

Elżbieta WOJNICKA-SYCZ^{1, 2}

Piotr SYCZ¹

Piotr WALENTYNOWICZ¹

Jarosław WAŚNIEWSKI¹

INTERNAL DETERMINANTS OF FIRMS' INNOVATIVENESS

This article presents an analysis of the determinants of a firm's innovativeness deriving from its internal potential and characteristics. The analysis is based on research carried out on 1355 firms that applied for public subsidies from the Innovative Economy Operational Program in 2014. The methods applied are logit regression, comparative analysis and literature review. The analysis is structured according to Bielski's model of an organization indicating the following subsystems: management, goals and values, people, technology and structure. This analysis shows that firms' innovativeness depends mainly on the following factors: their level of cooperation with academia, longer presence on the market, being highly equipped with modern technologies, being a medium-sized or large firm, as well as being an industrial rather than a service firm. All of the organizational subsystems play a role in determining innovativeness, but the most important ones are the technical subsystem, psycho-social subsystem and the subsystem of structure.

Keywords: *firms' innovativeness, research and development activity, determinants of innovativeness, organisation*

1. Introduction

Innovation is now regarded as a key factor in the development of both businesses and economies. The first comprehensive definition of innovation was given by the Austrian economist Joseph Schumpeter. According to him, innovations are: the introduction

¹Faculty of Management, University of Gdańsk, ul. J. Bażyńskiego 8, 80-309 Gdańsk, Poland, e-mail addresses: elzbieta.wojnicka-sycz@ug.edu.pl, syczpiotr1@gmail.com, piotr.walentynowicz@ug.edu.pl, jaroslaw.wasniewski@ug.edu.pl

²Faculty of Architecture, Gdansk University of Technology, ul. Gabriela Narutowicza 11/12, 80-233 Gdańsk, Poland.

of a new product or a product with a higher quality, introduction of a new method of production, the opening of a new market, the use of new materials or semi-finished products, the creation of a new organizational structure. He also distinguished between innovations created by a creative destruction, where new entrants with new technologies undermine the position of previously dominant firms, and innovations created by creative accumulation, where mainly large firms introduce innovations by developing their technological potential in a progressive way [18].

Innovations are not a goal in themselves, but a way to increase the market share or profitability and value of a company. By introducing new products and services, enterprises create and respond to the needs of customers, which generates profits and helps them survive. Innovation does not always rely on research and development activity, but often it depends upon the transfer of external knowledge and technology, which may be adopted by a firm. Innovation also embraces the introduction of significant changes into the marketing or organisation of firms [11]. Firms aiming to be world leaders, or at least internationally competitive, will try to introduce products or processes which are at least new to domestic markets and not only to the firm. Such innovations will usually be based on the research and development activity carried out in a firm or in cooperation with external partners, especially from academia. This will be especially the case for organisations who are aiming to be world leaders.

To achieve the benefits of innovation and research and development, it is important to understand the determinants. On the organisational level, determinants of innovation may be such organisational factors as strategic management, human capital – the qualifications of the employees, managerial skills, cooperation with external partners, a pro-innovative organizational culture, etc. These factors will be associated with different organisational subsystems. According to Bielski's model of an organisation, the following subsystems are present in organizations: management, goals and values, people, technology and structure [4, p. 7]. The hypothesis of the research is that the determinants of innovativeness derive from varied organisational subsystems, as successful innovation must be based on holistic activity integrated throughout the whole organisation, constituting an interconnected system which is as strong as its weakest element. An auxiliary hypothesis tested in the article is that determinants may differ according to the type of innovations: technological or non-technological, as well as according to the innovation and R&D activities of enterprises.

The above hypothesis is tested on the basis of research into the significance of particular organisational determinants of innovativeness with regard to the implementation of innovation in Polish firms that applied for public subsidies from the *Innovative Economy Operational Program 2007–2013* (OP IE). The research sample is composed of 1355 firms that applied for innovation grants, both successfully and unsuccessfully. The research was carried out by WYG PSDB in 2014 [25], commissioned by the Ministry for Infrastructure and Development and co-financed by the European Fund for Regional Development. This study into the organisational determinants of the innovativeness of

firms applying for OP IE funds is part of a broader study evaluating the Operational Program. The research was based on a CATI questionnaire. This article uses only some of the data collected by the questionnaire. The questions in the questionnaire connected with the determinants of firms' innovativeness were formulated by the authors of the article.

There have been several studies on the determinants of business innovativeness in Poland, for example: a study on enterprises from the Wielkopolski region carried out in 2011 by Zalewski and Skawińska [26], which found that the possibility of entering new markets/increasing sales, and new needs of commercial customers stimulate the innovative activity of firms or Pichlak [15] that analysed the impact of leadership on organisational innovation, communication systems, organizational culture, resources – financial, material and human, organizational structure and other determinants of innovativeness on the basis of empirical research carried out in the Silesia region. Wojnicka [22] found that interactions in the innovation process, especially with academia, increased the level of innovativeness in terms of products new to the branch, as well as the profitability of enterprises. Grudowski et al. [8] studied the conditions of employee involvement in the innovative activity of Pomeranian enterprises. This study showed that in the majority of enterprises, the management staff were interested in promoting employee participation in the process of innovation, but only a few managed to achieve this effectively.

In this article, a study into the determinants of innovativeness at organisational level has been presented, based on a broad sample ($n = 1355$) that is representative of the whole of Poland in terms of the general population of firms with a high propensity to innovate, i.e., those that applied for public grants for innovations. This large sample made it possible to use econometric modelling based on logit regression, which is used for the analysis of micro data from questionnaire research where answers are coded as binary variables.

2. Literature review

Determinants of innovativeness may derive from the nature of a firm's environment such as the impact of public grants and policy or presence of suitable international or local partners in the innovation process. However, to use external opportunities, an organisation must have a suitable strategy, make efforts aimed at innovation and build its innovative potential. As an organisation is an interconnected system, the determinants of innovation should be based in various organisational sub systems, in order to build a holistic internal environment promoting innovative processes.

Literature studies in Polish and international literature have focused on the external determinants of firms' innovativeness, which however require suitable responses in terms of shaping the innovative potential of an organisation. These studies indicate such

determinants as public policy and grants for innovation, cooperation with external partners such as scientific institutions, interconnections between the innovative and international activities of firms, or overall regional economic performance which determines, for example, the demand for innovation.

Innovation is connected with external benefits, which means that innovators are not able to take possession of all the profits from innovation, but society also benefits from them. This results in the need for state support in the form of grants, and the protection of intellectual property rights, to achieve a socially optimal level of innovation. One of the most important stimulants (or potentially de-stimulants) of innovation is thus public policy on innovation, which should aim to overcome barriers to innovation such as high risk, access to finance, costs of networking and cooperation, and difficulties faced by innovators in reaping the benefits from innovations due to imitations. To overcome barriers to cooperation in the innovation process, there may be bridging institutions – intermediaries, which are financed or co-financed by public funds. In recent years, innovation policy in Poland has been mainly financed by the European Union's structural funds, although such projects are also co-financed by domestic money (public and private). The study of Wojnicka-Sycz and Sycz [24] showed that public subsidies were important determinants of firms' R&D&I activity in Poland.

Some studies point to a strong relationship between innovation and international trade by domestic businesses. For example, in the study by Özçelik and Taymaz [14] it was found that innovations and R&D activities were crucial to the international competitiveness of Turkish manufacturing firms, while technology transfer through licence and know-how agreements were not found to be significant determinants of export performance. Similarly, research into 119 firms from three branches connected with smart specializations in the Pomorski region in Poland by the Institute of Development [23] showed that, in particular, a high priority placed on research and development but also greater overall innovativeness, increased the chances of success of firms on international markets, while both export activity and innovation lead to a more optimistic prognosis of the future profits of firms.

The study by McAdam et al. [9] carried out in the UK on the basis of a questionnaire survey of 2086 SMEs indicated that innovation was most strongly related to government grant aid, firm size, industrial sector, and the approach taken by the firm to organise how it develops products and processes.

Avermaete et al. [2] did research into small food- and drink-manufacturing enterprises in two Belgian regions. It was found that innovation was regarded as essential by most small firms producing food. However, some aspects of innovation depended on the age of the company, company size and the economic performance of a region.

Romijn and Albaladejo [16] explored the determinants of innovativeness in small electronics and software firms in the UK. They found the following significant factors: the importance of R&D, the role played by the regional academic base in nurturing high-

tech spin-offs, and proximity to suppliers, to be crucial factors determining the innovativeness of high tech firms. Spillover effects from universities on SMEs' innovativeness was also found by Clifton et al. [5].

According to many studies and current models of innovation and innovation management (open innovation, user driven innovation, design driven innovation, the concept of systems of innovation) participation in innovative networks is crucial to increasing the innovativeness of firms, which leads to increased profitability. In 2003, research carried out on 283 Polish firms located in places with high concentrations of employment in the same branch showed that interactions of firms with external partners in the innovation process, and especially cooperation with universities and knowledge-based business services, increased the chances that a firm introduced innovations new to the market, leading in an indirect way to higher profitability and an increased market share. Moreover, the qualifications of personnel and their mobility in the form of participation in conferences and fairs, which enhances tacit knowledge transfer, were found to be of special importance for developing an efficient innovation process. Research on 504 small and medium sized firms in Poland in 2001 showed that those cooperating with universities and research institutions in R&D had higher shares of revenue from exports and those cooperating with other enterprises had higher average shares of revenues from sales of innovations [22, p. 7]. The stream of research on communication based on "global pipelines" or "local buzz" and the absorptive capacity of firms shows that having international channels of communication, such as operating on international markets or participation in international networks with strong local cooperation with external partners and a suitable absorptive capacity, are determinants of firms' innovativeness, although the effects and patterns of gaining them may differ for firms of different size (see [3, 10, 1]).

Identifying the value and location of external knowledge and building pipelines to access that knowledge is, however, only part of the challenge when attempting to boost a firm's innovative capability. An equally immense task is to establish the ability to assimilate the information arriving through these pipelines and to apply it successfully towards commercial ends, that is, knowledge management [3, p. 44].

According to a study carried out in Spain on about 12 000 firms, greater technological intensity in a firm's environment fosters cooperation with universities and research institutions (U&RI). However, it was affirmed that companies with internal R&D capabilities are more likely to cooperate with U&RI irrespective of the industry [7, p. 249].

Varied existing studies into the determinants of innovativeness deriving from firms' internal environments in the Polish or international literature have usually focused on a set of determinants of innovation.

A meta-analysis of the relationships between organizational innovation and 13 of its potential determinants carried out by Damanpour [6] found statistically significant associations for specialization, functional differentiation, professionalism, centraliza-

tion, managerial attitude toward change, resources for technical knowledge, administrative intensity, slack resources, and external and internal communication. An important source of innovation in enterprises are its employees, especially management teams that generate the most creative solutions [11, p. 41).

According to Özsomer et al. [13] strategic posture is a major factor determining the innovativeness of firms, while an organization's structure mediates the effects of strategic posture, uncertainty, and hostility.

Empirical results from the research of Salavou [17] in Greece indicated that technology orientation was more important than customer orientation in explaining the novelty of products to customers and thus increased the chances of a firm producing a new product beyond the previous experiences and consumption patterns of consumers. Moreover, it was found that an orientation towards learning enhanced by stronger orientations towards customers and technology constituted a key organisational capability in creating more unique new products for the market.

Using data from 71 companies in Singapore, a study by Wan et al. [21] examined the relationship between firms' innovativeness and six of its potential determinants. The results indicated positive and significant relationships between organizational innovation and the following: decentralized structure, presence of organizational resources, belief that innovation is important, willingness to take risks and willingness to exchange ideas. The study did not find a significant relationship between greater belief that innovation is important among employees and organizational innovation itself. On the other hand, an important determinant of innovation is the commitment to the development of new ideas by providing psychological support and resources. Walentynowicz et al. [20] present in detail how to organize such support.

The stream of research examining the associations between levels of innovativeness and organisational factors has found that innovation is facilitated by such organisational characteristics as size, degree of centralization, degree of formalization, the level of resources and knowledge of how to innovate, access to knowledge and external information, etc.

Some theories show that innovation is facilitated by informal organisational structures which are believed to encourage new ideas. It has also been hypothesized that a greater variety of specialists would provide a broader knowledge base in an organisation and increase the cross fertilization of new ideas. Slack resources might enhance innovativeness by encouraging organizations to experiment with new products and processes [21].

The research carried out for this article was designed to tackle the internal determinants of firms' innovativeness. However, internal determinants that are the results of actions undertaken by firms to use external opportunities supporting innovation were also considered.

3. Research methods

The research on 1355 enterprises applying for grants from OP IE to assess the significance of internal determinants of firms' innovativeness considered the following aspects connected with particular subsystems of an organisation. These aspects were self-assessed by representatives of the companies during an interview based on a structured questionnaire:

1. Subsystem of management:
 - level of intensity of strategic planning in the company,
 - high-level managerial abilities to implement innovative solutions in the enterprise,
 - wide access to free financial resources.
2. Subsystem of goals and values:
 - strong focus on risky breakthrough solutions,
 - high intensity of research on customer needs in the company (important in a demand-driven approach to innovation),
 - importance of activity on the international market.
3. Psycho-social subsystem:
 - number of employees,
 - highly qualified employees,
 - high self-assessment of the ability to successfully apply for public funds.
4. Technological subsystem:
 - high-tech equipment with modern machines and technologies, software,
 - co-operation with academia,
 - carrying out R&D projects.
5. Subsystem of structure:
 - strong cooperation with external entities and the use of outsourcing (the concept of open innovation and the innovative system),
 - intensive staff rotation (employee mobility as a stimulant of innovation in the concept of an innovative system),
 - age and size of the company as measured by turnover,
 - ownership structure – the share of Polish capital.

The dependent variables analyzed reflect innovativeness and the R&D activity of firms. Apart from the impact of particular determinants on innovativeness, the hypothesis to be tested was whether innovativeness made the development prospects of firms better in terms of increasing revenues, profits, employment, expenditure on innovation and predicted revenue from the sale of new products/services over the next 2 years. Logit regression was used to analyze the association of specific characteristics with dependent variables describing particular aspects of innovativeness, e.g., the monitoring of customers' needs should stimulate marketing innovations, the ability of strategic planning or managerial skills should promote organisational innovations, and high-tech

equipment support innovations in technological products. An additional control variable in the econometric analysis was a binary variable stating whether or not an enterprise was a manufacturing firm. The analysis was carried out in two ways:

In the whole sample of 1355 firms, 716 enterprises were beneficiaries of OP IE support, and 639 companies unsuccessfully applied for support from the population of all of the OP IE's applicants. The results of the survey were analyzed according to a division into innovative and non-innovative enterprises. Firms that had introduced product, process, marketing or organizational innovation within 2 years before applying for support from POIG were classified as being innovative, while those that had not introduced any such innovation were classified as non-innovative. In this way, mainly those that were able to implement such projects without public support from OP IE were indicated as being innovative. Enterprises that had implemented any type of innovation within 2 years before applying for OP IE funding constituted 41.6% (564) of the companies surveyed, and those that had not implemented any innovation before applying for OP IE funding amounted to 58.4% (791) of the total number of enterprises examined. For the purposes of the analysis, the variables were presented in the form of zero-one variables. The analysis of the significance of differences between the percentage of enterprises with a given trait among innovative and non-innovative enterprises was carried out using the non-parametric Mann–Whitney U test for independent samples, which can be used in the case of dichotomous variables.³

An analysis of the impact of various organizational characteristics on firms' innovativeness and its specific types, as well as on R&D activity and developmental prospects, was carried out on the basis of the results of the survey for firms that received funding from OP IE. This analysis was done using logistic regression. Logistic regression, also called logit modelling, is used to model dichotomous outcome variables. Binary logistic regression is a special type of regression where a binary response variable is related to a set of explanatory variables, which can be discrete and/or continuous. Using a logit model, the log odds of the outcome are modelled as a linear combination of the predictor variables. The logit regression equation estimates the probability that the value of a dependent variable will be 1 for a given set of parameter estimates and values of explanatory variables⁴.

The logit models developed in this article take the following form:

$$P(Y_n = 1 | \mathbf{X}) = \Lambda(\mathbf{X}\beta) = \frac{\exp(\mathbf{X}\beta)}{1 + \exp(\mathbf{X}\beta)} \quad (1)$$

³http://www.naukowiec.org/wiedza/statystyka/test-u-manna-whitneya_755.html, accessed on 12.12.2017.

⁴<https://onlinecourses.science.psu.edu/stat504/node/149>, accessed on 12.12.2017.

where $A(\mathbf{X}\boldsymbol{\beta})$ is a logistic cumulative distribution function, Y_n are variables reflecting the R&D&I activity of firms, with $n = 1, \dots, N$ denoting the number of a firm, \mathbf{X} is a vector containing a set of determinants of innovation, and $\boldsymbol{\beta}$ is a vector of parameters.

4. Results

The results of the comparative analysis are presented in Tables 1 and 2. As Table 1 shows, in terms of the management subsystem, the single significant difference between innovative and non-innovative firms was a much higher share of entities assessing the level of strategic planning in the company to be intensive amongst innovative organizations. No difference was noticed with respect to the assessment of managerial capabilities or share of firms having access to free financial resources. In the case of the subsystem of goals and values, innovative firms were significantly more likely to perceive themselves as having a strong focus on breakthrough solutions.

Table 1. Differences in terms of the self-rating of determinants of innovativeness connected with the subsystems of management, goals and values and technology [% of firms]

Variable	Non-innovative	Innovative	<i>p</i> -value ^a
Management			
Intense strategic planning in the company	56.03	70.16	0.03
Managerial abilities to implement innovative solutions in the enterprise assessed as being high	63.30	71.55	0.52
Wide access to free financial resources	33.33	43.74	0.05
Goals and values			
Strong focus on risky breakthrough solutions	45.21	58.41	0.02
High intensity of research by the company on customer needs	44.33	53.60	0.38
Company operating mainly on international markets	15.43	20.23	0.02
Technology			
Cooperation with academia on innovative projects during the last 12 months	19.68	31.10	0.00
Carrying out R&D projects during the last 12 months	32.27	54.99	0.00
Carrying out R&D projects before applying for a grant from OP IE	0.18	43.87	0.00
Cooperation with academia before applying for a grant from OP IE	21.81	44.37	0.00
Highly rated equipment with modern machines and technologies, software.	57.27	74.34	0.00

^aIn Mann–Whitney *U* test.

Source: [19] based on [25].

Table 2. Differences in terms of self-rating of the determinants of innovativeness connected with the psycho-social subsystem, subsystem of structure and prospects [% of firms]

Variable	Non-innovative	Innovative	<i>p</i> -value
Psycho-social subsystem			
Medium-sized or large company – over 49 employees	21.63	39.57	0.00
Qualifications of employees assessed to be high	72.52	84.96	0.58
Ability to successfully apply for public funds assessed to be high	43.09	52.72	0.28
Structure			
Company set up before 2005	39.18	67.51	0.00
Company with 100% Polish ownership	89.89	88.62	0.39
Company with a turnover of over PLN 10 million per year	21.45	40.96	0.00
Intensive staff rotation	8.51	11.50	0.35
Strong cooperation with external entities and the use of outsourcing	21.28	25.41	0.74
Prospects for the next 2 years			
Prospects for increasing sales revenues	69.50	78.51	0.00
Prospects for increasing profits	68.09	74.21	0.01
Prospects of increasing employment	41.67	54.11	0.00
Prospects of increasing outlay on innovation	48.23	59.04	0.00
Prospects of increasing revenue from sales of innovative products/services	61.88	69.66	0.00

^aIn Mann–Whitney *U* test.

Source: [19] based on [25].

Additionally, a higher share of innovative entities were mainly focused on international markets. A similar share of innovative and non-innovative firms assessed the market research carried out in their companies as being high intensity. In terms of the technological subsystem, all of the analyzed characteristics of this subsystem (cooperation with academia, carrying out R&D projects and highly-rated equipment with modern machines, technologies and software) were more frequent in the innovative group. A similar share of innovative and non-innovative firms assessed the qualifications of their employees and ability to successfully apply for public grants as being high. The single difference in terms of the psycho-social subsystem was the number of employees – a higher share of innovative companies employed more than 49 employees. A higher share of older firms (originating before 2005) and those with a turnover of over 10 million PLN in 2013 are observed amongst innovative firms. No significant differences were perceived in terms of staff rotation or cooperation with external entities and usage of outsourcing. However, a higher share of innovative companies were expecting an increase in sales revenues, profits, increase in employment, growth in outlay on innovation and greater revenue from the sale of innovative products and services.

Table 3. Logit models based on the research into enterprises that received support from PO IG ($n = 716$)

Explanatory variables	Dependent variables					
	1	2	3	4		5
Constant	-1.19 $p = 0.01$	-1.48 $p = 0.01$	0.16	-0.89 $p = 0.01$	-0.98 $p = 0.01$	-1.78 $p = 0.01$
Very highly qualified employees	-0.35 $p = 0.05$		0.35*			
Cooperation with academia before OP IE project	0.6 $p = 0.01$	0.72 $p = 0.01$	1.36 $p = 0.01$	-0.61 $p = 0.01$	-0.57 $p = 0.01$	
Firm began operating before 2005	0.94 $p = 0.01$					
Very high propensity to take risks	0.08					
Medium-sized or large enterprise	0.64 $p = 0.01$	0.56 $p = 0.01$	0.85 $p = 0.01$	0.52 $p = 0.01$		
Very high level of monitoring of customers' needs		0.58 $p = 0.01$				
Operating mainly on the international market		-0.4 $p = 0.1$				
Intensification of cooperation with academia due to the project			1.28 $p = 0.01$	2.48 $p = 0.01$	2.48 $p = 0.01$	1.52 $p = 0.01$
Polish capital			-1.32 $p = 0.01$			
Key meaning of the project to a firm's development				0.33 $p = 0.1$		
Manufacturing firm					0.73 $p = 0.01$	
Managerial abilities in the firm assessed to be very high				-0.35 $p = 0.1$		
Possesses a large amount of high-tech equipment						0.54 $p = 0.01$
McFadden's pseudo R^2	0.11	0.05	0.22	0.17	0.18	0.1

1 – Introducing a product innovation before receiving funding from PO IG, 2 – Introducing a marketing innovation before receiving funding from PO IG, 3 – R&D activity during the previous year, 4 – Introducing product innovations in the previous year, 5 – Introducing process innovation in the previous year. Models obtained using logit regression. The tables do not present any values of average marginal effects in order to interpret the estimated coefficients, as only the direction of impact on the variables is measured.

Source: authors' calculations in Gretl based on the research carried out by WYGPSDB ([25]).

Analysis with the use of logit regression was carried out on the basis of the sample of 716 firms which obtained support from the *Innovative Economy Operational Program in Poland* in the years 2007–2013 (Table 3). The results of the econometric modelling indicate that the likelihood of a surveyed firm implementing innovation was significantly higher if it had cooperated with academia before the project co-financed by OP IE, if the company had been in existence for a long time – since before 2005, and if it was a medium-sized or large company; and the likelihood decreased when a firm

perceived its employees to be very highly qualified. On the other hand, when staff were perceived to be highly qualified, the likelihood of a firm carrying out R&D projects increased. Qualified, creative staff are important, especially for firms focusing on broader scale innovations requiring R&D.

Implementing marketing innovations was positively associated with cooperating with academia, being a relatively large (medium-sized or large) company and the opinion that a firm studies the needs of its customers to a very high degree. Implementing marketing innovations was negatively associated with firms declaring that their main market was international. Marketing innovation may be a substitute for technological innovations, which are important for international competitiveness. Moreover, it may be easier to introduce marketing innovations on the better known domestic market.

R&D activity in the past year is positively associated with the perception of a company as being equipped with highly qualified employees, being a larger firm, the intensification of cooperation with academia as a result of a project with OP IE, and negatively associated with a dependence on a purely Polish capital base. Cooperation between business and academia is difficult and in Poland is still rare among companies. However, the firms engaged in R&D use external knowledge derived from universities.

The implementation of technology product innovation in the past year is negatively associated with cooperation with academia before obtaining EU funds, but positively associated with intensified cooperation with academia in the most recent period as a result of obtaining such funds. This means that some of the firms which received support had previously not cooperated with academia, but began cooperating after EU funding had been granted. The conditions for public support were sometimes constructed as requiring such cooperation. Technology product innovation in the most recent period was positively associated with being a mid or large sized firm, the perception of the project as being key for the growth of the organization and being a manufacturing entity and was negatively associated with the perception that the managerial capabilities within the firm are very high level. Managers assessment of themselves as being very good may thus decrease the level of innovative activity in an organization, due to a reliance on, for example, luck and the current contacts of the managers. Technology process innovation in the past year is positively associated with cooperation with science as a result of gaining EU funds and with the declaration that the firm is equipped with a high level of new technology. This suggests that firms implementing technology process innovations try to find out the best available solutions and add technological breakthroughs to them for which academic staff are often required. These are, moreover, firms with high-tech equipment in new technologies.

5. Conclusions

The analysis indicates that there exist significant determinants of firms' innovativeness related to all of the organizational subsystems, but especially to the technological

side. In terms of management and goals and values, innovative companies more often engage in strategic planning and focus on risky breakthrough solutions, as well as being active on the international market. Those with 50 or more employees, with a longer presence on the market and higher turnover are more likely to be innovative. Moreover, innovation is positively associated with firms' wellbeing, as more innovative companies perceive their prospects as good in terms of financial results, outlay on innovation and revenue, as well as in terms of growth in employment.

At the level of an organization as a whole, the determinants of the research activity of firms, according to econometric analysis, turned out to be highly qualified staff and cooperation with academia. Moreover, R&D activity is carried out more often in the case of medium-sized or large companies and those having some share of foreign capital. The innovativeness of firms in terms of new products, processes and marketing innovations are positively associated with such factors as their cooperation with academia, longer presence on the market, level of the monitoring of customers' needs, having more than 49 employees, being highly equipped with modern technologies, as well as being a manufacturing firm.

The above analysis has shown that an organisational culture promoting cooperation with external partners and especially academia are of crucial importance. Moreover, determinants of innovativeness at the level of the organization as a whole differ according to the type of innovation and between R&D and innovation activity, sometimes having a seemingly paradoxical impact, as in the case of the international activity of a firm or the role of a highly qualified workforce.

The most obvious determinants of firms' innovativeness based on both types of the analysis performed above are those related to the technological subsystem, i.e., cooperation with academia and high-tech equipment, as well as those connected with the psycho-social and structural subsystems, i.e., the number of employees and the age and turnover of firms. Larger companies have greater human and financial potential to carry out R&D&I projects. This means that firms that aim to be highly innovative must focus on building technological potential in terms of equipment, finding suitable partners for R&D&I projects and have skilled workers, who would increase firms' absorptive capacity in terms of transferring knowledge from the external environment. Global pipelines, in the form of international activity, are also important determinants of firms' innovativeness. Strengthening the potential to be innovative should be a firm's strategic long-term vision, which requires consistent effort, since it may take some time to build, as this research indicates that older companies are more innovative. This confirms the Schumpeterian concept of the process of creative accumulation.

The analysis presented above confirms the hypothesis about the importance to an organisation of the presence of varied determinants of innovation connected with all of a firm's organisational subsystems, although some of them, especially the technological subsystem, are more important than others. A firm's innovation strategy should be ho-

listic, i.e., integrated in terms of strategic management, cooperation with external partners and acquiring knowledge in this way, as well as through employing skilled personnel, especially for R&D activity. Moreover, the potential to innovate should also be built through the purchase or development of high-tech equipment.

The study also shows that the efforts of firms focused on the realisation of projects financed by public grants (assessing them to be key for a company's development) is positively associated with the introduction of product innovations. Hence, not only external opportunities, in the form of grants designed by decision makers, are important, but also the responsible attitude of firms towards the realisation of these projects.

Although this research mainly confirms findings already present in the literature, the idea that over-assurance of managers in their managerial skills may lower their propensity to be innovative seems a promising area for future research. Nonetheless, further detailed analysis of the determinants of innovation in terms of the development of specific innovative potential including an analysis of interactions between various determinants could be interesting and probably desired, especially from the perspective of the management of a company that is willing to pursue an innovative path of development.

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