DETERMINANTS OF BUSINESS INNOVATION ACTIVITIES IN MANUFACTURING INDUSTRIES – CZECH REPUBLIC AND ESTONIA CASE STUDY

Viktor Prokop[1] and Jan Stejskal[2]
[1] *University of Pardubice, Faculty of Economics and Administration, Studentska 95, CZ 53210 Pardubice, Czech Republic, viktor.prokop@upce.cz*
2 University of Pardubice, Faculty of Economics and Administration, Studentska 95, CZ 53210 Pardubice, Czech Republic, jan.stejskal@upce.cz

ABSTRACT

Economic entities facing an ever accelerating pace of changes, which brings with it advantages and disadvantages. In recent years, the OECD described the Czech Republic and Estonia as a strengthening economies focusing on the promotion of research, development and innovation. However, finding of proper determinants of innovative activities represent a complex process lacking universal formula of which variables positively affect innovation creation. Prior studies showed the number of factors influencing innovation activities. Purpose of this article is to show that the proper combinations of these factors allow creation of more significant effects influencing the growth of companies´ turnover. We created own multiple linear regression models by using data from Community Innovation Survey conducted in the Czech Republic and Estonia between the years 2010-2012 to test the relationship between dependent variable represented by % of turnover in new or improved firms´ products and selected determinants of innovation activities. The aim of this article is to measure direct effects of individual determinants of business innovation activities on growth of turnover in innovated products in the manufacturing industry in the Czech Republic and Estonia and compare them with results of combinations of these factors. We show that both countries are more effective by using proper combinations of selected determinants of innovation activities. Specifically, we show that, by combining cooperation on innovation with different partners, companies in Estonian manufacturing industry are more effective and more significantly affect their growth of turnover than companies in the Czech Republic. We also show that in both countries there is a growing inefficiency in provision of public subsidies (from national or European funds). In the conclusion, we show the appropriate combination of factors that positively affect the formation of innovation and we are proposing a number of new practical implications for the policy makers of both countries.

KEYWORDS

Innovation, industry, entrepreneur, manufacturing, Czech Rep., Estonia

JEL CLASSIFICATION CODES

O30, O31, O38

1. INTRODUCTION

Innovations are the most important determinant of the entrepreneurs´ performance and nowadays in globalized world they are more and more important also in non-business organizations. The innovations in both types of organizations are subjects to constant changes, both internal and external (Hajek and Stejskal, 2015; Prajogo, 2016). Management, work with people and their management, as well as technology and corporate culture belong to the internal factors. Shefer and Frenkel (1998) assigned to this group others as entrepreneur size, age, ownership type, location, type of industry. These all can significantly affect the firms´ ability to produce innovation (it is confirmed by a number of studies, for example Balachandra and Friar, 1997; Kuratko et al., 2014). External factors are, paradoxically, less well understood and we know less about their impact on innovation. The effect of demand, market size, the activity of customers, competitors,

suppliers´ strategy, but also the legislative and institutional interventions of public administration, all these significantly affect all activities of entrepreneurs (Tripsas, 2008, Prokop and Stejskal, 2015). In addition, it should be noted that external interventions have very strong dynamics with no possibility of any interference on the part of company management (Kennerley and Neely, 2003). However, firm management can react by corporate competitive strategy that can take advantage of individual strengths and opportunities what are posed by various (external) factors. This clearly shows that managers must seek the "fit" between firms' innovation strategies and the conditions of its environment as external environment can moderate the relationship between firms' innovation strategies and their performance (Prajogo, 2016).

Therefore, every innovative firm moves in an environment which is known for its innovative milieu (Shefer and Frenkel, 1998; Oksanen and Stahl, 2013), which is created by external factors. Compared to the above-mentioned factors, there are other factors that can effectively help the innovation emergence: the rate of local innovation, the degree of cooperation and collaboration among firms and the degree of economies of localization and agglomeration (Shefer and Frenkel, 1998). Campagne (1991) and others argue that innovative environment conducive to innovation is considered a cost-reducing factor that diminishes uncertainty and increases production efficiencies. Just the study of the various production factors - factors what shape the innovation environment - will help in the correct targeting of public policies (Stejskal and Hajek, 2015a; Meričkova et al., 2015). These policies often support the creation of such an environment, innovation systems (mostly in the regions), respectively. They can be regionalized integration policies or regionalized innovation policies. And it is up to the representatives of public power which policy will be shaped by their decisions and thus they will increase either local innovativeness (rate of innovation in a specific locality) or local synergies (degree of socioeconomic interactions among the firms located in close proximity; Millat et al., 1991). It follows that the innovative capability of enterprises and organizations in the region depend nowadays on the use and acquisition of specific production factors.

The aim of this paper is to measure direct effects of individual determinants of business innovation activities on growth of turnover in innovated products in the manufacturing industry in the Czech Republic and Estonia and compare them with results of combinations of these factors. The remainder of the paper is structured as following. Theoretical background and hypotheses are discussed in the following part. Subsequently, the data methodology, results and their analysis are shown. In the last part, there are conclusions and recommendations.

2. SPECIFIC FACTOR INFLUENCING THE FIRMS´ INNOVATION ABSORPTION

Modern localization theory proves the significant role of agglomeration and localization economies. These variables help to create a space (city, region), whose growth and performance they support. They contribute also to the emergence of innovative environment in which they generate new ideas and promote the development of technology-intensive manufactures. The technology diffusion is realized in the region or other area, which requires from individual economic actors a strong rapid reaction capability, the ability to adapt the "new" streamed from technology-diffusion process. This process and the "new" both are just depending on environmental external factors, on particular customer requirements and market development. The expected societal return on new technology without the diffusion process will be insignificant (Shefer and Frenkel, 1998).

Technological diffusion is a complex process that is based on the interactions among various subjects (regional actors), Camagni (1991) includes as main: companies and environment and technology. The diffusion is the process by which a technology spreads across a population of organizations (Fichman, 2000). Often it is perceived on international level because it affects international trade and foreign direct investment (Keller, 2001). The globalization made in last 50 years from technological diffusion the essential part of all innovation environments.

The complexity of innovative environment and its dependence on technologies is significantly increased the requirements for rapid reaction capability, adoption and application of new knowledge (every time some firm adopts the innovation, other firms can improve their estimates of the true cost of adoption; Kapur, 1995). This is form of assimilation, which is defined as the process within organizations stretching from initial awareness of the innovation, to potentially, formal adoption and full-scale deployment. For the creation and

establishment of technology influencing the effective diffusion we need to know the factors that influence diffusion and assimilation. Fischman (2000) describes such factors as (1) those pertaining to the technologies and their diffusion contexts; (2) those pertaining to organizations and their adoption contexts; and (3) those pertaining to the combination of technology and organization. The „propagating" knowledge institutions are needed part of every innovation and technological environment. They help to generate new knowledge and to transform them into innovation. Among these organizations are included in R&D organizations, laboratories, government agencies, consultancy firms and also universities (Van Beers and Berghäll, 2008; Stejskal and Hajek, 2015b).

However, the individual factors do not occur alone (per se) in the environment but generally they operate in innovation-organization combinations. In fact, innovations don't arise in isolation, but are relevant to the organization or company, region or country. There the innovations can use the specific production factors and specific conditions in environment (we can talk about the so-called lab). These specific factors, which help strengthen the enterprises´ competitiveness and performance, are knowledge and ability to learn, ability to cooperate, creativity and innovativeness. The absorptive capacity of the recipient's knowledge is also important. High absorptive capacity in a domain increases the organizational capacity to assimilate innovations in that domain (Cohen and Levinthal, 1990). This, in turn, suggests that the primary antecedents of absorptive capacity related knowledge and diversity of knowledge will also predict innovativeness with respect to particular innovations (Fichman and Kemerer, 1997). Indispensable determinants (factors) are as well as private R&D expenditures (investments) and public support for this area.

There are many studies that explore the relationship between selected production factors and innovative capabilities or firm's performance. Becker and Dietz (2004) examined the manufacturing industry in Germany. Their analysis focused on the impact of R&D cooperation on firms' innovation input and output. They found that German firms use R&D to supplement their internal resources in the innovation processes, to improve the innovative performance and the implementation of product innovations. On the input side, the intensity of in-house R&D also stimulates the probability and the number of joint R&D activities with other firms and institutions significantly. Robin and Schubert (2013) examined how cooperation with public research institutions affects the success of innovation in the markets (with the German and French companies). They found that cooperating with public research increases product innovation, but has no effect on process innovation, which depends more on firms' openness. It was found a gap in the effect of cooperation between France and Germany which was caused by being different innovation environment. They derived two important policy implications from our results. First, public–private collaborations in research should not be encouraged at all costs, since they may not sustain all forms of innovation. Triguero and Córcoles (2013) analyzed the manufacturing industry in Spain. They concluded that there are similar determinants of persistence in R&D and innovative activities: external/environmental factors, market dynamism, R&D affects and innovation. Regarding firm specific characteristics, size and outsourcing also have a positive impact on all processes. Clausen (2013) dealt with the analysis of external knowledge sourcing from innovation cooperation and the role of absorptive capacity. His results show that internal R&D, training and an educated workforce, as core aspects of firms' absorptive capacity, are positively associated with (the intensity of) innovation cooperation. An implication is that external knowledge does not enter the firm freely. The costs firms must invoke in order to be able to source external knowledge in the OI context is considerable. Without investing in internal R&D, training and recruiting workers with good educational qualifications, firms may not be able to follow the open approach to innovation. Similar studies from specific area - Central and Eastern Europe – are only a few. Srholec (2014) dealt with the Czech Republic; concretely he focused on cooperation and innovative performance of firms in comparative study comparing the Czech Republic, Norway and the UK. Therefore we know very little about the factors that influence the innovative capability of Czech enterprises in the manufacturing industry.

We aim to make an initial comparison of firms´ situation in manufacturing industry in the Czech Republic and Estonia with an emphasis on the determinants of innovative activities. Both, Czech Republic and Estonia represent post communist countries with similar economies supporting science, research and innovation. However, Estonia has in recent years been regarded as a highly networked and highly innovative country with dynamic economy, favorable business climate and cost advantages that are open to growth (European Commission, 2016). Following previous arguments that innovations do not arise in isolation and individual factors do not occur alone we hypothesize that *(H) Combination of determinants of innovative activities more significantly influence growth of turnover in new or improved companies´ products in manufacturing industry in the Czech Republic and Estonia than the situation when these factors occur individually.*

Prior studies underlined the importance of innovation and their influence on firms´ productivity and growth (for example, Klomp and Van Leeuwen, 1999; Rao et al., 2001). Later studies showed the importance of other different factors influencing innovative activities and performance of companies, such as: cooperation, especially with different partners (López et al., 2014); public financing (Rodríguez-Pose and Di Cataldo, 2014); market orientation (Atuahene-Gima, 1996); participation in groups of companies or merging of companies (Dachs and Peters, 2014); investment in R&D (Hall et al., 2013).
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However, we claim, that this factors do not opperate separately. Actually, they are more significant in combination with each other because it causes in creation of synergies and spillover effects. In fact, Liu and Buck (2007) also claimed that the existing literature examines separately the impact of various channels and factors for innovative activities and technology spillovers, and does not comprehensively investigate the integrated effects which together affect the innovation performance of firms. Huber (1998) suggested that the relationship between different factors (internal/external), organizational creativity and learning and innovation are bidirectional and synergistic. There are a lack of studies examining this common effects, especially in the Czech Republic and Estonia. Therefore, to answer our hypothesis, we create groups of variables and test their impacts on the growth of turnover from innovations – firstly, each variable separately; subsequently, the effects of combinations between variables.

3. DATA METHODOLOGY

For the data collection, Community Innovation Survey 2010-2012 were used. Community Innovation Survey (CIS) are harmonized questionnaire and part of the EU science and technology statistics carried out with two years' frequency by EU member states and number of ESS member countries (Eurostat, 2016). We use CIS to analyze the impacts of different innovation activities´ determinants in The Czech Republic and Estonia between the years 2010-2012 and to make an initial comparison. In total, data on 5,449 Czech and 1,723 Estonian companies with at least 10 employees was obtained (response rate greater than 60 %). For the purpose of this study, we filtered 3,110 Czech and 921 Estonia companies, i.e., only companies from the manufacturing industries into our data group – specifically, countries covering NACE categories 10-33.

For this kind of analyses, regression models are commonly used (e.g. Schneider and Spieth, 2013). This model was fitted to investigate the relationship between one dependent variable represented by the % of turnover in new or improved products introduced during 2010-2012 that were new to the market and the number of selected independent variables (see Table 1). Multiple linear regression models have the following general form (Chatterjee and Hadi, 2013):

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \varepsilon \quad (1)$$

where y is dependent variable;
$x_1, x_2 \ldots x_n$ are independent variables;
ε is an error term accounts for the variability in y which cannot be explained by the linear effect of the n independent variables;
$\beta_1, \beta_2 \ldots \beta_n$ called the regression parameters or coefficients, are unknown constants to be determined (estimated) from the data.

Firstly, before composing the models, verification was conducted as to whether the data were correlated by using Spearman's test. After fulfilling the first prerequisite and dismissing the possibility of multicollinearity in the model, the analysis itself was conducted. General formula of the Spearman Rank Correlation Coefficient has following general form (Borradaile, 2013):

$$r_s = 1 - [(6*\sum di^2)/(N^3-N)] \quad (2)$$

Spearman´s Coefficient measures the strength of the linear relationship between two variables when the values of each variable are rank-ordered from 1 to N, where N represents the number of pairs of values (the N cases of each variable are assigned the integer values from 1 to N inclusive and no two cases share the same value). Difference between ranks for each case is represented by d_i.

Table 1 Variables used in the models

Dependent	Independent (categorical/continuous)					
	Cooperation	Innovation	Financing	Expenditures	Enterprise/Subsidiaries	Other
TURNMAR	CO	INN_G	FUNLOC	RRDIN	ENMRG	LARMAR
	CO_GP	INN_S	FUNGMT	RRDEX	ENOUT	GP
	CO_SUP	INN_P	FUNEU	RMAC	ENWEUR	
	CO_CUST			ROEK	ENNWOTH	
	CO_COMP					
	CO_UNI					
	CO_GOV					
	CO_CONS					

Legend - TURNMAR - % of turnover in new or improved products introduced during 2010-2012 that were new to the market, CO – cooperation arrangements on innovation activities, CO_GP – co-operation partner: other enterprises within enterprise group, CO_SUP – co-operation partner: Suppliers of equipment, materials, components, or software, CO_CUST – co-operation partner: clients or customers, CO_COMP – co-operation partner: competitors or other enterprises in sector, CO_UNI – co-operation partner: universities or other higher education institutions, CO_GOV – co-operation partner: government or public research institutes, CO_CONS – co-operation partner: Consultants and commercial labs, INN_G – introduced onto the market a new or significantly improved good, INN_S - ontroduced onto the market a new or significantly improved service, INN_P – introduced onto the market a new or significantly improved process (method of production; logistic, delivery or distribution system; supporting activities), FUNLOC - Public funding from local or regional authorities; FUNGMT – public funding from central government, FUNEU - public financial support from the EU, RRDIN - expenditures in intramural R&D in 2012 (% of total turnover), RRDEX - expenditures in extramural R&D in 2012 (% of total turnover), RMAC – expenditures in acquisition of machinery in 2012 (% of total turnover), ROEK - expenditures in acquisition of external knowledge in 2012 (% of total turnover), ENMRG - merge with or take over another enterprise, ENOUT - sell, close or outsource some of the tasks or functions of the enterprise, ENNWEUR - establish new subsidiaries in [home country] or in other European countries, ENNWOTH - establish new subsidiaries outside Europe, LARMAR – largest market in terms of turnover between 2010-2012 (1 – local or national, 0 – other), GP - part of the group of enterprises. Source: own research

4. DATA ANALYSIS AND RESULTS

To answer our hypothesis, we firstly analyzed the influence of each variable independently and measured their direct influence on % of turnover in new or improved products (new to the market). Table 2 shows the results of two mutually independent regression models – for the Czech Republic and Estonia. The first was assembled to analyze the situation of companies in manufacturing industry in the Czech Republic and the correlation coefficient of this model reached the value of 0.502. The coefficient of determination reached 0.252. P-value of the model was measured at 3.1 E-05. There was thus a rejection of the null hypothesis. The model could be regarded as significant. The second model analyzed situation of companies in manufacturing industry in Estonia. The correlation coefficient of this model reached the value of 0.706. The coefficient of determination reached 0.498. P-value of the model was measured at 1.2 E-04. There was thus a rejection of the null hypothesis.

Table 2 shows that only few determinants (from different groups) directly influence dependent variable – in the Czech Republic: (1) Expenditures in intramural R&D (most significant); (2) service innovation; (3) selection of the market (domestic; foreign); in Estonia: (1) cooperation with other enterprises within enterprise group; (2) establishment of new subsidiaries outside Europe; (3) public funding from central government; (4) cooperation with clients or customers; (5) participation in the groups of enterprises. Results

show that e. g. direct national and European public financing in the Czech manufacturing industries was completely insignificant (FUNGMT: 0.901; FUNEU: 0.532).

In Estonia, there, for example, were not found direct impacts of implementation of innovation on dependent variable (INN_P: 0.133; INN_S: 0.402). Therefore, it was necessary to use combinations of factors because innovation does not rise in isolation. These combinations allow emerge of synergies that significantly influence innovative activities (see Tables 3). These results confirm our claims above.

Table 2 Variables used in models for the Czech Republic and Estonia and their values

Variables	Czech Republic		Estonia	
	p-value	sd	p-value	sd
RRDIN	0.000***	0.157	0.000***	0.350
RRDEX	0.644	0.211	0.630	1.855
RMAC	0.530	0.058	0.488	0.136
ROEK	0.992	0.592	0.328	12.36
FUNGMT	0.901	0.086	0.014**	0.110
FUNEU	0.532	0.105	-	-
INN_P	0.437	0.085	0.133	0.090
INN_S	0.017**	0.077	0.402	0.109
CO	0.667	0.104	-	-
CO_GP	-	-	0.000***	0.154
CO_UNI	0.105	0.114	-	-
CO_CUST	-	-	0.047**	0.137
CO_COMP	-	-	0.249	0.115
CO_SUP	-	-	0.643	0.083
ENMRG	0.752	0.082	-	-
ENNWOTH	-	-	0.007***	0.164
LARMAR	0.017**	0.088	-	-
GP	0.187	0.051	0.037**	0.114

Legend: ** significant at P<0.05; *** significant at P<0.01; sd = standard deviation. Source: own reserch

By combining determinants of innovation activities, regression models showed us creation of advanced factors´ combinations and significant links influencing turnover in new or improved products of companies. In the Czech manufacturing industry, largest market in terms of turnover (LARMAR) was proved as important determinant with influence on dependent variable - in combination with other variables (factors). For example, public financial support from the EU was shown as insignificant (Table 2 – FUNEU: 0.532). On the other hand, in combination with LARMAR, we found significant impact on % of turnover from innovated products (FUNEU*LARMAR: 0.043**). This is important finding, because as we can see, there is emerging inefficiency in provision of public financial support (both from national and European funds). For example, common combinations of national and European funds do not lead to significant effects (Table 3: FUNEU*FUNGMT*INN_P: 0.987; FUNEU*FUNGMT*CO: 0.282). Conversely, proper targeting of the market in combination with innovations lead to creation of significant links (e. g. INN_P*LARMAR: 0.047**). To reach more significant results, involvement of cooperation is necessary (Table 3: ENMRG*INN_S*CO: 0.004***; LARMAR*ENMRG*CO: 0.003***).

In Estonian manufacturing industry, after implementation of advanced regression models, significant combinations of factors were also found. As it was shown above (Table 2), implementation of innovation and cooperation on innovation did not directly influence innovative activities in manufacturing industry in Estonia. On the other hand, proper factors´ combinations lead to creation of links with significant impact. For example, implementation of service innovation in combination with cooperation with different partners leads to creation of strong significant links (in most cases, see Table 3): CO_GP*INN_S (0.004***); CO_CUST*INN_S (0.006***); INN_S*C0_COMP (0.009***). Results of regression models showed, that finding appropriate determinants of innovative activities is a complex process that is influenced by number of

factors – different for each country, also for each industry. Joint involvement of combinations of these factors was shown as important process positively influencing innovative activities of businesses in both countries – the Czech Republic and Estonia. Therefore, following our findings above, we can confirm our Hypothesis that Combination of determinants of innovative activities more significantly influence growth of turnover in new or improved companies' products in manufacturing industry in the Czech Republic and Estonia than the situation when these factors occur individually.

Table 3 Advanced combinations of variables in the Czech Republic and Estonia

	Czech Republic				Estonia	
	INN_P	INN_S	CO		INN_S	INN_P
FUNEU*LARMAR	0.029 (0.068)**	0.024 (0.090)**	0.009 (0.066)***	GP	0.004 (0.100)***	0.662 (0.081)
FUNEU*FUNGMT	0.987 (0.082)	0.411 (0.060)	0.282 (0.080)	CO_GP	0.004 (0.113)***	0.430 (0.077)
LARMAR*FUNGMT	0.027 (0.037)**	0.025 (0.051)**	0.543 (0.047)	CO_CUST	0.006 (0.071)***	0.210 (0.046)
LARMAR*INN_S	0.040 (0.080)**	-	0.653 (0.033)	CO_COMP	0.009 (0.051)***	0.099 (0.036)*
FUNGMT*ENMRG	0.837 (0.036)	0.033 (0.035)**	0.110 (0.044)	CO_SUP	0.461 (0.058)	0.034 (0.080)**
FUNEU*INN_S	0.587 (0.063)	-	0.028 (0.053)**	CO_COMP*FUNGMT	0.046 (0.047)**	-
LARMAR*ENMRG	0.152 (0.060)	0.0757 (0.062)*	0.003 (0.056)***	GP*CO_CUST	0.007 (0.097)***	0.018 (0.051)**
ENMRG*INN_S	0.264 (0.084)	-	0.004 (0.049)***	CO_GP*CO_CUST	0.006 (0.087)***	0.019 (0.036)**
ENMRG*CO_UNI	0.173 (0.047)	0.011 (0.024)**	-	FUNGMT*CO_CUST	0.087 (0.058)**	0.506 (0.031)

Legend: * significant at P<0,1; ** significant at P<0,05; *** significant at P<0,01; table shows p-values; values of sd are shown in brackets. Source: own research

5. CONCLUSION

In this study, we show the importance of combinations of different determinants of business innovation activities. Both, the Czech Republic and Estonia were regarded by OECD (2012) as strengthening economies focusing on the promotion of research, development and innovation. Specifically, in 2012: The Czech Republic was becoming one of the world's 20 most competitive nations and developing a knowledge economy, with a focus on innovation, infrastructure and institutions; Estonia was strengthening the private sector's R&D investment and innovation capability and the business environment for innovation. But nowadays we can see that neither of the countries had made such a development and growth, as expected. It is clear; most of studies explained the different factors influencing business innovation activities (in the past, e. g. Balachandra and Friar, 1997; also nowadays, e. g. Antonelli et al., 2013). However, there is a lack of studies explaining combinations of these factors, therefore we defined the hypothesis. The results of multiple linear regression models allowed us to confirm our hypothesis and to claim that determinants of innovative activities more significantly influence firms´ innovation activities in combinations with each other.

Our findings provide: (1) initial comparison of companies´ situation in manufacturing industry in the Czech Republic and Estonia; (2) practical implications for policy makers. In both countries, it is necessary to combine individual factors. Appropriate choice of market location and cooperation arrangements on innovation activities in combination with other determinants was shown as very significant in the Czech Republic. In Estonia, results of regression models showed us advanced results and concrete partners of collaboration that significantly affected the growth of turnover from innovated products. We can see that in Estonia, collaboration arrangements on innovative activities with different partners resulted in very

significant impacts. This could be one of the reasons, why Estonia has been regarded by European Commission as a highly networked and highly innovative country with dynamic economy. Therefore, companies in the Czech manufacturing industry should focus on a suitable choice of cooperation partners (e. g. clients or customers, competitors or other enterprises in sector). Results also showed that in both countries there is a growing inefficiency in provision of public subsidies (from national or European funds) – therefore, proper targeting of public subsidiaries is necessary. Not each collaboration and each innovation activity requires public funding. In most cases, companies are more effective when they are financing their activities by themselves (Fitchett et al., 2014). Public authorities can use other (non-financial) methods to support companies (Sonne, 2012). For further research, we aim to make deeper analysis of factors combinations influencing businesses´ innovation activities and also to make comparison with other European countries and with different industries.

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