Public Innovation Policy and Other Determinants of Innovativeness in Poland

Elżbieta Wojnicka-Sycz

University of Gdańsk, Faculty of Management

Armii Krajowej Str. 101, 81-824 Sopot, Poland

and

Piotr Sycz

Ecleo Consulting

Raszyńska Str. 58/11, 02-033 Warsaw, Poland

Public Innovation Policy and Other Determinants of Innovativeness in Poland

Elżbieta Wojnicka-Sycz and Piotr Sycz

ABSTRACT

To achieve the benefits of innovativeness, in terms of economic growth and competitiveness of firms, it is important to understand its determinants. The aim of the article is to check if public innovation policy co-financed by European structural funds in Poland had positive impact on the Research and Development and Innovation (R&D&I) results of the country and which were other determinants of them. It should help to manage innovation processes in the economy by the public sector in the future. The analysis was carried out with the usage of econometric methods. The sources of data for the analysis were public statistics and data from research carried out on 1355 enterprises which received or unsuccessfully applied for public support for innovation. Analysis carried out on macro and micro levels has shown that crucial factors of R&D&I are public innovation grants from European structural funds, as well as promotion of cooperation and interactions between different agents of the innovation system and especially with science. Moreover of crucial importance are qualified employees and particularly research and development (R&D) personnel, as well as support for capital investment. Innovation policy should be complemented by suitable labour market, demographic, education, industrial and spatial policy. It will also depend on fiscal policy. Success in R&D&I will thus not only rely on efforts undertaken in the form of direct innovation grants from public sector but on horizontal activities undertaken by the public development policy of different levels and sectors.

***Key words*:** Innovation policy, Public sector, Innovation determinants, European structural funds

Introduction

Innovation is now regarded as a key factor of development of both businesses and economies. According to the neoclassical theory of economic growth, only technical progress is able to sustain long-term growth of economies in terms of per capita income (Solow, 1994). In developed countries, the share of Total Factor Productivity (TFP) reflecting technical progress in economic growth is about 60-80 per cent depending on the period for which the analysis is conducted (Hayami & Godo, 2005). The share of TFP in economic growth in Poland in the period 1999-2005 was 82 per cent (Siemek-Filuś, 2008). The share of TFP in the growth of value added in industry and construction in Poland in the years 2002-2008 was 65 per cent(Wojnicka-Sycz, 2013). This means that Poland is already reflecting the path of development characteristic of developed countries and determined by factors such as innovation, human capital, and knowledge.

The main weakness of the neoclassical growth model is that technological progress is outside the economic system – it is an exogenous variable, and thus the model does not include the possibility to influence technological progress. This drawback has been overcome by the so called "new theory of economic growth" proposed by Romer and Lucas, in which a huge role in the growth of productivity is attributed to human capital, knowledge and learning by doing (Romer, 1990). Robert Lucas proved the right of rising revenues from knowledge at the level of society, but declining at the company level (Lucas, 2010). The new growth theory shows that technological progress and innovation can be effectively influenced, for example, by instruments of innovation and industrial policy.

In Poland, since 2000, public innovation policy has become very important. It is executed at several levels: domestic, regional and, to a lesser extent, sectorial and local. Innovation policy in Poland is implemented via scientific, industrial and entrepreneurship-promoting policies as well as by means of regional policies carried out by regions themselves and on the domestic level by the ministry responsible for regional development. Moreover, some cities, especially metropolises, engage in pro-innovative activities like creation of science and technology parks. At all these levels most of the activities connected with innovation policy are co-financed by the European Union's structural funds. The European Union's structural funds support such activities as investment in modern technology and equipment in firms, acquiring patents, joint innovative projects between enterprises and scientific institutions, activities of business clusters or technology transfer centres, creation of laboratories for tenants of science and technology parks. The instruments of public innovation policy in Poland are thus varied and comprise innovation grants for firms, pro-innovative institutions and universities for different purposes like investment and R&D staff's work, special loans, tax exemptions, creation of pro-innovative infrastructure like technology parks, preparation of regional and domestic innovation strategies, securing of intellectual property rights, promotion of knowledge networks, etc. Still, the amount of money available for support of innovativeness is low in comparison with the most developed countries and it is mainly channelled by means of policy connected with the European Union's support in the form of structural funds. Poland ranks on the European Innovation Scoreboard 2015 in the group of moderate innovators among some other former communistic and Mediterranean countries with results lower than the European Union's average. Efforts in innovativeness and R&D of these countries will depend on whether the European Union as a whole reaches the indicators of R&D&I of its main competitors like the USA or Japan, especially whether the share of R&D in Gross Domestic Product reaches the order of 3 per cent. It is thus crucial that the innovation policy of these countries is well suited to their economies and effective.

There has been some recent discussion in Poland on whether the European Union structural funds connected with innovation policy were properly spent. The aim of this paper is to check if these public innovation grants had an impact on Research and Development and Innovation (R&D&I) results in Poland and to identify other determinants of them, of a macro and micro character, which should help to plan future Polish innovation policy but also the innovation policy of other countries of the "moderate innovators" group. The analysis in the article has been carried out based on data from the Central Statistical Office and from research into enterprises that applied for funding from the major program supporting innovativeness in Poland, "Innovative Economy" 2007-2013. The research was carried out for the evaluation of the Program by a consulting firm, WYGPSDB (2014) (http://www.wygpsdb.pl/homepage). It was commissioned by the Ministry of Infrastructure and Development and co-financed by the European Fund for Regional Development (EFRD).

The research was prepared according to European Union rules for evaluation of the impact of the European Union funds, which recommends research into both the beneficiaries and a control group of agents that did not receive funding, in order to carry out counterfactual analysis (Joint Evaluation Unit, 2006: 78-79).

As the rules governing European Structural Funds are similar for the European Union and are set by the European Commission and particular member states, together the results of the study may be used by other countries, especially those less developed members of the European Union, those that have a per capita GDP below 75 per cent of the European Union average. Moreover, the case study could apply to non-European countries facing the problem of weak results in R&D&I, which is still the case in Poland.

Macro Determinants of Innovativeness

To achieve the benefits of innovativeness, it is important to understand its determinants. Innovation is connected with external benefits, meaning that innovators are not able to take possession of all the profits from it, but society benefits from the innovations as well. External benefits of innovativeness and R&D are connected with the huge cost of the first copy of a new product/service and the relatively low cost of other copies of it, especially nowadays when such equipment as 3-D scanners and printers exist. 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, which could not be undertaken in some—especially risky and requiring in-depth research—areas, without public intervention. One of the most important stimuli of innovativeness is thus public innovation policy. This policy aims at decreasing barriers to innovativeness like high risk, access to finance, costs of networking and cooperation, and difficulties assuring innovators secure the benefits of innovators 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(see Wojnicka-Sycz& Sycz, 2013).

Of key significance to innovativeness are social conditions and challenges. Social conditions supporting an educated, creative and technologically-aware society will assure both supply and demand for innovation. Social challenges like aging of societies, pursuit of green economy or renewable energy are stimuli of innovativeness, as in these areas the research into new solutions is undertaken in part due to support granted for such innovations. It is reflected for example in the construction of the Horizon 2014-2020 Program of the European Union(Dębczyńska & Zaborowski, 2014: 461-463). The priorities of this major R&D Program of the European Union are smart, sustainable and inclusive growth and jobs (https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020).

According to an Organisation of Economic Cooperation and Development (OECD) survey on a sample of 20 OECD countries over the period 1982- 2001, the main determinants of countries' innovativeness appear to be the availability of scientists and engineers, research conducted in the public sector (including universities), business-academic links, the degree of product market competition, and a high level of financial development and access to foreign inventions (OECD, 2005: 33). The effect of direct public financial support for business R&D in this study was generally positive but modest. Intellectual property rights appeared to increase patenting significantly, but had little impact on R&D spending. The evidence also suggested that it might be difficult to raise significantly the real amount of domestic R&D in the short run because the supply of researchers is relatively inelastic (OECD, 2005: 33).

Analysis carried out by Chloe (1990) found that national innovativeness could be explained by four variables: Gross National Product (GNP) per capita, literacy rate, the ratio of manufacturing and service sectors to total GNP, and the number of scientists and engineers per population.

Some studies point to a strong relationship between innovation and international activity of domestic business (Ö zç elik & Taymaz, 2004; Wojnicka-Sycz, 2015).The study by McAdam et al. (2008) indicated that innovation of Small and Medium Sized Enterprises (SME)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.

Micro Determinants of Innovativeness

Macro determinants are not the only factors for success in innovativeness: micro factors and organisational characteristics are also crucial determinants.

Avermaete et al. (2003) found that innovation of small food firms depended on the age of the company, company size and regional economic performance. The paper by Romijn and Albaladejo (2002) explored determinants of innovation capability in small UK electronics and software firms. They found the importance of R&D, the key role played by the regional science base in nurturing high-tech spin-offs, and proximity to suppliers as crucial factors determining innovation capability of high tech firms.

According to many studies and current models of innovation, participation in innovative networks, especially with universities is crucial for higher innovative activity of firms, which determines increase of profitability (e.g. Koivisto et. al., 2015;Wojnicka, 2004).Clusters and regions with so-called innovative milieu are perceived as places stimulating innovation activity due to stronger cooperation linkages and transfer of knowledge enhanced by higher concentration and proximity of different agents (Porter,1990; Wojnicka et.al., 2005).

A meta-analysis of the relationships between organizational innovation and 13 of its potential determinants carried out by Damanpour (1991) resulted in statistically significant associations for specialization, functional differentiation, professionalism, centralization, managerial attitude toward change, technical knowledge resources, administrative intensity, slack resources, and external and internal communication. According to Özsomer et al. (1997) strategic posture is a major factor determining the innovativeness of firms while organization structure mediates the effects of strategic posture, uncertainty, and hostility.

Using data from 71 companies in Singapore, a study by Wan et al. (2005) found positive and significant relationships between organizational innovation and (1) decentralized structure, (2) presence of organizational resources,(3) belief that innovation is important, (4) willingness to take risks and (5) willingness to exchange ideas. The stream of research examining the associations between levels of innovativeness and organisational factors has found that the former was facilitated by such organisational characteristics as size, degree of centralization, degree of formalization, resource slack, degree of specialization, etc.

The Concept of a System of Innovation

The aforementioned determinants of innovativeness derived from literature in fact constitute a multilevel system of efforts undertaken by particular organisations and their employees, regional/ state authorities and external conditions like industrial specificity or regional/state endowment in resources like qualified personnel and knowledge institutions or propensity and ability to create innovation networks as well as overall economic performance which currently is highly interdependent between countries. Determinants of innovativeness may thus be of a macro and micro character. Macro determinants may include the following factors: suitable fiscal and granting policy favouring innovativeness, social and resource characteristics of certain countries like the level of education or technology awareness of the society, or presence of the policy of creation of pro-innovation institutions and of other determinants of efficient innovation systems like financial or transportation and communication infrastructure. Similar resource and institutional factors as well as suitable policy promoting cooperation in the innovation process such as clusters might be determinants of innovativeness deriving at a regional/territorial level.

On the micro level, determinants of innovativeness may be organisational factors such as strategic management, human capital – qualifications of the employees, managerial skills, cooperation with external partners, pro-innovative organizational culture, etc.

The wide range of determinants of innovativeness analysed in the literature confirms its systemic character. The system of innovation concept shows that important factors are not only internal innovative activity of firms but also cooperation in the innovation process with external partners that include enterprises, the public R&D sphere, bridging institutions, such as technology parks or technology transfer centres and knowledge intensive business services. According to the triple and quadruple helix concept, important agents in the innovation process aside from enterprises and academia include governmental agencies, which may, for example, create demand for innovative products through public procurement, and encourage it as well in society. The need for cooperation in the innovation process is driven by the complexity of current technologies, products and services – any one organisation cannot accumulate internally all of the knowledge and qualifications that are required for innovation.

To achieve efficient systems of innovation it is also important to have a suitable education system providing qualified human resources, well developed communication and transportation infrastructure facilitating cooperation in an innovation system, financial institutions providing funding for talented innovators' activities as well as taxing and granting policy helping to overcome barriers to innovation, and a transparent legal system promoting innovative activity by securing innovators' rights (e.g. Lundvall et al., 2002; Wojnicka, 2004). The internal skills of firms to do research or use external results of research and to change research into commercial innovations are also very important. These internal determinants may differ with different types of innovative activity like technological product or process innovations and organisational or marketing innovations.

Research Questions and Hypothesis

The research questions for this article include: (1)Which determinants at the macro and micro level were crucial determinants affecting the level of the achieved indicators of

innovativeness in Poland in the years 2004-2013, and (2) What was the significance of innovation grants and other financial instruments financed by the structural funds of the European Union to innovativeness in Poland?

Innovation policy will be ineffective if it does not stimulate the efforts of individual companies; firms will also not be able to carry out innovative projects if they lack suitable human or capital assets. The research hypothesis is that *there are more determinants besides public support for innovation that must occur in order to achieve good results in terms of R&D&I on a country level.* This system of support to the innovation processes may include different agents, their cooperation and environment creating suitable conditions for the systems' efficiency.

Innovation grants may promote a widening of the research base in the economy by increasing the number of researchers working in firms or in academia or increasing investment in capital goods required for innovation. However, other factors not influenced by these grants will affect the innovativeness results for a country. The particular research questions refer to the significance of these other determinants of innovativeness. Specifically, ***determinants*** of a ***micro character*** may be:

-internal efforts of firms aimed at improving their innovative potential, such as creation of stable work teams of highly qualified employees dealing with R&D&I in order to acquire public innovation grants;

-organisational factors determining innovativeness, such as the technological intensity of firms, which may be enhanced by public innovation grants;

-managerial capabilities of the executives of firms and their attitude to risk,

-strategic posture and monitoring of customers' needs;

-a firm's international status; and

-the intensity of cooperation with universities and creation of other innovative networks by firms.

From the ***macro*** perspective, external to firms' determinants yet crucial for countries' results in R&D&I, apart from public policy grants for innovative efforts, may be:

-the overall situation in the economy determined by macro factors, such as the total consumption or real wages that could influence innovativeness results through demand for innovative products or sources of finance for R&D in firms.

-the quality and elasticity of the labour market including the time spent of searching for jobs and the overall share of the professionally active population that may influence the availability of qualified human resources for R&D&I,

-higher propensity to export internationally based on more innovative products,

-higher transparency in the economy reflected in the level of corruption which implies more stable and transparent conditions for contracts, thus promoting innovativeness and overall economic activity in a country,

-overall level of education in the society, that will increase innovativeness: more educated people will be less afraid of and more capable of using innovative technologies and products.

Thus, sometimes slow progress in terms of innovativeness in some countries may be the result of a lack of horizontal innovation policy, that is policy creating a suitable environment for R&D&I projects on the domestic and organisational levels.

The structural funds taken into account in the article are those distributed via the major domestic operational program aimed at stimulating innovativeness which is the

"Innovative Economy" (PO IG) program of the years 2007-2013, and for longer analysis from the similar program for the years 2004-2006 - the Sectorial Operational Program "Improvement of the Competitiveness of Enterprises" (SPO WKP). The source of data for the analysis was data from the Central Statistical Office, from SIMIK system – data base on projects co-financed by structural funds and data from research carried out on 1355 enterprises which received or did not receive grants from the Innovation Economy Operational Program.

In most existing studies, the analysis concentrates on one level of analysis such as an organisation or a state. In this article, an overall approach is proposed, complying with a system of innovation concept, to find out if structural funds as a form of public innovation policy were significant determinants of the achieved results of innovativeness in Poland and which were other important factors, which might help to plan future innovation policy.

R&D&I Results in Poland Compared to the European Union

Expenditure on R&D as a share of GDP in Poland rose to 0.88 per cent of GDP in 2012 and 0.94 per cent in 2014 in comparison to 0.56 per cent in 2004, while in the European Union-28 in 2013 it was 2.02 per cent. Poland's performance continues to be significantly lower than the European Union-27 average, however. The European Innovation Scoreboard for 2014 showed the share of business expenditures in Poland on R&D as 0.33 per cent of GDP, while the European Union average was 1.31 per cent. The only countries a weaker performance than Poland were Cyprus – 0.06 per cent, Romania – 0.12 per cent, Latvia – 0.15 per cent, and Spain and Lithuania – 0.24 per cent.

The number of those employed in R&D per 1000 workers in Poland rose from 4.6 in 2004 to 5.2 in 2012 and 5.0 in 2013. According to Statistical Office of the European Communities (Eurostat) data, the number of those employed in R&D in the European Union-27 in 2011 in comparison to 2005 rose by 24 per cent, while during this period in Poland it increased by just 9 per cent - thus the dynamics of employment in R&D is lower than the European Union average. The workforce in R&D in the European Union-28 in 2013 was 1.12 per cent, while it was just 0.93 per cent in 2004, and in Poland it was 0.4 per cent in 2013 in comparison to 0.46 per cent in 2004. Those employed in R&D in enterprises in the European Union-28 in 2013 were 0.6 per cent of the work force, while in 2004 0.48 per cent. In Poland these numbers were respectively 0.17 per cent and 0.08 per cent. Thus the number of those employed in R&D in Poland continues to be too low, particularly in the business sector.

According to the European Innovation Scoreboard in 2014 patents submitted within the Patent Cooperation Treaty (PCT) to the European Patent Office per billion GDP PPP were 0.67 in Poland, while the EU-27 average was 1.98 and the highest performance was in Sweden and Finland (2.97) and Germany (2.74), and the lowest in Romania (0.41), Cyprus (0.55) and Bulgaria (0.59). Within the European Union, Slovakia and Spain had indicators lower than Poland. In 2013 the share of high technology exports rose overall to 6.7 per cent in comparison to 2.6 per cent in 2004 which reflects the progress of modernization in Polish manufacturing.

The number of innovative firms in Poland according to Eurostat in the years 2010-2012 was just 16.1 per cent compared to the European Union-27 average of 36 per cent, and 40.8 per cent in the European Union-15. Only Romania was lower than Poland (6.3 per cent).

This reveals a huge gap in R&D&I results in Poland in comparison with the European Union and the need to intensify efforts to strengthen research and innovation activity of firms and expand access to support from innovation policy (Table 1).[1]

Table 1: R&D&I Results for Poland 2004, 2013 Compared to the European Union, 2013

	Poland 2004	**Poland 2013**	**The EU-27 2013**
Expenditure on R&D as a share of GDP (per cent)	0.56	0.87 (0.94 in 2014)	2.02
The number of those employed in R&D per 1000 workers	4.6	5.0	.
The share of workforce in R&D (per cent)	0.46	0.4	1.12
The share of employed in R&D in enterprises (per cent)	0.08	0.17	0.6
Patents submitted within the Patent Cooperation Treaty (PCT) to the European Patent Office per billion GDP PPS	N/A	0.67	1.98
The share of innovative firms (per cent)	N/A	16.1	36
The share of high tech exports (per cent)	2.6	6.7	N/A

Sources: European Innovation Scoreboard, 2015; Central Statistical Office of Poland, September 25, 2016; Eurostat data, general statistics data base accessed September 25, 2016 at: http://ec.europa.eu/eurostat
Abbreviations: N/A=no answer

Macro Level Analysis Based on Statistical Data

At the country level, annual data is available only for the period 2003-2013.From this, analysis herein is carried out on stimulating factors of innovation in the years 2004-2013. Regarding data on the structural funds, the annual allocations planned in the Operational Programs in 2004-2013 were used and their size was calculated in euros per inhabitant[2].

[11] The EU-28, the EU-27 or the EU-15 stands for the number of members of the European Union. (http://europa.eu/about-eu/countries/member-countries/). The EU-28 includes Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom; the EU-27 is without Croatia that joined the EU in July 2013; the EU-15 is without Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. The EU-15 group is called "the old" EU member states. The statistical data was collected for different sets of the EU member states depending on the year of reference.

[2] European Union Structural Funds help to achieve the European Union's priorities of development by financing different activities especially in less developed regions that is with GDP per capita in Purchasing Power Standard (PPS) lower than 70% of the EU's average. They are planned in 7 years' periods. Poland entered the EU in 2004 so it was eligible for support from EU structural funds of the years 2000-2006 in the period 2004-2006 and 2007-2013. Each EU's member country proposes its own priorities of support co-financed by the EU funds which must resemble EU's priorities. Support from EU structural funds is organised in the forms of Operational Programs connected with different sectors. In the years 2004-2006 the major operational program connected with the support for innovativeness in Poland was SPO WKP - Sectorial Operational Program "The Increase of Competitiveness of Enterprises" and in the years 2007-2013 Operational Program "The Innovative Economy" – PO IG. These Programs co-financed such activities like innovative projects in firms mainly by

Models were also estimated using data on the real annual PLN funding in the programs SPO WKP 2004-2006 and PO IG 2007-2013 in constant prices per inhabitant, which gave very similar results to the ones based on planned funding. Data on the SPO WKP were taken under the consideration that in order to estimate a regression at least 8 time periods had to be taken into the calculation. Analysis was done based on linear models for the time series. A set of models was estimated with various variables reflecting R&D&I results in Poland over time under the impact of the change in the volume of structural funds per capita and control variables reflecting other potential determinants of R&D&I results. Due to insufficient data it was impossible to calculate the Granger's test for causality.

Variables reflecting R&D and innovativeness were the following: share of R&D in GDP, innovation expenditures in industry, share of industrial enterprises with innovation outlays, share of high tech export, R&D units in firms, inventions reported to European Patent Office (EPO),R&D outlays of firms, R&D general outlays.

Besides structural funds, variables reflecting the supply side of an economy were also analyzed, as follows:

1) Direct inputs to the innovation process: employment in R&D per thousand people that are professionally active, the share of people with tertiary education, the number of people employed in R&D in firms, R&D outlays in million Polish zloty,
2) Overall labor market efficiency: the professionally active out of a thousand people, period of successful job searching in months,
3) Institutional efficiency: indicator of perceived corruption.

Variables reflecting the demand side of an economy were also taken into consideration such as: dynamics of average real wages, dynamics of total real consumption and share of export in GDP. Thus the following models were estimated:

$$y_t = \beta_0 + \beta_1 x_{1t} + ... + \beta_k x_{kt} + \xi_t$$

where y_t were the variables reflecting R&D&I results over a time period (1,..,t), where $\beta_0,.., \beta_k$ were the coefficients of regressions, where $x_{1t},..., x_{kt}$ were the variables reflecting European structural funds and other possible determinants of R&D&I results.

Results

The results of this analysis on the state level (Table 2) using the annual allocations foreseen in the structural funds' programs in euro showed that the public grants had a positive impact on R&D results for the country but not on all measures of innovativeness of the domestic economy. Structural funds from SPO WKP and PO IG had a significant positive influence on expenditure on R&D as a share of Gross Domestic Product (GDP). Increase of these funds in euro per inhabitant particularly in the years 2004-2012 increased expenditure on R&D in GDP terms on average by 0.004 from time period to time period studied. On the basis of the model it can be estimated that without these funds the share of R&D in terms of GDP in 2012 would have been about 0.7 per cent in comparison to the actual 0.88 per cent.

financing acquiring of modern technology, but also e.g. a new design of a product. They also financed R&D infrastructure of universities as well as development and activities of bridging institutions like technology parks or technology transfer centres. Moreover in the years 2007-2013 cooperation of firms with universities and in the form of clusters was promoted.

Table 2: Econometric Analysis on the Domestic Level[3]

	Explained variables (OLS)										
Explanatory variables	Share of R&D in GDP		Innovation expenditures in industry in 2004 constant prices per capita	Share of industrial enterprises with > 49 employees with innovation outlays	Share of high tech export		R&D units in firms		Inventions reported to EPO	R&D outlays of firms 2004 constant prices in mln PLN	R&D general outlays in 2004 constant prices in mln PLN
	2004-2012	2005-2012	2005-2012	2004-2012	2004-2013	2004-2012	2004-2012	2004-2013	2004-2012	2006-2013	2004 - 2013
Constant	-0.672**	-0.02	-1503.73**	-5.4**	-84.76***	4.96**	19318.7**	-40487.4***	-941.26***	926.49**	-15789.8***
Employment in R&D per 1 thousandspersons professionally active	0.263***										4403.74***
Structural funds per inhabitant in euro according to annual allocations	0.004 **		4.93588***	-0.36***	0.0773***		19.6***	22.074***	3.6*	33.34**	105.46***
Share of people with tertiary education		0.031***									
Employed in R&D in firms		0.0000085**									
Dynamics of average real wage			17.7265**	0.48***							
Professionally active in thousands persons					0.0051***			2.39***			
R&D outlays in million zloty						0.00031					

[3]The values of all remaining diagnostic tests: serial correlation, heteroscedasticity, functional form, nonlinearity and normality were correct (p>0.1), estimations using robust standard errors.

						**					
Time of job searching in months						-0.212**					
Dynamics of total real consumption							-182.4**				
Share of export in GDP									26.7***		
Indicator of perceived corruption										39.21 ***	
R^2	0.9	0.97	0.7	0.99	0.9	0.9	0.7	0.7	0.84	0.94	0.93

OLS – Ordinary Least Squares *** p-value 0.01, ** p-value 0.05, *-p-value 0.1. Source: Author's calculations in Gretl on the basis of CSO data

Other stimulants of increased R&D expenditure were increased employment in R&D per 1000 workers which means that a key driver of increased expenditure on R&D is human resources which are capable of this work. The influence of this factor was significantly higher than the influence of the POIG and SPO WKP funds. Similarly expenditure on R&D in terms of GDP was increased by a higher number of people employed in businesses in R&D and an increased population with a better education and stronger demand for people with higher education. This means that aside from public innovation policy, high quality human resources for conducting R&D are also needed.

Structural funds also had a significant influence on expenditure on innovation in manufacturing per inhabitant in constant prices – increased structural funding in euro per inhabitant led to increased expenditure on innovation in manufacturing per inhabitant by nearly 5 zloty on average in the period 2005-2012, which suggests that each euro of funding led to the movement of private funding. In addition, higher innovation expenditure per inhabitant in manufacturing were increased by the higher dynamic of average real net wages per inhabitant – an increased wage dynamic of 1 resulted in increased expenditure on innovation per inhabitant in manufacturing on average of 17.7 zloty from time period to time period studied in 2005-2012. This means that the increase in innovation outlays is also dependent on the overall economic situation and the increase in total demand for more sophisticated innovative products is reflected in real wages. Moreover, higher wages may reflect higher spending by firms on more qualified employees capable of carrying out innovative processes in enterprises.

Public grants co-financed by European structural funds over the long term however resulted in a lower number of innovative firms in manufacturing in entities employing more than 49 workers, for whom there is a wide array of data. Thus it can be concluded that a certain concentration of innovation activity occurred in a smaller group of companies. This may in part be due to the fact that structural funds lead to an imbalance in competition, where companies which receive support can introduce innovation in a cheaper manner while it remains more difficult for the other firms to be innovative. On the other hand, support is necessary for innovation activity, as otherwise it would not be undertaken at a socially optimal level. In comparison with the year 2004, the number of innovative firms in manufacturing and services is significantly lower although expenditure on innovation has risen. Panel analysis on the level of province carried out additionally (WYG PSDB 2014) showed however, that in the last period (2009-2012), structural funds had a positive influence on the number of innovative firms, while the fall in the number of innovative firms was an effect of the economic recession, which was reflected as well in the dynamics of real wage growth, which as was shown by the estimation model, positively influenced companies introducing innovation in manufacturing.

The analyzed public innovation funds also had a positive influence on exports of high technology in GDP terms. The increase in this funding by 1 euro per inhabitant lead to an increase in exports in GDP of 0.0773 of a percentage point on average in the period 2004-2013 while the remaining factors were unchanged. On the basis of the model it can be estimated that without the funding from PO IG and SPO WKP the share of high technology exports in GDP in 2013 would have been 3.78 per cent instead of 6.7 per cent in reality. The influence of the funds on global competitiveness of high technology exports was thus high, stronger than the influence of expenditure on R&D in GDP terms. Weaker than the influence of structural funds, but positive was the influence of the number of those in the work force. This means that overall, the flexibility of the economy and the activity of the labor force are

significant for innovation. Stimulants of the increased exports in GDP were also expenditure on R&D, while there was a negative influence from the rising length of time for those seeking jobs in terms of months. This is confirmed by the significance of the overall competiveness of the economy, reflected by the adaptability of the labour market to innovative processes and the need for research to develop and produce globally competitive products of high technology.

European structural funds from Innovative Economy Operational Program and SPO WKP also influenced in a statistically significant manner the number of entities active in R&D in the manufacturing sector. The increased funding in PO IG and SPO WKP by 1 euro per inhabitant from time period to period studied lead to an increase in the number of entities pursuing research in the business sector on average by about 20 from period to period, while other factors remained fixed in the years 2004-2012 and by 22, when the years 2004-2013 are considered. A positive influence on the number of firms involved in R&D was also noted for an increase in the number of people in the labour force. A negative influence was noted however by a higher real dynamic of overall consumption, and thus overall expenditure by companies and institutions on products and services. It can be thus stated that lower demand for products may cause firms feel less confident about future and hence more prone to increase competitiveness by R&D.

The public grants from PO IG and SPO WKP also influenced positively another variable reflecting R&D activity – patents submitted to the European Patent Office (EPO). An increase in this funding of 1 euro per inhabitant from period to period studied led to an increase in the number of patents submitted on average of 3.6 per period. At the same time, there was a positive influence on submission of patents to the EPO by the rising exports in GDP terms. It should be noted that a higher tendency towards and possibility for exporting is reflected by the share of exports in GDP and forces the need for protection by patents abroad. This demonstrates the interdependencies between R&D activity reflected in patents needed to effectively increase competitiveness and productivity that may be obtained by research and innovative efforts of enterprises.

Structural funds from SPO WKP and PO IG also had a positive influence on global expenditure on R&D in manufacturing in 2004 constant prices in the years 2006-2013. Increasing structural funding by 1 euro per inhabitant leads to increased expenditure on R&D in manufacturing on average by 3.34 million zloty from period to period studied, with other variables constant. Simultaneously global expenditure on R&D was positively influenced in manufacturing by a higher indicator for protection against corruption. Falling corruption is a sign of more even competition and the elimination of mechanisms which prohibit open competition and thus facilitates greater efforts in company research and development. At the same time the influence of this variable was significantly higher than the influence of the structural funds. On the basis of this estimated model, which was characterized by a very high level of fit (coefficient of determination = 0.94) it can be estimated that with a lack of structural funds from SPO WKP and PO IG expenditures by companies on R&D in 2004 prices would have been in 2013 just 3 279.09 million zloty instead of 4 928.78 million zloty in 2004 prices in actuality and thus they would have been about 33.5 per cent lower. It should thus be estimated that the structural funds from POIG significantly spurred R&D efforts among businesses.

Public innovation grants connected with European funds in Poland also positively influenced higher expenditure on R&D overall in the years 2004-2013. Increase in structural

funds by 1 euro per inhabitant led to increased R&D overall in general in this period by nearly 105.5 million zloty (2.74 zloty per inhabitant) in 2004 constant prices ceteris paribus. At the same time, there was a significantly stronger influence of a control variable which was the number of those employed in R&D per 1000 in the labour force. A rise in this indicator of 1 point led to a rise in R&D expenditure overall in Poland in real terms of 4 404 million.

Macro Level Analysis of the Survey

Analysis based on micro data was done following the evaluation methodology of European Union Programs (WYG PSDB, 2014), on a sample of 716 firms which had support from POIG and a sample control group of 639 firms that had submitted an application but did not receive funding,. These firms were taken into account through access to data on them as being interested in some form of innovative activity due to submitting an application for a public innovation grant. This helped to check if receiving a public innovation grant from European Union structural funds really enhanced innovativeness of firms as it made it possible to check if not receiving a grant caused lower innovativeness in firms. Moreover, the contact information for these firms was available. The factors of the company potential were examined as well as their manner of engaging in innovative activities, and their characteristics with regard to their age, ownership structure, branch, number of employees and turnover. These factors influenced the implementation of technological and non-technological innovation as well as the firms' development perspective. Measures of R&D&I included those referring to technology product and process innovations but also variables reflecting organizational and marketing innovativeness of firms, and their R&D activity. The analysis was carried out using logit regression, and the estimations indicated the directions of the influence of the variables.

Logistic regression, also called a logit model, is used to model dichotomous outcome variables. Binary Logistic Regressionis 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. In the logit model the log odds of the outcome are modeled as a linear combination of the predictor variables. Logit regressions show the probability that an explained variable will be 1 or 0 with given parameters and values of explanatory variables: Prob (Y=1) = F(β'X), Prob (Y=0) =1- F(β'X). The set of structural parameters β shows the impact of explanatory variables (X) on an explained variable (Y) (Greene, 1993). The main drawback of inference based on logit models is the complicated interpretation of coefficients, as the estimations cannot be interpreted as a marginal increase of an explained variable caused by an individual increase of a given explanatory variable. The sign can be directly interpreted: the positive value of estimation means that an increase of a corresponding variable will increase the probability of the occurrence of a situation or feature described by the explained variable.[4]

The dependent variables (Y) in the logit models reflected R&D&I results of the surveyed firms as well as their prospects in development. They showed:

- Introduction of product innovation before applying to POIG,
- Introduction of marketing innovation before applying to POIG,
- R&D activity in the previous year,
- Prospects for growth of revenues from innovation,
- Introducing of process innovation before applying to POIG,

[4] http://www.ats.ucla.edu/stat/r/dae/logit.htm; https://onlinecourses.science.psu.edu/stat504/node/149

- Introducing of organizational innovation before applying to PO IG,
- Prospects for growth of innovation outlays,
- Prospects for growth of revenues,
- Prospects for employment growth.

Independent variables (X) describing the innovation determinants at the organizational level were chosen on the basis of different theories and research into the innovation process such as: the system of innovation concept, demand driven innovation, significance of size of a firm, its branch and level of internationalization, importance of technological and human capital potential in a firm (see Wojnicka, 2004; Smed et. al., 2010). Also a variable connected with the fact of receiving or not receiving the public innovation policy grant was included.

The following explanatory variables were analyzed:

- Receipt of support from PO IG by a firm,
- Perceiving very high and high qualifications of a firm's employees,
- Perceiving very high and high a firm's abilities to apply for support,
- Cooperation of a firm with science before applying to PO IG,
- Origin of a firm before 2005,
- Perceiving very high and high a firm's propensity to take risk in connection with innovation,
- Being a medium or large sized firm,
- Perceiving very intensive and intensive monitoring of customers' needs by a surveyed firm,
- Operating of a firm mainly on international market,
- Increase of cooperation with science by a surveyed firm,
- Domination of Polish capital in the ownership structure of a firm,
- Perceiving very high and high managerial abilities in a firm,
- Perceiving very high and high a firm's equipment in high technology,
- Perceiving very high and high the rotation of employees in a firm,
- Perceiving the intensive strategic planning in a firm,
- Presence of R&D activity in a firm,
- Turnover of a surveyed firm over 10 million Polish zloty.

Results

In the case of the joint primary (n=716) and control (n=639) sample, the entities which received support and those that applied but were rejected, receiving support from POIG increased the chances for implementation by the entity of R&D activity in the past year, and the expectations of increased revenues from innovation as well as overall higher revenues (Table 3). The receipt of support from POIG reduced however the chance that companies implemented innovative products before their application for support to POIG. Support was given thus to a greater degree to those entities who in the past 2 years before applying had not implemented product innovations. The analysis also indicated the following:

- Self-evaluation as highly capable of applying for public support by the company greatly increased the chances for implementing R&D activity and expectations for higher expenditure on innovation in the nearest future, however it decreased the chances for implementation by the entity of marketing based innovations before the application. High qualifications and abilities for application are thus key to carrying out R&D activity in a firm.

Table 3: Logit Models Based on the Research into Enterprises that Received Grants from PO IG and Those That Ineffectively Applied (n=1355)

Explanatory variables	Explained variables										
	Introducing product innovation before applying to POIG		Introducing of marketing innov. before applying POIG	R&D activity in previous year		Prospects for growth of revenues from innovation	Introducing of process innov. before appl. POIG	Introducing of organisational innov. Before appl. PO IG	Prospects for growth of innov. outlays.	Prospects for growth of revenues	Prospects for employment growth
Constant	-0.55***	-1.2***	-2.28***	-1.06***	-1.35***	-0.81***	-1.3***	-1.25***	-0.68***	0.01	-0.83***
Support from PO IG	-0.5***			0.42***	0.44***	0.66***				0.25*	
Very high and high qualifications				0.75***	0.64***						
Very high and high abilities to apply for support			-0.3**	0.25*					0.36***		
Cooperation with science before applying to PO IG		0.66***	0.65***				0.69***	0.57***			
Origin before 2005		0.8***					0.5***				-0.3**
Very high and high propensity to take risk	0.23*		0.3**		0.46***	0.77***			0.46***	0.41***	0.38***
Medium or large firm	0.61***	0.24*		0.65***	0.67***						
Very intensive and intensive monitoring of customers' needs			0.38***								
Operating mainly on international market				0.39**	0.37**						
Increase of cooperation with science recently	0.29**			1.85***	1.84***	0.8***			0.66***		0.37***
Polish capital			0.74***	-0.84***	-0.86***						
Very high and high managerial abilities	-0.3**									0.6***	
Very high and high equipment in high technology	0.47***	0.42***			0.41***	0.55***	0.3**			0.35**	0.44***
Very high and high rotation of employees					-0.36*		0.31	0.34*			

Intensive strategic planning			0.32**			0.44***		0.34**	0.32**		0.31**
R&D activity recently									0.35***	0.46***	0.36***
Turnover over 10 million zloty	0.49***		0.53***				0.58***				
R^2 McFaddena	0.06	0.08		0.17	0.18	0.09	0.07	0.03	0.06	0.05	

Estimations using logit regressions, in tables no values of average marginal effects are given needed to interpret the estimated coefficients as only the direction of impact of the variables is measured; *** p-value 0.01 ** p value 0.05

Source: Author's calculations in Gretl software (http://gretl.sourceforge.net/) on the basis of the research carried out by WYGPSDB (2014).

- Cooperation with scientific entities before application to PO IG was key for the implementation of all types of innovation in a company before application.
- Establishment of a firm before the year 2005 increased the chances for the implementation of technological innovation before application for public support, but it decreased the chances for expectations for increased employment in the future.
- Evaluation as a firm with a high or very high tendency to take risks increased the chances for implementation of product or marketing innovations, as carrying out R&D activity, and an optimistic perception of development in all areas.
- Activity of the firm mainly on international markets increased the chances for R&D activity, and thus this is key for international competitiveness.
- Intensification of cooperation with science in the recent past was noted to a large degree among firms which implemented production innovations before application, and also among those who implemented marketing innovations, were involved in R&D activity and expected greater expenditure on innovation and revenues from sales of innovation in the future, as well as expecting increased employment.
- Perception as a firm with highly capable management decreased the chances for implementation of production-based innovation, and increased those for expected increased revenues.
- Being highly equipped with modern technology was the most important factor in the potential of a firm to stimulate innovativeness both in production and processes, as well as R&D activity, as were the expectations for higher revenues from the sales of innovations, overall revenues and employment.
- Very high rotation of staff in a firm reduced the chances for R&D activity, thus for this work staff stability is necessary, which results from the fact that this work is often long-term can be carried out by only certain employees, and their leaving to join another firm could mean the loss of valuable information or company patents. High staff rotation increases however the chances for the implementation of process and organisational innovation.
- Chances for implementation of organisational innovation were increased by a high intensity of strategic planning in an organization.
- R&D activity in the most recent time period increased the chances for better perspectives in the realm of revenues, employment and expenditure on innovation. Revenues of over 10 million zloty in a firm however increased the chance for the implementation of product, marketing and process innovation.

The analysis confirmed the key significance of cooperation with science as well as the positive influence of support from PO IG on research and development activity and innovation, and the greater chances for innovation in both medium and large firms (over 49 employees). In addition, many of the factors with regard to potential and the characteristics of a business turned out to have significance for their innovativeness. Public innovation policy in the form of grants may stimulate R&D&I innovative activity in firms but what is also crucial are organizational features such as high qualifications of employees, satisfactory equipment in advanced technology, higher propensity to take risks, strategic posture as well as ability to apply for public support. Moreover the operation of a firm in an international market, as well as longer presence in the market will also stimulate higher efforts in terms of R&D&I in an organization. Pursuit of R&D activity will moreover influence and help to improve prospects for firms in terms of their future profitability and development.

Conclusions

Analyses were conducted at the macro, organizational and micro levels. At the macro level, the analysis showed that a suitable environment is crucial for R&D&I results for a country. This confirms that innovation is a complex phenomenon which has to be analysed from the system of innovation's perspective. The results of the research also suggested that the public support should be concentrated on improving the availability of human resources for R&D through programs increasing qualifications as well as promoting the creation of posts for researchers especially in companies. Moreover, a good direction would be the promotion of export activity of firms which fosters R&D&I efforts to meet the requirements of international markets. Improving the certainty of the economic rules by reducing corruption should enhance the chances that firms undertake more risky research and development projects. Innovation policy should be supplemented by labour market policy including the stimulation of higher professional activity and improving qualifications. Increasing the elasticity of the labour market could be achieved by assuring efficient employment agencies, developing new forms of jobs, and adjusting qualifications to suit labour market needs. However the overall economic situation is also strongly affecting the results of innovativeness, which depend on the international situation and efforts to improve innovativeness and competitiveness by companies. Consequently, the interaction is bilateral.

Analysis carried out at the organisation level confirmed the significance of the system of innovation concept, especially from the perspective of the crucial meaning of cooperation of firms in the innovation process with science. The analysis suggests that policy instruments directed at enterprises should promote their cooperation with science, promote acquiring of higher qualifications by their staff, support development of firms in terms of employment to get by them suitable critical mass – size making the innovation process more probable, nonetheless barriers to innovativeness of small companies should also be lowered. Moreover promotion of cooperation with foreign shareholders could enhance R&D activity of firms, probably by the higher availability for finance but also obstacles making firms based on Polish capital less prone to R&D activity should be reduced. Reindustrialisation could also increase results in innovativeness however it also implies that innovation awareness of service enterprises should be enhanced. Necessary also seem to be such instruments as grants for technological upgrading of firms, instruments lowering the risk of the innovation process which could encourage firms with higher risk aversion to innovate. Promotion of strategic planning in firms by providing them with better management knowledge could also be effective. A factor stimulating innovation activity of firms could also be promotion of their export activity. Firms should be also stimulated to create a stable team responsible for R&D, and their skills connected with application for grants should be developed for example by suitable training or public advisory services.

Analysis carried out at these different levels – macro and micro—has shown that the crucial factors determining results of R&D and innovativeness are public support (for example, in the form of structural funds), as well as promotion of cooperation and interaction among different agents of an innovation system and especially with agents reflecting science. Qualified employees and particularly R&D personnel are also of crucial importance. In Poland, public support for capital investment is still needed which would increase labour productivity. Innovation policy should be complemented by a suitable labour market, and appropriate demographic, educational and industrial policies. It will also depend on fiscal policies which create tax exemptions for innovators especially during times of crises. Success

in terms of the results of innovativeness of an economy will not only depend on efforts undertaken in the form of direct innovation grants but on horizontal activities undertaken by development policy at different levels—domestic, regional and directed at different sectors such as industry, science, and labour market—which should take into account the need to promote innovativeness and its determinants. This means that to achieve results in terms of R&D&I in a country, public innovation policy should aim at finding solutions to the origins of barriers to innovativeness which may derive from not having a suitable environment for innovative firms or having low internal potential and skills for R&D&I. Moreover, as the theory of innovation systems suggests, agents in innovation systems are interdependent and one weakness may decrease the effectiveness of others. Future research could be directed at finding weaknesses in innovation systems which make the whole system ineffective as well as defining public innovation policy responses to them.

References:

Avermaete, T., J. Viaene, E.J. Morgan & N. Crawford. 2003. Determinants of Innovation in Small Food Firms. *European Journal of Innovation Management*, 6(1): 8-17.

Chol, L. 1990. Determinants of National Innovativeness and International Market Segmentation. *International Marketing Review*, 7(5): 39-49.

Central Statistical Office of Poland data. Accessed September 25, 2016 at: http://www.stat.gov.pl

Damanpour, F. 1991. Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators. *Academy of Management Journal*, 34(3): 555-590.

Dębczyńska, W. & T. Zaborowski. 2014. "CSR and Innovativeness" Pp. 453-466 in J. Stachowicz, M. Nowicka-Skowron & L.A. Voronina (Ed). *Development of an Organization and a Region as a Challenge for Economics and Management*. Lublin-Toruń, Poland: Dom organizatora.

European Innovation Scoreboard. 2015. Belgium: European Union. Ref. Ares(2015)1933025-07/05/2015.

Eurostat data. Accessed September 25, 2016 at: http://ec.europa.eu/eurostat

Greene, W. H. 1993. *Econometric Analysis*. New York, NY: Macmillan Publishing Company.

Hayami, Y. & Y. Godo. 2005. *Development Economics from the Poverty to the Wealth of Nations. Third Edition.* New York, NY: Oxford University Press.

Jaumotte, F. & N. Pain. 2005. From Ideas to Development: The Determinants of R&D and Patenting. *OECD Economics Department Working Papers*, No. 457. Paris, France: OECD Publishing. DOI: http://www.dx.doi.org/10.1787/702226422387

Joint Evaluation Unit. 2006. *Evaluation methods for the European Union's external assistance*. Luxembourg, Belgium: European Commission.

Koivisto, J., P. Pohjols & N. Pitkanen. 2015. Systemic Innovation Model Translated into Public Sector Innovation Practice. *The Innovation Journal: The Public Sector Innovation Journal*, 20(1), article 6.

Lucas, R.E. Jr. 2010. *Lectures on the growth theory*. Warsaw, Poland: C.H. Beck.

Lundvall, B-A., B. Johnson, E.S. Andersen & B. Dalum. 2002. National systems of production, innovation and competence building. *Research Policy*, 31: 213-231.
McAdam, R., R. Reid, R. Harris & N. Mitchell. 2008. Key Determinants of Organisational and Technological Innovation in UK SMEs: an Empirical study. *Journal of Entrepreneurship and Innovation Management*, 8(1): 1-14.

Özçelik, E. & E. Taymaz. 2004. Does Innovativeness Matter for International Competitiveness in Developing Countries? The Case of Turkish Manufacturing Industries. *Research Policy*, 33: 409-424.

Özsomer, A, R.J. Calantone & A. di Bonetto. 1997. What makes firms more innovative? A look at organizational and environmental factors. *Journal of Business & Industrial Marketing*, 12(6): 400-416.

Porter, M. E. 1990. *The Competitive Advantage of Nations*. New York, NY: Free Press.

Romer, P. M. 1990. Endogenous Technological Change. *Journal of Political Economy and Technological Change*, 98(5): 71-102.

Romijn, H. & M. Albaladejo. 2002. Determinants of innovation capability in small electronics and software firms in southeast England. *Research Policy*, 31(7): 1053-1067.

Siemek-Filuś, A. 2008. *Determinants of Economic Growth of Polish Regions*. III Cracow Conference of Young Scientists. Cracow, Poland: AGH University of Science and Technology.

Smed, S., J.F. Jensen, B. Jeppesen, P. Kofoed, T.A. Rasmussen, T. Jensen , C. Rosenstand, J.R. Jensen, K. Fridriksson & J.H. Skjetne. 2010. *U-Drive: IT – User-Driven Innovation Transfer From ICT to Other Sectors.* Oslo, Norway: Norden Nordic Innovation Centre.

Solow, R.M. 1994. Perspectives on Growth Theory. *The Journal of Economic Perspectives*, 8(1): 45-54.

Subramanian, A. & S. Nilakanta. 1996. Organizational Innovativeness: Exploring the relationship between organizational determinants of innovation, Types of Innovations, and Measures of Organizational Performance. *Omega*, 24(6): 631-641.

Wan, D., Ch. Haut Ong & F. Lee. 2005. Determinants of Firm Innovation in Singapore, *Technovation*, 25(3): 261-268.

Wojnicka E. 2004. *The Innovative System of Poland from the Perspective of Enterprises*. Gdansk, Poland: Gdansk Institute for Market Economics.

Wojnicka, E., T. Brodzicki & S. Szultka. 2005. "Poland". Pp. 111-55 in *Business Clusters: Promoting Enterprise in Central and Eastern Europe*. Paris, France: Organisation for Economic Cooperation and Development.

Wojnicka-Sycz E. 2013. *Territorial Growth Pole Model Based on The System Of Development Factors*. Sopot, Poland: Wydawnictwo Uniwersytetu Gdańskiego.

Wojnicka-Sycz, E. & P. Sycz. 2013. *New Methods, Tools (especially ICT) and Solutions that Facilitate and Accelerate the Development of Innovation in Industry. Guidelines for Strategic Memorandum*. Warsaw, Poland: Industrial Development Agency for Central European Branch Based Innovation Support (CEBBIS) Project.

WYG PSDB. 2014. *Ex-post Evaluation of the Innovative Economy Operational Program*. Research carried out for the Ministry of Infrastructure and Development co-financed by European Fund for Reconstruction and Development. Warsaw, Poland.