Prokop, Viktor; Stejskal, Jan

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Viktor Prokop, Jan Stejskal

University of Pardubice, Czech Republic
Faculty of Economics and Administration
viktor.prokop@upce.cz

Introduction

The significance of innovation is supported by the fact that innovation has moved to the foreground in regional policy in the last decade and has been considered mandatory for surviving in a dynamic market environment (Tödtling & Trippl, 2005; Seidler-de Alwis & Hartmann 2008; Asheim, Boschma & Cooke, 2011). Therefore, innovation ranks at the top of policy agendas today, both in the fields of industrial and regional policy and among the different engines of economic growth. Nothing has received as much attention as innovation, which has been pinpointed as the fundamental driving force for economic growth and welfare as well as a key factor in competitiveness (Galia & Legros, 2004; Tödtling & Trippl, 2005; Matatkova & Stejskal, 2012; Hudson & Minea, 2013).

Competitiveness in the globalizing learning economy is not based on static comparative advantage but on dynamic competitive advantage, which can be influenced by innovation policies and supporting regulatory and institutional frameworks (Asheim & Coenen, 2006; Doh & Kim, 2014). Therefore, innovation plays a central role in attaining and sustaining competitive advantage. Innovation growth is seen as a mechanism to foster economic growth, and therefore regions capable of increasing their innovation potential benefit from further economic growth (Bilbao-Osorio & Rodríguez-Pose, 2004; Asheim & Coenen, 2006; Kafouros & Forsans, 2012). Together with learning and knowledge, the authors of (Houghton & Sheehan, 2000; Tödtling & Trippl, 2005; Baron & Tang, 2011) ascribe a critically important role to innovation and its influence on economic development and the competitiveness of firms, regions and nations.

In the so-called knowledge economy – together with the rate of technical progress – knowledge and its accumulation become in fact key production factors and increasingly determine productivity and growth (Houghton & Sheehan, 2000; Shih, Hsu, Zhu & Balasubramanian, 2012). These are the production factors that influence production, i. e., skills, learning, organization and innovation, where innovation – more than most other economic activities – depends on new economic knowledge, which is perceived to be the basic ingredient of the innovative process (Houghton & Sheehan, 2000; Audretsch & Feldman, 1996; Dois, Llerena & Labini, 2005; Martínez-Jurado & Moyano-Fuentes, 2014). Innovation and technological change depend on new economic knowledge more than most other economic activities.

Today, the increased complexity of knowledge processes influences firms, because organizations need to be able to respond to the growing demand for improved innovation (de Faria, Lima & Santos, 2010; Schilirò, 2010; Priem & Carr, 2012). Innovation is seen as a key driver of regional entrepreneurial creativity and investigates the underlying conditions that are essential for directing resources towards innovative use and for stimulating the region to become a strong innovative performer; on the other hand, innovation is not only a key source of progress but also an essential instrument in any development policy (Guellec & Wunsch-Vincent, 2009; Matatkova & Stejskal, 2012; Sleuwaegen & Boiardi; 2014;. The creation of innovation and learning are considered together to be key factors in regional development within institutional economics and have impact on the development and competitive position of companies; however, innovations do not arise within one company in isolation (Hajkova, 2010; Baron & Tang, 2011; Boons, Montalvo, Quist & Wagner, 2013). Therefore, firms have to search beyond their own boundaries, and these results in a rapidly growing number of firms developing a strong competitive position by co-creating new products and services with suppliers, customers, knowledge institutions, other firms and increasingly the creative sector (de Faria, Lima & Santos, 2010, Sleuwaegen & Boiardi; 2014).

Opportunities for growth exist in regions of all types and, as we have mentioned, innovation does not take place in isolation, rather interaction is central to the process of innovation. Thus, actual growth performance depends on how well a region (or enterprise) is able to mobilize its assets in order to fully exploit its potential for growth (Papacharalambous & McCalman, 2004). Innovative units (R&D departments within firms, universities, research centers, etc.) as well as local institutions and individuals interact with each other and with their external environment (Guellec & Wunsch-Vincent, 2009). Tsai and Wang (2009) add that collaboration with suppliers, customers and competitors enables a firm to deepen its existing technological competence, collaboration with research organizations helps a firm broaden its technological knowledge and firms can acquire new scientific knowledge to benefit their product or process innovations by interacting formally and informally with universities and research institutes (Cowan & Zinovyeva, 2013).

The aim of this paper is the identification and evaluation of specific important determinants of innovative activities that influence the economic growth of enterprises in the machinery industry in the Czech Republic by using own multiple regression models. Analyzed determinants of innovative activities are (i) total turnover, (ii) R&D expenditures, acquisition of external knowledge and total innovation expenditure, (iii) significant market, (iv) membership of a group of enterprises, (v) implementation of innovated goods, (vi) public financial support.

The structure of this paper is divided into following; Section 2 consists of theoretical background that clarifies the issue of innovation and their potential to influence economic growth. Section 3 will be dedicated to describe our methodology which utilizes own regression model and used data. In the last Sections will be discussed the main results and conclusions.

Theoretical background

Therefore, cooperation is important for companies, and thus many firms are relying more extensively on external alliances to acquire new technological knowledge using strategies such as technology licensing and collaborative agreements, because a fundamental prerequisite is the enhancement of strategically designed knowledge-based competencies such as technological know-how, process-product creativity skills and problem-solving expertise (Hadjimanolis, 1999; Schilirò, 2010; Alexander & Martin, 2013). We can say that innovation is an interactive, non-linear process in which actors (e. g., firms) interact with a manifold of other organizations (e. g., research institutes, customers, authorities, financial organizations) and institutions (e. g., regulations, culture), and this complex process, characterized by reciprocity and feedback mechanisms, determines the success of innovation (Papacharalambous & McCalman, 2004; Leydesdorff, Rotolo & De Nooy, 2013; Valgeirsdottir, Onarheim & Gabrielsen, 2014). Firms engaged in the innovation process are aware of the necessity of establishing R&D cooperation, because, when the firm improves its own R&D, external knowledge is more effective for the innovation process (Becker & Dietz, 2004; de Faria, Lima & Santos, 2010). It also leads to obtaining expertise which cannot be generated in-house; thus, collaboration with other firms and institutions in R&D is a crucial way of making external resources usable. It offers possibilities for efficient knowledge transfer, resource exchange and organizational leasing (Lee, Olson & Trimi, 2012). A significant element of cooperation is cooperation with the creative sector, because creativity is what makes people, firms and regions unique and represents the ability to find innovative solutions to problems, to create new products and processes, to set up new firms and to expand into new areas that create economic value (Sleuwaegen & Boiardi; 2014). In sum, a firm's decision to cooperate on innovation is driven by the fact that cooperation is an efficient way to improve the probability of the success of innovation projects.

Enterprises or regions (nations) need innovation in order to expand in a dynamic way, which is represented by new products, services, technology, operating systems and management methods and is a basic factor causing the development of the company, region (or nation); however, it does not always result in the creation of innovative activities and the implementation of innovation having a positive effect (Okwiet & Grabara, 2013). The authors of (Rodríguez-Pose, 1999; Tödtling & Trippl, 2005; Alegre & Chiva, 2008; Cassiman, Golovko & Martínez-Ros, 2010) dealt with problems connected to innovation, including barriers to innovation and system deficiencies (failures). Rodríguez-Pose (1999) adds that not all regions have the same capacity to assimilate and transform local innovation into economic activity. The reasons behind the formation of innovation-prone and innovation-averse societies are not just purely economic, because local social structures seem to play a significant role in the openness of any region to innovation, especially in the cases of regions with a lower capacity to transform their R&D efforts into economic growth (Wiesenthal, Leduc, Haegeman & Schwarz, 2012).

As we have stated, there are numerous cases where barriers to innovation have been created as a result. Hadjimanolis (1999) or Huang & Chi (2013) state that it is possible to classify barriers to innovation in various ways, but that it is possible to divide them generally into

external and internal. External barriers to innovation can be further subdivided into a) supply (difficulties in obtaining technological information, raw materials and financing), b) demand (customer needs, their perception of innovation's risk and domestic or foreign market limitations) and c) environment-related (various government regulations, antitrust measures and policy actions) (Alegre & Chiva, 2008). On the other hand, internal barriers can be further subdivided into a) resource-related (lack of internal funds, technical expertise, management time or culture), b) systems-related (out-of-date accountancy systems), c) human nature-related (the attitude of top managers to risk or employee resistance to innovation).

In addition to barriers to innovation, system deficiencies or system failures occur which result in low levels of research and innovation activities at the regional level (Cassiman, Golovko & Martínez-Ros, 2010; D'Este, Iammarino, Savona & von Tunzelmann, 2012). Researchers (Tödtling & Trippl, 2005; Cassiman, Golovko & Martínez-Ros, 2010) state that this is partly on account of organizationally thin regional innovation systems in which essential elements are missing or only weakly developed (e. g., the lack of a critical mass of innovative firms, a weak presence of other key organizations and institutions and low levels of clustering). Another reason is locked-in regional innovation systems, which are characterized by over-embeddedness and over-specialization in declining traditional sectors and outdated technologies. The third group of system deficiencies is fragmented regional innovation systems, which suffer from a lack of networking and knowledge exchange between actors in a system, leading to insufficient levels of collective learning and systemic innovation activities (Dellestrand, 2011).

Innovation has also been becoming more complex for small and medium enterprises (SMEs), which are the engine of economic growth and technological progress (Zeng, Xie & Ming Tam, 2010). It is not just large established enterprises in particular but also SMEs that play an important role in innovation and in enhancing economic performance and contributing to regional development by innovating technology and strengthening their capacity (Tsai & Chyuan Wang, 2009). SMEs also play an important role in economic performance, because they exert a strong influence on the economies of many countries through their ability to innovate new products and processes in the rapidly changing and increasingly competitive global market and because they provide the sources for most new jobs and innovations (Brammer, Hoejmose, & Marchant, 2012). However, innovation is a difficult undertaking, especially for firms with little experience and limited resources (Guellec & Wunsch-Vincent, 2009; Tsai & Chyuan Wang, 2009; Zeng, Xie & Ming Tam, 2010).

SMEs in both less developed and industrialized countries are expected to face relatively more barriers to innovation than large firms due to inadequate internal resources and expertise (Alegre & Chiva, 2008; D'Este, Iammarino, Savona & von Tunzelmann, 2012). Therefore, the performance of SMEs in terms of industrial renewal, job creation, export growth, and productivity demands the attention of policy makers (Foreman-Peck, 2013). It is necessary for SMEs to unite different companies, research facilities, suppliers and customers into a dense innovation network that enables them to share knowledge and profit from complementary competencies. Moreover, the situation is even harder for small firms in less developed countries, because they have to face the limitations of an inadequate infrastructure in addition

to the liability of their size (Vrgovic, Vidicki, Glassman & Walton, 2012). SMEs also encounter problems such as a lack of financing, difficulties in exploiting technology, constrained managerial capabilities, low productivity and regulatory burdens (Mina, Lahr & Hughes, 2013).

As we have stated, innovation is considered a territorially embedded process and cannot be fully understood independently of the social and institutional conditions of every society; therefore, the innovation potential of any territory is embedded in the conditions of that territory (Guellec & Wunsch-Vincent, 2009; Cooke, 2013). Territories rely not just on their internal capacity to produce innovation either by direct inputs in the research process or by the creation of innovation-prone systems in the local environment, but also on their capacity to attract and assimilate innovation produced elsewhere. The respective capacities of innovating and assimilating innovation have regularly been considered two of the key factors behind the economic dynamism of any territory (Ponds, Van Oort & Frenken, 2010). Therefore, determinants that influence innovative activity are listed in the following section.

The potential of innovation creation is related to the process of leasing determined by the relationship of the company and its environment; therefore, companies' innovation behavior depends on the interaction of firm-specific determinants (Becker & Dietz, 2004; Hagel & Brown, 2011). The most often cited determinants for innovative activities include company size, technological intensity, group membership and activities dedicated to innovation, internal and external R&D and its intensity, training and cooperation, environmental factors such as using external resources, market structures and industrial technology level (Tsai, 2009). Sleuwaegen and Boiardi (2014) list four contextual factors that influence a firm's innovation rate. They are a) the presence of high-quality cluster-relevant innovation inputs, b) the intensity of local competition and the extent to which innovation is rewarded, c) the presence of demanding customers and d) the availability of clusters of vertically- and horizontally-related industries. It is also important to have the appropriate political institutions to provide the right environment to make innovation activity possible (they form the "rules of the game" or "the codes of conduct" that reduce uncertainty in the economic system); thus, the institutional environment is crucial to economic behavior and performance and growth in the long run (Papacharalambous & McCalman, 2004; Rodríguez-Pose & Crescenzi, 2008). To summarize, interactions between companies and a large variety of institutions (the financial system, laws and practices governing labor markets, etc.) are crucially important for generating and diffusing innovation as long as companies recombine existing artifacts into innovative solutions with the support of a wide variety of institutions that provide the knowledge and necessary skills (Galia & Legros, 2004). However, there are a number of cases where we encounter a situation for which this cooperation is not successful and the participants are not able to transform cooperation into innovation and this leads to crowding-out effects (Ordanini, Miceli, Pizzetti & Parasuraman, 2011). The reason can be human capital, because human capital can be seen as an enabling factor in profitable innovation; therefore, without sufficient skills, firms (or regions, nations) benefit less from innovation, because they do not have the requisite complementary capabilities or absorptive capacity (Lin, Wu, Chang, Wang & Lee, 2012).

In order for individual companies to be innovative, they should focus on activities such as improving their capacity for permanent innovation or creation generation, fostering innovation through promoting entrepreneurship, using the innovative company´s potential to keep a strong competitive position based on key competencies, investing in smart infrastructure and upgrading workers' skills (Ponds, Van Oort & Frenken. 2010). They should further focus on the ability to predict the future and think in a prospective way, constant connection with the customers, getting to know their present and future needs, having a team of creators and innovators to guarantee a high level of company innovation (Mollick, 2012), having an appropriate range of information, encouraging R&D and investment, steering market actors towards innovation-related investments (AlAzzawi, 2012), accelerating activities for which barriers may otherwise have been too high and the flexibility to adapt to changing operating conditions.

Data and methodology

For the data collection we used a harmonised questionnaire of EU Member States from the Community Innovation Survey (CIS) carried out in the Czech Republic for the period 2010-2012 by combining sample (stratified random sampling) and exhaustive surveys. In total, data on 5,151 Czech companies with at least 10 employees was obtained (response rate greater than 60 %). For the purpose of this study, we filtered 284 companies, i.e., only companies from the machinery industry into our data group – specifically, countries covering NACE categories 29-30.

The basic characteristics of the dataset are given in Table 1. The innovation activity of the industries was estimated by calculating the number of companies that introduced a new product or process to the market. Table 1 shows that there are significant differences between sectors.

Table 1. Average values of numerical determinants for machinery industry

	InnovP	InnovP*	InnovS	InnovS*	InnovP+S	Without innovation
TURN12	559,799,589	594,853,616	942,771	35,996,798	35,054,027	116,767,234
EMP12	773.67	697.98	168	392.77	416.85	245.14
RRDIN12	4,276,111	4,748,737	200	472,826	472,626	155,741
RRDEX12	8,456,971	8,502,417	0	45,446	45,446	36,989
ROEK12	954,707	956,954	0	2,247	2,247	92,511
RTOT12	21,703,694	22,685,974	2,270	984,550	982,280	1,233,905
N	104	132	3	31	28	149

Legend: TURN12 – total turnover in 2012, EMP12 – average number of employees in 2012, RRDIN12 – in-house R&D expenditure, RRDEX12 – external R&D expenditure, ROEK12 – acquisition of external knowledge,

RTOT12 – total innovation expenditure in 2012, InnovP – innovated only products, InnovP* - innovated products (possible with/without services), InnovS – innovated only services, InnovS* - innovated services (possible with/without products), InnovP+S – innovated products and services.

Target group of machinery industry firms can be described also help with the indicators presented in table 2. From all analyzed firms only 163 (58 %) were some innovations (mostly the product). This part of the target group uses some public subsidies for cost reductions. The minority of them asked for the national subsidies (15.49 %). then the EU authorities (13.38 %). The lowest support flowed from local level.

Table 2. Descriptive characteristics of the target group

	Product innovation	**Service innovation**	**Total**
Characteristics	46.48%	10.92%	57.39%
National subsidies	13.03%	2.46%	15.49%
Local subsidies	1.06%	0.00%	1.06%
EU subsidies	10.21%	3.17%	13.38%
Collaboration during the innovation process	28.17%	6.69%	34.86%
Private investment to intercompany R&D	34.51%	8.80%	43.31%
Knowledge acquisition from external sources (purchase)	8.10%	1.76%	9.86%
Knowledge acquisition of the knowledge sector	22.54%	3.87%	26.41%

Source: own research

Only 34.86 % of all analyzed firms have collaborated during the innovation process. Majority of collaborators was from product innovators. The rate of collaborators is very low. This can be explained by the fact that the machinery industry competes mainly through design and product innovation and any cooperation would reduce their chance of succeeding with product innovation. These results correspond to the share of knowledge acquisition from external sources (e. g. purchase). This is only 8.10 %. The firms from the machinery industry acquired the largest share of new knowledge from knowledge sector (universities and research organizations).

For analysis of the relationship between variables we used the simple linear regression model. This model was fitted to investigate the relationship between the growth of total turnover between the years 2010 – 2012 and selected determinants of innovative activities of firms (table 2). Simple linear regression models are represented by an equation of the form:

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \quad (1)$$

where y_i is the *i* measurement of the dependent variable, β_0 and β_1 are regression coefficients known as the intercept and the slope respectively, x_i is the *i* measurement of the independent variable and ε_i is its associated error term (Angus, Casado & Fitzsimons 2012).

Results and analysis

Input variables listed in Table 3 were analyzed by simple regression model.

Table 3. Input variables of the model

Dependent variable	Independent variables - categorical	Independent variables - continuous
GTUR	LARMACS	RRDIN/ TURN
	GP	RRDEX/ TURN
	INPDGD	ROEK/ TURN
	FUNGMT	RTOT/ TURN
	FUNEU	(RRDIN+RRDEX)/TURN

Legend: GTUR - the growth of total turnover between the years 2010 – 2012, LARMACS - significant market (domestic/foreign), GP - part of the group of enterprises, INPDGD - implementation of innovated goods, FUNGMT - public financial support from central government, FUNEU - public financial support from the EU, TURN - total turnover, RRDIN - in-house R&D expenditure, RRDEX - external R&D expenditure, ROEK - acquisition of external knowledge, RTOT - total innovation expenditure.

Regression model explained 84.07 % of the total variance in the data. By analyzing of parameters has been found that the individual variables affecting GTUR variable. Of the following variables and their interactions (e.g. GP*FUNEU: we examine how these two determinants GP and FUNEU affect the dependent variable) were identified positive but marginal link:

- LARMACS
- GP
- INPDGD
- FUNGMT
- FUNEU
- LARMACS*GP
- LARMACS*INPDGD
- GP*INPDGD
- LARMACS*FUNGMT
- GP*FUNGMT
- INPDGD*FUNGMT
- LARMACS*FUNEU
- GP*FUNEU
- INPDGD*FUNEU
- FUNGMT*FUNEU
- LARMACS*GP*FUNGMT
- LARMACS*INPDGD*FUNGMT
- LARMACS*GP*FUNEU
- LARMACS*INPDGD*FUNEU
- GP*INPDGD*FUNEU
- LARMACS*FUNGMT*FUNEU

- INPDGD*FUNGMT*FUNEU
- LARMACS*GP*FUNGMT*FUNEU

The following variables were evaluated as insignificant

- RRDIN/ TURN
- RRDEX/ TURN
- ROEK/ TURN
- RTOT/ TURN
- (RRDIN+RRDEX)/TURN
- LARMACS*GP*INPDGD
- GP*INPDGD*FUNGMT
- LARMACS*GP*INPDGD*FUNGMT
- LARMACS*GP*INPDGD*FUNEU
- LARMACS*GP* FUNGMT*FUNEU
- GP* INPDGD*FUNGMT*FUNEU

Results are in the following table.

Table 4 Determinants with influence on innovative activities

	p	t	sd
LARMACS	0.000009	4.6031	0.37551
GP	0.000002	4.9638	0.38810
INPDGD	0.000000	-11.6001	0.35634
FUNGMT	0.000000	13.1045	0.48507
FUNEU	0.000327	3.6806	0.47396
LARMACS*GP	0.000000	10.1429	0.23620
LARMACS*INPDGD	0.000000	10.1623	0.39307
GP*INPDGD	0.000000	9.9270	0.42242
LARMACS*FUNGMT	0.000000	-5.4368	0.29632
GP*FUNGMT	0.000000	-6.3400	0.30058
INPDGD*FUNGMT	0.000000	8.9156	0.45816
LARMACS*FUNEU	0.000000	-7.4476	0.29975
GP* FUNEU	0.000000	-8.2153	0.30055
INPDGD* FUNEU	0.000000	8.5220	0.49831
FUNGMT* FUNEU	0.000000	-11.1263	0.57903
LARMACS*GP*FUNGMT	0.000000	12.3687	0.18827
LARMACS* INPDGD*FUNGMT	0.011463	2.5609	0.25271
LARMACS*GP*FUNEU	0.000000	-12.4237	0.18750
LARMACS*INPDGD*FUNEU	0.000000	-15.4590	0.29923
GP*INPDGD*FUNEU	0.000000	-14.3493	0.32108
LARMACS*FUNGMT*FUNEU	0.000000	11.6688	0.19190
INPDGD*FUNGMT*FUNEU	0.000000	12.7555	0.18891
LARMACS*GP*FUNGMT*FUNEU	0.000000	-7.4589	0.56546
LARMACS*GP*FUNGMT*FUNEU	0.000000	-12.6601	0.18824

Legend: ***significant at P<0.05, R = 0.916896, R^2 = 0.840698
Source: own processing

The greatest influence on the dependent variable was analyzed in determinants of the market supported by the government, and support by EU funds. Table 4 shows that there are large numbers of factors that affect the innovation activity, but their significance are marginal.

Conclusions

Seemingly unsatisfactory results of our analysis, however paradoxically, provide interesting conclusions. There are a large number of internal and external factors which affect the innovation capabilities of the firms. The results of our analyses show that only some are significant. Analysed determinants as a whole influence the dependent variable of more than 82 %. However their individual significance is negligible.

Unlike the machinery sector no significant effect was determined based on the internal and external R&D expenditures, and also total costs and revenues. On the other hand, determinants of the market supported by the government, and support by EU funds were examined.

Further research should lead to a more detailed analysis of the various determinants of innovative capacity of firms. Further analysis should also take account the industries and social and economic characteristics of the regions where the firms are localized. New separate research should be devoted to the influence of knowledge, methods of their acquisition and cooperation. Even these determinants have a positive impact on the innovative capacity of firms.

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