28*	0.480* *2.07*
group	0.021 *1.17*	–0.014 *–0.8*	0.071* *3.33*	–0.023 *–1.2*	–0.014 *–0.8*	0.071* *3.33*
% of employees with degree	–0.005 *–0.95*	–0.039* *–8.26*	0.006 *0.97*	0.171* *32.84*	–0.039* *–8.26*	0.006 *0.97*
local funding	0.171* *5.52*	0.208* *6.79*	0.052 *1.42*	0.018 *0.54*	0.208* *6.79*	0.052 *1.42*
government funding	0.323* *10.87*	0.271* *9.27*	–0.019 *–0.55*	–0.047 *–1.52*	0.271* *9.27*	–0.019 *–0.55*
eu funding	–0.026 *–0.93*	0.246* *8.77*	0.02 *0.62*	0.008 *0.28*	0.246* *8.77*	0.02 *0.62*
eu framework funding	0.146* *3.27*	–0.182* *–4.14*	–0.026 *–0.5*	0.189* *4.1*	–0.182* *–4.14*	–0.026 *–0.5*
largest market: national (local as base level)	0.145 *1.82*	0.279* *3.35*	0.328* *2.99*	0.484* *5.11*	0.279* *3.35*	0.328* *2.99*
largest market: other European Union or associated countries (local as base level)	0.561* *7.01*	0.445* *5.32*	0.406* *3.7*	0.376* *3.95*	0.445* *5.32*	0.406* *3.7*
largest market: all other countries (local as base level)	0.707* *8.48*	0.662* *7.64*	0.382* *3.38*	0.033 *0.33*	0.662* *7.64*	0.382* *3.38*
size 500 (size 0 as base level)	–0.190* *–5.2*	0.135* *3.76*	0.452* *11.02*	0.298** *7.65*	0.135* *3.76*	0.452* *11.02*
size 250 (size 0 as base level)	0.067* *2.36*	0.297* *10.6*	0.401* *12.73*	0.01 *0.33*	0.297* *10.6*	0.401* *12.73*
size 50 (size 0 as base level)	0.066* *3.8*	0.146* *8.34*	0.155* *7.37*	–0.066* *–3.46*	0.146* *8.34*	0.155* *7.37*
constant	–0.337* *–2.35*	–0.517* *–3.56*	–1.313* *–7.31*	–1.747* *–10.93*	–0.517* *–3.56*	–1.313* *–7.31*
number of observations	35,323			35,323		

Note: Values of z statistics in *italics*. Coefficients significant at 5% level are marked with an *.

Source: Authors' own calculations.

The model results indicate the expected positive effect of cooperation on all kinds of innovation activities (De Marchi, 2012). The effect is the strongest for the innovation consisting of the introduction to the market a new or significantly improved method of production and the weakest for the introduction of a new or significantly improved distribution system. Model results indicate mixed effects of local, governmental, EU and EU Framework Programme funds on the probability of the occurrence of all types of innovations. The model indicates that the size of the enterprise and its largest market constitute a significant determinant of the occurrence of all types of innovation.

T a b l e 5

Results of Probit Estimation.
Country Fixed Effects and Robust Estimator of Variance Included

	Innovation good	Innovation service	Innovation method of production	Innovation distribution system	Innovation supporting activities
most valuable cooperation partner: other enterprise (enterprises without cooperation partner as base level)	0.727* *14.89*	0.764* *14.42*	0.720* *14.77*	0.707* *12.58*	0.734* *14.78*
most valuable cooperation partner: suppliers (enterprises without cooperation partner as base level)	0.522* *11.05*	0.835* *16.22*	0.774* *16.31*	0.705* *12.77*	0.930* *19.22*
most valuable cooperation partner: clients private	0.779* *14.62*	0.860* *15.16*	0.750* *14.14*	0.592* *9.62*	0.651* *12.07*
most valuable cooperation partner: clients public (enterprises without cooperation partner as base level)	0.467* *4.62*	1.026* *9.88*	0.746* *7.35*	0.484* *4.13*	0.692* *6.81*
most valuable cooperation partner: competitor (enterprises without cooperation partner as base level)	0.417* *6.21*	0.854* *12.1*	0.542* *8.02*	0.515* *6.49*	0.665* *9.76*
most valuable cooperation partner: consultants (enterprises without cooperation partner as base level)	0.512* *8.35*	0.742* *11.38*	0.683* *11.14*	0.623* *8.85*	0.821* *13.23*
most valuable cooperation partner: universities (enterprises without cooperation partner as base level)	0.571* *10.95*	0.571* *10.08*	0.545* *10.45*	0.352* *5.63*	0.449* *8.38*
most valuable cooperation partner: government (enterprises without cooperation partner as base level)	0.641* *11.55*	0.490* *8.09*	0.561* *10.08*	0.352* *5.2*	0.435* *7.57*
predicted probability of r&d investment	0.157* *2.63*	0.171* *1.68*	0.115* *3.47*	0.888* *3.04*	0.155* *2.61*
group	–0.002 *–0.06*	0.013 *0.52*	–0.003 *–0.11*	0.067* *2.39*	–0.017 *–0.7*
% of employees with degree	0.001 *0.1*	0.135* *23.79*	–0.017* *–3.17*	0.031* *4.99*	0.046* *8.46*
local funding	0.124* *3.52*	0.043 *1.18*	0.179* *5.09*	0.048 *1.17*	0.006 *0.16*
government funding	0.300* *9.09*	–0.012 *–0.36*	0.208* *6.37*	0.028 *0.77*	–0.064 *–1.95*
eu funding	0.122* *–3.32*	0.105* *–2.8*	0.248* *–6.84*	0.080* *–2.00*	–0.007 *–0.21*
eu framework funding	–0.033 *–0.63*	0.220* *4.11*	–0.172* *–3.3*	–0.008 *–0.14*	0.177* *3.38*
largest market: national (local as base level)	–0.150* *–4.68*	0.461* *13.78*	0.062 *1.94*	0.212* *5.71*	0.251* *7.77*
largest market: other european union or associated countries (local as base level)	0.301* *10.02*	0.379* *11.94*	0.173* *5.74*	0.345* *9.84*	0.214* *7.00*
largest market: all other countries (local as base level)	0.489* *12.81*	0.031 *0.77*	0.455* *11.97*	0.376* *8.75*	0.206* *5.41*
size 500 (size 0 as base level)	–0.122* *–2.82*	0.181* *3.96*	0.106* *2.47*	0.329* *6.81*	0.259* *5.93*
size 250 (size 0 as base level)	0.142* *4.15*	0.116* *3.22*	0.348* *10.2*	0.403* *10.72*	0.397* *11.62*
size 50 (size 0 as base level)	0.109* *4.7*	–0.047 *–1.9*	0.154* *6.66*	0.102* *3.76*	0.152* *6.48*
constant	–1.032* *–6.39*	–1.637* *–9.35*	–0.931* *–5.77*	–1.078* *–5.67*	–1.410* *–8.54*
log-likelihood	–11819.566	–10316.991	–11788.208	–8498.5018	–11425.198
number of observations	19,214	19,214	19,214	19,214	19,214

Note: Coefficients significant at 5% level are marked with an *.
Source: Authors' own calculations.

In the next step we deepen the analysis by investigating which type of cooperation partner contributes to the probability of innovation in the highest extent. We account for the following categories of cooperation partners: other enterprises within enterprise group, suppliers of equipment, clients or customers from the private sector, clients or customers from the public sector, competitors or other firms, consultants and, commercial labs, private R&D institute, universities or other higher education institutions, government or, public or private research institutes. As a base level we choose enterprises that do not have a cooperation partner. Such approach allows to compare the effects of cooperation with external and group partners with regards to the probability of innovation occurrence. Table 5 presents the obtained probit model results.

The above specification presents the influence of the choice of the main cooperation partner on the probability of innovation activities. The effect of the type of cooperation partners varies with the innovation type. The summary of the obtained results is presented in Table 6.

Table 6

Summary of the Results Concerning the Influence of the Type of Cooperation Partner on the Probability of Innovation Occurrence

Type of innovation activity	**Cooperation partner increasing the probability of innovation occurrence in the highest degree**
Introduction onto the market a new or significantly improved good	Clients or customers from the private sector
Introduction onto the market a new or significantly improved service	Clients or customers from the public sector
Introduction onto the market a new or significantly improved method of production	Suppliers
Introduction onto the market a new or significantly improved logistic, delivery or distribution system	Other enterprises
Introduction onto the market a new or significantly improved supporting activities	Suppliers

Source: Authors' own calculations.

For the innovation concerning introduction onto the market a new or significantly improved good and introduction onto the market a new or significantly improved service, the partner who in the greatest extent increases the probability of the innovation, is client either from public or private sector. It corresponds to the literature investigating the impact of cooperation with customers on product innovation (Kang and Kang, 2010). In our study it also appears that in the context of introducing innovative methods of production, collaboration with clients is less relevant comparing to cooperation with suppliers, what is in line with other analyzes (Tu, Hwang and Wong, 2014). Suppliers are also partners increasing the probability of introduction onto the market innovative supporting activities, while other enterprises influence mostly the probability of method of production

innovations (Soosay, Hyland and Ferrer, 2008). However, the relevance of co-operation with universities or governments is not as strong as expected, when compared with other partners (Freitas, Marques and de Paula e Silva, 2013). The same applies to cooperation with competitors (Un, Cuervo-Cazurra and Asakawa, 2010).

Conclusions

The goal of the presented study was to verify the character and impact of having partners in creating innovations. Our results indicate the positive effect of cooperation on all considered kinds of innovation activities. The effect is the strongest for the innovation consisting of the introduction to the market a new or significantly improved method of production and the weakest for the introduction of a new or significantly improved distribution system. Therefore, in case of all types of innovations the existence of cooperation partner increases the probability of the occurrence of innovation, but the effects on particular types of innovation activities differ. What is more, the results of the empirical model enabled to formulate more general conclusions regarding the effect of different types of funding, the size of the enterprise and its largest market on the probability of innovation occurrence.

We hope that the proposed research perspective tying theoretical and empirical economic literature with current studies on market cooperation is a value added. It also serves as a contribution to the international literature, as it is based on a novel and versatile CIS database covering a broad range of innovations. Importantly, it confronts and generally confirms the previous literature, based on different methodology and geographical scope, by providing implications regarding the importance of various collaboration partners for different types of innovation, like clients (Kang and Kang, 2010), suppliers (Tu, Hwang and Wong, 2014) or other enterprises (Soosay, Hyland and Ferrer, 2008). The study brings relevant policy implications. First, it appears that there is no one policy regarding collaboration that fits all types of innovation. Eventual policies and public programs have to address specific characteristics of particular industries and desired innovations. Another point is that policies stimulating collaboration for innovation have to co-exist with other ones, like those providing subsidies and grants. At the same time, the authors are aware of the limitations of the study, i.e. potential measurement errors stemming mostly from measures of innovation activity in the available innovation surveys (Lööf, Mairesse and Mohnen, 2016). Further empirical studies may bring more data-based conclusions for public policies, as well as decisions of individual entities.

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