EFFECTS OF INNOVATION ACTIVITY IN METALLURGICAL ENTERPRISES IN EASTERN POLAND

EFEKTY DZIAŁALNOŚCI INNOWACYJNEJ W PRZEDSIĘBIORSTWACH PRZEMYSŁOWYCH SEKTORA METALURGICZNEGO W POLSCE WSCHODNIEJ

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Abstract: The main goal of this paper is to introduce the effects of innovation activity in industrial enterprises that represent metallurgical sector and how they influence main attributes of innovation activity. In the paper author used propability theory - probit modeling. The main hypothesis of this paper is the claim that the various effects of innovation activity in can influence it in different directions. The research had been made among 126 industrial enterprises representing metallurgical sector in Eastern Poland. What is new and distinctive about the article, that this topic was not so far described using a selected test method - probit modelling.

Streszczenie: Głównym celem niniejszego opracowania jest przedstawienie efektów działalności innowacyjnej jak wpływają one na główne atrybuty działalności innowacyjnej. W badaniach autor wykorzystał teorię prawdopodobieństwem - modelowanie probitowe. Główną hipotezą jest twierdzenie, że różne efekty działalności innowacyjnej moą wpływać na nią w rżnokierunkowo. Badanie zostało wykonane wśród 126 przedsiębiorstw przemysłowych reprezentujących sektor metalurgiczny w Polsce Wschodniej. Nowością z punktu widzenia naukowego jest to, że temat ten nie został do tej pory opisany za pomocą wybranej metody badawczej.

Słowa kluczowe:innowacje, przemysł, sektor metalurgiczny, region

Key words: innovation, industry, metallurgical sector, region

INTRODUCTION

Nowadays, due to the internationalization and globalization of processes, most industrial companies – most significantly manufacturers - are part of a more or less formal innovation networks. In everyday language, innovation is most often associated with production processes, especially with the technique, technology and introduction of new products (Janasz 2006). Also in this context, and thus in the sphere of economy and technology, the word “innovation” has been formulated and implemented in economic

science. The first definition of innovation was proposed by J. Schumpeter, according to whom "innovation" is the launch of a new or improved product, entering into a new market and new or improved methods of production (Schumpeter 1960). As it comes to industry, the metallurgical sector is often considered to be an "invisible" sector. Although this sector brings together a number of large companies, it is dominated by SME's acting as subcontractors for various industries, such as automotive, aerospace, machinery, transport, construction and food.

The structure of the industry in "catching up" countries is generally not particularly modern (competitive) in nature, characterized by a low share of high technology products in international trade. Observation of the most developed economies suggests that despite the increasing importance of internationalization of the economy, the region is still seen as an alternative opportunity not only to survive, but also the development of the SME sector in the new constellation of the global market. For this reason, one of the main objectives of the EU regional policy is to ensure the smooth adaptation of industrial structures on a regional basis in the face of global changes in the social, economic and technological way (Frenkel 2003).

Companies from the metallurgical sector in Poland are usually relatively small and this makes this sector "invisible". Moreover, it entails financial and commercial consequences. Nevertheless, the metallurgical industry in Poland consists of flexible, versatile, innovative and service-oriented enterprises. They also offer a lot of job vacancies (Obróbka… ,2010). The main advantage of this sector is that it uses an intensive approach to technology and an innovative attitude.

Globalization processes tend to lead to specialized companies implementing innovative solutions. The metallurgical industry and its unique products are difficult to copy, which in turn promotes the continuous increase of technological innovations.

The article is a continuation of the author's reflections on the conditions of innovative industrial enterprises in Eastern Poland and the effects of innovation activity, hence the research methodology is the same in all articles in this field (Szopik-Depczyńska 2015).

1. EFFECTS OF INNOVATION ACTIVITY - THEORETICAL BASIS

Enterprises incur expenditures on innovation activity for various reasons. This may be to facilitate increases in the efficiency and volume of production or the level of employment. In addition, some companies are forced to implement new solutions because they need to adapt to new market regulations. However, there is no way at this point to emphasize measurable, beneficial effects of implemented innovations on the economy of the entire

region. New or improved solutions, through a process of diffusion, reach out to companies to improve their general productivity. This also applies to competitors who adopt the latest, more efficient solutions in order to mitigate the advantage of technological market leader (Bukowski, Szpor, Śniegocki 2012). Taking into consideration the above deliberations, the basic aim of the study was to use probit modeling tool to determine the significance of innovation activity (in particular investments in innovations and implementation of new solutions) and the effects of such processes. The main hypothesis of this paper is the claim that the effects of innovative activity of metallurgical enterprises is dependent on a diverse range of factors and that innovative activity can influence the effects of these processes in different directions. The study was conducted on the basis of a standardized questionnaire amongst a group of 126 companies of metallurgical sector Western Poland (regions: Warmia and Mazury, Podlaskie, Lubelskie, Swiętokrzyskie, Podkarpackie). These companies are distinguished based on the code of Eurostat NACE rev. 1. Analyses were static and carried out within a three-year period time, according to the OECD methodological standards of innovation research.

2. METHODOLOGY OF THE RESEARCH - PROBIT MODELING

Analyses were based on the theory of probability. In the case where the value of the dependent variable is dichotomous it is not possible to use multiple regression. Therefore, logistic regression is used. Its advantage is that the analysis and interpretation of results are similar to those used in classical regression methods. Thus, the selection of variables and methods of testing hypotheses have a similar pattern. However, there are also some differences, such as more complicated and time-consuming calculations and no need to calculate residuals (Stanisz 2007). Pioneers in the use of the logistic curve were P.F. Verhulst and R. F. Pearl, J. Berkson (Berkson 1944) and in Poland, as it comes to innovation activity in Poland - A. Świadek (Świadek 2011) and followers (Czerniachowicz, Świadek, Tomaszewski 2013). To examine the impact of the level of technology used in companies for their innovation activity the calculus of probability was used. This is due to the dichotomous nature of the data accepted for testing, for example, taking the value of 0 (when the test will not occur, for example, the company did not incur any expenditure on R&D) or 1 (when studied phenomenon occurs, for example, the company incurred expenses on R&D). Independent variables were the attributes of innovation activity highlighted in accordance with international standards set by OECD and Eurostat. These variables were (OECD 2005):

• investment in innovation activities in relation to their structure (costs related to conducting R&D, investments in new fixed assets, such as buildings, facilities, land and machinery, companies investment in new software);

• the implementation of new products and processes, including those not directly related to the production;

• cooperation in the field of new solutions in subject aspect (vertical and horizontal cooperation with the institutions and the scientific field).

On the side of the dependent variables and thus being influenced by the above mentioned attributes are the effects of innovation activity, also according to OECD methodology.

2. EFFECTS OF INNOVATION ACTIVITY IN METALLURGICAL SECTOR - ABSOLUTE VALUES

In the case of the effects of innovationAB activity (presented in Table 1) in absolute terms, no percentages were calculated since the survey completed by the representatives of the companies allowed the selection of more than one answer at a time. As it comes to the effects of innovation, the biggest number of companies - 46 - increased production flexibility. More than 40 companies improved the quality of the offered products and led to its extension (43 and 42 companies). So in that case there had been significant effects associated with the market side of production processes. 39 companies had entered to new markets and 29 increased production capacity.

Table 1. Effects of innovation activity in metallurgical companies in Eastern Poland

Lp.	**Effects of innovation activity**	Number of enterprises
1.	Increased range of products	42
2.	Entering new markets	39
3.	Improved quality of products	43
4.	Increased production flexibility	46
5.	Increase production capacity	29
6.	Reduced unit labor costs	18
7.	Reduced unit material and / or energy intensity of production	9
8.	Limiting the harm to the environment	12
9.	Filling the regulations and standards	16

Source: own study based on research.

A few less companies saw reduced unit labour costs, fulfillment of regulations and standards, limited harm to natural environment and reduced unit material and / or energy intensity of production; 18, 16, 12 and 9 responses respectively.

It is, however, important to note that without concurrent efforts to keep improving the productivity or labour productivity, such upward trends may not continue in time; it is strongly dependent on the current business cycle, which can affect the emerging problems in the area of cost rationalization.

3. EFFECTS OF INNOVATION ACTIVITY IN METALLURGICAL SECTOR - PROBIT MODELING

Research results in tables 2A and 2B (tables separated due to high number of dependent variables) show that the innovation activity attributes have the greatest positive impact on the effect of reduced unit labour cost. 6 from all 9 models with a positive sign occurred, which means that almost all of the attributes of innovation activity increase the probability of occurrence of this very important feature of production activity in metallurgical enterprises.

Table 2A Values of parameters for independent variables "effects of innovation activity" in probit models describing innovativeness of metallurgical companies in Eastern Poland

Effects of innovation activity **Innovation attribute**	**Increased range of products**	**Entering new markets**	**Improved quality of products**	**Increased production flexibility**
Expenditures on R&D activity				0,47x-0,52
Investments in the so far non-applied (including):				
a) in buildings, premises and lands				
b) in machines and technical devices	0,74x-1,00			
Computer software				0,48x-0,63
Launching new products	1,07x-0,99	0,74x-0,87	0,82x-0,82	
Implementation of new technological processes (including):				
a) production methods	0,66x-0,73		0,52x-0,64	

Effects of innovation activity Innovation attribute	Increased range of products	Entering new markets	Improved quality of products	Increased production flexibility
b) by-production systems				
c) support systems				

Source: own study based on research.

Table 2B Values of parameters for independent variables "effects of innovation activity" in probit models describing innovativeness of metallurgical companies in Eastern Poland.

Effects of innovation activity Innovation atribute	Increased production capacity	Reduced unit labor costs	Reduced unit material and / or energy intensity of production	Limiting the harm to the environment	Filling the regulations and standards
Expenditures on R&D activity		1,14x-1,64			
Investments in the so far non-applied (including):					
a) in buildings, premises and lands					
b) in machines and technical devices	-1,33x+1,87	0,95x-1,86			
Computer software	-0,73x+1,21	1,00x-1,78			0,66x-1,58
Launching new products	-0,83x+1,19				
Implementation of new technological processes (including):					
a) production methods	-1,37x+1,49	0,97x-1,60		0,78x-1,74	
b) by-production systems	-1,04x+1,11	0,91x-1,42	0,87x-1,83	0,94x-1,70	0,75x-1,42
c) support systems	-0,79x+0,91	0,96x-1,30	0,76x-1,66		0,89x-1,36

Source: own study based on research.

Investments in machines and technical devices, launching new products and implementation of new production methods have the positive effect on increasing the range of

products. The importance of this effect is confirmed by the results of the study in absolute terms.

On the other hand, which is a negative phenomenon, 6 of all 9 innovation attributes have a negative impact on increased production capacity (negative sign of the parameter). They decrease the probability of occurrence of this particular effect of innovation activity. This might not be a good sign, due to the fact, that expanding activities (such as increased range of products or entering to the new markets) often require increasing production, (including enlargement of the machine park) as well as improving quality of products. When it comes to improved quality of products, research results show that the probability of such effect can only be increased by launching new products (what seems to be a reasonable) and implementation of new or improved technological processes and more specifically - production methods.

When it comes to the manufacturing sphere, implementation of by-production systems (in the area of logistics or distribution) increases the probability of reducing unit material and/or energy intensity of production, limitation of the harm to the environment and filling the regulations and standards. Implementing support systems (such as software in accounting) has a positive impact on reducing unit material and/or energy intensity of production and filling the regulations and standards. Moreover, new or improved production methods increase the probability of limitation of the harm to the environment an investments in the so far non-applied computer software have positive effect on increasing production flexibility and filling the regulations and standards.

In many cases there were no statistically significant models (empty spaces in tables 2A and 2B). Generally though, the research results show that the attributes of innovation activity affect the effects of such activity in a positive way (except for the effect of increasing production capacity). In the majority of cases probit models with a positive sign of the parameter have been reported.

2. CONCLUSION

The main opportunities for innovation in the metallurgical sector are cooperation and networking in the field of innovation and R&D. There is a need to improve relations and communication within the supply chain, the intention of which will be to effectively stimulate innovation. There should also be improvement to the conditions for innovation programs - mainly for SME's - by increasing the involvement of representatives of SME's in the creation of new programs for innovation and competitiveness of the sector. Universities must increase transfer of knowledge to the metallurgical SME sector. The organization of clusters can be very useful in this matter.

This research study has proved that described conditions are important for innovation activity in every regional industrial system, therefore these factors should be considered in innovative strategies and innovation policy in Poland.

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