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R&D Cooperations and Innovation Success

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Abstract

Generally, establishments can choose among different cooperation partners for innovation. However, the choice of a particular partner is pivotal to the success of any cooperative arrangement for innovation and therefore not an easy one. The ensuing analysis uses a comprehensive firm-level dataset of Central, East and Southeast European (CESEE) and Former Soviet Union (FSU) countries to shed light on the role of different cooperative arrangements – cooperations with domestic suppliers, domestic client firms, foreign suppliers, foreign client firms and with external academic or research institutes – for a product innovators' success, captured in terms of either annual average sales per new or significantly improved product or, alternatively, the probability of applying for a patent. It demonstrates that the choice of cooperation partner is essential: Innovators profit greatly from innovation partnerships with foreign suppliers only in terms of higher sales from novel or improved products but, in turn, are less likely to apply for patents if engaged in cooperative arrangements with foreign suppliers or client firms, indicating that patenting is probably predominantly undertaken by foreign cooperation partners. Furthermore, it highlights that establishment size, ownership structure, trading status or absorptive capacity greatly matter and that the institutional environment is essential for an innovator's commercial success, which assigns a decisive role to policy-makers in building an environment that helps innovators extract returns to innovations to the fullest extent possible.

Keywords: product innovators, types of R&D cooperations, innovation success, Central, East and Southeast Europe

JEL classification: O30, O32, O34, F61

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1. Introduction

In the course of the last couple of decades, cooperative activities of firms on R&D and innovation have increased substantially, arousing interest of economists and policy-makers alike, particularly with respect to the highly desirable positive effects such cooperative activities entail in terms of knowledge spillovers, access to complementary knowledge or cost- and risk-sharing. For instance, as is well documented by Hagedoorn (2002), joint R&D activities of firms have soared, particularly since the late 1970s, but even more so once the temporary slump at the beginning of the 1990s was overcome. Furthermore, establishments from the Triad – comprising Europe, Asia and North America – have come to dominate inter-firm R&D partnerships, with North American establishments clearly dominating the global R&D partnering landscape. Since the 1980s, high-technology industries have become the key R&D partnering industries, almost entirely driven by the growing importance and dominance of the information technology (IT) industry and the pharmaceutical industry.

This proliferation of joint R&D and innovation activities is seen as the result of two major structural changes of the recent past. First, swifter globalisation over the last couple of decades not only intensified competitive pressures among establishments but also paved the way for more and more intense cross-national strategic alliances. Second, with the quickly growing product and technology complexity, both costs and risks have increased substantially for innovators, making it increasingly harder for them to only rely on their own limited resources and capabilities to develop new products and processes.

Different motives have been highlighted in the literature as to why establishments enter into cooperative arrangements for innovation, despite the associated costs in terms of leakage of sensitive information, loss of control or ownership or conflict in aims and objectives. In general, such cooperations are found to be helpful to either compensate for the prevailing deficiencies in internal resources and competencies, to reduce and share the risks and/or costs associated with innovations, but also to get better access to markets or realise economies of scale and scope in R&D activities.

Furthermore, establishments can choose among different potential partners but have specific reasons and motivations to choose a particular cooperation partner for their joint innovation projects. For instance, von Hippel (1976, 1978, 1988) highlights that, as recipients of novel products and services, *customers or users* are important cooperation partners, particularly if the focus is on product development and product innovation. As emphasised by Shaw (1994), such arrangements are advantageous since customers can provide complementary knowledge and technical know-how, provide a better understanding of user behaviour that is vital for product development, refinement and, ultimately, acceptance or help entrepreneurs find a good and acceptable price-performance balance, to name but a few. Hence, such cooperative arrangements are more likely if the product under development is more novel and complex.

Similar to customers or users, *suppliers* can be vital cooperation partners for innovation. In particular, establishments seek to enter cooperative arrangements with suppliers to improve input quality and cut production costs through successful process innovations (Hagedoorn, 1993).

Alternatively, despite the imminent threat of leakage of sensitive information, innovators can opt to enter cooperative arrangements with *competitors*, particularly if both face a common problem that can be tackled or solved jointly by pooling resources, if they identify complementary strengths and competencies that can be exploited successfully, or if they intend to learn more about their rivals' core competencies and capabilities. Likewise, as highlighted by Tether (2002), due to their stronger industry-orientation, *universities or (public and private) research institutes* have become key partners for cooperation for innovation, particularly if the focus of the cooperation is more on basic research, more long-term oriented and excessively expensive and therefore difficult to pursue alone. Such cooperative arrangements are considered especially useful and successful for the development of novel technological fields and complex technologies, technological know-how and market novelties. Finally, quickly progressing globalisation and internationalisation has facilitated access to foreign systems of innovation, enabling innovators to look and go beyond the confinements of local/national innovation systems and to get access to and profit from knowledge and competencies of *foreign cooperation partners* and foreign comparative technological advantages. These types of cooperative arrangements have spread widely, despite the associated disadvantages in terms of lack of control in such long-distance collaborations or lack of trust between establishments from different countries (Hagedoorn, 2002), and are of particular importance if innovators are unable to find the necessary competencies, knowledge and know-how domestically. By and large, above motivations for the particular choice of cooperation partner have been confirmed by a large body of empirical literature (see, e.g., Tether, 2002; Veugelers and Cassiman, 2003; Belderbos et al., 2004a, 2004b; Badillo and Moreno, 2012, among others).

In general, results shows that most product innovators do not cooperate to develop new products but for those that do, cooperations with foreign partners are of greater importance than cooperations with domestic partners while lateral cooperation (with external academic or research institutes) is of minor or no importance at all. Moreover, patenting of new products or services is hardly used in the region. Additionally, the econometric analysis demonstrates that the choice of cooperation partner is pivotal to an innovator's success: product innovators in the region can generate significantly higher returns from their innovative activities if they cooperate with foreign suppliers. Similarly, product innovators that engage in cooperations with external academic or research institutions are significantly more likely to apply for a patent while those that engage in cooperations with either foreign suppliers or foreign client firms are significantly less likely to apply for a patent. It also highlights that particular establishment characteristics such as size, ownership structure, trading status or absorptive capacity greatly matter and that the institutional setting is vital for a product innovator's innovation success, which suggests that policy-makers play a particularly strong and decisive role in building an environment that helps innovators extract returns to innovations to the fullest extent possible.

The remainder of the paper is organised as follows: section 2 provides an overview of the still scarce empirical literature and highlights that the choice of cooperation partner is pivotal to an innovator's innovation success. Section 3 discusses data sources and provides some descriptive evidence on the relative importance of different cooperation strategies in the region as well as on average innovation success, proxied by average sales from new products, on the one hand, and by the prevalence of patenting, on the other. The methodological approach and model specification are discussed in section 4 while results are presented and discussed in section 5. Finally, section 6 summarises and concludes.

2. Related literature

While there is a wealth of empirical literature and evidence on the input-related effects of cooperative R&D activities, there is still a dearth of empirical evidence on the success or the effects of such cooperative activities on the performance of firms engaged in R&D cooperation projects.

In general, the still scant empirical evidence seems to suggest that the choice of partner is pivotal to innovation success. However, observable results strongly depend on the type of innovation considered and the particular proxy used for innovation success. For instance, results highlight that, given their superior science research capabilities, joint R&D efforts with *public institutions, universities or research institutes* are beneficial for the development of novel products. In this respect, Belderbos et al. (2004) in their study on Dutch enterprises or Aschhoff and Schmidt (2006) for a sample of German enterprises highlight that research institutes are important partners if firms intend to develop products that are new to the market. Furthermore, the beneficial effects of R&D cooperations with public institutions, universities or research institutes also emerge for other proxies of innovation success. For instance, Miotti and Sachwald (2003) emphasise that the cooperation of French enterprises with public institutions helped spur patenting. Similarly, Lööf and Broström (2004) address university-industry linkages and study the impact of firms' collaboration with universities on innovation sales and the patent application probability in Sweden. They demonstrate that university collaborations were beneficial for larger manufacturing firms with 100 or more employees while no significant effect was found for service firms. In contrast, Janz et al. (2004) in their comparative study on German and Swedish manufacturing and service firms find no significant effect of R&D cooperation with either universities or other higher education institutes on innovation sales.

Results are less clear-cut for the effects of R&D cooperations with *customers or suppliers* though and strongly depend on the particular proxy used to measure innovation success. For instance, there is some evidence of a positive effect of R&D cooperations with customers or suppliers on the share of innovative products in turnover (see, e.g., Miotti and Sachwald, 2003). In contrast, empirical analyses fail to find any significant effects for R&D cooperations with suppliers and customers on innovation sales (see, e.g., Janz et al., 2004) or on the reduction of costs due to new or significantly improved processes or on the share of sales with significantly improved products, the share of sales from significantly improved products or products new to the firm as well as new to the market (see, e.g., Aschhoff and Schmidt, 2006). In contrast, Knudsen (2007) finds that customer relationships have a negative impact on innovative success since customers may not be able to articulate needs and conceptualise ideas which renders the generation of new and useful ideas a difficult endeavor and makes customers unlikely partners for the development of more radical innovations. In contrast, Kruitbosch (2010), for a sample of Flemish enterprises, draws a more refined picture and shows that the degree of novelty of the new product matters for the outcome: while customer collaboration has a positive significant impact on the share of sales from new-to-the-firm product innovations, no significant effect emerges for new-to the-market product innovations. Hence, these findings suggest that customers are vital sources of information, ideas and inspiration for the development of new-to-the-firm products, but, due to their own limited experience, are less important for the development of new-to-the-market products.

Similarly, effects of joint R&D efforts with *rivals* are equally mixed: some studies highlight that R&D cooperations with competitors help reduce costs but have no significant effect on the share of total sales from market novelties (see, e.g., Aschhoff and Schmidt, 2006) or on either patenting or the share of innovative products in turnover (Miotti and Sachwald, 2003). In contrast, others do point to significant effects. The direction of the effect, however, differs by the proxy used for innovation success. In this respect, a positive significant effect of R&D cooperation with rivals on sales of products that are new to the market is highlighted by Belderbos et al. (2004) while a negative effect on innovation sales per employee emerges in Janz et al. (2004), which is, however, only significant for Germany but insignificant for Sweden.

3. Data

The ensuing analysis uses Enterprise Survey data for a large set of Central, East and Southeast European (CESEE) and Former Soviet Union (FSU) countries, comprising Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, FYR Macedonia, Georgia, Hungary, Kosovo, Latvia, Lithuania, Moldova, Montenegro, Poland, Romania, Serbia, Slovenia, the Slovak Republic and Ukraine. The data was collected as part of the Eastern European component of the Business Environment and Enterprise Performance Survey (BEEPS), which is a joint initiative of the World Bank Group (WB) and the European Bank for Reconstruction and Development (EBRD). In particular, the analysis uses the 2013-wave of the BEEPs in the course of which both an Enterprise as well as an Innovation Module were conducted.

The Enterprise Survey is based on interviews with firms in the manufacturing and services sectors, intended to provide an understanding of firms' perception of the environment in which they operate. It collects information on the quality of individual firms' business environment, how it is perceived by them and how it changes over time, identifying various constraints or obstacles to firm performance and growth and capturing the effects a country's business environment has on a firm's international competitiveness. The standardised sampling strategy and survey instruments used in collecting the data guarantee that survey data from different countries are comparable. In particular, to obtain representative final samples and unbiased estimates for the whole population, each country-sample is selected using random sampling, stratified by establishment size (according to the following size classes: small with 5 to 19 employees, medium with 20 to 99 employees, and large with more than 99 employees), region (of main economic activity) and business sector (based on the ISIC classification, revision 3.1, covering all manufacturing sectors (group D), construction (group F), services (groups G and H), transport, storage and communications (group I) and IT (from group K)). The primary sampling unit of each survey is the establishment with five or more full-time employees, located in major urban centres, which is engaged in non-agricultural activities.

The Innovation Module is a follow-up to the Enterprise Survey, which intends to validate questions, which measure firm-level innovation and to measure the nature and determinants of innovation. It gathers information on four types of innovation, namely: product, process, organisational and marketing innovations. This data set is particularly suited for this type of analysis as it provides a direct link between the introduction of a new or significantly improved product, on the one hand, and the mode of its development (i.e. different cooperative strategies), on the other. It therefore avoids complications of previous studies, which explicitly had to account for time-lags between the start of any cooperations and their success, which proves particularly problematic in a purely cross-sectional setting.

The total sample consists of 7,950 establishments. However, due to missing data, a total of 6,418 establishments from 22 countries in Central, East and Southeast Europe (CESEE) and the Former Soviet Union are in the sample, of which 2,204 establishments are product innovators that are subject to the ensuing analysis.

In what follows, some descriptive results of the major variables of interest will be discussed, such as the prevalence of product innovators, the average number of new or significantly improved products an innovator is able to develop, the annual average sales of new products or the probability of patenting as two indicators of innovation success as well as the prevalence and importance of different modes of cooperation. That way, general patterns of key variables and their major differences across countries become obvious.

Given the analysis' focus on product innovators and their innovation success, Table 1 below reports the prevalence of product innovators for each country in the sample separately (column 2). Generally, product innovators are identified by the following question: '*During the last three years, has this establishment introduced new or significantly improved products or services?*'. An establishment is considered a product innovator if the response was yes, and zero otherwise. Table 1 highlights that product innovators are a minority in each country considered. The only notable exception is Kosovo, were 57 per cent of all establishments introduced new or significantly improved products or services during the last three years. The share of product innovators is also high in the Czech Republic with almost 50 per cent, or Bosnia and Herzegovina, Romania and Croatia with around 40 per cent. In contrast, product innovators are particularly rare in Albania and Georgia, where less than 10 per cent of all establishments in the sample introduced new or significantly improved products or services during the previous three years.

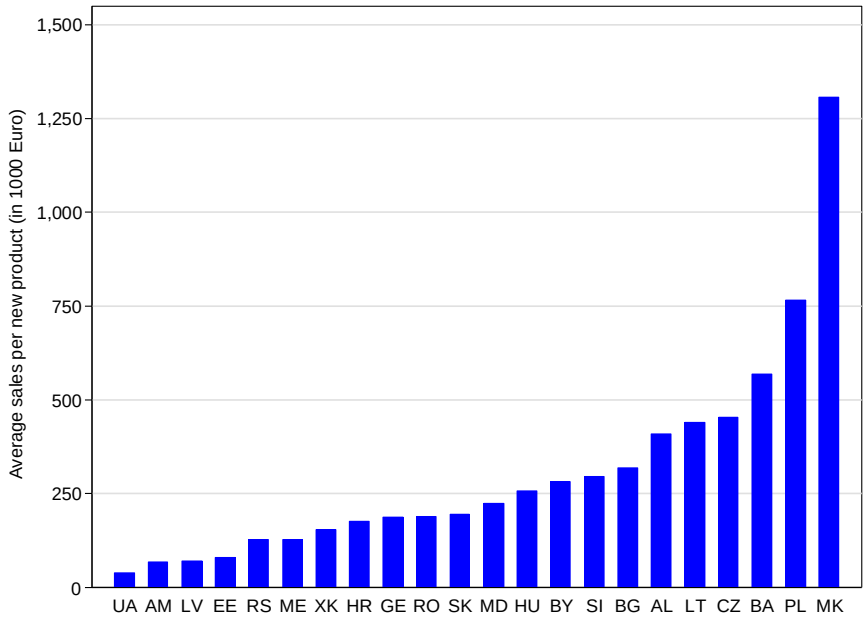
Table 1 / Prevalence of product innovators and their average number of new or significantly improved products

REP	Country	Non-innovators (%)	Innovators (%)	Average number of new products per establishment over 3 years
		(1)	(2)	(3)
AL	Albania	91.6	8.4	14.6
AM	Armenia	87.9	12.1	10.2
BA	Bosnia & Herzegovina	56.1	43.9	5.3
BG	Bulgaria	73.0	27.0	6.7
BY	Belarus	68.5	31.5	5.5
CZ	Czech Republic	50.6	49.4	7.6
EE	Estonia	76.3	23.7	5.1
GE	Georgia	91.4	8.6	3.3
HR	Croatia	60.3	39.7	6.9
HU	Hungary	77.2	22.8	7.6
LT	Lithuania	73.8	26.2	4.0
LV	Latvia	81.4	18.6	5.9
MD	Moldova	72.3	27.7	5.6
ME	Montenegro	85.7	14.3	4.4
MK	Macedonia	73.0	27.0	5.7
PL	Poland	65.4	34.6	4.2
RO	Romania	59.1	40.9	5.8
RS	Serbia	60.5	39.5	5.4
SI	Slovenia	66.0	34.0	7.5
SK	Slovak Republic	80.1	19.9	3.8
UA	Ukraine	89.1	10.9	4.7
XK	Kosovo	42.9	57.1	12.9

Source: BEEPS, own calculations.

However, establishments differ little in terms of the average number of new or significantly improved products they were able to introduce over the previous three years. The third column of Table 1 stresses that in the majority of countries considered product innovators in the region introduced an average of 5 to 6 new or significantly products in the market over the previous three years. It also points to notable exceptions, though: with on average 10 to 15 new products, the number of new or significantly improved products per establishment was particularly high in Albania, Kosovo and Armenia or with around three new or significantly improved products per establishment only, it was relatively low in Georgia.

Figure 1 / Annual average sales per new or significantly improved product (in 1000 euro), by country



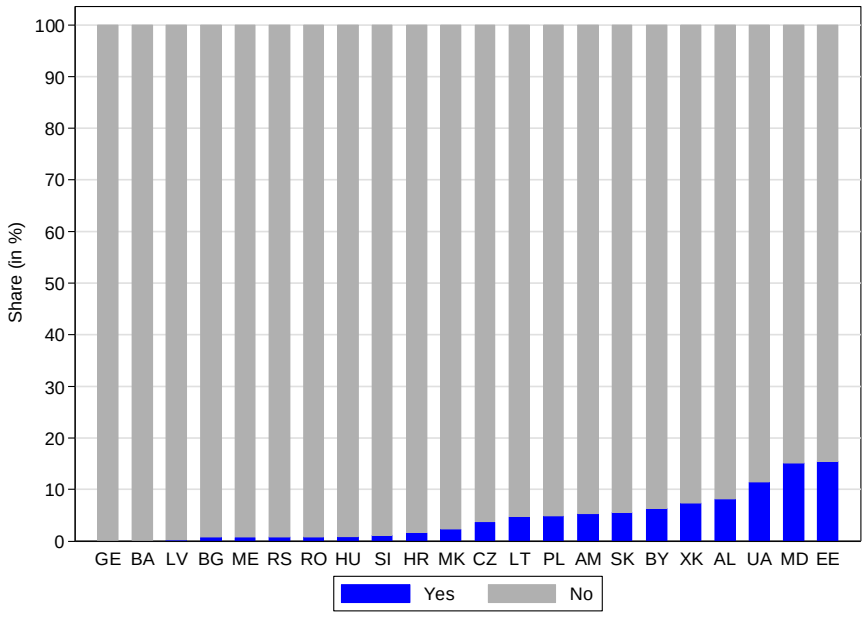
Source: BEEPS, own calculations
Note: at current exchange rates.

The ensuing analysis seeks to shed light on how different modes of cooperation affect establishments' innovation success, captured either in terms of (1) annual average sales of new products or (2) patenting activities. Hence, both variables of interest are depicted in Figure 1 and Figure 2 below. In particular, annual average sales per new or significantly improved product (in 1000 euro) are depicted in Figure 1 where average sales were derived from the following question: '*In fiscal year XXXX, what percentage of this establishment's total annual sales was accounted for by products that were introduced or significantly improved over the last three years?*' Subsequently, the shares were then multiplied with total annual sales for all products and services in the same fiscal year, divided by the establishment's total number of new products and services and, for the sake of comparability, converted to euro by means of average exchange rates (taken from Eurostat). In general, Figure 1 points to rather strong heterogeneity across countries in the region and emphasises that annual average sales per new product were particularly high in Macedonia, followed by Poland and Bosnia and Herzegovina. Moreover, it shows that in a large group of countries, annual sales from product innovations were below 250,000 euro on average but particularly low in Ukraine with only 39,000 euro on average, followed by

Armenia with 67,600 euro on average, Latvia with 71,100 euro on average and Estonia with 80,100 euro on average.

Additionally, to capture the prevalence and importance of patenting activities among product innovators, Figure 2 depicts the share of product innovators that applied for a patent. Patenting activities were identified by means of the following question: '*During the last three years, did this establishment apply for a patent or a trademark?*'. Establishment were then considered to patent if the response was either (1) yes, for a patent only or (2) yes, for both a patent and a trademark. As has been highlighted repeatedly in the literature, patents are an imperfect measure of an establishment's innovation output and success due to the apparent industry bias – termed the 'propensity to patent' by Scherer (1983) – and the reluctance of innovators to actually resort to patents to protect one's intellectual property. For instance, Arundel (2001) analyses the 1993 EU innovation survey for Norway, Germany, Luxembourg, the Netherlands, Belgium, Denmark, and Ireland and emphasises that patents are not the most important means of innovative manufacturing firms of securing returns to innovation: only around 11 per cent of product innovators or 7 per cent of process innovators rate patents with the highest score (i.e. crucial). In fact, the majority of all firms rated lead-time-advantage, followed by secrecy as most relevant. This reluctance to patent is also corroborated in Figure 2, which highlights that in order to protect intellectual property and innovations, patenting of new products or services is hardly used in the countries under consideration. With between 10 and 15 per cent only, the share of product innovators that applied for patents was highest in Estonia, Moldova and Ukraine. In contrast, with less than 1 per cent of all product innovators applying for patents, Bosnia and Herzegovina, Latvia, Bulgaria, Montenegro, Serbia, Romania and Hungary were the bottom of the league.

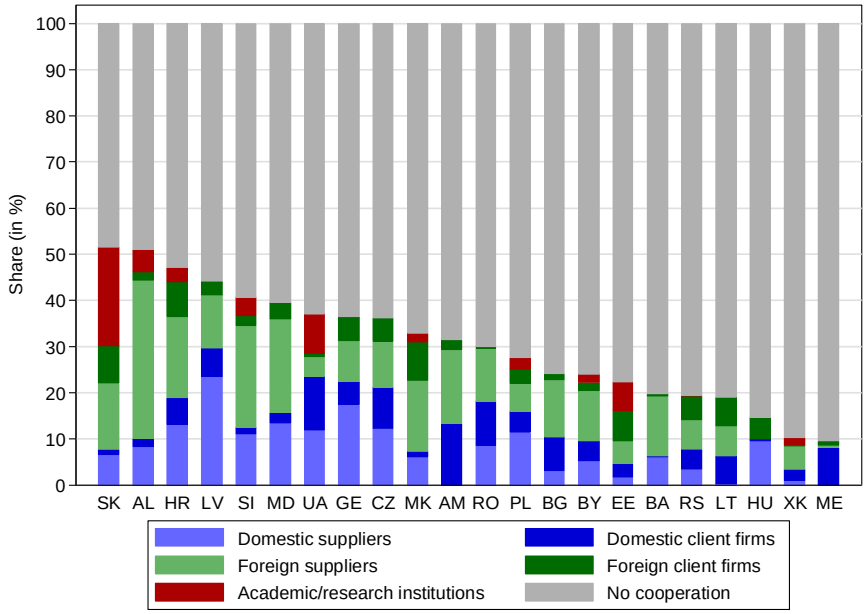
Figure 2 / Share of product innovators that applied for a patent (in %)



Source: BEEPS, own calculations

Collaboration on product innovations was measured by means of the following question: '*Which of the following best describes the way in which the main new or significantly improved product was introduced*?'. Nine different responses were possible, comprising (1) developed or adapted by this establishment, from its own ideas, (2) licensed products or services from another firm, (3) developed in cooperation with domestic suppliers, (4) developed in cooperation with suppliers abroad, (5) developed in cooperation with domestic clients firms, (6) developed in cooperation with client firms abroad, (7) developed in cooperation with external academic or research institutions, (8) introduced the establishment's own version of a product or service already supplied (by another firm), and (9) other. The analysis will use the following five different types of cooperation: cooperations with (i) domestic suppliers, (ii) domestic client firms, (iii) foreign suppliers, (iv) foreign client firms or (v) cooperations with external academic or research institutions (referred to as lateral cooperations).

Figure 3 / Prevalence of different cooperation strategies, by country



Source: BEEPS, own calculations

The prevalence of the five different cooperation strategies among product innovators is depicted in Figure 3 below for each country separately. It points to a number of interesting findings. First, it highlights that, in general, the majority of product innovators does not cooperate to develop new or significantly improved products. The only two exceptions are Slovakia and Albania, where 52 and 51 per cent of all product innovators, respectively, cooperated to develop new or significantly improved products. Cooperation is also important for product innovators in Croatia, Latvia, Moldova or Slovenia. In contrast, cooperation is least prevalent among product innovators in Montenegro or Kosovo where less than 10 per cent cooperated to develop a new or significantly new product. Second, Figure 3 demonstrates that the importance of the five different cooperation strategies differs across countries analysed. Particularly, it shows that except for Slovakia, where 21 per cent of all product innovators engaged in cooperations with external academic or research institutions, and Ukraine, where around 9 per cent of all product innovators cooperated with external academic or research institutions, lateral

cooperation is of minor or no importance at all. Third, it highlights that cooperations with foreign partners (i.e. suppliers or client firms) is of greater importance than cooperations with domestic partners (i.e. suppliers or client firms) in the majority of countries. Particularly, foreign cooperations are of prime importance in Albania, where 36 per cent of all product innovators developed new products in cooperation with foreign suppliers and client firms. This is followed by Croatia, Slovenia, Moldova, Macedonia and Slovakia, where between 20 and 25 per cent of all product innovators engaged in cooperations with foreign partners. In contrast, Montenegro, Hungary and Ukraine were the bottom of the league since less than 5 per cent of all product innovators only cooperated with foreign suppliers and client firms to develop new products. Finally, it shows that in almost all countries analysed, cooperations with (domestic or foreign) suppliers dominate. Exceptions are Armenia, Bulgaria, Estonia, Latvia, Montenegro, Romania, Serbia and Ukraine, where domestic client firms dominate cooperations with domestic partners.

Moreover, to control for different country characteristics and to shed light on the role of particular institutions for innovation success, this core firm-level data-set was complemented by other data sources such as the World Bank World Development Indicators (WDI), the Worldwide Governance Indicators (WGI) which report aggregate and individual governance indicators for 215 economies over the period 1996-2013 and for six dimensions of governance, the property rights index from the Heritage Foundation which captures the degree to which a country's laws protect private property rights, and the intellectual property rights index 2014 which evaluates the protection of intellectual property in a total of 97 countries from around the world.

4. Methodological approach

To shed light on the role played by the particular choice of cooperation partner for a product innovator's innovation success, the following model is specified:

$$Success_{ij}^{k} = \alpha_0 + \beta_1 DomSupp_{ij} + \beta_2 DomClient_{ij} + \beta_3 ForSupp_{ij} + \beta_4 ForClient_{ij} + \cdots$$
$$\ldots + \beta_5 LatCoop_{ij} + \beta_6 FC_{ij} + \beta_7 ID_i + \beta_8 C_j + \varepsilon_{ij} \quad (1)$$

where $Success_{ij}^{k}$ refers to either of two different measures of innovation success, namely (1) average sales of new products (logged) as a measure of returns to newly introduced product innovations which also incorporates the demand side of product markets and therefore captures the ultimate test of innovation and commercial success for the firm and (2) the probability of applying for a patent which tends to be more important the higher the costs of development, the higher the degree of technological novelty of the innovation and the higher the ease with which an innovation can be imitated. i refers to the firm and j to the country.

The major variables of interest are $DomSupp_{ij}$, $DomClient_{ij}$, $ForSupp_{ij}$, $ForClient_{ij}$ and $LatCoop_{ij}$ which capture the five different modes of cooperation used by a product innovator to develop its major new product or service. These are dummy variables equal to one if a product innovator engaged in cooperation with domestic suppliers, domestic client firms, foreign supplies or foreign client firms or cooperations with external academic or research institutions to develop its major product novelty, respectively, and zero otherwise.

Moreover, a set of firm characteristics are included in the term FC_{ij}, such as:

Size: Several empirical studies have demonstrated that firm size – as a proxy for R&D efforts and absorptive capacity – and the propensity to cooperate are positively related (see, e.g., Fritsch and Lukas, 2001; Veugelers, 1997 or Belderbos et al., 2004a). A similar positive size-effect can be expected for innovation success since larger firms tend to have stronger market presence, a larger base of loyal customers and higher market power, which enables them to generate higher sales from their innovative efforts. Empirically, the role of establishment size for innovation performance and success is mixed, however. While a significant positive effect on an establishment's propensity to patent or on its share of innovative products in turnover is found by Miotti and Sachwald (2003) or on sales from new-to-the-firm product innovations is detected by Aschhoff and Schmidt (2006), Kruitbosch (2010) is unable to find any significant size effect on the proportion of turnover attributed to new-to-the-firm and new-to-the-market product innovations among firms in Flandern. In contrast, in their comparative study on the relationship between innovation and productivity, Janz et al. (2003) find a negative size effect for innovation sales per employee for German firms but no significant effect for Swedish ones. For the analysis, establishment size is captured in terms of size dummies based on the number of employees. In this respect, the dummy $medium$ refers to medium-sized establishments with between 20 and 99 employees, the dummy $large$ refers to large establishments with over 99 employees while $small$ is the reference group with less than 20 employees.

Age: Generally, the success of product innovations can differ by firm age since, for instance, younger firms may have just developed their first products, whose sales from new products account for all or almost all of their annual sales. Some evidence of this negative age effect is provided, for instance, by Aschhoff and Schmidt (2006), who show that younger firms have significantly higher sales from new-to-the-firm product innovations. For the analysis, age is defined as the log of age, which in turn is the difference between the fiscal year and the year in which the establishment began its operations.

Absorptive capacity: Generally, absorptive capacity – the ability of a firm to recognise the value of new external information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990) – is considered an essential prerequisite for innovation success of firms, particularly in times when innovation processes need to be opened up to also benefit from rich external knowledge sources. The innovation performance enhancing effects of absorptive capacity have been demonstrated empirically also by, for instance, Aschhoff and Schmidt (2006) who find that establishments with a higher share of highly qualified employees also have a significantly higher share of sales of new-to-the-market product innovations. Furthermore, their analysis points to the strong role played by the degree of novelty of new products since they fail to find any significant effect on the share of sales of new-to-the-firm product innovations. The ensuing analysis uses two alternative proxies for an establishments' absorptive capacity: either i) share of employees with a university degree in the total labour force or ii) a dummy for training programmes which is equal to one if an establishment offers internal formal training programmes to its employees, and zero otherwise.

Marketing: Innovation success, particularly if captured in terms of sales from innovative products, also greatly depends on the particular marketing strategies used for advertising and product placement on the one hand and the additional resources establishment use for marketing on the other, both aimed at maximising the commercial benefits from the introduction of new products. Hence, successful marketing is expected to increase the returns from the introduction of new or significantly improved products. To capture an establishment's marketing efforts, a dummy variable is included which is equal to one if the establishment introduced any new or significantly improved marketing method in the last three years, and zero otherwise.

Ownership structure: An establishment's ownership structure can also be decisive for its innovation success. For instance, innovators can profit greatly from easier access to superior (financial and technological) resources, capabilities and information of foreign owners, which, in turn, helps them to develop more successful novel products. The state as co-owner can offer similar advantages in terms of easier access to (more substantial) funds or information that can be exploited technologically and commercially. Hence, in the analysis, an establishment's ownership structure is captured by the following two indicators: (i) the share of the establishment owned by private foreign individuals, companies or organisations (in %) as well as (ii) the share of the establishment owned by the government or state (in %).

Trading status: Whether an establishment trades internationally or caters to and sources from domestic markets only is also decisive for its innovation success. Internationally trading firms have access to and can tap into foreign knowledge which they can exploit to develop new and internationally competitive products or processes. Furthermore, they can export to larger markets and profit form higher demand for their products. Finally, they can profit from imports of technology embodied in inputs and capital goods. To capture the role of trading status, the ensuing analysis uses three different dummy variables. A

dummy variable for $exporter\ only$ is included which is equal to one if an establishment reports direct exports only, and zero otherwise. Furthermore, a dummy variable for $importer\ only$ is included which is equal to one if an establishment reports direct imports of material inputs or supplies only, and zero otherwise, while a dummy for $exporter\ and\ importer$ is included which is equal to one if an establishment reports both, direct exports and imports, and zero otherwise.

Furthermore, in order to capture industry-specific effects, a set of industry dummies ID_i is included for manufacturing, construction, transport, wholesale and retail trade, real estate, hotel and restaurants and other services, with manufacturing as reference group.

Moreover, to test for the role of country characteristics in general and the institutional environment in particular for a firm's innovation success, a number of different country-level variables C_j are included:

Real GDP growth rate: In general, given better sales and profit prospects, establishments may choose to introduce their product novelties in times of high or increasing demand and growth. Hence, a positive relationship between innovation success and real GDG growth is expected. The variable refers to the annual real GDP growth rate, taken from the World Bank WDI.

Political stability: Reflects perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. It is taken from the Worldwide Governance Indicators[1] (WGI) and refers to the percentile rank among all countries and ranges from 0 (lowest) to 100 (highest) rank.

Regulatory quality: Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. It is taken from the Worldwide Governance Indicators (WGI) and refers to the percentile rank among all countries and ranges from 0 (lowest) to 100 (highest) rank.

Rule of law: Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The indicator is taken from the Worldwide Governance Indicators (WGI) and refers to the percentile rank among all countries and ranges from 0 (lowest) to 100 (highest) rank.

Control of corruption: Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests. The indicator is taken from the Worldwide Governance Indicators (WGI) and refers to the percentile rank among all countries and ranges from 0 (lowest) to 100 (highest) rank.

Property rights index: The indicator is an assessment of the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those

[1] Worldwide Governance Indicators (WGI) report aggregate and individual governance indicators for 215 economies over the period 1996–2013, for six dimensions of governance, namely (1) Voice and Accountability, (2) Political Stability and Absence of Violence, (3) Government Effectiveness, (4) Regulatory Quality, (5) Rule of Law, and (6) Control of Corruption.

laws. It also assesses the likelihood that private property will be expropriated and analyses the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts. The more certain the legal protection of property, the higher a country's score. It is taken from the Heritage Foundation but not available for Kosovo.

Intellectual property rights index: This index evaluates the protection of intellectual property (IP). In addition to an opinion-based measure of the protection of IP, it assesses protection of two major forms of intellectual property rights (patents and copyrights) from de jure and de facto perspectives. It is taken from the international property rights index 2014, which evaluates the protection of international property in a total of 97 countries from around the world. It is, however, not available for Kosovo and Belarus.

Finally, ε_{ij} refers to the error term.

The list of variables and their definitions are provided in Annex Table A.3 while Annex Table A.1 presents summary statistics (i.e. weight-adjusted means) of all firm-level variables used in the analysis for the sample as a whole as well as for each country individually. It shows that the number of product innovators differs across countries analysed (between 19 only in Montenegro and 219 in Romania). Furthermore, it highlights that, on average, around 62 per cent of all establishments in the sample are small, 28 per cent are medium-sized while only around 10 per cent are large. The size-distribution of product innovators differs, however, across countries. For instance, product innovators are predominantly of small size in Macedonia and Hungary while in Ukraine and Poland (with around 20 per cent) or in Belarus, Slovakia or Armenia (with around 15 per cent) a non-negligible share of product innovators is large. Moreover, the average product innovator in the sample is around 14 years old with non-negligible age-variation across countries. For instance, with around 18 years on average, product innovators are oldest in Slovenia and Poland while with only around 7 years on average, they are the youngest in Albania and Georgia. Interesting differences also emerge in terms of ownership structure. Around 11 per cent of the average product innovator in the sample is owned by private foreign individuals, companies or organisations while only around 1 per cent is in public hands. At the level of the individual country, the average product innovator is entirely in private domestic hands in Albania and Kosovo while only a very small share is in private foreign hands in Montenegro, Georgia or Ukraine. By contrast, with around 18 per cent, the share of foreign ownership is highest in the Czech Republic and Moldova. Given the design of the survey, the role of the state as owner is limited (or nil) in the majority of countries but highest in Belarus (with 11 per cent). Similar interesting differences are observable in terms of trading status of product innovators. The majority of product innovator in the region cater to domestic markets only (63 per cent) while only around 22 per cent are exporters only, another 10 per cent are importers only and the remaining 4 per cent are both exporters and importers. The share of non-trading product innovators is particularly high in Georgia (with 91 per cent), followed by Moldova (with 86 per cent) and Albania (with 85 per cent). In contrast, the share of trading product innovators is highest in Slovenia (with 65 per cent), followed by Serbia (with 56 per cent), the Czech Republic (with 55 per cent) and Slovakia (with 52 per cent). The dominance of exporting product innovators is also visible at the individual country level: except for Albania where product innovators are more likely to be importers only and Georgia where product innovators are more likely be both exporters and importers, the majority of product innovators export only. Finally, almost 50 per cent of all product innovators also introduced new or significantly improved marketing methods in the course of the previous three years. With over 70 per cent, the share of product innovators that also introduced marketing innovations is

highest in Belarus and Kosovo, followed by around 60 per cent in Moldova and Romania. By contrast, product innovators were least likely to also introduce marketing innovations in Montenegro and Latvia.

Methodologically, two different approaches are used, both explicitly accounting for the particular nature of the data: (1) a standard OLS approach for the analysis of (the log of) average sales per new product and (2) a probit model for the analysis of the propensity to patent. Furthermore, given that the two outcome variables of interest are only observable if establishments actually introduce new or significantly new products, the issue of a selection bias arises automatically. To explicitly account for the presence of a selection bias in the results, a Heckman two-stage estimation approach was used in both cases with the probability of being a product innovator determining the selection equation and either the log of sales per new product or the probability of patenting determining the outcome. However, since there was no evidence of the presence of a selection bias in any of the specifications tested and discussed, i.e. the likelihood ratio test of the independence of error terms was never rejected, results of simple but unbiased OLS and probit models will be presented and discussed only. Furthermore, White tests of heteroscedasticity were rejected for all specifications, hence, reported coefficient are efficient.

5. Results

Results of the analysis are presented in Table 2 and Table 3 below. While Table 2 reports results using the log of annual average sales per new or significantly improved product as measure of innovation success, Table 3 reports results using the probability of patenting as crude proxy for innovation success.

Generally, Table 2 and Table 3 both demonstrate that the choice of cooperation partner is pivotal to an innovator's innovation success. Particularly, Table 2 highlights that while all coefficients for all five different types of cooperation partners are positive (but for cooperations with domestic clients) – suggesting that cooperations are in general conducive to innovation success – only the coefficient for cooperations with foreign suppliers is significant also. Hence, results suggest that product innovators in the region considered can reap significantly higher returns from their innovative activities if they cooperate with foreign suppliers. More specifically, results highlight that product innovators engaging in cooperations with foreign suppliers have around 0.4 per cent higher annual sales per new product than those that do not. This finding points to the importance of foreign innovation partnerships for the commercial success of product innovators in the region and underscores the essential role of public policy support in facilitating international cooperations for innovation. In contrast, Table 3 draws a different picture of the role of different cooperation strategies for an establishment's probability to patent. Particularly, in line with findings by Miotti and Sachwald (2003) or Lööf and Broström (2004) for larger manufacturing firms, product innovators that engage in lateral cooperations (with external academic or research institutions) are also significantly more likely to apply for a patent (by 11 percentage points). In contrast, those that engage in foreign cooperations with foreign suppliers or client firms are significantly less likely to apply for a patent (by around 4 per centage points). These findings suggest that cooperations with research institutions which tend to be targeted at more basic research with lower commercialisation potential or value and therefore gobble up more extensive resources but generate more novel insights and knowledge pose stronger incentives for protection and patenting. In contrast, the significantly lower probability of product innovators engaged in foreign cooperations with either suppliers or clients to patent suggests that product novelties probably get patented abroad by the foreign partner.

In addition, particular establishment characteristics also greatly matter for an innovator's innovation success. For instance, in line with, e.g., Miotti and Sachwald (2003) or Aschhoff and Schmidt (2006), we find robust evidence of a positive size effect, irrespective of the measure used for innovation success. On the one hand, larger establishments profit more from their innovative activities and are able to reap higher returns from their product innovations than smaller ones. More specifically, results show that medium-sized establishments have around 1.1 per cent higher average annual sales from new/significantly improved products than micro-firms while large establishments have even around 2.2 per cent higher average annual sales from new products than micro-firms. On the other hand, larger establishments are also more likely to apply for patents: medium-sized establishments are around 3 percentage points and large establishments are around 4 percentage points more likely to apply for patents than micro-establishments.

Table 2 / Results for sales per new or significantly improved product

Dep.Var.: log annual sales per product	(1)	(2)	(3)	(4)	(5)	(6)
Cooperation with domestic suppliers	0.182	0.194	0.172	0.172	0.206	0.267
	(1.018)	(1.083)	(0.963)	(0.966)	(1.132)	(1.436)
Cooperation with domestic clients	-0.087	-0.080	-0.071	-0.070	-0.022	-0.050
	(-0.354)	(-0.327)	(-0.293)	(-0.286)	(-0.088)	(-0.194)
Cooperation with foreign suppliers	0.360**	0.351**	0.365**	0.375**	0.419**	0.414**
	(2.239)	(2.182)	(2.274)	(2.344)	(2.532)	(2.402)
Cooperation with foreign clients	0.231	0.209	0.202	0.191	0.269	0.263
	(0.945)	(0.857)	(0.828)	(0.786)	(1.086)	(1.043)
Lateral cooperation	0.118	0.143	0.132	0.105	0.071	0.259
	(0.301)	(0.365)	(0.339)	(0.270)	(0.177)	(0.600)
Medium-sized	1.078***	1.090***	1.104***	1.124***	1.079***	1.093***
	(9.312)	(9.394)	(9.538)	(9.726)	(8.954)	(8.780)
Large	2.197***	2.215***	2.244***	2.264***	2.260***	2.179***
	(13.531)	(13.590)	(13.798)	(13.946)	(13.428)	(12.476)
Log age	-0.074	-0.060	-0.078	-0.086	-0.082	-0.100
	(-1.069)	(-0.880)	(-1.132)	(-1.264)	(-1.128)	(-1.292)
Training (yes=1)	0.464***	0.455***	0.442***	0.431***	0.430***	0.418***
	(4.371)	(4.283)	(4.180)	(4.083)	(3.904)	(3.656)
Marketing (yes=1)	0.007	-0.019	0.001	-0.023	0.009	-0.022
	(0.067)	(-0.179)	(0.008)	(-0.217)	(0.082)	(-0.200)
Foreign share (%)	0.004**	0.004**	0.004**	0.004**	0.004**	0.004**
	(2.121)	(2.375)	(2.185)	(2.130)	(2.216)	(1.990)
State share (%)	0.006	0.009	0.009	0.009	0.009	0.026**
	(0.901)	(1.341)	(1.333)	(1.254)	(1.257)	(2.039)
Exporter only (yes=1)	0.471***	0.470***	0.430***	0.406***	0.454***	0.528***
	(3.598)	(3.583)	(3.279)	(3.092)	(3.336)	(3.737)
Importer only (yes=1)	0.105	0.078	0.069	0.064	0.100	0.145
	(0.483)	(0.355)	(0.317)	(0.295)	(0.439)	(0.601)
Exporter & importer (yes=1)	0.408**	0.391**	0.323*	0.287*	0.351**	0.456**
	(2.393)	(2.279)	(1.875)	(1.667)	(1.982)	(2.538)
Real GDP growth rate (%)	-0.033**	-0.030**	-0.028**	-0.012	-0.044***	-0.025*
	(-2.511)	(-2.241)	(-2.095)	(-0.888)	(-3.289)	(-1.727)
Political stability	0.009***					
	(3.822)					
Regulatory quality		0.009***				
		(3.447)				
Rule of law			0.013***			
			(4.666)			
Control of corruption				0.017***		
				(5.458)		
Property rights index					0.016***	
					(4.332)	
Intellectual property rights index						0.164***
						(3.514)
Industry dummies	yes	yes	yes	yes	yes	yes
Constant	8.994***	8.885***	8.821***	8.625***	8.878***	8.712***
	(37.592)	(33.835)	(35.693)	(33.680)	(34.478)	(26.991)
No of observations	1,440	1,440	1,440	1,440	1,357	1,280
Adjusted R^2	0.233	0.232	0.237	0.241	0.236	0.227
Rho	-0.3018	-0.0580	-0.0671	0.0278	0.0294	-0.2613
LR-test of independence of error terms	0.7985	0.8013	0.7961	0.9043	0.9020	0.8987
White test	0.7736	0.7062	0.7699	0.7748	0.6227	0.6125

Note: The property rights index is not available for Kosovo while the intellectual property rights index is not available for Belarus and Kosovo, hence the drop of observations in the last two columns.

Table 3 / Results for the probability of patenting

Dep.Var.: probability of patenting	(1)	(2)	(3)	(4)	(5)	(6)
Cooperation with domestic suppliers	0.013	0.014	0.015	0.015	0.022	-0.004
	(0.762)	(0.807)	(0.835)	(0.847)	(1.226)	(-0.231)
Cooperation with domestic clients	-0.014	-0.012	-0.013	-0.013	-0.008	-0.020
	(-0.596)	(-0.550)	(-0.574)	(-0.585)	(-0.340)	(-0.927)
Cooperation with foreign suppliers	-0.038***	-0.038***	-0.038***	-0.038***	-0.033**	-0.032**
	(-2.652)	(-2.712)	(-2.739)	(-2.802)	(-2.393)	(-2.090)
Cooperation with foreign clients	-0.039**	-0.038*	-0.038*	-0.037*	-0.035*	-0.038**
	(-1.993)	(-1.958)	(-1.950)	(-1.930)	(-1.890)	(-1.997)
Lateral cooperation	0.114**	0.110**	0.110**	0.111**	0.140***	0.104**
	(2.404)	(2.340)	(2.345)	(2.351)	(2.774)	(2.091)
Medium-sized	0.032***	0.030**	0.029**	0.026**	0.025**	0.031**
	(2.654)	(2.509)	(2.450)	(2.249)	(2.072)	(2.376)
Large	0.044***	0.041**	0.040**	0.036**	0.038**	0.043**
	(2.608)	(2.480)	(2.426)	(2.229)	(2.355)	(2.451)
Log age	0.004	0.004	0.005	0.006	0.004	0.007
	(0.547)	(0.646)	(0.737)	(0.895)	(0.567)	(0.997)
Foreign share (%)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.461)	(-0.372)	(-0.299)	(-0.132)	(-0.222)	(-0.320)
State share (%)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.660)	(0.312)	(0.308)	(0.249)	(0.612)	(0.899)
Exporter only (yes=1)	0.041***	0.044***	0.045***	0.049***	0.057***	0.036**
	(2.783)	(2.934)	(3.027)	(3.229)	(3.642)	(2.287)
Importer only (yes=1)	0.027	0.027	0.027	0.028	0.040	0.012
	(1.066)	(1.062)	(1.089)	(1.127)	(1.529)	(0.485)
Exporter & importer (yes=1)	0.115***	0.123***	0.127***	0.137***	0.117***	0.083***
	(5.045)	(5.248)	(5.348)	(5.616)	(5.101)	(3.878)
Real GDP growth rate (%)	0.008***	0.007***	0.007***	0.006***	0.007***	0.010***
	(7.845)	(7.551)	(7.542)	(6.258)	(7.968)	(4.323)
Political stability	-0.000					
	(-0.170)					
Regulatory quality		-0.000				
		(-1.619)				
Rule of law			-0.000**			
			(-1.994)			
Control of corruption				-0.001***		
				(-3.193)		
Property rights index					-0.000	
					(-0.211)	
Intellectual property rights index						0.003
						(0.794)
No of observations	1,811	1,811	1,811	1,811	1,679	1,403
Log likelihood	-382.3	-381.0	-380.3	-377.2	-339.5	-269.8
Rho	-0.1079	-0.1867	-0.2519	-0.3259	-0.1730	0.0860
LR-test of independence of error terms	0.7869	0.6557	0.5481	0.4356	0.6820	0.8880

Note: Above table reports marginal effects, evaluated at the mean; z-statistics are in parentheses, *** p<0.01, ** p<0.05, * p<0.1; The property rights index is not available for Kosovo while the intellectual property rights index is not available for Belarus and Kosovo, hence the drop of observations in the last two columns.

In line with, for instance, Aschhoff and Schmidt (2006), we find that an innovator's absorptive capacity matters greatly for the commercial success of novel products. In particular, product innovators that offer internal formal training programmes to their employees are able to profit more from their product innovations and to generate higher average annual sales from new or significantly improved products. In particular, our results highlight that establishments that offer training programmes have around 0.5 per

cent higher average annual sales from new products than those that do not offer any such training programmes.[2]

Similarly, an establishment's particular ownership structure is crucial for its innovation success, but this only holds if innovation success is measured in terms of average annual sales per new product. However, while no significant role is attributable to state ownership, foreign ownership matters greatly. This finding lends support to the hypothesis that easier access to superior foreign resources, knowledge and capabilities helps innovators in the region generate greater commercial success from novel products. More specifically, our results highlight that an increase in the foreign ownership share of 10 percentage points is associated with around 4 per cent higher average annual sales per new product.

Furthermore, there is robust evidence that innovation success is related to an establishment's particular trading status, irrespective of the indicator used to measure innovation success. Both, exporters only as well as exporters and importers are able to reap higher returns from their product innovations than establishments which cater to or source from domestic markets only. Moreover, product innovations of exporters only prove more successful and generate higher annual average sales than those of establishments that both export and import. Hence, our findings indicate that innovation success is significantly higher among establishments that enjoy access to larger markets and to international knowledge and technology that can be exploited to develop new and internationally competitive products. Interestingly, we do not find any indication that importers only are able to profit more from their product innovations than establishments that cater to and source from domestic markets only which points to the limited role of foreign knowledge or technology for a product innovator's innovation success – particularly if confined to domestic markets only. Furthermore, both, exporters only as well as exporters and importers are also more likely to apply for patents. However, innovators that both export and import are considerably more likely to apply for patents than innovators that export only. Again, no significant effect emerges for importers only, rendering them equally likely to patent than establishments which source from and cater to domestic markets only.

Our results also attribute a non-negligible role to macro-economic conditions or institutions for a product innovator's innovation success. In particular, our results emphasise that a country's real GDP growth rate and an innovator's ability to profit from product innovations are inversely related, suggesting that returns to product innovations are significantly higher in economies with lower real GDP growth. In contrast, product innovators are more likely to apply for patents in economies characterised by higher real GDP growth rates. In addition, different institutions are pivotal to a product innovator's success in reaping the fruits from its labour. The role of institutions differs, however, by the measure used for innovation success. In particular, all tested institutions turn out to be conducive to a product innovator's ability to fully profit from innovative efforts: political stability, higher regulatory quality, stronger rule of law, a stronger control of corruption but also stronger property rights protection and intellectual property rights protection all allow product innovators to cream off higher returns from their new or significantly improved products. In contrast, institutions hardly matter for a product innovator's likelihood to patent: the only significant – though negative – effects are observable for institutions like the rule of law or the control of corruption. This suggests that product innovators are less likely to patent if located in

[2] Alternatively, we also tested whether innovation success is affected by the share of employees with a university degree in the total labour force. However, no significant effects emerge. To conserve space, results are not reported here but are available from the author upon request.

economies with stronger rule of law or a stronger control of corruption where the need to protect ones intellectual property is probably less pressing.

By contrast, no significant effects emerge for either an establishment's age or its marketing efforts for its annual average sales from new or significantly improved products. The negative – though insignificant – coefficient on age suggests that, as indicated by Aschhoff and Schmidt (2006), younger firms indeed have higher average annual sales from new products, which they have just developed to enter the market. The insignificant coefficient on marketing highlights that marketing strategies and efforts matter little in general, though they may be particularly important and decisive in some industries, like the textile industry or the food and tobacco industries, where product placement is of utmost importance. Likewise, age also plays no significant role for a product innovator's likelihood to apply for a patent.

6. Summary and conclusion

Cooperative activities of firms on R&D and innovation have proliferated substantially in the course of the last couple of decades due to, first, more rapid globalisation which intensified competition but also paved the way for more and more intense cross-national strategic alliances and, second, the quickly growing product and technology complexity and the substantial rise in both costs and risks, which made it harder for innovators to solely rely on their own limited resources and capabilities to develop new products and processes. In this new and changing environment, cooperations on innovation have proven helpful in compensating for the prevailing deficiencies in internal resources or competencies, in reducing and sharing the risks and/or costs associated with innovations or in getting better access to (new) markets. Theoretically, establishments can choose among different cooperation partners. However, the choice of a particular cooperation partner is not an easy one, but one that is pivotal to the success of any cooperative arrangements on innovation.

Hence, the aim of the analysis is to identify those cooperative arrangements for innovation, which prove successful. Particularly, it uses a large set of Central, East and Southeast European (CESEE) and Former Soviet Union (FSU) countries to shed light on the role of different cooperative arrangements such as cooperations with domestic suppliers, domestic clients, foreign suppliers, foreign clients as well as cooperations with external academic or research institutes for product innovators' success, captured in terms of either annual average sales per new or significantly improved product or, alternatively, the probability of applying for a patent. This way, it addresses two particular shortcomings in the literature: first, the lack of attention given to the different roles played by different domestic and foreign cooperative arrangements, which is essential in economically and technologically lagging economies where innovators operate in partly severely dysfunctional domestic systems of innovation and where innovators can greatly profit from entering into cooperative arrangements with foreign suppliers or clients and, second, the lack of systematic cross-country comparisons, particularly of less developed emerging economies.

Our analysis demonstrates that the choice of cooperation partner is essential for an innovator's success. In particular, product innovators in the region can generate significantly higher sales from new products if they cooperate with foreign suppliers. This finding emphasises the importance of foreign innovation partnerships with suppliers for product innovators in the region and underscores the role of public policy support in that direction. Furthermore, product innovators that engage in cooperations with external academic or research institutions are more likely to apply for a patent, which is expected since cooperative arrangements with such institutions focus more on basic research, aimed at exploring novel technological fields and developing complex technologies, technological know-how and market novelties. In contrast, product innovators that engage in cooperations with foreign suppliers or foreign client firms are less likely to apply for a patent, which indicates that novel products developed jointly with foreign partners are predominantly patented abroad.

The analysis also shows that particular establishment characteristics matter greatly. It reveals that larger establishments with stronger market presence and power, establishments with higher foreign ownership

and probably better access to superior foreign resources or capabilities that can more successfully be exploited, establishments that export only or both export and import and therefore enjoy access to a larger market as well as establishments with higher absorptive capacities that can more successfully translate external knowledge into commercially exploitable new products are also able to generate higher sales from their product innovations. Similarly, larger establishments that probably generate more product innovations and possess the financial means to protect them and establishments that export only or both export and import and therefore face fiercer competition in international markets are also more likely to apply for patents.

Furthermore, the analysis demonstrates that an innovator's institutional setting is vital for its innovation success, which emphasises that policy-makers play a particularly strong and decisive role in building an environment that helps innovators extract returns to innovations to the fullest extent possible.

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Table A.1 / Weighted means

REP	Country	N*	Small	Medium	Large	Age (years)	Foreign share (%)	State share (%)	Exporter only	Importer only	Exporter & importer	Marketing
AL	Albania	38	0.696	0.291	0.013	7.5	0.0	0.0	0.047	0.088	0.017	0.400
AM	Armenia	57	0.438	0.404	0.158	16.1	6.9	0.0	0.138	0.055	0.035	0.295
BA	Bosnia & Herzegovina	132	0.480	0.440	0.081	15.6	5.9	0.0	0.173	0.108	0.064	0.538
BG	Bulgaria	73	0.746	0.202	0.052	12.7	7.4	0.0	0.144	0.025	0.090	0.274
BY	Belarus	111	0.456	0.383	0.161	11.8	10.3	11.1	0.211	0.060	0.076	0.735
CZ	Czech Republic	129	0.547	0.379	0.074	15.0	18.7	0.0	0.325	0.041	0.184	0.281
EE	Estonia	62	0.587	0.372	0.041	14.3	11.9	0.0	0.261	0.047	0.113	0.453
GE	Georgia	36	0.481	0.470	0.049	7.3	2.2	0.0	0.008	0.034	0.046	0.439
HR	Croatia	144	0.709	0.250	0.041	14.8	8.8	0.1	0.192	0.061	0.138	0.570
HU	Hungary	66	0.772	0.175	0.053	10.6	9.4	0.0	0.266	0.054	0.064	0.443
LT	Lithuania	66	0.606	0.334	0.060	12.4	11.7	3.7	0.216	0.005	0.144	0.446
LV	Latvia	67	0.634	0.307	0.058	12.1	11.8	0.0	0.254	0.111	0.092	0.177
MD	Moldova	107	0.525	0.392	0.083	9.9	18.4	2.1	0.108	0.022	0.010	0.633
ME	Montenegro	19	0.659	0.326	0.015	12.6	1.9	0.0	0.182	0.032	0.000	0.067
MK	Macedonia	112	0.821	0.131	0.048	10.3	15.5	0.0	0.272	0.029	0.066	0.585
PL	Poland	181	0.524	0.284	0.192	17.7	8.3	0.0	0.180	0.038	0.083	0.521
RO	Romania	219	0.727	0.208	0.065	13.1	12.2	0.0	0.170	0.037	0.055	0.618
RS	Serbia	129	0.731	0.236	0.033	13.2	5.2	0.0	0.340	0.017	0.200	0.322
SI	Slovenia	95	0.757	0.218	0.024	18.2	17.1	0.0	0.424	0.031	0.194	0.501
SK	Slovakia	53	0.560	0.281	0.159	14.5	10.7	0.0	0.356	0.092	0.074	0.285
UA	Ukraine	200	0.476	0.303	0.221	15.3	2.3	0.5	0.160	0.059	0.097	0.354
XK	Kosovo	108	0.583	0.353	0.064	13.2	0.0	0.0	0.211	0.142	0.073	0.733
	Average	2204	0.620	0.282	0.097	14.2	11.2	0.9	0.224	0.041	0.102	0.485

Note: * refers to the total number of product innovators per country; means are weight-adjusted.

Table A.2 / Correlation matrix

	DomSupp	DomClient	ForSupp	ForClient	LatCoop	Medium	Large	LogAge	Foreign share	State share	ExpOnly	ImpOnly	ExpImp	grRGDP	PolStab	RegQual	ROL	Corrup	PRP	IPRP
DomSupp	1.000																			
DomClient	-0.070	1.000																		
ForSupp	-0.107	-0.076	1.000																	
ForClient	-0.067	-0.048	-0.073	1.000																
LatCoop	-0.039	-0.027	-0.042	-0.026	1.000															
Medium	-0.042	-0.012	0.028	0.018	0.023	1.000														
Large	-0.005	-0.027	0.014	0.035	0.028	-0.291	1.000													
LogAge	-0.032	0.034	-0.017	0.030	0.057	0.081	0.174	1.000												
Foreign share	-0.071	-0.015	0.075	0.072	0.018	0.025	0.173	-0.065	1.000											
State share	0.015	-0.019	0.006	-0.018	-0.010	0.019	0.034	0.039	-0.014	1.000										
ExpOnly	-0.044	-0.012	0.066	0.075	-0.003	0.108	0.023	0.037	0.154	0.032	1.000									
ImpOnly	-0.051	0.030	0.018	-0.040	-0.009	0.045	-0.008	-0.011	0.016	-0.015	-0.126	1.000								
ExpImp	-0.051	-0.014	0.032	0.102	0.038	-0.014	0.259	0.115	0.064	0.048	-0.203	-0.097	1.000							
grRGDP	0.059	-0.026	0.008	-0.002	-0.027	0.048	0.001	-0.087	-0.005	0.147	-0.025	-0.034	-0.102	1.000						
PolStab	0.044	0.033	-0.059	0.014	0.030	-0.018	0.009	0.096	0.092	-0.024	0.028	-0.042	0.101	-0.126	1.000					
RegQual	0.035	0.031	-0.023	0.023	0.011	-0.046	-0.031	0.058	0.107	-0.056	0.045	-0.035	0.106	-0.222	0.673	1.000				
ROL	0.041	0.010	-0.025	0.033	0.025	-0.034	-0.024	0.094	0.116	-0.045	0.084	-0.041	0.137	-0.196	0.767	0.927	1.000			
Corrup	0.015	0.005	-0.031	0.038	0.037	-0.050	-0.026	0.109	0.098	-0.072	0.091	-0.031	0.145	-0.371	0.605	0.894	0.935	1.000		
PRP	0.054	0.011	-0.059	0.032	0.036	-0.002	0.002	0.060	0.112	-0.013	0.075	-0.062	0.111	0.055	0.814	0.743	0.859	0.729	1.000	
IPRP	0.011	0.019	-0.071	0.004	0.028	-0.042	0.018	0.104	0.098	-0.073	0.038	-0.041	0.108	-0.407	0.826	0.703	0.726	0.663	0.706	1.000

Table A.3 / List of variables

Variable	Definition	Source
Log of sales per new product	Log of sales in fiscal year XXXX per new/significantly improved product	BEEPS
Patent	Dummy=1 if product innovator applied for a patent only or patent and trademark and zero otherwise	BEEPS
Small	Reference group	BEEPS
Medium	Dummy=1 if establishment has between 20 and 99 employees and zero otherwise	BEEPS
Large	Dummy=1 if establishment has more than 99 employees	BEEPS
Log of age	Log of age (as the difference between the fiscal year and the year in which the establishment began operations)	BEEPS
Foreign share	The share of the firm owned by private foreign individuals, companies or organisations (in %)	BEEPS
State share	The share of the firm owned by the government or state (in %)	BEEPS
Exporter only	Dummy=1 if an establishment reports positive direct exports only and zero otherwise	BEEPS
Importer only	Dummy=1 if an establishment reports positive direct imports only and zero otherwise	BEEPS
Exporter and importer	Dummy=1 if an establishment reports positive direct exports and imports and zero otherwise	BEEPS
Domestic supplier	Dummy=1 if the main new or significantly improved product was developed in cooperation with domestic suppliers and zero otherwise	BEEPS
Domestic client firm	Dummy=1 if the main new or significantly improved product was developed in cooperation with domestic suppliers and zero otherwise	BEEPS
Foreign supplier	Dummy=1 if the main new or significantly improved product was developed in cooperation with foreign suppliers and zero otherwise	BEEPS
Foreign client firm	Dummy=1 if the main new or significantly improved product was developed in cooperation with foreign client firms and zero otherwise	BEEPS
Lateral cooperation	Dummy=1 if the main new or significantly improved product was developed in cooperation with external academic or research institutions and zero otherwise	BEEPS
Marketing	Dummy=1 if during the last three years, the establishment introduced new or significantly improved marketing methods and zero otherwise	BEEPS
Real GDP growth	Annual real GDP growth rate	WDI
Regulatory quality	Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development; Rank=Percentile rank among all countries (ranges from 0 (lowest) to 100 (highest) rank)	WGI
Rule of law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence; Rank=Percentile rank among all countries (ranges from 0 (lowest) to 100 (highest) rank)	WGI
Control of corruption	Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests; Rank=Percentile rank among all countries (ranges from 0 (lowest) to 100 (highest) rank)	WGI
Property rights protection	The property rights component is an assessment of the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyses the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts; Score=The more certain the legal protection of property, the higher a country's score;	Heritage Foundation
Intellectual property rights protection	Evaluates the protection of intellectual property in a total of 97 countries from around the world; Score=the higher the better a country's protection of intellectual property;	IPRI 2014

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