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Exporting status and success in innovation: Evidence from Community Innovation Survey micro data for EU countries

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Abstract

This paper provides another piece of the evidence in explaining the innovation-exporting nexus. Using a large sample of micro data from four waves of Eurostat's Community Innovation Survey for between 14 and 16 EU member states, we investigate the relationship between firms' export status and different sorts of innovation activities. We find robust evidence of systematically positive relationship between the two, whereby the strongest correlation is found in case of product innovation and the smallest in case of organizational innovations. While general evidence shows that innovation success is increasing in firm size, we find that exporting has the strongest effect on innovation in medium-sized firms, followed by small firms. We also explore the differential effects between old versus new EU member states and find that the effects of export status, size and market concentration on firms' innovation performance are substantially lower in the new EU member states. On the other hand, foreign ownership is found to exert a significant positive influence on the likelihood of innovation in the new EU member states only. The latter renders foreign ownership as one of the most prominent determinants of successful innovation activities in the new EU member states.

Content

1. Introduction

There is a long tradition in macroeconomic literature on the link between trade and innovation and it offers at least two mainstream theoretical models that support the causality stemming from innovation and leading to exporting (Harris and Moffat, 2011). The first group of models is based either on factor endowments such as skilled/unskilled labor, capital, materials or technology (Davis, 1995) or technology (Greenhalgh, 1990; Greenhalgh et. al, 1994). The later are building either on the product-life-cycle (Vernon, 1966) or the technology-gap theory of trade (Posner, 1960). More recent models (Grossman and Helpman, 1995) also assume that firms are able to improve their product quality and affect an outward shift of their demand curve.

A parallel strain of literature suggests that internationalization could lead to improved innovative performance (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1998). In this framework firms adapt to competitive pressure in the foreign market by innovating, either through the learning-by-exporting mechanism or by taking advantage of economies of scale in production to finance subsequent investment in research and development.

Recent advances in microeconomic models have linked innovation and exporting for individual firms. Building on models of monopolistic competition, sunk market-entry costs and firm-specific productivity (Constantini and Melitz, 2007), efforts have been made to endogenise firm heterogeneity, as firms are assumed to engage in investment before the start of exporting. More specifically, they demonstrate that in anticipation of trade liberalization firms may bring forward the decision to innovate, in order to be ready for future participation in the export market. Likewise, Atkeson and Burstein (2010) model the interdependence between the choices of exporting and investing in R&D and firm productivity. In addition, Lileeva and Trefler (2010) find evidence from micro data that exporting is correlated with firm investment in R&D and innovation. Aw et al. (2009) and Bustos (2012) suggest that the interplay of exporting and innovation (R&D expenses in case of Aw et al., 2009) can generate amplification effects for firms to experience greater productivity gains.

A number of empirical studies for individual countries find a positive impact of innovation on exporting [Wagner (1996), Wakelin (1997, 1998), Ebling and Janz (1999), Aw et al. (2005, 2009), Girma et al. (2007)]. Cassiman and Martinez-Ros (2007), find for a sample of Spanish firms that engaging in product innovation significantly increases the probability to start exporting. Similarly, Becker and Egger (2007) find after controlling for the endogeneity of innovation that product innovation at German firms plays an important role in increasing the propensity to export, while they find no such evidence for process innovation. Finally, Bratti and Felice (2012) find that exporting significantly increases the likelihood of introducing product innovations and that this effect is not fully captured by the usual channels, such as larger markets or higher investments in R&D. They argue that heterogeneity in foreign customers' tastes and needs might explain these findings.

Damijan et al (2010) go one step further by investigating whether there is a causal link between firm's innovation (and its overall productivity) triggering the decision to start exporting, and furthermore, whether there is a causal link leading from firm's exporting performance to further innovation efforts (and improvements in productivity). By exploring a sample of Slovenian firms, however, they find no empirical support for the hypothesis that either product or process

innovations increase the likelihood of becoming an exporter. But they do find evidence that firm's exporting performance increases the probability of process rather than product innovations.

This paper provides another piece of the evidence in explaining the innovation-exporting nexus. Using a large sample of micro data for EU member states, we investigate the contemporaneous relationship between firms' exporting and innovation activities. We explore the Eurostat's Community Innovation Survey (CIS) data for all four currently available waves (CIS III, CIS IV, CIS 2006 and CIS 2008) for between 14 and 16 EU member states. As firm-level data for four CIS waves cannot be merged year-by-year, we are, unfortunately, unable to explore the causality between export performance and innovation activities, but are able to exploit a number of interesting features in the data. By estimating a probit model, we investigate the impact of export status on firms' different sorts of innovation performance (product, process, marketing and organizational innovation), whereby we control for firm size, R&D expenditures, market concentration, foreign ownership and a number of additional firm-, sector- and country-specific control variables.

Our results can be summarized as follows. First, we find robust confirmation of systematically positive relationship between export status and successful innovation, whereby the strongest correlation is found in case of product innovation and the smallest in case of organizational innovations. Second, the impact of exporting is robust to the definition of innovation, i.e. new-to-firm versus new-to-market innovation. Third, while innovation success is, in general, increasing in firm size, we find consistent evidence that exporting performance exerts the strongest effects on innovation in medium-sized firms, followed by small firms. Fourth, by exploring the differential effects between old versus new EU member states, we find that the effects of export status, size and market concentration on firms' innovation performance in the new EU member states to be substantially smaller. Foreign ownership, on the other hand, is found to exert a highly significant positive influence on the likelihood of innovation in the new EU member states. Finally, we also show that the results are robust to the estimation technique by accounting for the endogeneity by using the IV probit model.

The outline of the paper is as follows. Next chapter presents data and describes main characteristic of the dataset. Third chapter discusses the main empirical approach and robustness checks. In chapter four we present the baseline results and results obtained after numerous robustness checks. Last section concludes.

2. Data

We use Eurostat's Community Innovation Survey (CIS) data for all four currently available waves (CIS III, CIS IV, CIS 2006 and CIS 2008). CIS is a survey on innovation activity carried out biannually by the EU member states and some European Social Survey participating countries. The survey is designed to provide information on the innovativeness of sectors by type of enterprises, on the different types of innovation and on various aspects of the innovation development, such as the objectives, the sources of information, the public funding, the innovation expenditures etc. As compiling survey data is voluntary for the participating countries that means that the sample changes from wave to wave. Table 1 describes the period of each CIS wave included in the sample and lists the participating countries.

Table 1. Description of the CIS database

	Coverage	# of countries	Countries included in the sample
CIS III	1998-2000	15	Belgium, Bulgaria, Czech Republic, Estonia, Germany, Greece, Hungary, Latvia, Lithuania, Norway, Portugal, Romania, Slovenia, Slovakia, Spain
CIS IV	2002-2004	16	Belgium, Bulgaria, Czech Republic, Estonia, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Norway Portugal, Romania, Slovenia, Slovakia, Spain
CIS 2006	2004-2006	14	Bulgaria, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Norway, Portugal, Romania, Slovenia, Slovakia, Spain
CIS 2008	2006-2008	16	Bulgaria, Cyprus, Czech Republic, Germany, Estonia, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Portugal, Romania, Slovenia, Slovakia, Spain

Source: Eurostat

While the target population surveyed by the CIS is the whole population of enterprises of certain size, industry and country, CIS survey is sample based on voluntary participation. The survey includes enterprises from the following industries: mining and quarrying (NACE[1] 10-14), manufacturing (NACE 15-37), electricity, gas and water supply (NACE 40-41), wholesale trade (NACE 51), transport, storage and communication (NACE 60-64), financial intermediation (NACE 65-67), computer and related activities (NACE 72), research and development (NACE 73), architectural and engineering activities (NACE 74.2) and technical testing and analysis (NACE 74.3).

The cut-off point for enterprise inclusion is 10 employees, although firms with less than 10 employees can also be included if treated separately. The statistical unit is an enterprise, when that is not feasible other statistical units are used and double counting of balance sheet data is avoided. The sample of firms for each country is obtained using stratified sampling according to industry classification (NACE 2 digit industries, apart from NACE 74.2 and 74.3) and size classes according to the number of employees. At least three size classes are considered: 10-49 employees (small), 50-249 employees (medium-sized) and 250+ employees (large). The regional component is also considered to ensure that the geographic distribution of sampled firms reflects that of the population.

One of the key features of CIS data is that is has been anonymized to ensure that individual respondents cannot be identified. This prevents vertically linking the same enterprise through time to analyze the dynamic effects of changes in innovation status and trade participation. Without time-series data on firm operations one can only rely on the cross-sectional dimension of the data and hence can only provide evidence on correlations between variables rather than analyze causality. Secondly, in addition to removing firm identifiers the anonymization process also ensures that industries with a small number of firms surveyed were not included in the sample. The requirement that for each country-industry-size class combination at least three firms exist ensures that for a large number of industries the data is omitted.

Table 2 presents a description of the dataset for each of the four CIS waves. The feature of the data is that the sample size is progressively increasing by successive waves of the survey. This is primarily a reflection of increasing sample sizes per country as the number of participating countries has not changed significantly. Crucially, though, the composition of countries has been changing throughout the period and that is reflected in some of the aggregate characteristics of the sample.

[1] NACE nomenclature of activities revision 1.1

The third wave (CIS 2006) does not include Germany or Italy, which is reflected in the average size of the firms as measured by turnover. The relatively very high standard deviations are indicative of a distribution that is heavily skewed to the right. This is due primarily to the imposed cut-off of firm size at 10 employees for the sampling process.

Initially, approximately one half of the surveyed firms declared themselves to be exporters, a quarter of firms were product innovators and a fifth of the firms samples were process innovating between 1998 and 2000. With subsequent waves of surveys and a substantial increase in sample size, the share of exporters and innovators decreases. In waves 2-4 only about 35 per cent of firms export, while a fifth of firms product innovate and one in six firms process innovate. A further drop in innovative success rates is observed in the last wave. The share of revenue attributed to newly introduced products has stabilized at about seven per cent for products new to the firm and 4.7 per cent for products that are new to the market as well. Again, the standard deviation indicates very high heterogeneity between firms with respect to these two measures.

Table 2. Basic characteristics of the CIS sample (1998-2008)

CIS wave	# of firms	Turnover (000 EUR) *mean (sd)*	# of exporters	# of prod. innovators	# of proc. Innovators	New product share of sales *mean (sd)*	New to market share of sales *mean (sd)*
CIS III	49,761	39,097 (661,315)	24,223	12,788	10,828	0.128 (0.234)	0.063 (0.166)
CIS IV	104,717	31,314 (503,549)	38,073	18,278	16,999	0.053 (0.166)	0.034 (0.128)
CIS 2006	109,333	19,488 (211,917)	40,606	18,096	17,319	0.073 (0.210)	0.042 (0.149)
CIS 2008	128,698	37,906 (674,810)	52,467	15,113	15,450	0.074 (0.182)	0.047 (0.138)

Source: Eurostat

Note: End of year bilateral exchange rates were used to calculate the values in Euro

The breakdown with respect to firm size, presented in Table 3, reveals that the likelihood of exporting and innovation is increasing in firm size. The majority of firms sampled are small firms (with between 10 and 49 employees), which also display the lowest share of exporters and innovators alike. Medium-sized and large firms are increasingly much more likely to be exporters and innovators, indicating that firm size is a key feature in both trade and innovation activity of firms. This could further indicate that both exporting and innovation are associated with substantial costs, which are less burdensome for larger firms. In addition, all three size classes display the same ordering of innovation likelihood, with the most likely being product innovation, followed by process innovation and marketing innovation.

Table 3. Sample characteristics with respect to size class

Size class	# of firms	share of exporters	share or product innovators	share of process innovators	share of marketing innovators	share of foreign owned
10<emp<49	193,998	0.297	0.137	0.130	0.031	0.188
50<emp<249	133,357	0.453	0.195	0.188	0.061	0.195
emp>250	46,518	0.561	0.303	0.290	0.112	0.261

Source: Eurostat

Note: Since CIS III does not differentiate between varieties of innovation within the three main groups (product, process and marketing), we limit the analysis in this table to these three broad categories of innovation.

Compared with other studies, the ordering of successful innovation activities corresponds with the one found in other studies in the EU (Eurostat, 2013). While Eurostat reports that slightly over 50 per cent of EU firms (excluding Greece) innovated between 2008 and 2010, the numbers are far lower for certain EU states (Bulgaria (27.1 %), Poland (28.1 %) and Latvia (29.9 %)). As our sample is based primarily on CEEC countries, which have lower rates of successful innovation, a vast part of the observed differences are due to differences in sample composition. In order to gain better insight into the national composition of the sample, we present country-wise aggregate statistics in Table 4.

Table 4. By country summary statistics for CIS 2008 (2006-2008)

country	# of manuf. firms in pop.	# of sampled firms	Share of exporters	Share of product innovators	Share of process innovators	Share of marketing innovators
	1	2	3	4	5	6
BG	30,288	15,859	0.244	0.113	0.104	0.060
CY	5,530	2,048	0.280	0.164	0.313	0.172
CZ	151,753	6,804	0.487	0.212	0.207	0.143
DE	195,439	6,026	0.514	0.264	0.243	0.207
EE	5,478	3,986	0.742	0.228	0.353	0.146
ES	207,499	37,400	0.403	0.189	0.193	0.090
HU	56,346	5,390	0.509	0.128	0.103	0.069
IE	4,989	2,178	0.398	0.228	0.216	0.152
IT	459,728	19,904	0.334	0.197	0.187	0.116
LT	7,488	2,111	0.511	0.134	0.222	0.109
LV	15,768	1,077	0.551	0.156	0.187	0.104
NO	17,623	4,883	0.397	0.189	0.120	0.144
PT	79,589	6,512	0.555	0.321	0.316	0.210
RO	57,305	9,631	0.338	0.136	0.162	0.124
SI	17,344	2,593	0.648	0.240	0.217	0.151
SK	8,081	2,296	0.500	0.144	0.150	0.096

Source: Eurostat

Notes: Column 1 provides the total number of firms in manufacturing (population) in order to provide a lower bound for the actual population among which the survey was performed. Note that services firms are not included in data for column 1, but services firms from sectors NACE 40-41, 51, 60-64, 65-67 72, 73, 74.2 and 74.3 are included in the sample. Columns 3 – 6 show shares of exporters and innovators within the sampled firms.

Table 4 shows the extent of heterogeneity in both exporting participation and innovation activity between countries. The share of exporters ranges from 24.4 per cent (Bulgaria) to 74.2 per cent (Estonia), a 49.8 percentage point difference. Data on innovators also places Bulgaria at the lower end with a share of 11 per cent product innovators and 10 per cent process innovators, while the highest share of innovating firms is found in Portugal at 32 and 31 per cent respectively. Also worth noting is the implied sample participation rates that stem from the comparison of the number of manufacturing firms in the population and the number of firms sampled in CIS for each country. Again, there is great heterogeneity amongst the participating countries with the rates ranging from 72.7 per cent in Estonia to 3.1 per cent in Germany. Even though these participation rates represent the upper bound of the actual rates (for which we would have to account for the population numbers in the surveyed services sectors) they show extremely high rates of heterogeneity between countries. Even though substantial efforts have been made by Eurostat to maintain sample representativeness, aggregate results presented henceforth will not be a true reflection of the composition of the population.

As far as differences between CEEC countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovenia and Slovakia) and other countries in CIS 2008 is concerned, we find the average export participation rate for CEEC countries to be somewhat higher than that for Western European countries and Cyprus (50.3 per cent compared to 41.2 per cent). On the other hand, Western European countries have a higher share of innovative firms for all three types of innovation considered (22.2 per cent to 16.6 per cent for product innovation, 22.7 per cent to 18.9 per cent for process innovation and 15.6 per cent to 11.1 per cent for marketing innovation). While higher rates of export participation may be an indication of a smaller domestic market for CEEC countries, higher rates of innovation may reflect a more fundamental difference in capacity to innovate. In addition, this is a reflection of sample composition as the share of small firms is significantly smaller in the non-CEEC countries captured by the CIS. As small firms are likely to have a smaller capacity to innovate than large firms this could be reflected in the aggregate data.

In Table 5 we explore the correlations between the key variables of interest. Namely, we are interested in the relationship between exporting experience and successful innovation. In order to obtain an overview of the relationship between the key variables in question, we show correlations between export status, product innovation, process innovation, marketing innovation, foreign ownership and employment size class. Apart from size all other variables are indicator variables, while size class assumes values "0" for firms with between 10 and 49 employees, "1" for firms with at least 50 and at most 249 employees and "2" for firms with at least 250 employees.

Table 5. Correlation matrix for CIS 2008 (all countries)

	Export ind	Prod. inn	Proc. inn	Mark. inn	Foreign owner	Size class
Export ind	1					
Prod. inn	0.263***	1				
Proc. inn	0.222***	0.468***	1			
Mark. inn	0.156***	0.353***	0.292***	1		
For. owner	0.010**	-0.006*	-0.007**	-0.010**	1	
Size class	0.234***	0.168***	0.171***	0.122***	0.023***	1

Source: Eurostat

*Note: *** denotes statistical significance at the 0.1 per cent.*

Table 5 demonstrates that there are very strong correlations among the explored variables. The strongest positive correlation is found between different kinds of innovation, indicating that firms that innovate in one area are very likely to also be innovative in other areas. Both innovation and firm size are also positively, but modestly correlated with export status. The strongest correlation is found for product innovation indicating that it may have the biggest effect on firms becoming exporters or that exporting is most likely to lead to product innovation. Foreign ownership, while positively correlated with exporting status, is negatively correlated with all three types of innovation. This may be an indication of the fact that foreign-owned firms have transferred their innovative activities to the headquarters of a parent company.

3. Model and econometric methods

3.1. Model specification

Our aim in this paper is to explore the effect of exporting status on firm innovation. For this purpose we consider all three types of innovation that are covered continually by the Community Innovation Survey separately (product innovation, process innovation and organizational/marketing

innovation). In addition to exporting status there are several other key determinants of innovation that are dictated by theory and have been included in other studies of innovative success.

First, it has been suggested (Schumpeter, 1950; Cohen and Levin, 1989) that innovative activity increases more than proportionally with **firm size**. This is primarily due to the fact that larger firm are able to take advantage of scale economies in R&D expenditure. In addition, larger size allows firms to spread fixed costs and risk over larger output (Cohen and Klepper, 1996; Legge, 2000). Finally, one could argue that larger firms have easier access to financial markets and are better able to offset risks inherent to innovation activities. Cohen et al. (1987) suggest that the impact of firm size on innovative success is industry dependent. Due to administrative inefficiencies and the falling marginal productivity of R&D investment firm size may not lead straightforwardly to an increase in innovative success.

Second, **market power** has traditionally been considered to exert a negative effect on R&D investment, since it reduces the need to stay ahead of competition by innovating. The opposite argument could also be made, as larger "monopoly" profits are expected once the benefits of innovation kick in and higher monopoly profits could help finance the initial R&D investment. Tindahl and Poldahl (2006) find an inverted U-shaped relationship between market concentration (as measured by the Hirschman-Herfindahl index) and R&D expenditure.

Third, it has been shown that firm **ownership** also matters, as firms that were part of a multinational enterprise were found less likely to innovate than locally owned firms (Roper, 2000). This may be due to the fact that R&D departments have been located to the headquarters of the parent company and the affiliates do not engage in R&D. While Dachs and Ebersberger (2009) found no significant relationship between foreign ownership and innovation on Austrian CIS data, Falk (2008) using CIS data for 12 countries found a positive correlation between foreign ownership and the likelihood of introducing new products.

Fourth, **absorptive capacity** or the ability to benefit from existing knowledge in the market is a key to the success of innovative activities. Harris and Moffat (2011) suggest that "*prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends*".

Finally, we also control for **in-house and external R&D expenditure** and sources of **information and co-operation for innovation activities**. R&D expenditure is an essential control variable in estimating the probability of a successful innovation. While undertaking R&D investment does not guarantee innovation success, it is central in establishing absorptive capacity and capacity to innovate.

We estimate the following probit model of the likelihood of successful innovation:

$$P(INN_i^{type}=1) = a + b_1 \exp_i + b_2 controls_i + dT_i + gI_i + hC_i + e_i \quad (1)$$

where INN_i^{type} is an indicator variable for innovative success in the past three years of a given CIS wave. INN takes on value 1 when a firm has successfully innovated in the period in question and 0 otherwise. We test for all four types of innovation that have been included in all four waves of CIS

surveys (product, process, organizational and marketing innovation). exp_i is an indicator variable of the export status of the firm, it assumes value 1 if the firm in question is an exporter and 0 otherwise. $controls_i$ is a vector that includes a set of determinants discussed above: $R\&D/turnover_i$ represents the share of R&D expenditure in firm total turnover, $Share\ of\ in\text{-}house\ R\&D_i$ represents the costs of in-house R&D expenditure relative to total R&D expenditure, $size_i$ is an indicator of firm size class (1: 10-49 employees, 2: 50-249 employees, and 3: above 250 employees), fdi_i is an indicator of foreign ownership ("1" if the firms is foreign owned, "0" if it is locally owned), $market_i$ is a measure of market concentration. We use a revenue based Hirschmann-Herfindahl index for a specific industry and CIS wave.

Due to an insufficient number of observations in a large number of country-industry pairs, we cannot employ country-industry pair indices. The second reason for using Europe-wide concentration indices is that we only have access to data for total turnover and no separate information for domestic and exporting sales. As we cannot differentiate between local sales and sales to foreign markets, we are only able to account for concentration in the regional market. In order to control for both investment in research and development as well as absorptive capacity to assimilate existing knowledge, we also introduce the share of *total research and development expenditure* in firm turnover. We estimate the remaining absorptive capacity ($absorb_i$) following the procedure outlined in Harris and Li (2009). Using information on sources of information and cooperation internal and external to the firm, we undertake factor analysis separately for each CIS wave to account for the latent characteristics common to those variables. By source of information or cooperation these variables can be split into *market sources* (buyers, suppliers, competitors, consultants), *institutional sources* (universities and other public institutions), and *other sources* (conferences, publications, professional associations). Splitting the variables into those on sources of information and those indicating the type of cooperation partner, we perform maximum-likelihood factor analysis separately on two subsets of variables to extract factors with eigenvalues of at least 1 (Kaiser criterion). We follow Harris and Moffat (2011) and perform the factor analysis individually on each of the included four CIS waves in order to allow greater flexibility in the determination of the latent characteristics. We extract one principal component for co-operation variables and three for the set of variables on sources of information, accounting from between 74% and 87% of the total variance. The 17 variables used to measure absorptive capacity are supported by the Kaiser-Meyer-Olkin measure of sampling adequacy with the KMO statistic exceeding 85% and the overall values ranging from 85.3% to 87.8%.

A more complete specification, which would include measures of employment, measures of firm financial health and foremost a measure of firm productivity, are, unfortunately, limited either by the construction of the CIS dataset or by the availability of more detailed CIS data to researchers.

3.2. Other econometric methods

The key econometric issue in estimating (1) is endogeneity of the export variable. It is likely that innovative success and presence in the export market are codetermined, with causality working in both directions (Becker and Egger, 2009; Damijan et al., 2010; Cassiman and Martinez-Ros, 2007, Bratti and Felice, 2012). This would, of course, cause the error term to be correlated with the dependent variable, yielding biased estimates. Given the structure of the dataset, we cannot use lagged or initial values of exporting status to mitigate the issue of endogeneity, since we are dealing with a cross-sectional dataset. In addition, we are somewhat restricted in our use of instruments for exporting status, with no information on productivity, imports or employment, some of the key

determinants of exporting status spotlighted in the relevant literature (see Wagner, 2007 and Greenaway, Kneller 2007 for surveys). The second likely cause of endogeneity is omitted variable bias. It is namely very likely that firm productivity, size, employee skill structure etc. would be key determinants in the likelihood of innovative success. Given that we have no way of controlling for these variables.

Given the above restrictions, we choose estimate an IV version of model (1) by instrumenting for exporting status and foreign ownership. Exporting status and innovation success are likely co-determined and would bias the estimates in case of an OLS regressions. The cause of endogeneity in this case and in the relationship between inward foreign direct investment and innovation would be an omitted variable. Given that the likely contributing factor to both the success in innovation, exporting status and foreign ownership is the unobserved productivity, it would likely cause the error term to be correlated with the right-hand side variables. In order to mitigate the issue, we perform two-stage least squares, where exports and foreign ownership are instrumented in the second stage by initial turnover per employee, the share of exporters in the relevant industry-year-country pairing, the share of foreign owned firms in the industry-year-country pairing and the full set of industry-year interaction dummies.

4. Results

This section presents the estimates of the relationship between innovative success and export status. We employ probit estimation to asses the likelihood of being a product, process, marketing or organizational innovator based on the determinants set out in model (1). We first present baseline results and then proceed with the robustness checks.

4.1. Baseline results

The baseline estimates of (1) are presented in Table 6. It reveals a strong and robust positive effect of contemporaneous exporting status on the likelihood of being an innovator. All four types of innovation display a positive correlation with exporting status, with the quantitatively highest correlation found between exporting status and product innovation. Surprisingly, a negative (but very small) effect of research and development expenditure share in turnover on innovation is found. This may primarily reflect the fact that R&D share and innovation are contemporaneous and that these are innovations new to the firm and not necessarily new to the market. Share of in-house R&D expenditure in general has a positive effect on the likelihood of exporting apart from process innovation where the effect is significantly negative.

Results confirm that larger firms are more likely to innovate, with the effect predictably most pronounced in case of organizational innovations and smallest in case of marketing innovation. Market concentration does not have a statistically significant effect on innovation, while the effect of foreign ownership (being part of a MNC network) depends on the type of innovation. Only process and marketing innovation are affected by foreign ownership, with process innovation being negatively affected and marketing innovation being positively correlated with foreign investment. This may be a reflection of the fact that most innovation in MNC is carried out by the headquarters. Cooperation and sources of information factor variables have a strong positive effect on all types of innovation.

Table 6. Baseline probit estimates for the complete sample (CIS III, CIS IV, CIS 2006 and CIS 2008)

VARIABLES	(1) Product innov.	(2) Process innov.	(3) Marketing innov.	(4) Organizational innov.
Export status	0.183***	0.110***	0.145***	0.079***
	(0.012)	(0.011)	(0.014)	(0.013)
R&D/turnover	-9.5E-8***	-2.5E-6***	-1.9E-6***	-2.7E-6***
	(3.7E-8)	(3.4E-7)	(4.7E-7)	(3.7E-7)
Share of in-house R&D	0.525***	-0.115***	0.160***	-0.004
	(0.014)	(0.013)	(0.017)	(0.015)
Initial size class	0.061***	0.067***	0.024***	0.133***
	(0.007)	(0.007)	(0.008)	(0.008)
market	-0.030**	-0.047***	0.013	-0.047***
	(0.014)	(0.013)	(0.015)	(0.015)
fdi	0.135***	0.025*	0.219***	0.100***
	(0.014)	(0.013)	(0.016)	(0.015)
Cooperation factor	-0.281	-0.046	-0.400	-0.284
	(0.193)	(0.189)	(0.317)	(0.294)
Information factor 1	0.011	-0.061***	0.034**	0.026*
	(0.013)	(0.012)	(0.014)	(0.013)
Information factor 2	0.078***	0.076***	0.056***	0.083***
	(0.003)	(0.003)	(0.003)	(0.003)
Information factor 3	0.124***	0.092***	0.143***	0.140***
	(0.005)	(0.005)	(0.006)	(0.006)
Constant	-1.011**	1.388**	-1.559***	-0.806**
	(0.426)	(0.546)	(0.437)	(0.357)
Industry dummies	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES
CIS year	YES	YES	YES	YES

*Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*
Dependent variables are successful product, process, marketing and organizational innovations, respectively.
Cooperation factor is a common underlying factor obtained from 7 variables measuring type of cooperation.
Information factors are underlying factors obtained from 10 variables measuring the importance of different information sources.

Secondly, we explore the difference between new-to-firm innovation and new-to-market innovation. CIS provides also information on new-to-market product and process innovations, which we explore in Table 7. We re-estimate model (1) using new-to-market product and process innovation as dependent variables.

These estimates confirm the importance of export status on the likelihood of being an innovator. As before, product innovation appears to benefit more than process innovation from exporting. In this case the share of R&D has a positive effect on innovation, significantly so for product innovation, while marginally insignificant in case of process innovation. Size also matters, as larger firms remain more likely to be innovators. Market concentration negatively effects innovative effort in case of process innovation, while it has no effect on product innovation. Finally, while all factor variables matter greatly for both innovation types, foreign ownership only has a significantly positive effect on new-to-market product innovation.

Next we explore the different elasticities of the regressors with respect to size class. As mentioned above, differently-sized firms may experience different responses of innovation to the included right-hand variables. To allow more flexibility in the estimated model, we include the full set interaction terms for medium and large firms (small firms, 10 to 49 employees, are the reference group).

Table 7. Baseline probit estimates for the complete sample (CIS III, CIS IV, CIS 2006 and CIS 2008)

	(1) New to market product innov.	(2) New to market process innov.
Export status	0.120***	0.008
	(0.013)	(0.031)
R&D/turnover	1.3E-6***	0.022**
	(4.3E-7)	(0.009)
Share of in-house R&D	0.467***	0.236***
	(0.016)	(0.039)
Initial size class	0.046***	0.112***
	(0.008)	(0.019)
Market	-0.099***	0.006
	(0.015)	(0.030)
FDI	0.108***	0.072**
	(0.016)	(0.035)
Cooperation factor	-0.360*	-5.753
	(0.208)	(3.861)
Information factor 1	0.083***	-0.001
	(0.014)	(0.034)
Information factor 2	0.082***	0.043***
	(0.003)	(0.007)
Information factor 3	0.067***	0.029**
	(0.006)	(0.014)
Constant	0.087***	0.066***
	(0.006)	(0.012)
Industry dummies	YES	YES
Country dummies	YES	YES
CIS year	YES	YES
# of observations	55,299	10,776
Pseudo R^2	0.099	0.070

*Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*
Dependent variables are new-to-market product and process innovations. Cooperation factor is a common underlying factor obtained from 7 variables measuring type of cooperation. Information factors are underlying factors obtained from 10 variables measuring the importance of different information sources.

Table 8 reveals that, on average, large firms innovate more than medium or small firms. Exporting status benefits medium firms most, followed by small firms. Large firms, it turns out, do not experience significantly different effects of exporting on innovation than small firms. While small firms experience a negative effect of the share of R&D on innovation, the effect disappears for large firms and only holds for product innovation in case of medium firms. Market concentration appears to only affect innovative performance for medium-sized firms, where it negatively impacts the probability of product innovation. While foreign ownership has a negative effect on the innovative performance of small firms, it has a generally positive effect for medium and large firms.

Finally, we focus on the potential differences in the impact of innovation determinants between Central and Eastern European Economies and the remaining CIS countries. Although neither group of countries is homogeneous, the CEEC countries have had the joint experience of transitioning from socialism to a market economy in the late 1990s, while the remaining countries in the CIS had a longer history of functioning under competitive markets. We therefore estimate model (1) with the addition of the CEEC country dichotomous variable and a full set of interaction terms. The CEEC indicator takes on value 1 when the country in questions is Bulgaria, Czech republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovenia or Slovakia and 0 otherwise. Table 9 present estimates of model (1) with the full set of CEEC interaction dummies.

Table 8. Full size interaction estimates for the complete sample (CIS III, CIS IV, CIS 2006 and CIS 2008)

	(1) Product innov.	(2) Process innov.
Export	0.191***	0.091***
	(0.011)	(0.011)
Medium size	0.150***	-0.004
	(0.031)	(0.030)
Large size	0.116	0.293***
	(0.106)	(0.100)
Medium*export	0.065**	0.116***
	(0.030)	(0.028)
Large*export	-0.014	0.030
	(0.099)	(0.096)
R&D/turnover	-1.0E-7***	-0.000***
	(3.6E-8)	(0.000)
Medium*R&D/turn.	-1.5E-4***	0.003
	(3.3E-5)	(0.002)
Large*R&D/turnover	0.961	0.290
	(0.702)	(0.555)
Share of in-house R&D	0.529***	-0.175***
	(0.015)	(0.014)
Med*Share of in-house R&D	-0.032	0.158***
	(0.034)	(0.031)
Lar*Share in-house R&D	0.261	0.055
	(0.161)	(0.127)
Market	-0.307*	0.039
	(0.172)	(0.168)
Medium*market	-1.959***	-0.650*
	(0.379)	(0.366)
Large*market	-1.541*	-1.272
	(0.856)	(0.786)
FDI	0.014	-0.070***
	(0.013)	(0.013)
Medium*FDI	-0.009	0.088***
	(0.028)	(0.027)
Large*FDI	-0.002	0.147*
	(0.096)	(0.089)
Cooperation factor	0.078***	0.074***
	(0.003)	(0.003)
Information factor 1	0.133***	0.103***
	(0.005)	(0.005)
Information factor 2	0.084***	0.081***
	(0.005)	(0.004)
Information factor 3	0.086***	0.033***
	(0.004)	(0.004)
Constant	0.251	0.931***
	(0.296)	(0.339)
Industry dummies	YES	YES
Country dummies	YES	YES
CIS year	YES	YES
# of observations	84,987	85,074
Pseudo R^2	0.172	0.086

*Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Dependent variables are successful product and process innovations in the three years between two CIS waves. Cooperation factor is a common underlying factor obtained from 7 variables measuring type of cooperation. Information factors are underlying factors obtained from 10 variables measuring the importance of different information sources.

Table 9. Full CEEC interaction estimates for the complete sample (CIS III, CIS IV, CIS 2006 and CIS 2008)

	(1) Product Innovation	(2) Process innovation	(3) Product innov. new-to-market	(4) Process innov. new-to-market
Export	0.190***	0.134***	0.162***	0.039
	(0.014)	(0.014)	(0.017)	(0.035)
CEEC	0.159***	-0.012	0.171***	-0.008
	(0.054)	(0.053)	(0.055)	(0.180)
CEEC*export	0.022	-0.071***	-0.073***	-0.122**
	(0.022)	(0.021)	(0.024)	(0.052)
Initial size class	0.056***	0.070***	0.072***	0.182***
	(0.009)	(0.009)	(0.010)	(0.022)
CEEC*Initial size	0.010	-1.1E-4	-0.058***	-0.164***
	(0.014)	(0.013)	(0.015)	(0.033)
R&D/turnover	-1.0E-7***	-3.1E-6***	5.2E-4**	-0.021*
	(3.6E-8)	(4.5E-7)	(2.3E-4)	(0.012)
CEEC*R&D/turn.	-5.8E-5	2.2E-4	-7.5E-4***	0.109
	(6.2E-5)	(2.2E-4)	(2.8E-4)	(0.068)
Share of in-house R&D	0.530***	-0.145***	0.471***	0.093**
	(0.017)	(0.016)	(0.020)	(0.045)
CEEC*share in_house	0.017	0.057**	-0.009	0.195***
	(0.028)	(0.026)	(0.030)	(0.069)
Market	0.255	-0.197	-0.046	14.186***
	(0.206)	(0.202)	(0.228)	(0.649)
CEEC*market	-1.338***	0.278	-0.580**	-3.645***
	(0.232)	(0.224)	(0.247)	(0.949)
FDI	0.018	-0.081***	0.043**	-0.102**
	(0.016)	(0.015)	(0.018)	(0.041)
CEEC*FDI	-0.016	0.054**	0.115***	0.272***
	(0.024)	(0.023)	(0.026)	(0.061)
Cooperation factor	0.078***	0.075***	0.082***	0.043***
	(0.003)	(0.003)	(0.003)	(0.007)
Information factor 1	0.129***	0.094***	0.073***	0.063***
	(0.005)	(0.005)	(0.006)	(0.013)
Information factor 2	0.092***	0.074***	0.087***	0.072***
	(0.005)	(0.005)	(0.005)	(0.011)
Information factor 3	0.086***	0.034***	0.028***	0.089***
	(0.004)	(0.004)	(0.005)	(0.011)
Constant	-0.558	1.661***	-1.274***	-1.760***
	(0.417)	(0.532)	(0.396)	(0.220)
Industry dummies	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES
CIS year	YES	YES	YES	YES
Observations	77,726	77,814	58,532	14,784
Pseudo R^2	0.164	0.085	0.095	0.185

*Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Dependent variables are successful product and process innovations in the three years between two CIS waves. Cooperation factor is a common underlying factor obtained from 7 variables measuring type of cooperation. Information factors are underlying factors obtained from 10 variables measuring the importance of different information sources.

Table 9 shows that, while firms in the CEEC sample are in general more likely to innovate (with the exception of new-to-market process innovations), the impact of exporting on innovation for firms in CEEC countries is significantly smaller than that of non-CEEC countries. The only exception being the case of product innovations, where the coefficient is marginally insignificant. Size also has a smaller effect on innovation in case of CEEC firms, but the effect is only significant for new-to-market innovations. On the other side, foreign ownership has a significantly larger impact on innovation (apart from product innovation) in firms in the CEEC subsample. This confirms that foreign affiliates are an important driver of innovations in the CEEC countries.

In summary, we find that exporting status is positively correlated with contemporaneous innovative success. Although the finding is robust, exporting status is likely determined simultaneously with the innovation decision or at the very least innovative effort. Both decisions are likely to depend on common variables, such as managerial quality, firm productivity, etc., making exporting status endogenous in model (1). A similar argument could also be made about foreign ownership as it too depends on firm productivity and other latent characteristics. We account for the endogeneity issue in the next section.

4.2. Robustness check

Table 10. 2-stage IV probit regressions on the complete sample (CIS III, CIS IV, CIS 2006 and CIS 2008)

	(1) Product innov.	(2) Process innov.	(3) Marketing innov.	(4) Organizational innov.
Export	0.401***	0.246***	0.257**	0.223**
	(0.093)	(0.090)	(0.106)	(0.091)
R&D/turnover	-9.3E-8***	-2.5E-6	-2.1E-6	-3.3E-7
	(1.9E-8)	(4.2E-6)	(6.0E-6)	(2.1E-7)
Initial size class	-0.025**	-0.002	-0.015	0.031***
	(0.012)	(0.011)	(0.014)	(0.012)
Market	-0.196***	-0.095	-0.228**	-0.197*
	(0.068)	(0.065)	(0.100)	(0.102)
FDI	-0.012	-0.053***	-0.014	-0.043*
	(0.018)	(0.018)	(0.022)	(0.023)
Cooperation factor	0.025***	0.026***	0.019***	0.029***
	(0.001)	(0.001)	(0.002)	(0.002)
Information fac 1	0.045***	0.038***	0.040***	0.052***
	(0.003)	(0.003)	(0.003)	(0.003)
Information fac 1	0.025***	0.031***	0.027***	0.044***
	(0.002)	(0.002)	(0.002)	(0.002)
Information fac 1	0.027***	0.013***	0.019***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)
Constant	0.221	0.844***	0.079	-0.176***
	(0.183)	(0.181)	(0.051)	(0.062)
Industry dummies	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES
CIS year	YES	YES	YES	YES
Overidentifying restrictions test $\chi^2(2)$	1.609 (0.205)	0.625 (0.429)	2.558 (0.120)	0.177 (0.674)
Observations	102,792	102,855	80,291	77,079
R-squared	0.100	0.096	0.052	0.077

*Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Dependent variables are successful product, process, marketing and organizational innovations in the three years between two CIS waves. Export status and foreign ownership variables were instrumented by initial turnover per employee, the share of exporters in the relevant industry-year-country pairing, the share of foreign owned firms in the industry-year-country pairing and the full set of industry-year interaction dummies.

In this section we present results of the two-stage instrumental variable probit regression (2SLS IV probit) of model (1). We only present estimates of the second stage of the estimation algorithm. Instrumental variables used in the estimation are initial turnover per employee, share of exporters in the relevant country-year-industry triplet, share of foreign-owned firms in the relevant country-year-industry and a full set of industry and time dummies. Given that we do not have information on the number of employees, only the size class, we choose the lower bound of the size class as a proxy for the denominator in turnover per employee[2].

Table 10 shows that exporting status, even when instrumented, is a very significant predictor of contemporaneous success in innovation. All four types of innovation consistently display a positive correlation between exports and innovation. The strongest effect is again found for product innovation, while the weakest is found in organizational innovation. Size class now yields mixed results – significantly negative effect is found for product innovation and positive for organizational innovation. Results for process and marketing innovation indicate no significant correlation between firm size and innovation. Both market concentration and foreign ownership seem to have a negative effect on innovative success, while, as before, sources of cooperation and information, combined into the four factor variables, yield robustly positive effects on innovation.

Finally, the test of overidentifying restrictions (Sargan test statistic) is not significantly different from zero, indicating that the instruments are valid.

5. Conclusions

The relationship between firm innovation and export participation is one of the key relationships from both the perspective of an individual firm as well as from the policy perspective. Firms may learn how to innovate by interacting with foreign consumers, suppliers and competitors. Alternatively, innovating firms may be more likely to engage in exports. From the perspective of policy makers, this may encourage them to stimulate exporting when trying to encourage more innovative success and vice versa.

This paper provides another piece of the puzzle in explaining the innovation-exporting nexus. Using data on four waves of Community Innovation Survey (CIS III to CIS 2008) for between 14 and 16 countries we find that the correlation between exporting status and innovation is indeed robust. The strongest correlation is systematically found in case of product innovation, while the correlation coefficient is smallest with organizational innovations. The impact of exporting is robust to the definition of innovation (new-to-firm versus new-to-market innovation) and is strongest for small and medium-sized firms. While we find consistent evidence that firm size positively impacts innovative success, the evidence on the effect of the share of research and development in turnover is mixed. Namely, R&D share is found to have a negative or insignificant effect on new-to-firm innovation, but has been revealed to have a strong positive effect on new-to-market innovations. This may be due to the fact that we are only able to consider contemporaneous effects of R&D on innovation and in part as a consequence of the difference between new-to-firm and new-to-market innovations.

[2] We also tried using the upper bounds (49 employees for the first size class, 249 for the second and an arbitrary limit of 1000 for the third size class), but this did not alter the results significantly.

We also explored the different response elasticities between CEECs firms and the remainder of the countries included in the sample and found the effects of export status, size and market concentration to be substantially smaller. Foreign ownership, on the other hand, was shown to exert a highly significant positive influence on the likelihood of innovation. Finally, we also show that the results are by-and-large robust to the estimation technique as using IV probit to account for the endogeneity did not alter the main findings significantly.

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