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*Barriers to Technological Innovation and International Market
Orientation of Polish Manufacturing Enterprises*

Bariery innowacji technologicznych i międzynarodowa orientacja rynkowa polskich przedsiębiorstw
przemysłowych

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Słowa kluczowe: innowacyjność, konkurencyjność, polskie przedsiębiorstwo, kwestionariusz Community Innovation Survey.

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Introduction

Recent literature as well as business practices provide evidence that innovation is regarded as an essential tool for stimulating the growth of enterprises and economies. High risk and uncertainty are the features that distinguish innovation from activities connected with the routine management of the company. In this context, the aim of the paper is to examine the importance of innovation obstacles and their impact on innovation performance as well as on international market orientation of Polish manufacturing enterprises.

The paper is organised as follows. The first part of the paper provides an overview of the literature and research hypotheses. The second part contains the sample description, methods applied and the operationalization of variables. In the third

part, the results of the data analysis are presented. Conclusions, implications, and limitations of the research make up the final section.

1. Overview of literature and hypotheses development

The firm-level studies reveal a positive relationship between innovation and international competitiveness (Halpern, 2007; Montobbio, 2003; Soete, 1981).

Bleaney and Wakelin (2002) argue that non-innovating firms are more likely to be present with sales internationally if they have cost advantage, while innovating firms are more likely to export if they implement more innovations. Other studies show that the probability of exporting as well as the intensity of export are positively influenced by R&D and successful innovations (Gourlay and Seaton, 2004). As for the impact of process innovation on firms export behaviour, no such strong evidence has been found (Clausen and Pohjola, 2009). However, it should be noted that majority of studies refer to mature economies where firms compete mostly based on differentiation rather than cost/price advantage, whereas firms' competitive strategies in CEE countries, including Poland, suggest that they still resemble many characteristics of cost/price advantage and their abilities to increase differentiation-based competitive advantage are still insufficient, although improving (Wziątek-Kubiak, Balcerowicz and Pęczkowski, 2009; Stojcic, Hashi and Telhaj, 2011). For the purpose of this paper, technological product and process (TPP) will be defined as technologically implemented new products and processes and significant technological improvements in products and processes (Oslo Manual, 2005, p. 31).

Given the results of the abovementioned studies, the first research hypothesis is placed:

H1. There is a positive relation between the product (H1a) and/or process (H1b) innovation and international market orientation of Polish manufacturing firms.

Determinants of innovation output, can be broadly divided into two groups: factors that enhance innovation performance and those that hamper innovation. In this article we will argue, following the proposal of Oslo Manual (2005), that **innovation barrier** is every factor that slows down or even prevents innovation activity. It can also adversely affect innovation activity to the extent that it does not bring in the expected results. Extended lists of different innovation barriers are presented in several research articles (Larsen and Levis, 2007; Guijrrro- Madrid *et al.*, 2009; Buse *et al.*, 2010; Saatcioglu and Ozmen, 2010). Most often they are categorized according to resource / competence areas of firm resources; often they are grouped as internal and external ones. Larsen and Levis (2007) distinguish financial and marketing skills shortages, as well as management and personal characteristic barriers and other barriers (such as long time of new product development, lack of external professional partners, lack of trust). Canadian Survey of Innovation and Advanced Technology (SIAT) divides impediments to advanced technology adoption into five categories: cost-related; insti-

tution-related; labour-related; organization-related and information-related (Baldwin and Lin, 2002). Similar list of internal and external barriers present Buse *et al.* (2010). Authors argue that without a thorough understanding of internal business processes and profound analysis of business environment, including both internal and external barriers, full usage of global opportunities that may strengthen innovation capabilities, is significantly limited.

Different taxonomy is proposed by D'Este *et al.* (2012), as they divide innovation barriers into revealed barriers – those reflecting the degree of difficulty of the innovation process and deterring barriers – seen by the firm as insurmountable.

Guijrrro-Madrid *et al.* (2009) presents the impact of different innovation barriers on product, process and management innovation among Spanish firms. Process and management innovations are negatively influenced by internal barriers – human resources and weak financial position. At the same time, barriers originating from the environment influence them positively. The importance of barriers to innovation in new product development process is raised by Larsen and Lewis (2007). Based on investigation of case studies of British firms awarded for “ground-breaking product innovation”, Authors argue that enterprises are as likely to overcome the existing barriers, as to ignore them, meaning that both strategies may lead to success.

Complementarities between innovation barriers and their interactive effects are investigated in several articles from both streams of literature.

Galia and Legros (2004) have found that the obstacles related to risk, cost and finance, organizational attitude, lack of specific skills or information, and those related to the institutional environment and customer responsiveness are complementary for firms which postponed innovative projects, while for these which abandon projects, the group is much reduced and covers only barriers concerning risk, cost, finance, organizational attitude, skilled personnel, and technological information. Significant correlation between lack of financial resources and excessive risk, high cost and cost difficult to control is found in many works (Guijrrro-Madrid, 2009; Hewitt-Dundas, 2006; Galia and Legros, 2004).

Those results are similar also for Polish economy (Wziątek-Kubiak and Pęczkowski, 2013; Lewandowska, 2012; Okoń-Horodyńska, 2008; Okoń-Horodyńska and Zachorowska-Mazurkiewicz, 2007). Following this extended literature review, covering both international as well as domestic positions, the following hypothesis is placed:

H2. Innovation barriers adversely affect introduction of product (H2a) innovation and/or (H2b) process innovation within Polish manufacturing firms.

Having in mind the high probability of the link between innovation and international market orientation as well as the link between innovation barriers and innovation performance, the last hypothesis is proposed:

H3. Innovation barriers negatively affect international market orientation of Polish manufacturing firms.

2. Sample characteristic and methods applied

The study uses the micro data from questionnaire PNT-02 (Polish version of *Community Innovation Survey*) for the period 2008–2010, conducted in Poland in 2011 by Central Statistical Office (GUS). The research covered the original sample of medium and big sized enterprises from Polish industry NACE section B (Mining and Quarrying); section C (Manufacturing); section D (Electricity, Gas, Steam, and Air Conditioning Supply) and section E (Water Supply, Sewerage, Waste Management, and Remediation Activity). Chi-square with column proportions was applied to verify statistically significant differences between distinguished clusters of *Active Innovators* (those who introduced product and/or process innovation in 2008–2010) and *Non Active Innovators* ($p < 0.05$) (Table 1).

Table 1. Sample characteristic

| Sample characteristic | <i>Active Innovators</i> , n=2795 | | <i>Non Active Innovators</i> , n=4988 | | Total sample, N=7783 | | |
|---|--------------------------------------|-------|---------------------------------------|------|-------------------------|------|------|
| | N | % | N | % | N | % | |
| Introduction of product innovation | 2055 | 73.5a | 0 | 0b | 2055 | 26.4 | |
| Introduction of process innovation | 2169 | 77.6a | 0 | 0b | 2169 | 27.9 | |
| Introduction of marketing innovation | 1107 | 39.6a | 402 | 8.1b | 1509 | 19.4 | |
| Introduction of organizational innovation | 1349 | 48.3a | 458 | 9.2b | 1807 | 23.2 | |
| Firms size | Medium | 1885 | 67.4b | 4356 | 87.3a | 6241 | 80.2 |
| | Large | 910 | 32.6a | 632 | 12.7b | 1542 | 19.8 |
| Capital group | Polish capital group | 478 | 17.1a | 406 | 8.1a | 884 | 11.4 |
| | Foreign capital group | 615 | 22a | 527 | 10.6b | 1142 | 14.7 |
| | Independent firm | 1702 | 60.9b | 4055 | 81.3a | 5757 | 74.0 |

Note: Each letter (a, b) denotes a subset of categories whose column proportions (Bonferroni method) differ significantly from each other at the 0.05 level.

Within the sample of innovative firms 73.5% of them declare introduction of product innovation, 77.6% – the introduction of process innovation, nearly 40% – marketing innovation and 48.3% – organisational innovation. Medium size firms constitute 67.4% of the sample and large firms 32.6%. The share of firms belonging to Polish owned capital groups accounts for 17.1%, whereas firms of foreign capital groups amounts to 22%. The remaining 60.9% firms in the sample are independent firms.

The explorative character of study influenced the data analysis methods.

To verify the relationship between the introduction of product and process innovation and sales orientation of surveyed firms, as well as relation between innovation barriers and innovation performance, logistic regression models (a type of probabilistic statistical classification model used to predict a binary response from a binary predictor) were constructed.

In order to minimize the number of variables factor, Oblimin rotation with Kaiser normalization (Kaiser, 1958) was used. The reliability of the factor analysis results

was proven with the Cronbach's α . Based on the analysis of critical values between parameters, a hierarchy of barriers determining innovation performance as well as international market orientation was established.

3. Results

Logistic regression results for the relationship between the implementation of innovation and sales destinations of firms will be broken down based on the market type into: "local market" (within the home country), "domestic (national) market"; EU, EFTA or EU candidate country ("EU/EFTA")¹ and „other markets". Other logistic regression models will be constructed in order to investigate the influence of financial as well as market/knowledge related barriers on both the innovation activities and sales orientation of surveyed firms.

Table 2. Results of logistic regression for the relationship between the introduction of product and process innovation and the sales market of Polish manufacturing enterprises, results for *Active Innovators*, n=2795

| Type of innovation | Target market | | | | | | | |
|--------------------|----------------|---------|-------------------|---------|------------|---------|-----------------|---------|
| | "Local market" | | "Domestic market" | | "EU, EFTA" | | "Other markets" | |
| | B | Exp (B) | B | Exp (B) | B | Exp (B) | B | Exp (B) |
| Product | 0.292** | 1.34 | 0.211* | 1.234 | -0.173* | 0.841 | -0.111 | 0.895 |
| Process | -0.08 | 0.923 | 0.339** | 1.404 | 0.305*** | 1.357 | 0.276*** | 1.318 |

B – Logistic regression estimate of the predictor; Exp(B) odds ratio for p at the level of: p<0.10, *p<0.05, **p < 0.01, *** p < 0.001. Note: Each letter (a, b) denotes a subset of categories whose column proportions (Bonferroni method) differ significantly from each other at the 0.05 level.

Results of Table 2 show that there is a positive relationship between introduction of process innovation and **sales on both EU markets (B=0.305***) and "other markets" (B=0.276***)**. The probability of being in a group of Polish firms selling on EU markets and "other markets" increases by a bit less than 150 percent (Exp(B)=1.357) (Exp(B)=1.318) with each additional indication for the process innovation. This leads to the conclusion that hypotheses **H1b** was **supported**, whereas **H1a** about the possible relation between product innovation and international sales orientation was **rejected**.

Factor analysis of innovation barriers using Oblimin rotation (KMO=0.895; $\chi^2(55)=53081.37$; p<0.001) allowed to determine 2 underlying factors which explain 74.48% of the Variance. The first factor named – "market and knowledge barriers" (*InnoBarrMarkKnow*) explains 60.01% (Cronbach's $\alpha = .891$) of the Variance, the

¹ Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden, United Kingdom.

second one – “financial barriers” (*InnoBarrFin*) explains 14.47% (Crombach’s $\alpha = .874$) of the Variance (details see Table 3).

Table 3. Rotation Matrix for innovation barriers of Polish manufacturing enterprises

| Type of innovation barrier | Component | |
|---|------------------|-------------|
| | InnoBarrMarkKnow | InnoBarrFin |
| Lack of information on technology | 0.855 | |
| Lack of information on markets | 0.864 | |
| Lack of qualified personnel | 0.782 | |
| Difficulties in finding cooperation partner | 0.786 | |
| Market dominated by established firms | 0.702 | |
| Uncertain demand for innovative products | 0.748 | |
| Lack of funds within firms or group | | 0.898 |
| Innovation cost too high | | 0.873 |
| Lack of finance from sources outside firm | | 0.868 |
| Cronbach Alfa | 0.891 | 0.874 |

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.

The group of “market/knowledge barriers” (*InnoBarrMarkKnow*) consists of such obstacles as: lack of information on technology, lack of information on markets, lack of qualified personnel, difficulties in finding cooperation partner, market dominated by established firms, uncertain demand for innovative goods or services. The group of “financial barriers” (*InnoBarrFin*) covers: lack of funds within firms or group’, lack of finance from sources outside firm, and too high cost of innovation.

The relation between both financial (*InnoBarrFin*) and market/knowledge (*InnoBarrMarkKnow*) related barriers and introduction of innovation show that they have significant impact on the introduction of both the product (*InnoProd*) as well as process innovation (*InnoProc*) by Polish firms. For both types of innovation, “market/knowledge related barriers” are more significant than “financial barriers”. Table 4 for details.

Table 4. Results of logistic regression for the relationship between the perception of financial and market/knowledge innovation barriers and introduction of product and process innovation, results for *Active Innovators*, n=2795

| Type of innovation barriers | InnoProd | | InnoProc | |
|-----------------------------|-----------|---------|-----------|---------|
| | B | Exp (B) | B | Exp (B) |
| InnoBarrMarkKnow | 0.461***a | 1.586 | 0.451***a | 1.57 |
| InnoBarrFin | 0.302***b | 0.74 | 0.399***b | 0.671 |

B – Logistic regression estimate of the predictor; Exp(B) odds ratio for p at the level of: $p < 0.10$, $*p < 0.05$, $**p < 0.01$, $*** p < 0.001$

Each subscript letter denotes a subset of categories whose column proportions (Bonferroni method) differ significantly from each other at the 0.05 level.

The abovementioned results of logistic regression allows us to **support** hypotheses **H2a** and **H2b**.

Table 5. Results of logistic regression for the relationship between the perception of financial and market/knowledge innovation barriers and the sales market, results of the whole sample, n=7783

| Type of innovation barrier | Target market | | | | | | | |
|----------------------------|----------------------|---------|--------------------|---------|---------------------|---------|---------------------|---------|
| | "Local market" | | "Domestic market" | | "EU, EFTA" | | „Other markets" | |
| | B | Exp (B) | B | Exp (B) | B | Exp (B) | B | Exp (B) |
| InnoBarrMarkKnow | -0.13b | 0.88 | 0.01b | 1.01 | -0.08b | 0.930 | -0.09b | 0.91 |
| InnoBarrFin | 0.39*** _a | 1.46 | 0.19* _a | 1.21 | 0.19** _a | 1.21 | 0.20** _a | 1.28 |

Each subscript letter denotes a subset of categories whose column proportions (Bonferroni method) differ significantly from each other at the 0.05 level.

Source for Tables 1–5: own calculations in IBM SPSS21 based on Polish CIS 2008–2010

Another logistic regression model was built in order to verify the relation between both financial (*InnoBarrFin*) and market/knowledge related barriers (*InnoBarrMarkKnow*) and market orientation of firms. The results revealed that there is statistically a significant relation between financial barriers and market orientation of surveyed firms; this also related to external markets. Based on the above, the hypothesis **H3** has been **supported** for financial barriers influence. Details, see Table 5 above.

4. Conclusions, limitations, and implications

The obtained results do not confirm the re-orientation of Polish firms toward gaining differentiation-based international competitive advantage resulting from product innovation. It seems that surveyed firms still base their strategies on international markets on cost/price advantage resulting, among others, from introduction of process innovation.

The importance of financial and market/knowledge related barriers for the introduction of both product and process innovation as well as international market orientation (in case of financial barriers) show that there is a striking need for both improving financial standing of firms as well as their knowledge base. Deeper analysis may reveal which type of financial obstacles – those related to lack of financial resources within the firm or those coming from external sources – are perceived as more important obstacles for both innovation performance and market orientation of Polish firms. Introduction of innovative financial mechanisms (Błach, 2013), still rare in Polish economy, may result in strengthening of the firms innovation performance.

Certain limitations of the study provide opportunities for future research. The research setting is restricted to the medium and big sized enterprises and the results cannot be transferred towards the small firms, which still constitute the majority of

Polish economy. The results are based on one wave of PNT-02 questionnaire, so the long-term analysis is much limited.

Nevertheless, the analysis provides some hints for further research of connections between innovation and market orientation as well as the impact of innovation barriers on both innovation performance and international competitive advantage of Polish firms.

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Barriers to Technological Innovation and International Market Orientation of Polish Manufacturing Enterprises

Abstract. The aim of this paper is to assess the influence of innovation barriers for technological innovation on the innovation performance as well as sales market orientation of Polish firms. The analysis is conducted on the sample of 7783 manufacturing enterprises participating in the survey GUS PNT–02/CIS for the years 2008–2010. The results show statistically significant relations between innovation barriers and both innovation performance and international market orientation of surveyed firms. Various advanced statistical methods were used in order to verify research hypotheses. The results of the study reveal complexity of interactions between analysed variables leading to the conclusion that innovation process cannot be reduced to linear relationships only.

Bariery innowacji technologicznych i międzynarodowa orientacja rynkowa polskich przedsiębiorstw przemysłowych

Abstrakt. Celem niniejszej pracy jest ocena wpływu barier innowacji technologicznych na sprawność innowacyjną i międzynarodową orientację rynkową przedsiębiorstw polskiego przemysłu przetwórczego. Analizę przeprowadzono na próbie n=7783 przedsiębiorstw, biorących udział w badaniu GUS PNT-02 za lata 2008–2010. Wyniki wskazują na statystycznie istotne zależności między barierami a sprawnością innowacyjną oraz orientacją rynkową badanych firm. W celu weryfikacji hipotez badawczych, w badaniu zastosowano szereg zaawansowanych metod statystycznych. Wyniki wskazują na złożoność interakcji pomiędzy analizowanymi zmiennymi, prowadząc do wniosku, że proces innowacji nie może być zredukowany wyłącznie do relacji liniowych.