The Impact of Funds from the Innovative Economy Operational Program on the R&D&I Performance of Poland

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Abstract

The aim of the article is to review the impact of funds from the Innovative Economy Program on the Research&Development&Innovation (R&D&I) performance of Poland. The paper also looks at determinants other than public support which were crucial for achievement of these results based on a systemic definition of innovation. The analysis has shown that innovation policy in the form of grants channeled through the Innovative Economy Operational Program had a clear impact on the strengthening of the R&D activity of Poland, especially those of firms. The effects of it are also visible in the form of the increased international competitiveness of Polish high technology products. However the impact on innovativeness of enterprises as a whole in Poland is not visible. It suggests that crucial would be support for turning R&D efforts into commercial innovations and widening of the number of firms receiving support from public funds, for example in the form of cheap loans to make the competition more even. Nonetheless other determinants of innovativeness like qualified personnel for R&D, the level of industrialization of the economy, the overall situation in the domestic economy as well as transparency are needed to achieve good results in terms of R&D&I.

Keywords: innovation policy, innovation determinants, structural funds, Innovative Economy OP

Introduction

Innovation is now regarded as a key factor of development of both businesses and economies. According to the neoclassical theory of economic growth — the Robert Solow model, only the change in the rate of technological progress induces growth effects, while changes in other factors affect only the level of the economy. Only technical progress is able to sustain long-term growth of economies in terms of per capita income (Solow 1994). 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 new theory of economic growth. In the theory of endogenous growth, employees are treated as able to actively influence and create changes in the production process, and therefore a huge role in the growth of productivity is attributed to human capital, knowledge and learning by doing (Romer 1990). In endogenous models economic growth is connected with increased revenues from the scale (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.

Innovation currently is defined mainly as a new value created for customers by significant changes in the existing, and introduction of, new products and services, technological processes as

well as changes in organization and marketing of an organization.[1] Expenditure connected with innovation processes embrace actions such as Research and Development (R&D) activity, purchase of new embodied technology in the form of machines, purchase of disembodied technology like patents and know how, training of personnel or new design of products. It means that Research and Development activity is only part of an innovation process and it does not have to be carried out in an organization. Results of R&D activity may be patented and patents are often used as measures of R&D activity, apart from expenditures spent on it as well as human resources engaged in R&D activity in an economy. Results of an innovation process are new and significantly changed products and services as well as organizational and marketing innovations. High technology branches and products are those that are characterized by a high share of R&D in revenues or production and export of such products by a country shall also resemble its higher innovation potential.

The systemic view of innovation shows that important is not only internal innovative activity of firms, but also cooperation in the process with external partners in a system of innovation consisting of enterprises, the public R&D sphere, bridging institutions like technology parks or technology transfer centers and knowledge intensive business services. This cooperation may be direct by joint or commissioned R&D and innovation activity, and indirect by transfer of embodied technology or tacit knowledge flows by mobility and socialization of workers of different organizations. According to the triple and quadruple helix concept important agents in the innovation process apart from enterprises and academia are also governmental agencies, which may, for example, create demand for innovative products by public procurement, as well as society. People — customers should be engaged in the innovation process by firms to find out their current and hidden needs and take ideas from them, and society's technological awareness will determine demand for innovative products. The need for cooperation in the innovation process is the result of the complexity of current technology as well as products and services — any single organization cannot accumulate the whole required knowledge and qualifications for innovation internally.

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 innovation systems, financial institutions providing finance for talented innovators' activities as well as proper taxing and granting policy helping to overcome barriers to innovation as well as a transparent legal system promoting innovative activity by securing innovators' rights. This means that innovation is a complex phenomenon and such will be its determinants. These determinants may be direct as support for innovation, qualified workers, entrepreneurial skills, cooperation with science, presence of knowledge intensive business services, or indirect like quality of infrastructure, efficiency of labor market, the overall macroeconomic situation and general demand. Efficient innovative systems must be based on horizontal activities crossing different sectors, spatial levels and policies to create a pro-innovative environment. Innovation is connected with external benefits, which means that innovators are not able to take possession of all the profits from it, but society benefits from their innovations. 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 and destimulants of innovativeness is thus public innovation policy decreasing barriers to innovativeness like high risk, access to finance, costs of networking and cooperation, and difficulties with homesteading of benefits by innovators due to imitations. To overcome barriers of 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, however the projects financed by structural funds were co-financed by domestic money (public and private). 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 — PO IG — Operational Program "The Innovative Economy." These Programs co-financed such activities as innovative projects in firms mainly by financing acquisition of modern technology, but also, for example,

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1. See, for example: OSLO Manual. [@:] https://www.oecd.org/sti/inno/2367580.pdf.

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 centers. Moreover, in the years 2007–2013 cooperation of firms with universities and in the form of clusters was promoted. The funds were granted on the basis of project applications assessed by experts and the procedure of choosing projects promoted projects being the best in terms of quality and cost efficiency. However factors other than innovation policy in the above form affects results of innovativeness of a country. The overall condition of the economy may, for example, also affect innovation behavior of firms. According to the research carried out by Zalewski and Skawińska (2014) in 2011 on enterprises from Wielkopolski region in Poland, the economic crisis of the years 2008–2009 caused mainly reductions of costs and made firms aware of the need for modernization and increased quality of their products, so it inspired innovative changes, which confirmed the creative destruction model of Schumpeter.

According to the 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. 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 (Jaumotte and Pain 2005, 33).

Some studies point to a strong relationship between innovation and international activity of domestic business. For example in the study by Özçelik and Taymaz (2004) it was found that innovations and R&D activities were crucial for the international competitiveness of Turkish manufacturing firms while technology transfer through license and know-how agreements did not show up as significant determinants of export performance. Similarly, research into 119 firms of three branches connected with smart specializations in the Pomorski region in Poland showed that especially stronger research and development activity of firms but also stronger overall innovativeness increased chances of greater success of the firms on international markets, while both export activity and innovativeness increased optimistic prognosis by the firms of their future profits. It means that other determinants of being an international player such as the exchange rate will also affect innovativeness motivated by foreign demand.[2]

According to many studies and current models of innovation and innovation management (open innovation, user driven innovation, design driven innovation, systems of innovation concept) participation in innovative networks is crucial for higher innovative activity of firms, which determines increase of profitability (Andreosso-O'Callaghan and Lenihan 2008, 561; Wojnicka 2004, 7). According to a study carried out in Spain on about 12 000 firms, greater technological intensity of the environment fosters cooperation with universities and research institutions (U&RI). In sectors with higher complexity of technology, R&D cooperation with U&RI is more frequent than in sectors with lower complexity of technology. However it was affirmed that companies with internal R&D capabilities have more probabilities of cooperating with U&RI irrespectively of the industry. These internal R&D initiatives provide them with the necessary capacity to recognize and take advantage of external knowledge. It was also found that firms that invest in external R&D and acquire external knowledge, have a greater propensity for cooperating with U&RI. Thus, the degree of openness of the firms regarding innovation, positively affects their cooperation activities (González-Moreno and Sáez-Martínez 2009, 249). 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-Sycz 2013).

The aim of the article is to determine whether the structural funds of Innovative Economy Operational Program 2007–2013 had impact on the achieved results of innovativeness in Poland

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2. See: Analysis with the Usage of Logit Regression of the Results of Research for the Report "Analysis of Branches of the Highest Export Activity in the Pomorski Region" prepared by Elżbieta Wojnicka-Sycz in 2015.

and which were other determinants of these results. The analysis is carried out on the state level. 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" program of the years 2007–2013. For longer analysis also funds from the similar program for the years 2004–2006 — the Sectorial Operational Program "Improvement of the Competitiveness of Enterprises" were taken into account. The source of data for the analysis was data from Central Statistical Office and from SIMIK — a data base on projects co-financed by structural funds. The systemic definition of innovation is the basis of analysis and hence many variables reflecting direct and indirect factors depicting the domestic economy are considered. The analysis is carried out for the period 2004–2013.

1 The indicators of innovativeness of Poland in the years 2004–2013

Between 2004–2013 the number of entities involved in R&D in Poland increased over four-fold in the business sector. Expenditures on R&D in 2013 rose to 43% in comparison to 31,5% in 2006.[3] Expenditure on R&D as a share of GDP rose to 0,88% of GDP in 2012 in comparison to 0,56% in 2004. Poland's performance continues to be significantly lower than the EU 27 average however, particularly in the share of business expenditures in which the European Innovation Scoreboard of 2014 shows 0,33% share of R&D in GDP in Poland, while the EU average was 1,31%. The only countries with weaker performance than Poland were Cyprus — 0,06%, Romania — 0,12%, Latvia — 0,15%, Spain and Lithuania — 0,24%.

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 Eurostat data, the number of those employed in R&D in the EU-27 in 2011 in comparison to 2005 rose by 24%, while during this period in Poland it increased by just 9% — thus the dynamics of employment in R&D is lower than the EU average. The workforce in R&D in the EU-28 in 2013 was 1,12%, while it was just 0,93% in 2004, and in Poland it was 0,4% in 2013 in comparison to 0,46% in 2004. Those employed in R&D in enterprises in the EU-28 in 2013 were 0,6% of the work force, while in 2004 0,48%. In Poland these numbers were respectively 0,17% and 0,08%. Thus the number of those employed in R&D in Poland continues to be too low, particularly in the business sector.

From year to year in the period 2004–2013 the number of Polish patents submitted to the European Patent Office rose and in 2013 it was 465 91 in comparison to 124 29 in 2004 (partial calculation of patents). 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 was in Poland 0,67, 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 at 0,59. Indicators lower than Poland within the EU countries were also noted by Slovakia and Spain. In 2013 the share of high technology exports rose overall to 6,7% in comparison to 2,6% in 2004 which reflects the progress of modernization in Polish manufacturing. In 2013 expenditure on innovation was higher in manufacturing than in 2004, and in the service sector lower than in 2006. Despite a rise in real expenditure there was a decrease in the number of companies who incurred these expenditures in the service sector from 18,8% in 2006 to 9,33% in 2013, while in manufacturing this was 20,3% in 2006 and 13,3% in 2013.

This may be due to the fact that due to other sources of competitiveness, such as relatively lower costs due to a weakening PLN currency rate in the past years, Polish firms have slowed down their innovation processes, while at the same time increased their R&D activities. R&D activity was noted however in significantly fewer firms than innovation activity and it is not yet visible in the innovation statistics. However the number of innovative firms in Poland according to Eurostat in the years 2010–2012 was just 16.1% compared to the EU-27 average of 36%; and 40,8% in the EU-15, and only Romania was lower than Poland (6,3%). This shows the need to intensify efforts to strengthen innovation activity, expand access to support through instruments which will allow

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3. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

a greater number of companies to participate and also a more rapid reflection of the results of the research within the performance of the companies.

2. Determinants of the achievement of results in innovativeness on country level

At the country level annual data from the Central Statistical Office on R&D&I results is available only for the period 2003–2013. As data on the structural funds, data on the real annual PLN funding in the programmes SPO WKP and PO IG 2004–2013 in constant prices per inhabitant were used. Data on the SPO WKP were taken under the consideration that in order to estimate a regression at least 8 time periods were necessary. A database was created on various macroeconomic data reflecting economic supply and demand, and as potential direct and indirect factors influencing innovation indicators. They were used as control variables in estimations aimed at checking the impact of structural funds on R&D&I results as well as probable additional systemic factors affecting these results. In detail this pooled data contained such variables on the domestic level as GDP per capita in PPP and its dynamics, structure of employment and value added in the economy, variables reflecting the labor market like number of professionally active people, unemployment rate, level of education of society, entrepreneurial activity measured by number of entities registered in REGON per population and number of startups, level and dynamics of wages, foreign direct investment flows, exchange rate, dynamics of consumption, dynamics of export, index of perceived corruption, level of macro indicators like public deficit and debt or inflation rate. As explanatory variables reflecting the R&D&I results were taken those collected by the Central Statistical Office according to international standards of measurement of innovative efforts and results. These were such variables as: share of R&D in GDP, share of industrial enterprises with over 49 employees with innovation outlays, share of high tech export, R&D units in firms, inventions reported to EPO, R&D outlays of firms in PLN per capita, R&D general outlays in PLN per capita. Analysis was done based on time series linear models. The method of choosing data for regressions was elimination of control variables which turned out not to be statistically significant — that is with p-value over 0,1. The method of estimation was Ordinary Least Squares. Finally, only regressions with satisfactory values of residual tests and at least 0,7 R^2 (goodness of fit) and independent variables statistically significant on at least $p = 0,1$ level were taken into account.

The available data made it possible to estimate a regression taking into consideration enterprise expenditure on R&D available for 2006–2013, as well as data covering expenditure on R&D overall for the years 2004–2013 and the number of R&D entities and those working in R&D overall and in enterprises in the years 2004–2013.

The analysis, presented in table 1, has shown that increased support from the structural funds per inhabitant from period to period studied in the years 2006–2013 by PLN 1 lead to an increase of expenditure by firms on R&D per inhabitant of PLN 0,33 with other variables stable, at the same time a rising indicator of protection against corruption reflected by falling corruption lead to an even stronger than in the case of structural funding increase in expenditure by companies on R&D per inhabitant. It seems that economic transparency, reflected by falling corruption, can influence the intensity of R&D efforts because it decreases its costs, increases chances for sales or contracts without the additional costs linked to corruption, evens out the conditions of competition and means that to a greater degree firms may operate on meritorial criteria and capabilities and to a lesser degree upon "deals." This model is characterized by a high degree of fit ($R^2 = 0,99$) and upon its basis it may be estimated that if there were no structural funds in 2013 expenditure by companies on R&D in 2013 would have been 40% lower.

Higher payment of funding from SPO WKP and PO IG from year to year by PLN 1 per inhabitant lead to higher expenditure on R&D per inhabitant from period to period studied of PLN 1,07 in the years 2005–2013 with other variables stable. At the same time a decrease in the growth of GDP from year to year was assisted by an increase in expenditure on R&D per inhabitant overall, ceteris paribus. This results as the more simple competitive advantages are used up as more well developed countries are characterized by lower GDP growth which forces the need to seek new solutions and concentrate on advanced products and branches, and thus higher R&D expenditure.

Tab. 1. Econometric analysis on the domestic level

Explanatory variables and regression R-squared coefficient	Explained variables and models data ranges						
	2004–2013	2005–2012	2005–2012	2005–2013	2005–2013	2005–2013	2006–2013
	R&D units in firms	Share of R&D in GDP	Inventions reported to EPO	Share of industrial enterprises with over 49 employees with innovation outlays	Share of high tech export	R&D general outlays in PLN per capita	R&D units in firms
Constant	−15 527,60***	−0,14	97,1***	−5,4**	−67,97***	977,017***	−15 527,60***
Structural funds per inhabitant in constant prices in PLN according to payments from programs	12,13***	0,0015***	2,9***	−0,072***	0,015**	1,07***	12,13***
Employed in R&D in general		0,000009*					
GDP dynamics						−8,1***	
Share of employed in industry in labour force				−1,47**			
Professionally active in thousands persons	0,93*				0,004***		0,93*
Indicator of perceived corruption							
Real effective exchange rate (percentage change)			−2,05*				
R^2	0,94	0,90	0,95	0,78	0,81	0,98	0,94

*** $p < 0,01$; ** $p < 0,05$; * $p < 0,1$

The values of all remaining diagnostic tests—i.e., serial correlation, heteroscedasticity, functional form, nonlinearity, and normality—were correct ($p > 0,1$); OLS estimations using robust standard errors.

Source: Own calculations in on the basis of data published by Central Statistical Office of Poland

This model is characterized by a very high level of fit ($R^2 = 0{,}98$) and on its basis it can be estimated that in 2013 without structural funds the expenditure on R&D per inhabitant would have been 47,5% lower. Greater support from the structural funds by PLN 1 per inhabitant from year to year in the period 2005–2012 lead to an increased number of Polish patents submitted to the European Patent Office by 2,9 (according to partial calculation of patents). At the same time the fall of the zloty currency rate in real terms influences the higher number of patent applications which suggests greater pricing competitiveness of Polish exports, and thus a greater tendency to use patent protection abroad. Greater support from the structural funds per inhabitant from period to period studied in the years 2005–2013 by 1 zloty lead to a higher number of companies active in R&D from year to year. At the same time the rising number of R&D active businesses facilitated a rising number of people employed in R&D by 12 from year to year. Simultaneously the rising number of those working in R&D facilitated a higher number of those overall in the workforce.

Increasing support from the structural funds from period to period studied by PLN 1 per inhabitant in the years 2005–2013 lead to increased exports of high technology by 0,015 of a percentage point from period to period with other variables stable. At the same time exports from high technology was facilitated by a rise in the number of those active in the workforce. Increasing support from the structural funds from period to period studied by PLN 1 per inhabitant in the years 2005–2013 lead to a fall in the share of innovative companies among businesses in manufacturing with over 49 employees by 0,072 of a percentage point. At the same time the fall in the number of innovative firms in manufacturing was influenced by the number of people working in manufacturing which suggests a move to more labor intensive production and less innovative technology and less innovation in general. Increased funding from SPO WKP and PO IG by PLN 1 per inhabitant in the years 2005–2012 caused on average an increase in R&D expenditure of 0,015 of a percentage point from period to period studied, while increased employment in R&D by 1 person lead to increased expenditure on R&D in GDP terms of 0,000009 of a percentage point with other variables stable.

The analysis using the annual allocations foreseen in the structural funds' programs in euro performed additionally by Wojnicka-Sycz, Sycz (2014) has also shown that structural funds were stimulants of higher overall innovation expenditures in industry and that increase of the share of people with tertiary level education from year to year in the analyzed period 2005–2012 was accompanied by increase of the share of R&D in GDP.

The above analysis has proven that structural funds from the Innovative Economy Program and the Sectorial Operational Program "Improvement of the Competitiveness of Enterprises" had positive impact especially on the R&D activity of firms and outputs of innovation like patents or high technology export. However they caused a decrease in the number of companies active in innovation activity, although innovation outlays of firms increased. It may mean that EU funds cause uneven competition and make innovative activity cheaper and more profitable for firms receiving grants, while more difficult for the rest of them. It suggests that the support is available for a too small number of companies. Probably support based on cheap loans funded by EU funds which would be returned and be available for another companies could help to overcome this problem. Such instruments will be more available in the current programming period 2014–2020.

Conclusions

The money from the Innovative Economy Program had positive impact especially on research and development activity of Poland and such indicators of innovativeness like high technology exports and European Patent Office applications. As on the micro level the support from the Innovation Economy Program was crucial for beneficiaries' innovativeness[4] it suggests that support should be more widely available for firms for example by usage of return-type instruments like cheap loans. Also innovation grants should aim at turning results of R&D into commercial innovations.

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4. See: "Macro analysis" by Elżbieta Wojnicka-Sycz and Piotr Sycz. In Ex post evaluation of the "Innovative Economy Program." Research carried out for the Ministry of Infrastructure and Development co-financed by EFRD.

The analysis has shown that also other determinants of innovativeness are crucial for the results. On a macro level the stimuli of research and development activity are public support for R&D — like grants from structural funds, human resources for R&D, share of export in GDP and decrease of the real exchange rate which fosters the acquisition of foreign patents and reflects overall competitiveness of the economy and factors connected with the economic cycle as well as transparency of the economy. It suggests that the directions of public support should be improvement of the availability of human resources for R&D through programs increasing qualifications as well as promotion of creating 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. Improvement of the certainty of the economic rules which is reduction of corruption should enhance the chance that firms undertake riskier research and development projects. Innovation policy should be supplemented by labor market policy including the stimulation of higher professional activity of people and improvement of their qualifications. However the overall situation of the economy is also strongly affecting performance in innovativeness and is dependent on the international situation and efforts in innovativeness and competitiveness of companies. Thus the interaction here is bilateral.

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