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INNOVATION AND EXPORTING:
A STUDY ON EASTERN EUROPEAN FIRMS

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Abstract

This paper provides an empirical analysis about the relationship among innovation, productivity and exporting propensity within manufacturing firms of seven Eastern European Union countries. We analyse marginal effects of product, process and organisational-marketing innovations and test complementarity among them when the objective function is represented by the exporting propensity of a firm. Analysing CIS2008 data, we obtain that productivity improves exporting propensity; the more firms innovate the higher is their exporting probability; complementarity between process and organisational-marketing innovations is accepted in medium high and high technology firms. Complementary innovation strategies are detected for Bulgarian firms, even if Bulgaria is one of the least innovative Eastern European countries.

JEL classification: F14, O33

Keywords: Propensity to export; Eastern Europe countries; Productivity; Complementarity; Product innovations; Process innovations; Organisational/Marketing innovations

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1. Introduction

Since the collapse of Soviet Union, Eastern European countries have gained a geopolitical and geostrategic economic importance. They hold a strategic position from democracy and international trade perspectives. These countries have captured the interest of world powerful nations, such as USA, Russia and European Union because, on one hand, they represent an important link with western markets thanks to their close proximity, and, on the other hand, they are regions of high importance in terms of stability and security of world. Moreover, Eastern European countries provide good conditions in terms of labour supply. They can guarantee low cost and high skilled labour force, especially in the Information Technology sector. European countries take an advantage from this opportunity by investing in these economies. The most important European nations play a fundamental role in Eastern European countries both as producers and knowledge owners (Halpern and Muraközy, 2012). Direct foreign investments coming from advanced economies give advantage also in terms of technology transfer. For Eastern European less advanced countries, the innovation transfer is important to fill their gap with more advanced economies.

In this view and given the increasing importance of international trade in the growth convergence process, this paper aims at studying the role of innovation and productivity on exporting propensity in seven Eastern European countries at firm level, by evaluating the role of simple and complex innovation strategies to promote firms' internationalization.

Melitz (2003) studies the relationship between productivity and export pointing to firms' heterogeneous characteristics. The most productive firms are the ones that decide to export, intermediate productive firms supply the domestic market only and, finally, the least productive ones exit the market. This theoretical finding is justified by previous evidence on productivity differences at firm level (e.g. Bernard and Jensen, 1999). Recent contributions explore how firms can improve their productivity in order to increase their export propensity. One of the factors that has the highest effect on exports is innovation. Using Melitz's model, Paula Bustos (2011) has drawn a theoretical framework in which she shows that an increase of the technology level improves firm's productivity. Thus, high technology-type firms are more productive than low technology ones. These firms can enlarge their market boundaries and sell their products in foreign markets. On the other hand, low technology firms can decide to supply their products in domestic market only or in both markets (domestic and foreign), but the latter is possible depending on their productivity level. Melitz and Costantini (2007) have confirmed this positive correlation between innovation and exports. They have asserted that exporters are more innovative. This is possible only if they conduct a step-by-step liberalization and if they are able to prevent it.

Nowadays nobody doubt on the key role of innovation on determining productivity level and of productivity on influencing trade decisions. Recently the research is focused on the effect of innovation on exporting taking into account of different types of innovation, especially product and process innovation. With reference to the issue if the innovation output drive exporting propensity, different conclusions have been obtained. Using Spanish manufacturing firms' data, Cassiman et al. (2010) provide evidence that innovation increases the probability of exporting and product innovation has a higher positive effect on the export-productivity relationship than the other innovative practices. The same conclusion is confirmed by Becker and Egger (2013) for German manufacturing firms. They have also underlined that process innovation increases the propensity to export but only if it is simultaneously introduced with product innovation. Van Beveren and Vanderbussche (2010) have found a complementarity relation between product and process innovations for Belgian firms registered at the National Office for Social Security. As Becker and Egger, they suggest that the combination of product and process innovations is more related with firms entry into the foreign market than the single adoption of the two practices. Polder et al. (2010) find complementarity among product and process innovations in Dutch firms. They also consider organisational innovation and argue that substitutability prevails on complementarity for this kind of output when compared to product innovation.

Our paper follows the same perspective of previous studies. We investigate on the relationship between innovation, productivity and propensity to export within manufacturing firms in Eastern Europe. Moreover, we test for the presence of complementarity among product, process and organisational innovation practices. We use data from the Community Innovation Survey 2008 for seven Eastern European Union countries: Bulgaria, Czech Republic, Hungary, Romania, Lithuania, Slovenia and Slovakia. These countries are interesting because in recent years they have gained importance on the European scenario and to the best of our knowledge there are few works about them. Two papers focusing on the analysis of innovation, productivity and exports in these countries are Halpern and Muraközy (2012) Darmijan et al. (2009). The first one estimates the relationship between firm's innovation and performance in Hungary, by using CIS2004 and CIS2006 data. Their results suggest that innovative firms have higher propensity to export and higher productivity than non-innovative ones, but this depends on their characteristics (such as public support, environmental, health and safety aspects, regulation and standards, labour productivity, capital intensity), rather than different innovation practices. The second paper concerns the casual relation between innovation and propensity exporting in Slovenian firms in 1992-2002 years. Specifically the authors have tested if innovations increase the possibility of a firm to become exporter and if positive learning effects of exporting are implied in new innovations

and increase productivity. They have found that the past exporting status have an important role for medium and large firms when they apply process innovations. This is not verify for product innovations. Past exporting status, also increase the medium and large exporters' productivity, so there is an indirect relation between productivity and process innovations.

Our paper, compared with these twos, consider also organisational and marketing innovations and, specifically, try to find, first, the presence of complementarity between innovations when the objective function of firm is represented by his exporting propensity and, second, the existence of a relationship between productivity and firm's decision to become an exporter.

This paper is organized as follows. Section 2 develops a simplified model, in which the relation between innovation, productivity and exports is explained at micro level. Our interest is focused on how innovations can influence trade decisions of a firm, by using Melitz (2003) and Bustos (2011) assumptions. Following Topkis (1995, 1998), Milgrom and Roberts (1990, 1995) and Milgrom and Shannon (1994), we explain in section 3 the econometric strategy to study complementarity among innovative practices using supermodular functions' properties. In section 4, we describe the firm-level data set for seven countries of Eastern Europe. Section 5 presents results about marginal effects and complementarity test for all countries. In Section 6 and 7, we concentrate our analysis on Bulgarian firms and medium high – high technology firms, respectively. Finally, Section 8 concludes with a brief discussion of results and policy implications.

2. Innovation, productivity and exports: a simple theoretical model

We present a simple partial equilibrium model, which strictly follows Bustos (2011) and Melitz (2003) in the simplified version of Helpman (2006). We consider an economy characterized by monopolistic competition and product differentiation. There are no barriers for firms to enter the market. The production function has increasing returns to scale. Firm's productivity is random. Specifically, firms do not know *ex ante* their productivity. They discover it after entering the market and paying fixed sunk costs. To simplify the analysis, labor is the only input. Production needs both skilled and unskilled workers. All firms aim at maximizing profits, given the decreasing demand for each product. The demand of a product j, x_j, can be expressed by the following function:

(1) $$x_j = A\, p_j^{-\varepsilon}$$

A rapresents the dimension of the market, which is an exogenous variable at firm level and an endogenous one at industry level; p_j is the product's price and ε is demand elasticity. ε is equal to $\frac{1}{1-\alpha}$, with 0 < α <1; this means $\varepsilon > 1$. Each firm chooses the price p_j that maximizes its profit π_j given good *j* demand:

(2) $$\begin{cases} max \quad \pi_j = p_j * x_j - \frac{c}{\vartheta_j} * x_j - cf \\ s.t. \; x_j = A\, p_j^{-\varepsilon} \end{cases}$$

Marginal cost *c* is exogenous as in Melitz model and we assume that it depends on the share of skilled and unskilled employees. In foreign markets a firm must pay additional variable and fixed trade costs. They concern transport, information, commercial barriers and sales costs. We model variable trade costs as *iceberg costs* for simplicity. Firms produce a quantity greater than one to sell one unit to a foreign customer. They are assumed to be homogeneous across destination countries. Moreover, fixed costs to export are higher than fixed costs in domestic market.

Next, we consider three different groups of firms: non innovators, simple innovators and complex innovators. The first group comprises all firms adopting a baseline or low technology (Bustos, 2011). As for the other two groups we classify firms with reference to three kinds of innovation: product, process, and organizational/marketing innovations. When firms use only one kind of innovation they are called simple innovators. When they use two or more innovation practices we call them complex innovators.

Being innovative or not has an impact on the required mix of labor skills and imply different variable and fixed production costs. Innovators probably need more skilled workers than non innovators. In turn, complex innovators ask for even higher skill intensive technology than simple innovators. The adoption of high-level technology implies two important effects on costs. First, high-level technology requires higher fixed costs, cf_T, in terms of payments for technology adoption and capital goods that embody new technologies.

Second, high-level technology allows lower marginal costs, c_T, in terms of wage payments to skilled and unskilled labour as in Bustos (2011). As considered in our work, technology, T, can be equal to NI (non-innovators), SI (simple innovator) or CI (complex innovator), so we can draw the relation between fixed costs and between marginal costs as follow

(3) $cf_{CI} > cf_{SI} > cf_{NI}$

(4) $c_{NI} > c_{SI} > c_{CI}$

Technology's variable costs (4) have an influence on production's costs; in fact they are part of variable costs of production, which are defined as $\frac{c_T}{\vartheta_j}$. We can declare that an increase of technology level requires higher variable costs of production.

For each firm's type (non-innovator, simple innovator and complex innovator), we can calculate profits obtained in domestic and foreign markets for all productivity levels. Following Helpman (2006), we get

(5) $$\pi_{T_j}^{D} = B_T * \theta_T^D - cf_T^D$$

(6) $$\pi_{T_j}^{X} = \tau_j^{(1-\varepsilon)} * B_T * \theta_T^X - cf_T^X$$

where $A * \frac{\alpha}{c_T}^{(\varepsilon-1)} * (1-\alpha) = B_T$ and $\theta_T^D = \vartheta_j^{(\varepsilon-1)}$, where ϑ_j is firm's productivity.

By ordering firms along their productivity, we can identify exiters, non exporters and exporters. The least productive firms exit the domestic market because they can't bear entrance costs and face the high competition (firms' profits can't cover fixed costs; profits are less than 0). Non exporters earn profits selling in the domestic market only and exporters serve domestic and foreign markets. Exporters' profits are obtained by summing up profits from sales in both markets.

We can represent graphically firms' profits with straight lines (figure 1). We start by drawing two linear functions for non-innovators each indicating profits in domestic and foreign markets, respectively. The assumption of higher fixed and variable costs in foreign market implies that the profit's shape in foreign market is more sloping than the domestic market one and begin from a lower point of reference graph. By summing domestic and export profits we obtain a polygonal chain for total profits given that, conditional on its productivity, a firm can be an exiter, a non exporter and an exporter. For non innovators, total profits correspond to the solid line. Being a simple innovator rather than a non innovator changes both slope (specifically the parameter B_T) and intersection with y-axis ($-cf_T$) of both domestic and export profit functions. This implies that the simple innovators' total profit graph is right-shifted (dashed line). For the same reasoning the complex innovators' total profit graph is further right shifted (dotted line).

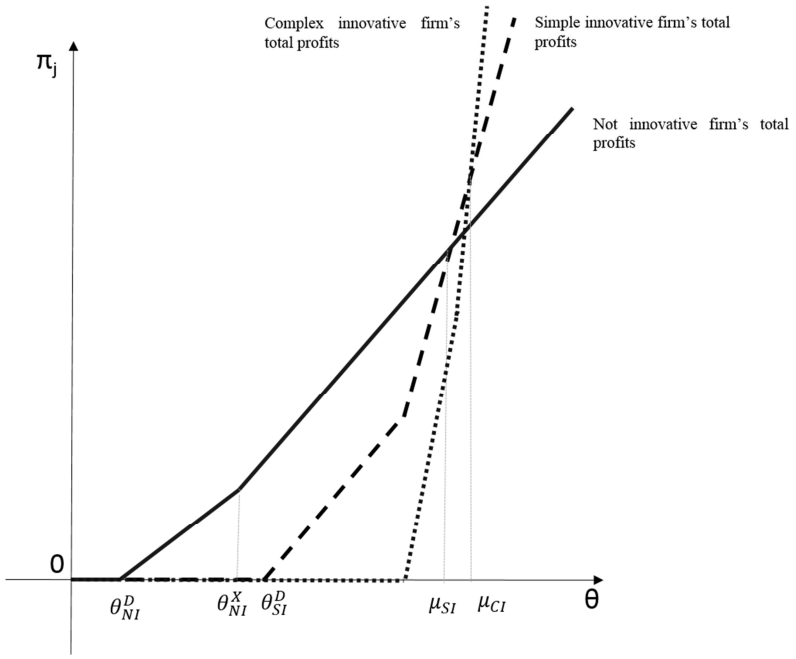

Figure 1 *– Firms' Total Profits for non-innovators, simple innovators and complex innovators*

It is possible to classify firms into five categories given their technological propensity and productivity levels:

- Firms exit the market if their productivity is lower than θ_{NI}^D because of negative profits;
- Non innovators serve the domestic market if their productivity is between/inside the range θ_{NI}^D - θ_{NI}^X;
- Non innovators serve both domestic and foreign markets if their productivity is between/inside the range θ_{NI}^X - μ_{SI};
- Simple innovators serve both domestic and foreign markets if their productivity is between/inside the range μ_{SI} - μ_{CI};
- Complex innovators serve both domestic and foreign markets if their productivity is higher than μ_{CI}.

We can draw three important conclusions. First, the most productive firms use more than one type of innovation. Second, some exporters do not innovate, because their productivity cannot compensate high (fixed) costs required to exploit high-level technology. Finally, non exporters have no incentive to innovate, so they are non innovators too.

The first of these results maybe be the most important for our study; firms that use more than one innovation can be more productive, so they are interested to entry in foreign market (Melitz, 2003; Bernard and Jensen, 1999). We can assert that more innovative firms have higher propensity to export than non innovative ones: analysing figure 1, we can see that non innovators have lesser productivity than simple innovators (one innovation), but complex innovators (2 or more

innovations) have the highest level of productivity. This assertion can be connected with a Becker and Egger work of 2013. In order to estimate the impact of potentially endogenous innovations on export at firm level, they have obtained some important results. First of all, they have seen that if a firm uses two types of innovations (specifically product and process innovations), it exhibits higher probability to export than a firm that doesn't innovate. This conclusion is especially related with product innovation, otherwise product innovation has a dominant impact on exports than process innovation. Process innovation increases propensity to export only if it is combined with product innovation. Their study driven us to check the presence of complementarity between innovations and its impact on firms' probability to export.

3. Complementarity: definition and econometric testing strategy

Complementarity refers to *Edgeworth complements*: two activities are complements, if an increase of one activity increases the returns of doing more of the other activity. This definition means that the firm's objective function has decreasing returns of scale. The complementarity relation is symmetric: the increase of one activity can imply a worse economic performance, while an increase of both activities can imply a better economic performance, so the firm prefers to implement both activities. In this work, the activities are represented by innovation practices. Since innovation practices are typically investigated in discrete settings, we study complementarity among product, process and organizational/marketing innovation through the properties of supermodular functions (Topkis 1995, 1998; Milgrom and Roberts 1990, 1995; Milgrom and Shannon 1994).

Specifically, in the presence of three innovation practices of the firm, we introduce three binary decision variables that are used to define the set of all possible combinations of three innovation practices. This set is the lattice I, whose elements are eight (that is 2^3):

$$I = \{\{000\},\{001\},\{010\},\{100\},\{101\},\{110\},\{011\},\{111\}\} \tag{7}$$

where the element $\{000\}$ indicates that a firm adopts neither of the three practices, and $\{111\}$ indicates that a firm adopts all practices. All other elements refer to mixed innovation/no innovation combinations.

As a first step the econometric procedure requires the estimation of the logit model

(8) $$Pr\left(E_j = 1 \middle| \theta_j\right) = \frac{exp\left(\theta_j \beta\right)}{1 + exp\left(\theta_j \beta\right)}$$

with $$\theta_j \beta = a_0 + a_1 C_j + a_2 \pi_j + \sum_{s \in S} a_s D_{sj} + \sum_{i \in I} a_i D_{ij} + \sum_{e \in E} a_e D_{ej} + \varepsilon_j$$

where D_{ij} ,with $i \in I$, is a dummy equal to one when the combination of innovation activities is i and zero otherwise, where i is an element of the lattice I, as defined in (7). D_{sj}, is a sector-specific dummy, where s is an element of S, a set of possible technology level that a firm can adopt. In our study, S comprehends low and medium high – high technology. π_j, is a measure of firm's relative profitability, which captures heterogeneity of firms' productivity levels. D_{ej}, is a dummy's size; e is an element of E, which captures firms' dimension (small, medium and large). Finally, ε_j is an error term.

Following Topkis (1998), we state that innovation variables included in the lattice I are complements if and only if the exporting probability is significantly influenced by the presence of complementarities among innovation practices considered two by two. For each couple of innovation practices we want to test it by estimating the econometric model (8) subject to the following inequality constraints:

- Complementarity between product and process innovation practices:

(8.1) $$b_{000} + b_{110} - b_{100} - b_{010} \geq 0$$

$$b_{111} + b_{001} - b_{101} - b_{011} \geq 0$$

with at least one of the two inequalities holding strictly.

- Complementarity between product and organizational/marketing innovation practices:

(8.2) $$b_{000} + b_{101} - b_{100} - b_{001} \geq 0$$

$$b_{111} + b_{010} - b_{011} - b_{110} \geq 0$$

with at least one of the two inequalities holding strictly.

- Complementarity between process and organizational/marketing innovation practices:

(8.3) $$b_{000} + b_{011} - b_{010} - b_{001} \geq 0$$

$$b_{111} + b_{100} - b_{101} - b_{110} \geq 0$$

with at least one of the two inequalities holding strictly. For each firm, $K = 3$ and, as shown in Mohnen and Roller (2005, p. 1463), the number of nontrivial inequalities is $2^{(K-2)} \sum_{i=1}^{K-1} i$, that is six

nontrivial inequalities. It is also checked the presence of substitutable innovation practices by replacing the ≥ sign by the ≤ sign in all inequalities.

Our idea is to evaluate complementarity hypotheses by using a parametric bootstrap procedure for directly testing the combined hypotheses (8.1), (8.2) or (8.3) as proposed by Bernardini Papalia et al. (2015)[1]. The procedure is conducted for each couple of complementarity constraints by estimating the constrained and the unconstrained models and testing the null hypothesis by bootstrapping. It consists of three steps. In Step 1 a parametric bootstrap from a population, in which the null hypothesis H_0 is true, is computed. First, parameters are estimated under H_0 using the observed data. T bootstrap samples of size n are generated. Then, parameters are estimated for each replicated data set under H_0. Further, the parameters are estimated under the alternative hypothesis H_1, similarly. The second step is to repeat these computations conditional on the observed data set. The final step is to choose a test statistic to investigate the compatibility of the null hypothesis with the observed data. We estimate constrained and unconstrained logit models to compute the LRT from the original dataset of size N. We then draw a random sample of size N with replacement from the original dataset, fit constrained and unconstrained models and compute the LRT. We repeat this step 1000 times, obtaining the sequence $\{LRT_i\}_{i=1}^{i=1000}$. However, we do not use the traditional chi-square distribution[2]. Specifically, each value LRT_i is compared with the likelihood ratio for the observed data LRT_{data} .An indicator function I_i is constructed, which takes the value 1 if the inequality $LRT_i > LRT_{data}$ holds and 0 otherwise. Then the corresponding standard error is computed to calculate z-statistics and Normal-based 95% confidence interval to verify if the null hypothesis at hand cannot be rejected.

4. Data description

Our analysis on innovation and exporting concerns manufacturing firms of seven Eastern Europe countries: Bulgaria, Czech Republic, Lithuania, Hungary, Romania, Slovakia and Slovenia.

[1] With reference to the literature on complementarity testing, Mohnen and Roller (2005) apply statistical Wald tests for dichotomously practices. Linear regression under inequality constraints are to be computed and the critical values of such tests are cumbersome. Carree et al (2011) propose an induced test along the lines of Savin (1980).

[2] The likelihood ratio test (LRT) is generally used to test the inequality constraint hypothesis in non linear econometric models. An important result from the work of Barlow et al. (1972), Robertson et al. (1988), and Silvapulle and Sen (2004) is that the asymptotic distribution of the LRT is no chi-square distribution and its p value cannot straightforwardly be computed.

Data come from the Sixth Community Innovation Survey (CIS2008), which is based on Oslo Manual 2005. The CIS2008 dataset covers 2006-2008 years for all sectors of the economy. In this work, the focus is on the manufacturing sector.

The CIS2008 survey distinguishes among four types of innovation: products, process, organisational, and marketing innovations. Product innovations involve the introduction of new goods or an improvement of an already existing one. Process innovations include the introduction of new method of production or a new logistic/delivery/distributive system or an improvement of the existing ones. Organisational innovations concern changes in workplace organisation, in external relations or in business practices. Marketing innovations involve packaging or design changes or the creation of new sale markets. We have decided to combine organizational innovations with marketing innovations in order to simplify the model; thus, in our work there are three groups of innovations. This simplification has been made, because marketing can be related with firm's organisation. For each innovation practice the survey reports a binary variable; this means that if a firm applies a specific innovation the variable is equal to 1, and 0 otherwise. In order to identify if a firm implements simple and complex innovations, eight dummy variables are considered and correspond to the elements of the lattice (6): d000, d100, d010, d001, d110, d101, d011, and d111.

A preliminary analysis of some macroeconomic indicators is proposed for the same years. They come from Eurostat Database and include per capita GDP, both for real and nominal terms, intra and extra EU exports of merchandise over GDP, research and development (R&D) expenditure over GDP, public funds for R&D over GDP, number of patents of the European Patent Office (EPO).

Between 2006 and 2008, pro capita GDP values of Slovenia and Czech Republic fill the highest positions, both in nominal and in real terms. In both countries, these values have been subjected to a positive trend during the considered period (from 10,900 euro in 2006 to 11,700 euro in 2008 for Czech Republic, and from 15,100 euro in 2006 to 16,600 euro in 2008 for Slovenia). The GDP's situation of Bulgaria and Hungary, is completely different: they occupy the lowest positions. Both countries, present a nominal and real pro capita GDP smaller than 5,000 euro. The values of the others countries (Lithuania, Slovakia and Hungary), are comprehended between 6,900 euro and 8,000 euro in Lithuania and between 7,700 euro and 9,000 euro in Slovakia, while, for Hungary, the value is always 9,200 euro.

As for exports, Slovakia, Hungary, Czech Republic and Slovenia have the highest openness values, for every three years, they have been all above 50% of GDP (in 2006 Slovenia had an exports value of 58.62%, Czech Republic of 61.10%, Hungary of 65.90% and Slovakia of 73.64%. These percentages have suffered an increase in 2007 and a little decrease in 2008, but the value still

remained above the 50%). Bulgaria is the least exporting country (under 30% in each period). Proceeding with detailed analysis, we can assert that European Union members are the most important commercial partners of these countries (in each countries, *intra* European Union products exports are always higher than the *extra* European Union products exports). This fact is confirmed also by our elaboration of CIS2008 data (Bulgaria, Romania, Czech Republic, Hungary and Slovakia are countries in which firms' exports partners are represented by European Union members. Slovenian and Lithuanian firms export both to European Union market and to foreign European Union market. We can also assert that, firms that export only outside the European Union have less relevance).

For what concerns R&D expenditure, firms invest few resources; all shares are well below the European Union's average (1.85%). Bulgaria, Romania, Slovakia and Lithuania are the least innovative countries; their total R&D expenditure is under the 0.89% of GDP. Slovenia seems to be the most active country in investing resources in R&D, it has spent between 1.53% and 1.63 of GDP on R&D, during the 3-year period. This country is followed, in this order, by Czech Republic and Hungary. Public funding of R&D investment is negligible (Czech and Slovenian government, that are the most active, have spent on average for R&D, 0.55% and 0.51% of GDP).

Another important indicator concerns Patents: Hungary and Czech Republic are the countries that register the highest number of patents to EPO (164.13 and 150.46 in 2006 with an increase in the next two years. In 2008, Czech Republic has beaten Hungary and registers 207.64 patents, against 180.21 of Hungary), followed by Slovenia (98.42 in 2006, 119.11 in 2007 and 138.91 in 2008). The others countries haven't produced a huge number of patents: Lithuania has the lowest number of registered patents (9.67 in 2006, 9.8 in 2007 and 16.87 in 2008); Bulgaria, Romania and Slovakia have produced less than 40.36 (Slovakia) number of patents each other.

In summary, Czech Republic provides the highest effort for innovation and is a relatively good exporter among East European countries, while Bulgaria seems to have the least propensity to innovate and to export.

We next analyse the effects of simple and complex innovation practices on export propensity for all countries by taking into account firms' dimension (small, medium and large), and sectors' technology intensity (low, medium low, medium - high tech).

5. Test of complementarity among innovations

As a first step the exporting propensity is studied through a logit estimation model. The specification model is given by (7) and marginal effects of innovation's variables and productivity are calculated. Then we have tested complementarity by applying the methodology presented in section 3.

Productivity is measured in terms of firm's relative profitability, as proposed by Aw et al. (2008). For any firm *j*, we calculate the natural log of turnover share as follows:

$$\pi_j = \ln\left(\frac{turnover_j}{sector\ turnover}\right) - \frac{1}{n}\sum_j \ln\left(\frac{turnover_j}{sector\ turnover}\right)$$

where *n* is the number of firms in a sector.

For what concerns size dummies, we have generated three binary variables that are related to each size: large, medium and small[3]. Furthermore, dummies for technology intensity refer to a classification of NACE Rev.2 sectors in low, medium low, and medium – high technology sectors[4].

As we can see from Table 1, innovation variables have significant coefficients for all countries except Romania, where only organisational/marketing innovation and product innovation are significant. Analysing the higher values of marginal effects, it is possible to affirm that the dummies d000 (no innovations) and d111 (complex innovation – three innovations are applied), have the highest impact on propensity to export. The impact of d000 prevails in Hungary (+31.2%), Slovakia (+29.7%) and Bulgaria (-16.7%), while d111 has higher impact in Czech Republic (+26.2%) and Slovenia (+18.2%). Two of considered countries, Lithuania and Romania, presents a different situation: the greatest impact on propensity to export is generated by product innovation (+22.4% and -13.85%). Comparing marginal effects that refer to one innovation's dummies with the ones that refer to two, we can assert that the application of two innovations produces higher probability to export on six countries' firms (Bulgaria, Czech Republic, Lithuania, Romania, Slovenia and Slovakia), while this assumption isn't verify for Hungary. Focusing on dummy d111, it is possible to conclude that the integration of each types of innovation generates larger marginal effects than the dummies that concern to one or two innovations.

Finally, we can see that firm productivity has always a positive influence on exporting propensity; values spread from +5.1% of Romania to +10.1% of Hungary.

[3] Concerning size, we refer to CIS2008 classification. Firm's size depending on the number of employees: if a firm has less than 50 employees, it has been classified as small; if a firm has a number of employees between 50 and 249, it is a medium firm; finally, if the number of employees is higher than 249, firm is classify as large.

[4] This classification follows OECD (2008) by aggregating medium-high and high technology intensive sectors.

Table 1. Exporting propensity logit estimates, marginal effects

	Bulgaria		Czech Republic		Hungary		Lithuania		Romania		Slovenia		Slovakia	
	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error
Productivity	0.082***	0.005	0.075***	0.008	0.101***	0.01	0.053***	0.013	0.051***	0.007	0.066***	0.012	0.069***	0.016
d000	-0.167***	0.016	0.187***	0.015	0.319***	0.026	0.132***	0.034	-0.003	0.019	0.128***	0.029	0.297***	0.034
d100	-0.112***	0.019	0.184***	0.012	0.223***	0.014	0.224***	0.026	-0.135**	0.064	0.134***	0.027	0.201***	0.017
d010	-0.143***	0.014	0.175***	0.011	0.229***	0.014	0.169***	0.029	-0.012	0.039	0.129***	0.027	0.172***	0.021
d001	-0.123***	0.014	0.199***	0.011	0.209***	0.014	0.182***	0.029	-0.082***	0.026	0.117***	0.025	0.187***	0.02
d110	-0.113***	0.026	0.161***	0.015	0.234***	0.013	0.181***	0.035	0.051	0.056	0.138***	0.028	0.194***	0.019
d101	-0.071***	0.023	0.182***	0.012	0.235***	0.013	0.217***	0.032	0.013	0.06	0.120***	0.025	0.186***	0.019
d011	-0.102***	0.019	0.175***	0.012	0.243***	0.012	0.196***	0.027	-0.021	0.039	0.117***	0.024	0.180***	0.02
d111	-0.034	0.022	0.262***	0.013	0.278***	0.012	0.217***	0.028	0.049	0.028	0.182***	0.037	0.242***	0.023
No. Observations	8126		2688		2636		857		4846		1238		801	

*Note: statistical significance: * 0.05-0.1; ** 0.01-0.05; *** <0.01. Size and sector dummies have been considered.*

We then check for the presence of complementarity among innovation practices within Eastern Europe manufacturing firms when the objective function is represented by exporting propensity of a firm. We test complementarity assuming innovative practices as exogenous. For each couple of complementarity constraints - (7.1), (7.2) or (7.3) - we have tested them by bootstrapping. Substitutability between innovations has also been tested by replacing the $\geq$ sign with $\leq$ sign in all inequalities. The results obtained through bootstrapping are reported in Table 2.

Table 2. Complementarity and Substitutability in Eastern Europe Countries, Bootstrapping Test results

Country/Innovations	Product/Process	Product/Organisational-Marketing	Process/Organisational Marketing
Bulgaria	C	C	C
Czech Republic	/	/	/
Hungary	S	/	/
Lithuania	S	S	/
Romania	/	C	/
Slovenia	/	/	/
Slovakia	/	S	/

Note: 'C' indicates a significant complementarity between two innovation practices, 'S' indicates substitutability, while 'm' indicates missing values

The complementarity hypothesis cannot be rejected for all possible couples of innovation practices in Bulgarian firms. There is another country only, Romania, with a significant effect of complex innovation for product and organisational/marketing innovations on export propensity. It is interesting to observe substitutability for Hungarian, Lithuanian and Slovak firms. Substitutability is found between product and process innovations for Hungarian and Lithuanian firms; between product and organisational/marketing innovations for Lithuanian and Slovak firms. Neither relation between innovative practices emerges within Czech and Slovenian manufacturing firms.

6. The case of Bulgarian manufacturing firms

In this section, we further investigate the case of Bulgaria since it seems the most intriguing situation. Macroeconomic indicators show Bulgaria as a country with low export flows and poor R&D investment, especially from the public sector. However, our analysis presented in section 5 shows a clear evidence of complex innovation strategies to sustain export propensity when considering all firms. We check if this conclusion is robust across groups of firms identified by

specific firms' characteristics. These characteristics are represented by size and sector; especially, we refer to large, medium and small firms and firms that adopt medium high – high technology.

The marginal effects, related with Bulgarian firms' propensity to export, are reported in Table 3. Analysing this table, we can see interesting aspects. First, the role of firm's productivity. This variable has always a positive impact on firms' exporting propensity, both if we refer to size of firms or to technology level. If we focus on firms' size, the higher marginal effects concerns medium firms (+8%), but large and small ones have a similar value: +7.3% and +6.8%. Productivity has a greater impact if we consider firms' technology level; medium high – high technology firms have an increase of +9.1% of exporting propensity if they are more productive. Second interesting conclusion is about non-innovators. The lack of innovation (d000) has a negative influence on exporting propensity: -24% in small firms, -22% in medium firms, -10.3% in large firms and +5% in high tech sectors, but the last value isn't significant. As we can see, smallest firms hasn't an incentive to export than the largest ones. This result, maybe, is driven by the high competition that firms must face: small firms must be more innovative in order to competing with established firms, otherwise, on one hand, innovations permit to firms to improve themselves, on the other hand, the need to export is a key factor for possible investments in innovation's initiative.

Another important aspect, concern complex innovators. The adoption of all types of innovations and its impact on probability to exports, are related with firms' size. Thanks to Table 3, we can assert that large firms has an increase of their exporting propensity if they integrate all innovative practices (+11.6%). Contrary to what is observed for large firms, medium and small firms face a decrease of their propensity of export if they decide to introduce all innovations (-5.3% and -9.5%). Maybe this conclusion could be related with a lack of available finance for small and medium firms. For these firms the lack of capital is an important barrier to invest in innovations, because they don't have resources to invest in innovation's inputs. Large firms has access to additional resources, so they can invest in new technologies, training to their workforce and winning new markets (Laforet, 2006).

Medium high – high technology firms enlarge their probability to export (+29%) if they apply product, process and organisational/marketing innovations. From studies of each innovation, it is obvious that if a firm introduces only process innovations, this generates a higher decrease of propensity to export than the introduction of product or organisational/marketing innovations: -13.1% (non-significant) for large firms, -21.1% for medium firms and -14.2% for small firms. Product innovations are the ones that produce the lowest losses of exporting probability. Finally, considering the adoption of two innovations, the worst situation happens when product or organisational/marketing innovations join process innovations; in fact, changes of dummy d110

(product and process innovations) or dummy d011 (process and organisational/marketing innovations) create a significant decrease of probability to export. Variations of d110, have a higher impact on medium firms (-17.5%), while variations of d011 in small (-12.2%) and large (-16.8% - non –significant) firms. As we can see from Table 3, the all sample of Bulgarian firms has marginal effects similar to medium and small ones, so it is possible to assert that these kinds of firms play a significant role within Bulgaria's economy.

Summarizing the obtained conclusions, we can say that using innovations reduces the propensity to export of Bulgarian firms, irrespective of whether they are small, medium or large firms, while if we refer to medium high – high technology firms, innovations have a positive impact.

Table 3. Exporting propensity logit estimates for Bulgarian firms, marginal effects

	All Sample		Large		Medium		Small		Medium High - High Technology	
	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error
Productivity	0.082***	0.005	0.073***	0.018	0.08***	0.01109	0.068***	0.004	0.091***	00.02
d000	-0.167***	0.016	-0.103	0.093	-0.221***	0.02802	-0.240***	0.013	0.05	0.044
d100	-0.112***	0.019	-0.036	0.133	-0.188***	0.05057	-0.122***	0.01	0.183**	0.075
d010	-0.143***	0.014	-0.131	0.144	-0.211***	0.04144	-0.142***	0.007	-0.069	0.084
d001	-0.123***	0.014	-0.099	0.117	-0.17***	0.0369	-0.135***	0.008	0.078	0.063
d110	-0.113***	0.026	-0.123	0.156	-0.175**	0.07695	-0.121***	0.013	0.134	0.093
d101	-0.071***	0.022	-0.056	0.115	-0.066	0.05911	-0.109***	0.011	0.217***	0.061
d011	-0.102***	0.019	-0.168	0.129	-0.111**	0.04807	-0.122***	0.01	0.095	0.085
d111	-0.034	0.022	0.116*	0.067	-0.053	0.04791	-0.095***	0.012	0.29***	0.058
No. Observations	8126		334		2042		5750		790	

*Note: statistical significance: * 0.05-0.1; ** 0.01-0.05; *** <0.01. Size and sector dummies have been considered*

With reference to bootstrapping results, the hypothesis of complementarity for product and process innovation practices cannot be rejected in small firms and medium high – high tech firms. Between process and organisational/marketing innovations and between product and organisational/marketing innovations, Bulgaria exhibits complementarities in small and medium firms, and medium high – high tech firms. Simple innovation strategies seem to be negligible in fostering export propensity.

Table 4. Complementarity and Substitutability in Bulgarian Firms, Bootstrapping Test Results

Sample/Innovations	Product/Process	Product/Organisational-Marketing	Process/Organisational-Marketing
All Sample	C	C	C
Large	/	/	/
Medium	/	C	C
Small	C	C	C
Medium High-High Technology	C	C	C

Note: 'C' indicates a significant complementarity between two innovation practices, while 'S' indicates substitutability

These results have driven us to investigate what connections Bulgarian firms have with other EU countries. Specifically, we focus our attention on their major economic partners: Germany, Italy, Netherlands and Austria. We have concentrated on Foreign Direct Investments (FDI), trade flows and cultural relations. It is important to specify, for a better understanding, that CIS2008 records data referred to a period during which Bulgaria became member of the European Union.

First, we have analysed inward FDI stocks in 2008 for manufacturing sector. Germany has the highest value, 326 million of euro against 145 million of Italy, and 82 million of Netherlands (these values represent respectively the 5.94%, the 2.6% and the1.5% of total manufacturing FDI stocks of Bulgaria). There is a missing value for Austria[5].

As for manufacturing exports of Bulgaria between 2006 and 2008 (source: UNCTAD), we can assert that Italy and Germany represent its most important partner. In 2006, Italy was the first exporting partner of Bulgaria (the exports value was about the 14.92% of the total of manufacturing exports). In 2007 and 2008, Germany has beaten Italy and became the new greatest exporting partner of Bulgaria (in 2007 its exports were equal to 14.51% of the Bulgarian total manufacturing exports and in 2008 about the 14.15%). Analysing the manufacturing imports of Bulgaria between the same period, we can confirm that Germany is the leading country (in 2006 imports were equal to 18.84% of Bulgarian total manufacturing imports, in 2007 they were about the 16.5% while, in 2008, they represented the 15.76% of Bulgarian total manufacturing imports). In spite of these

[5] Source: Eurostat – EU direct investment positions, breakdown by country and economic activity (NACE 2.2). POST: Financial Account, Direct Investment, Abroad. NACE_R2: Manufacturing. PARTNER: Bulgaria

percentages, if we consider the single value of imports, we can assert that the importance of trade with Germany has increased over time (+13.1% in 2007 and +13.5% in 2008). Between 2006 and 2008, Trade relations with Austria and Netherlands were less significant than Germany and Italy ones (exports to Austria represent the 3% of total manufacturing exports, for every three years, while exports to Netherlands have a value of 1.7%. Imports have the same trend of exports, for both countries). In 2007, exports and imports between Bulgaria and Austria had an increase, respectively of the 20.81% and the 35.4%, while, in 2008, they also had an increase but the variation was smaller than the one of the previous year (+12.9% and +17%). Concerning imports, trade variations between Bulgaria and Netherlands have been the same trend (+60.1% in 2007 and +11.33% in 2008), but in terms of exports, the variation has been higher in 2008 (+1.5% in 2007 and +27.2%).

Finally, we have concentrated on cultural relations. Many researchers have studied the link between international trade and national culture. They have shown that countries sharing common cultural characteristics measured in terms of language, religion, education, law and politics have huge advantages (Chaiyabut, 2013; Melitz, 2007). Chaiyabut explains that exports and imports effectiveness can be improved by learning partners' national culture and, second, that the misunderstanding of cultures generates complexities, especially when people from different cultures work in the same organisation. An interesting work by Jacques Melitz (2008) is focused on the knowledge of foreign languages. He shows that direct communication is necessary to promote trade and good translation skills are important in overcoming linguistic obstacles. Another important result obtained by Melitz is that the knowledge of European non-english languages is a comparative advantage in foreign trade, while the knowledge of english language is not.

In this view, we have decided to identify which are the most widely known languages in Bulgaria, in addition to the native one. The three most common foreign languages in Bulgaria are English, Russian and German. About the 25% of Bulgarians are able to have a conversation in English, the 13% in Russian and the 8% German.

English is not a comparative advantage. Russian relates to extra EU trade and is not studied in this paper. We can argue that Germany has the tightest cultural link with Bulgaria. From an historical point of view, the relationship between these two countries began during World War I thank to the German military help in Macedonia and became even closer during World War II.

From Bulgarian perspective, Germany represents the key partner within European Union. For German investors, Bulgaria offers low taxes, qualified (good German speakers) and cheap work force, an anti-corruption policy under development and good infrastructure[6].

[6] Concerning infrastructure, in recent years Bulgaria present lower electricity and natural gas prices for industrial consumers; it is also one of the countries with the highest increase of motorisation rate of passenger cars and of lorries

This strong connection may explain why we obtain complementarity among innovation practices in Bulgaria. Bernardini Papalia et al. (2015) show that exporting propensity of German manufacturing firms is significantly favoured by complementary innovations. Therefore it is possible that German innovation and export model has been transferred into Bulgarian firms.

7. The case of medium high – high tech manufacturing firms

The second interesting result of our work is related to medium high – high tech sectors. Medium high and high tech manufacturing firms come from C26, C27, C28, C29 and C30 sectors of NACE Rev 2.2 classification[7].

It is necessary to specify that the complementarity test cannot be done for Lithuania because of insufficient observations.

With reference to marginal effects, productivity always increases export propensity, but not so much (from 2.8% of Czech firms to 9% of Bulgaria). Considering innovation's dummies, thanks to Table 5, we can assert that the adoption of all innovations generates the higher marginal effect of exporting propensity of a firm (from 17.8% of Hungary to 30.6% of Lithuania). This assertion cannot be verify for Hungarian and Slovak firms. In these countries, firms have a higher increase of their propensity to export if they are non-innovative (in Hungary, dummy d000 is equal to 27.2% and dummy d111 is about the 17.8%; in Slovakia, d000 is equal to 28.4% and d111 to 22.2%). Comparing the marginal effects of innovation's dummies, we can see that, in each country, firms obtain a higher increase of their exporting probability if they apply more than one innovation; specifically, they have more propensity for exports if they adopt two or three innovations. In spite of this, it is interesting that Eastern Europe medium high and high technology firms prefer to be complex innovators or non-innovators, rather than apply one or two innovations.

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and road tractors. It shows a strong rises in inland waterways transport and in the share of road freight transport (more information can be consult on "Energy, Transport and Environment Indicators", 2014 Edition, Eurostat pocketbooks).
In terms of corruption, Bulgaria is one of the most corrupted European countries, overall this situation affects healthcare, local authorities, customs and police. With its entrance on European Union, in 2007, lots of efforts have been made: new structures have been established and specialisation increase has been started (further information refer to "BULGARIA to the EU Anti-Corruption Report 2014", European Commission).

[7] Sector C26 concerns *Manufacture of computer, electronic and optical products*, Sector C27 is related with *Manufacture of electrical equipment*, Sector C28 concerns *Manufacture of machinery and equipment n.e.c.*, Sector C29 refers to *Manufacture of motor vehicles, trailers and semi-trailers* and Sector C30 includes the *manufacture of other transport equipment*.

Table 5. Exporting Propensity in Medium High – High Technology Firms, Marginal Effects

	Bulgaria		**Czech Republic**		**Hungary**		**Lithuania**		**Romania**		**Slovenia**		**Slovakia**	
	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error	Marginal Effect	Std. Error
Productivity	0.091***	00.02	0.028***	0.007	0.062***	0.014	0.071	0.051	0.035**	0.014	0.035**	0.015	0.062**	0.027
d000	0.05	0.044	0.108***	0.016	0.272***	0.032	0.247***	0.069	0.142***	0.032	0.109***	0.04	0.285***	0.045
d100	0.183**	0.075	0.078***	0.013	0.113***	0.02			0.117	0.156	0.079***	0.027	0.126***	0.026
d010	-0.069	0.084	0.072***	0.011	0.138***	0.018			0.084	0.079			0.114***	0.026
d001	0.078	0.063	0.088***	0.013	0.121***	0.018			0.031	0.054	0.063***	0.023	0.14***	0.027
d110	0.134	0.093	0.081***	0.013	0.137***	0.018	0.146	0.092	0.258***	0.067				
d101	0.217***	0.061	0.085***	0.014					0.215***	0.079			0.135***	0.029
d011	0.095	0.085	0.073***	0.012	0.145***	0.019			0.186***	0.056	0.08***	0.025	0.131***	0.029
d111	0.29***	0.058	0.187***	0.022	0.179***	0.021	0.307***	0.055	0.227***	0.041	0.277	0.061	0.223***	0.036
No. Observations	790		767		612		70		800		235		207	

*Note: statistical significance: * 0.05-0.1; ** 0.01-0.05; *** <0.01. Size and sector dummies have been considered*

Testing the existence of complex and simple innovations for exporting propensity we have found heterogeneous results across countries as reported in Table 6.

Table 6 confirms the presence of complementarity between all innovations in Bulgarian firms, which remains the most interesting one. Bulgarian and Hungarian firms are the only firms that have a complementarity relation between product and process innovations. For these two cases, Van Baveren and Vandebussche (2010) and Polder et al. (2010) underline the potential presence of complementarity for product and process innovations for exporting propensity. Complementarity between process and organisational/marketing innovations exists in high tech firms for all countries, except for Czech and Romanian firms. Polder et al. (2010) confirm that there is neither complementarity nor substitutability between process and organisational/marketing innovations. The only case of substitutability among product and process innovations is detected for Czech firms.

Table 6. Complementarity and Substitutability in Medium High – High Technology Sectors, Bootstrapping Test Results

Country/Innovations	Product/Process	Product/Organisational-Marketing	Process/Organisational Marketing
Bulgaria	C	C	C
Czech Republic	S	/	/
Hungary	C	/	C
Lithuania	m	m	m
Romania	/	/	/
Slovenia	/	/	C
Slovakia	/	/	C

Note: 'C' indicates a significant complementarity between two innovation practices, 'S' indicates substitutability, while 'm' indicates missing values

8. Conclusion

Our aim has been to investigating the relationship between innovation, productivity and propensity to export in manufacturing firms of Eastern Europe. In our analysis, we have studied the marginal effects of productivity and innovation types on firms' exporting probability and we have tested the presence of complementarity among product, process and organizational/marketing innovation practices.

A central finding is that previous evidence about the positive effect of firms' productivity on the propensity to export at micro level is confirmed for Eastern Europe countries, and this relationship

is connected with the innovation capacity of a firm. In each country, except Bulgaria, a higher number of innovations improves the exporting propensity. As for the complementarity issue, we have found that both complementarity and substitutability emerge between product and process innovations and between product and organisational/marketing innovations. Complementarity between process and organisational/marketing innovations refers to Bulgarian firms.

Two interesting cases have been considered for a deeper investigation.

The first one concerns Bulgarian firms. Generally, innovations have a negative impact on exporting propensity. Results seem to indicate that process innovations have the worst impact on exporting propensity of firms, while innovative products, or an improvement of them, are more convenient. However, this negative effect is lower in absolute value for large firms than for small and medium sized firms. Moreover, if firms apply a complex innovation strategy, they could obtain an increase of their export propensity. Finally, we can show that medium high and high technology Bulgarian firms adopt complex innovations and these allow them to have a higher probability to export.

Focusing on complementarity test, we find evidence of a huge presence of complementarity. In small sized firms and medium high – high technology firms, complementarities have been obtained among all types of innovation.

The second important case is related to medium high and high technology across all countries. Two relevant results emerge. Firms that are part of medium high and high technology sectors, have an advantage if they use more innovations, because they face a higher exporting propensity. Furthermore, bootstrapping results show some cases of a complementarity relationship among process and organizational/marketing innovations and other cases of mixed results (complementarity and substitutability) between product and process innovations.

From a policy point of view, small and medium firms have an important role in Eastern European economies. As such, governments should implement innovation policies in order to improve firms' productivity level, expand their size and be more competitive. These policies should consider funding schemes or reliefs for the introduction of new innovative practices. This could allow to small and medium firms to enlarge their export propensity.

Focusing on Bulgaria, small sized and medium high – high technology firms should take advantage from complementarity and further increase the number of complex innovations; in particular, they should invest more funds on process and organizational/marketing innovations. In view of the positive role of complex innovation strategies on improving firms' efficiency and export propensity, even Hungarian, Slovenian and Slovak firms should pay more attention to the implementation of all types of innovation practices. They could study the best way to integrate these types of innovative practices.

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