

THE ASSESMENT OF THE EFFECTIVENESS OF SELECTED INNOVATION SUPPORT INSTRUMENTS USED IN POLAND IN 2007-2013



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ABSTRACT

The international competitiveness of the national economy largely depends on the innovative abilities of companies and domestic industry. In this context, adequate shaping of national innovation policy is of crucial importance. It is essential to direct innovation policy in such a way that it should lead to the development of opportunities associated with current and future competitive advantages of the economy. The article contains an assessment of the impact of selected public support instruments used in Poland in the period 2007-2013 for the intensification of the innovation processes in the domestic economy. The purpose of the research is to analyse and assess the effectiveness of selected public support instruments implemented in Poland in the 2007 – 2013 period. This leads to the following research hypothesis: public support instruments implemented in Poland in the years 2007 – 2013 had an impact on the level of innovativeness of Polish economy when compared to 2004 – 2006 period. The research method included the evaluation of: 1) the compliance of the aims of the investigated instruments with the general and detailed objectives of “Dynamic Poland 2020” strategy and 2) the influence of the investigated instruments on the changes of the indicators that measure innovation performance (innovation enablers and innovation results).

KEY WORDS

innovation policy, public support instruments, national innovation system

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1. INNOVATIVENESS – A CONCEPTUAL ANALYSIS

The issue of innovativeness of economies is a frequent subject of analysis in the literature on the subject. The founder of the theory of innovation is considered to be J. Schumpeter (1950). The research in this field has been continued by a.o. R. Solow (1956), M. Kalecki (1962), Ch. Freeman (1982), P. Drucker (1985), B-A. Lundvall (1992), Etzkowitz, Leyesdorf (2000), B. Godin (2003), X. Sala-i-Martin, S. Artadi (2004), D. Chen, C. Dahlman (2005), T. Hollanders, S. Tarantola (2011), S. Dutta (2012), S. Borrás, Ch. Edquist (2013), T. Baczko (2005-2012), S. Marciniak (2010), A. H. Jasiński (2010), W. Janasz (2006), S. Lis, K. Rybiński (2011), and others.

Some authors have analysed both the aspects of innovation and of the competitiveness of economies. This is due to the interconnectedness of these issues.

For this reason, analysis of the innovation policy (implemented using public support instruments) as one of the factors that determine these two areas of study requires their precise definition.

Competitiveness is a result of the efficiency with which a company, located within a given geographical area, takes advantage of its investments in economic activity and the competitiveness of a nation depends on the innovation abilities of the domestic industry (Porter 1991).

Innovation is an implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practice, workplace organisations, or an interaction with the environment (Podręcznik Oslo 2008).

Innovativeness is a tendency and an ability to create new and improve existing products and technological processes, new systems of organization and management, as well as other changes (creative and imitative) that lead to the creation of new values in the economy and the adaptation of domestic and foreign scientific and technical achievements (Marciniak 2010).

The subject of research in innovation theory has been evolving. It initially involved the enterprise, then its environment and the industrial sector in which the enterprise operates, and further on, the scope of the study included, for example, the system of laws and regulations, and institutions in a given country (Niosi et al. 1993, p. 210). This systemic approach to the subject of innovation theory is most fully presented in the concept of a national system of innovation.

A national innovation system includes the entirety of interconnected institutional and structural factors that have an impact on the generation, selection, and absorption of both technical and extra-technical innovation (Freeman, 1982).

A complementary definition was suggested by S. Metcalfe, who defines the national innovation system as a complex of separate institutions that jointly or individually contribute to the development of the knowledge economy, simultaneously creating an environment within which the government formulates and implements innovation policy (Metcalfe 1995).

In turn, innovation policy includes research and technological policy. Its purpose is to support the process of the introduction of new products, services, processes, and management techniques into economic practices. This is supported by creating a climate conducive to innovation, the promotion of an innovation culture in business, the development of services for innovation [Innowacje i transfer ... 2011], for example, with the aid of public support measures. The main area of impact of innovation policies are enterprises.

The innovation support measure is a tool (co-) financed by the state budget promoting research and innovation initiatives in organizations. The support measure is most often implemented for a multi-year period. According to this definition, the following types of intervention are identified (Izsak et al. 2013; Reid, Peter 2008):

- directing financial support of innovation processes in enterprises;
- creating, disseminating, and coordinating knowledge transfer among the participants in the national innovation systems (public and private research organisations, enterprises, intermediary

bodies, etc.); and,

- establishing new institutions and law for the development of innovative processes in enterprises.

2. ORIGIN AND PURPOSE OF RESEARCH

Belonging to a particular political and economic structure, for example - the EU, largely determines what kinds of support instruments are implemented in a given country, at least within the scope that results from contracts signed with the European Commission that regulate the use of EU funding.

In Poland, this is reflected in the structure and the subject of the national implementation of the operational programmes co-financed by the European Structural and Investment Funds in 2007-2013 and 2014-2020.

Another example of such unification of innovation and competitiveness policy is the development of national and regional strategies of smart specialisations (Kardas 2011), according to the methodology proposed by the EC, which will determine the direction of regional support instruments to be implemented in the countries of the Community in the upcoming financial perspective (2020).

The mutual resemblance of the array instruments for the support of innovation in EU countries serves the global trend of the internationalisation of business and research. In response to that, the instruments for strengthening international cooperation of the participants of the national systems of innovation gain in importance. This results in the formation of international programmes, which are joined by the support agencies located in different countries of the Community, allowing (by funding) national research institutions and businesses the implementation of business projects in international cooperation. These programs include, for example, era.net action, Programme COST, Programme Eureka.

At the same time, the dynamism of the national innovation systems and the specificity of the economic circumstances of individual countries justify the absence in the literature on the subject of an optimal model of innovation policy, or an optimal set of public support instruments (Izsák et al. 2013).

Nevertheless, those involved in creating innovation policies often use best practice concerning the implementation of these support instruments, which have proven successful in cooperating countries. It takes place across the EU as a whole, which has implemented an SME Instrument as part of the

Horizon 2020 Programme, [http://ec.europa.eu/research/sme-techweb/pdf/SME%20Instrument %20in%20WP%202014-2015.pdf](http://ec.europa.eu/research/sme-techweb/pdf/SME%20Instrument%20in%20WP%202014-2015.pdf), accessed on 28.02.2015) which reflects an instrument used for many years in the USA called SBIR (Small Business Innovation Research) <http://www.sbir.gov> accessed on 28.02.2015). Such a replication of patterns also occurs at the level of individual countries. For example, in 2004, the Netherlands introduced a program – STW Valorisation Grant inspired by the American SBIR, while the United States made use of the EU standard concerning the regional focus of support instruments by implementing in 2013 Program National Network for Manufacturing Innovation (NNMI) (<http://manufacturing.gov/nnmi.html>, accessed on 28.02.2015) (Sacio-Szymańska 2013a).

The adoption of this direction of innovation policy seems to be justified; however, it often does not lead to the expected effects from the use of a given support instrument. This is mainly due to the specific social, economic, and cultural conditions of a country and the related challenges for individual innovation policies, which cannot be resolved by a mere transfer of an instrument itself. It will not work in other conditions than those in the reference country, with a different education system, a different financial system, a different structure of the industry, with a lower level of economic development, or in a different social culture, which can stimulate or hinder innovation activities, or with limited relationship that occurs between the actors of the national innovation system.

Therefore, the mission of those who create innovation policy is to ensure such a configuration of instruments, so that it is harmonized with the other elements forming the national innovation system. Moreover, the selection of instruments is a continuous learning process, because national innovation systems are dynamic structures, where the application of specific support measures results in changes of strengths and weaknesses of the system, and which in turn require changes to the structure of the implemented set of support instruments.

For these reasons, the solutions that were used in other countries should always be tailored to the specific needs of the economy and should take into account its strengths and weaknesses, and their implementation should be preceded by the following steps:

- a diagnosis of the state of innovation in the economy with an indication of its main issues; and,
- a formulation of key objectives of the innovation policy and its priorities.

These were the assumptions adopted in the conducted analyses. The research objective was to analyse the innovation processes of the Polish economy, including its strengths and weaknesses, and to prepare recommendations for areas that require attention and support from the government.

The main stages of analysis include the following:

- the analysis of the condition of innovation in the Polish economy according to international rankings (Sacio-Szymańska 2011),
- the comparative analysis of innovation trends of selected economies (Sacio-Szymanska 2013b, Sacio-Szymańska 2014);
- the comparative analysis of innovation support instruments of selected economies (Sacio-Szymanska 2013c); and,
- the evaluation of the effectiveness of innovation support instruments applied in Poland in the period 2007-2013 (Kosztowniak 2014a).

The subject of this article is to present a methodology for the final stage of the research on the effectiveness assessment of national instruments supporting innovation. In the article the results of an analysis are presented and recommendations with regard to the possibility of effective application of tools to support innovation in Poland.

3. METHODS

In this research, the following thesis was assumed: Research tools to promote innovation implemented in Poland in the period 2007-2013 changed the level of innovation in the economy compared to the years 2004-2006.

The analysis included 46 instruments promoting innovation implemented in Poland in the years 2007-2013.

The following criteria were adopted in the selection of the innovation support instruments:

1. Implementation period: start - 2007 and end - 2013;
2. Budget value per instrument, i.e. more than 5% of the share of the instruments in the global budget of the EU support in the instruments analysed, amounting to 8,517,977,130.00 euro;
3. The number of projects included in the support, indicating a large target group of beneficiaries.

In accordance with the adopted selection criteria, the scope of research includes eight innovation support instruments:

- 1) Support for target projects (I1),
- 2) Strengthening and development of teaching staff and an increase in the number of graduates with

majors that have a key role for a knowledge-based economy (I2),

3) Support of R&D projects for the benefit of businesses carried out by research organizations (I3),

4) New investments with high innovative potential (I4),

5) Support of the implementation of the R&D results (I5),

6) The development research centres with high potential (I6)

7) Support for scientific research for building a knowledge-based economy (I7), and

8) Technology Loan (I8).

The key features of these eight researched instruments for innovation support for the period 2007-2013 are the following:

- the total budget was EUR 5,433,782,763, i.e. 63.80% of the total subsidy value (a total of 10 billion Euro, including 8.65 billion Euro of EU subsidies, while the remainder is financed from the national budget (<http://www.poig.gov.pl>, accessed on 03.05.2015)) scheduled for the period 2007-2013.
- the relationship of budgets per analysed instrument to the value of the global budget for innovation support oscillated around 5% and above; and,
- The number of projects that have received funding amounted to more than 2,800.

and the EU classification of innovation policy priorities;

II. Empirical verification of the impact of innovation support instruments on the change of the key and supplementary indicators significant for the creation and performance measurement of innovation - evaluation ex post;

III. Determining the impact of the innovation instrument on the identified strengths and weaknesses of Polish innovation, and opportunities and threats; and,

IV. Evaluation ex ante of the innovation instrument - formulation of recommendation.

The article presents the results of analyses concerning points I and II.

4. RESEARCH RESULTS

Stage I. Verification of the compliance of the studied instrument for innovation with the general and specific objectives of Innovation Strategy and the Efficiency of the Economy - "Dynamic Poland 2020" and the EU classification of innovation policy priorities.

The main objective: "Highly competitive economy (innovative and effective) based on knowledge and cooperation" delineated in the Innovation Strategy and the Efficiency of the Economy - "Dynamic Poland

Tab. 1. The correlation between the thematic orientation of the analysed support instruments with the objectives of the SIEG

SIEG specific objectives	Analysed instruments							
	(I ₁)	(I ₂)	(I ₃)	(I ₄)	(I ₅)	(I ₆)	(I ₇)	(I ₈)
Objective 1. Adapting the regulatory and financial milieu to the needs of an innovative and efficient economy (Directions: 1.1-1.4)				1.2 1.4			1.2	1.1 1.2
Objective 2. Stimulating innovation through the increase of efficiency of knowledge and work (Directions: 2.1-2.6)	2.1 – 2.6	2.1 2.2 2.5	2.1 2.2 2.3 2.5	2.1	2.1 2.3	2.2 2.6	2.1 2.3 2.5	2.1 2.3
Objective 3. Increasing the efficiency in use of natural resources and raw materials (Directions: 3.1-3.2)	-	3.1.	-	3.1	-	-	-	3.1
Objective 4. Increasing the internationalisation of the Polish economy (Directions: 4.1-4.3)	4.1	-	4.1	4.1 4.2	4.1	4.3	-	4.1 4.2

The evaluation method of innovation support included the following stages:

I. Verification of compliance of the studied instrument for innovation with the general and specific objectives of Innovation Strategy and the Efficiency of the Economy - "Dynamic Poland 2020"

by 2020" (SIEG) developed by the Ministry of Economics is implemented through four specific objectives (Tab. 1.).

The analysis of the eight instruments under investigation in relation to the ability to implement the objectives of the Strategy point to the following

conclusions:

- The analysed instruments primarily addressed two of the four specific directions within Objective 1 (that is 1.2. Focusing public expenditure on the pro-development and pro-innovative activities; 1.4. Facilitating access to capital for companies at all stages of their development) with a particular focus on high risk capital and the SME sector.
- Directions referred to in Objective 2 (Stimulating innovation through the increase of efficiency of knowledge and work) were fully supported by the instruments for innovation support, including directions 2.1. (Increasing the level and effectiveness of science in Poland, strengthening its links with the economy and increasing international competitiveness of science) and 2.3 (Promoting cooperation in innovation).
- The studied instruments only indirectly and to a limited extent support Objective 3 (Increasing the efficiency of using natural resources and raw materials) by addressing priority: 3.1 (The socio-economic system transformation towards “a more green path”), and in particular by reducing energy and material consumption of the economy (by stressing the role of innovation in the area of biotechnology).
- The analysed instruments supported Objective 4 (Increase in the internationalisation of the Polish economy) mainly in Direction 4.1 (Promotion of Polish export and Polish investments abroad through the implementation of joint projects with companies developing innovative product and process solutions).

Moreover, the analysis was conducted whether the main priority objectives of the eight innovation instruments operating in Poland in the years 2007-2013 addressed the development of the EU strategy Europe 2020, including the EU classification of innovation policy priorities (Cunningham et. al 2008). In accordance with this classification, the

instruments are allocated to the areas of strategic intervention, reflecting the main priorities for innovation policy requirements in the five areas (actions) presented in Tab. 2.

The analysis shows that these objectives in the specific priorities of the EU innovation policy were supported unevenly, as was the case in the adequacy of the priority objectives of innovation instruments in the period 2007-2013 in Poland to the strategy of “Dynamic Poland by 2020.”

The most strongly supported area in terms of the number of available instruments and the value of the subsidies is the Research and Technology area (specific priorities: 2.1.4. Research infrastructures; 2.2.3. R&D cooperation (collaborative projects, public-private partnerships with research institutes), and 2.3.1. Direct support of R&D in enterprises (grants and loans)), including such instruments as Development of Centres with High R&D Potential, Support for R&D Projects Carried out by Scientific Bodies for Businesses, and Support for Target Projects.

The least supported area among the eight examined instruments is the area in the EU classification as Markets and Innovation Culture. The verified impact of the eight researched innovation instruments does not guarantee direct support in this area. Indirectly, this aspect of the innovation process was addressed by instruments directed at enhancing other strategic areas of intervention (e.g., Implementation of R&D, R&D Staff, and Entrepreneurship). In particular, the aspects of intellectual property protection was a specific priority in the framework of area 2 (Implementation of R&D), priority 2.2.2 (Transfer of knowledge (contractual research, licensing, research and protection of intellectual property in public research, academic, non-profit institutions)). However, the development of innovation culture was included in the specific priority 3.1.1 (Building awareness and initiating a dialogue between the public and representatives of the world of science and

Tab. 2. The correlation between the thematic orientation of the analysed support instruments and the areas of strategic intervention of the EU innovation policy

Priorities of EU classification of support instruments	Analysed support instruments							
	(I ₁)	(I ₂)	(I ₃)	(I ₄)	(I ₅)	(I ₆)	(I ₇)	(I ₈)
1. Innovation policy, horizontal research							x	
2. Research and technology	x		x		x	x		
3. Human resources (education and skills)		x						
4. Enterprises				x				x
5. Markets and innovation culture								

research of the strategic area of intervention Human resources for R&D), and in the priority 4.2.2 (Support for the development of organizational innovation including new forms of work organisation, etc. of the Strategic Area of Intervention – Entrepreneurship).

Stage II. The empirical verification of the impact of innovation support instruments on the change of the key and supplementary indicators significant for the creation and performance measurement of innovation - evaluation ex post.

The process of empirical verification of the instruments for supporting innovation employed creating indicators and measuring the effects of innovation in terms of macro-economy – at the national and international level. These indicators have enabled an assessment of both the level and trends of innovation in the Polish economy, and the research included mainly the 2004-2006 and 2007-2013 periods.

The complete list of indicators included 26 positions (Appendix 1). In this article, only the following results of the analyses in terms of key indicators are given:

Indicators of innovation creation:

- business expenditure on R&D (% of GDP),
- industrial companies that cooperated in the field of innovative activity in % of businesses active in innovation (share in %).

Performance measurement indicators for innovation:

- the number of patent applications to the USPTO (per million people),
- net income from the sale of high and medium-high technology products in industrial processing companies (in % of net income). Indicator taking into account both the creation and measurement aspects of innovation:

- the number of companies that have bought and sold: licenses, research and development work, means of production processes automation, consulting services, and other technologies.

Indicators of innovation creation:

Business expenditure on R&D

A very important issue to be addressed in the economic literature is the structure of expenditures for research and development (R&D). This structure determines the ability of the economy to transform the R&D results into new technologies and products, which are characterized by a high level of innovation. From the point of view of the usefulness for the economy, the optimal proportion of private and public funds is considered to be 65 to 35 (Janasz, 2006). However, in the structure of national gross expenditure on R&D, the expenditure of enterprises ranged, on average, at the level of 40-30%. This, unfortunately, has not increased in spite of the continuation of the privatisation process in the Polish economy since the 1990s. The lowest share - 20.34% - was reached in 2002. The first period of the EU budget, 2004-2006, brought a slight increase in the participation from 28.68% to 31.54%; the second period was influenced by the financial crisis, and the participation dropped from 30.36% in 2007 to 30.13% in 2011 to increase to 37.21% in 2012 (Fig. 1).

Industrial companies cooperating in the field of innovative activity (% of innovation active enterprises)

Efficient business relationships with the scientific and research sphere are a prerequisite for the

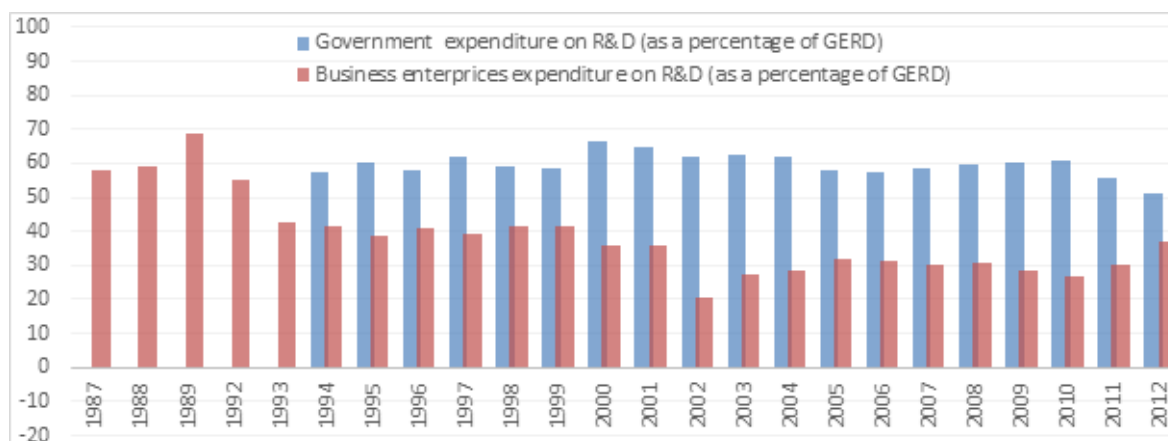


Fig. 1. Government and companies expenditure on R&D in Poland in the years 1987-2012 (in % of the domestic expenditure on R&D, GERD)

Source: OECD.StatExtracts, Factbook Country Statistical Profiles - 2014 edition, <http://stats.oecd.org>. (06.02.2014).

efficiency of the innovation system, which in turn translates into increasing the competitiveness of the economy. An analysis of the type, scope, and intensity of links between enterprises and the sphere of research and development in Poland is a frequent subject of analysis. The conclusions are clear: The scale of the cooperation has remained unsatisfactory for a many years (Szultka, 2008; Górak 2007).

The GUS (Central Statistics Office) data concerning statistics used for monitoring tendencies of industrial companies to cooperate in the field of innovative activity (% of enterprises innovatively active²) for the years 2002-2012, clearly shows that, after an increase in this activity to 46.2% in the years 2004-2006, this cooperation dropped down to 33.7% (in 2007-2009) and 33.8% (2010-2012). While in the first period of

more than 249 employees, and, what is more, it applies to a greater extent to the public sector than the private sector. The greatest activity in the cooperation in innovation was evidenced by large companies (that is, those employing more than 250 people) in their 65.1% share in 2006-2008, and 58.6% in 2010-2012.

The cooperation of small businesses, which constitute the largest group of companies in Poland (about 70%), showed a much lower activity in this realm at 25.8% and 22.1%, respectively. Another group, the medium-sized enterprises (50 to 249 employees) showed a reduction in the activity during the investigated period from 44.6% in 2006-2008, down to 35.7% in 2010-2012.

Performance measurement indicators for innovation:

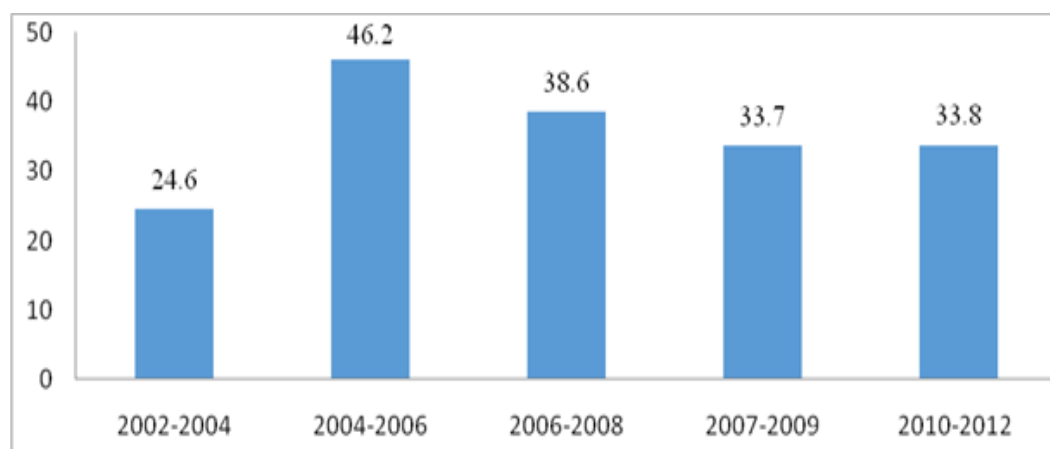


Fig. 2. Industrial companies cooperating in the field of innovative activity in Poland during 2002-2012 (in % of innovation active businesses)

Source: Działalność innowacyjna przedsiębiorstw w latach 2002-2004, 2004-2006, 2006-2009, 2010-2012, GUS, Warszawa 2013.

EU budgeting, there was indeed a significant improvement (since this ratio increased almost two-fold from 24.6%, in 2002-2004, to 46.2% in 2004-2006), and the second EU budgeting period the activity of cooperation definitely decreased and remained at a low level of 33.7% and 33.8% (Fig. 2) (Działalność innowacyjna..., 2012, p. 21)..

The statistics presented in Fig. 2 refers to the general population of industrial companies; however, the most relevant information in this area becomes apparent only after the analysis of industrial enterprises, according to the company's size.

The tendency to cooperate in the field of innovative activity in the period 2006-2008, 2007-2009, and 2010-2012 was most visible in enterprises employing

The number of patent applications

A good measure of the country's involvement in the global technological development is the number of patents obtained at simultaneously in Europe, USA, and Japan. The need for such a broad patent protection arises for unique, breakthrough inventions (Weresa, 2007).

For Poland, the years 1985-2003 were characterised by a fairly large variation of patent applications in this group. Upward trend started from 2004, showing the dynamic annual increase of about 10-15%. However, concerning the Polish share of patent applications in this group, despite the upward trend, their share in the global applications was below 1.00% (Fig. 3).

The analysis of the number of entries in the triadic patent families shows the number of applications per million inhabitants in the years 1985-2011 indicated a very low level, fewer than 1.00 application per

² An innovation active enterprise is a business that introduced at least one product or process innovation in the period under investigation, or carried out during this period, at least one innovation project, which has been interrupted or abandoned during this period (concluded without a success) or hadn't been completed before the end of this period (i.e. is being continued).

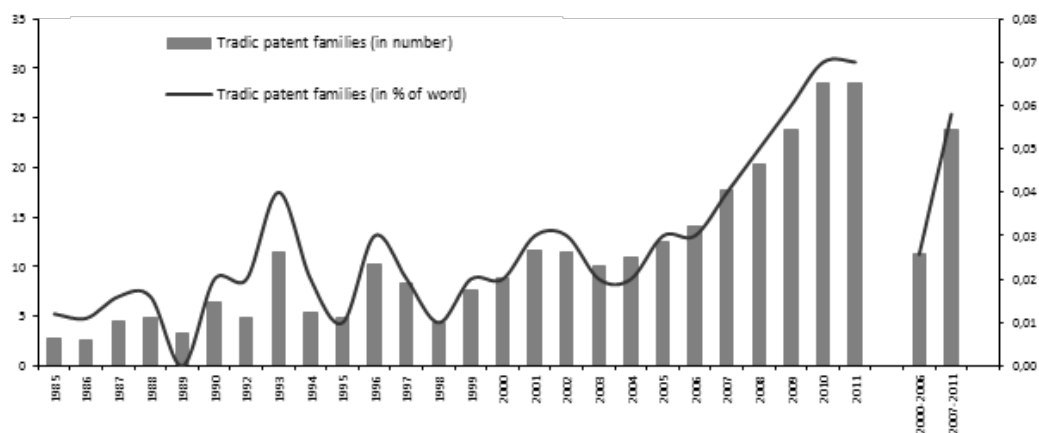


Fig. 3. The number of (triadic patents families) reported by Poland in the years 1985-2012 (in number, in % of world)²
Source: OECD.StatExtracts, Factbook Country Statistical Profiles – 2013 edition. KeyShort-Term Economic Indicators, <http://stats.oecd.org> (02.06.2014).

2 Triadic patent families-inventions patented in the patent offices of the United States, the EPO and Japan.

million inhabitants - 0.7. In other countries, much higher ratios were achieved (for example, Czech Republic: 1.8; Hungary 4.4; United Kingdom 26.0; USA 44.0; Sweden 94.0).

Net income from the sale of high and medium-high technology products in industrial processing companies (% of share).

The high-tech sector is characterized by high levels of expenditure on R&D and scientific and technical employees, intensive cooperation with research and scientific centres, a short life cycle of product and process development, high dynamics of the resource exchange in the technical infrastructure, and the effects of innovative activity in the form of numerous patents and licences (Grudzewski, Hejduk, 2008). An analysis of the structure of the sales income according to the level of technology indicates that, in Poland, high technology products have very low participation in the total value of sales (Tab. 3).

The share in the net income from the sale of the products belonging to high and medium-high

technology 31.6% in 2005, then increased to 34.6% in 2010, and in 2012, it dropped to the level of slightly lower than in 2006 and was 32.4%.

However, a positive trend was noted while analysing an additional measure, namely, the share of high-technology export in the total export. It was found that it grew gradually from 2.6% in 2003 to 5.9% in 2012 (the value of this indicator in 2012 in the Czech Republic was 16%, in Hungary - 18%, in the United Kingdom - 22%, and in Sweden 13%) (<http://data.worldbank.org/> indicator /TX.VAL.TECH.MF.ZS accessed on 28.02.2015).

Indicators taking into account both the creation and measurement aspects of innovation:

The number of companies that have bought and sold: licenses, research and development work, means of production processes automation, consulting services, and other technologies

When purchasing technology in the years 2004-2012, Polish companies focused on the means of

Tab. 3. Net income from the sale of innovative products for high and medium-high technology entities and exports share of high-technology in Poland in the years 2003-2012 (in %)

Description	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
The share in the net income from the sale of the products belonging to <i>high</i> and <i>medium-high technology</i> in companies with more than 9 employees (%)	.	.	31.6	32.8	32.7	33.2	34.2	34.6	32.9	32.4

Source: GUS, System Monitorowania Rozwoju, [Strateg.stat.gov.pl](http://strateg.stat.gov.pl), <http://strateg.stat.gov.pl/Home/Strateg> (accessed 08.06.2014).

automation, consulting services, and licenses, while the sale of technology concentrated on automation, consulting services, and R&D work. There was a significant excess of purchases over sales in technology, which unfortunately did not decline, which indicates an existence of a technological gap in

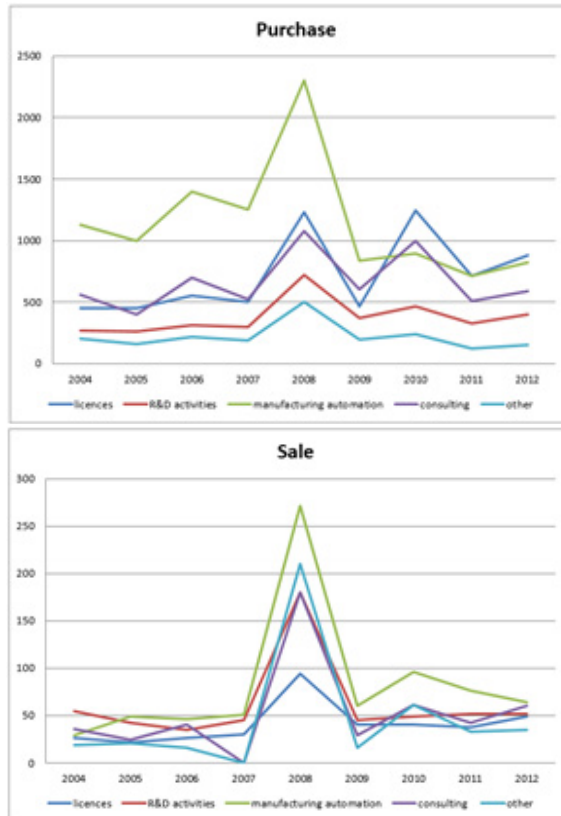


Fig. 4. The number of industrial companies, which purchased/sold technologies in Poland in the years 2009-2012 (in numbers)

Source: Author's elaboration based on *Nauka i technika za lata 2006-2012*, GUS, Warszawa 2006-2012.

the Polish economy (Fig. 4). Until 2008, purchase dynamics of licenses, research and development projects, the automation of production processes, consulting services, and other technologies showed a slightly increasing trend. The highest increase was reported in 2008 (three-fold in absolute value). This was due to the favourable economic situation in Poland during the analysed period. The primary cause of the collapse of the trend in 2009 was a global economic crisis and the associated reduction in the turnover of goods and services. For this reason, despite the available public support, companies significantly reduced their investment budgets.

The increase in the number of production process automations in industrial enterprises is undoubtedly a positive phenomenon, which is conducive to the transformation of the Polish economy into a more

technologically advanced one.

However, the disparity between the number of sold and purchased new technologies indicates, among other things, the following:

- 1) A low level of competitive capacity of many Polish products on the global market;
- 2) A clear competitive advantage of foreign products, sometimes coming from countries with no more than an average level of development;
- 3) A low productivity of many foreign technologies used in the Polish industry;
- 4) An excessive consumption of resources, raw materials, and energy;
- 5) An excessive diversity in manufactured products within one company, making it difficult for specialization and reduce unit costs (Grudzewski, Hejduk, 2008).

In conclusion, the analysis of the empirical impact of instruments in support of innovation (I1 – I8) on the five key component groups in 2007-2012 compared to 2004-2006 shows that the following can be said about the effects of this impact (Tab. 4):

- 1) They can be observed in different timeframes, i.e.:
 - they can become apparent already during the implementation process of the instrument (current impact);
 - they may become apparent later (future impact);
 - they can be observed both during and after the implementation period of the instrument to promote innovation (current and future impact); and,
 - they can affect other areas of innovation and through the dissemination effect (technology, know-how, etc.) become apparent only later in the future (multi-area, multifaceted impact), for example, in the third period of the EU budget - in 2014-2020.
- 2) They may be positive or negative and may exhibit different levels of intensity:
 - within Component I (Business expenditure on R&D) there has been a reduction. The impact of the instruments on this component has been interpreted as a strong, ongoing (X3) stemming from the I1, I3-I8 instruments, and it is predicted that a moderate impact (Y2) stemming from the I2 instrument will continue.
 - within Component II (Industrial companies that cooperated in the field of innovative activity) there has been a clear decline. For this component, some of the instruments cause current effects, some - future effects, but there are also double effects, i.e. - both current and future. Thus, for example, the

Tab. 4. The matrix of the relationship between instruments to support innovation activities carried out in Poland and key components (indicators) for creation and measurement of the innovative and competitive position of Poland¹

Instruments for innovation support	Support for target projects (I ₁)	Strengthening and development of teaching staff and an increase in the number of graduates with majors that have a key role for a knowledge-based economy (I ₂)	Support of R&D projects for the benefit of businesses, carried out by research bodies (I ₃)	New investments with high innovative potential (I ₄)	Support of the implementation of the R&D results (I ₅)	The development of research centres with high potential (I ₆)	Support for scientific research for building a knowledge-based economy (I ₇)	Technology Loan (I ₈)
Key components								
I. Business expenditure on R&D in GDP (%).	X3	Y2	X3	X3	X3	X32)	X3	X3
II. Industrial companies that cooperated in the field of innovative activity (% of innovation active enterprises	X2	Y23)	X3	X2/Y2	X2	Y2	X2	X2/Y2
III The number of patent applications to USPTO (per capita, per million inhabitants)	Y3	X2/ Y2	X2	X2/Y2	X3	X3	X3/Y3	X0/Y0
IV. Net income from the sale of high and medium-high technology products in industrial processing companies (% of share).	Y3	Y1	X2/Y2	X3/ Y2	X2/Y2	Y2	Y2	X3/Y3
V. The number of companies that have bought and sold: licenses, research and development work, means of production processes automation, consulting services, and other technologies.	X3	Y2	X2/Y2	X3	X3	Y2	X2/Y2	X3/Y3

Explanation:

¹⁾ The current impact of the instrument (index) was defined as: strong - X3; moderate - X2; weak -X1; none-X0. Future impact, including the result of the spread of positive effects of promoting innovation, respectively: strong-Y3, moderate-Y2; weak-Y1; none-Y0.

²⁾ Research centres expenditures on R&D;

³⁾ By future employees, i.e. graduates of the targeted curriculum programmes), the instrument can contribute to the development of cooperation, innovative activities between companies.

current effects (strong and moderate) occur mainly on the part of I1, I3, I5, I7 instruments, while future effects are caused by the I2 and I6 instruments, and dual effects: current and future, from the I4 and I8 instruments.

- within Component III (The number of patent applications to the USPTO), there was a decline in their number in 2007-2008, in comparison their number in 2001-2006 in the triadic patent families reported to Patent Cooperation Treaty. For this component, the I3, I5, I6 instruments indicate current impact, for I2, I4 and I7 - current and future impact, additionally, future effects are expected from I1, in the absence of influence from I8.
- within Component IV (Net income from the sale of high and medium-high technology products in industrial processing companies) a small increase in net income was noted in businesses with more than 9 employees, and those with more than 49 employees. This is interpreted as having simultaneously current and future impact on this component by the I3-I5, and I8 instruments, and the future influence of the innovation instruments - I1-I2, I6-I7.
- within Component V (The number of companies that have bought and sold: licenses, research and development work, means of production processes automation, consulting services, and other technologies) the increase in the gap in Polish economy was confirmed, i.e. an increase in the difference between the number of purchases (import) and sales (export) of technology. This is interpreted as having current influence from the I1, I4-I5 instruments, simultaneously current and future influence from I3, I7, I8, instruments, and a future impact from the I2, I6 instruments.

CONCLUSIONS

The analysis and the interpretation of the results of innovation changes in Poland seems to indicate the following conclusions concerning the EU measures for financing innovation support instruments during the implementation period 2007-2013:

- they did not result in a significant increase of R&D expenditure in business, which ranged on average, at the level of 40-30%.
- they did not contribute significantly to the increase of the dynamics of the cooperation between the research sector and business.
- they did not result in an increase in the overall

number of patents, both per million inhabitants and in the global application share.

- they merely allowed maintaining the level of industrial products sales of high and medium-high technology at the level of the corresponding to years 2004-2006.
- they did not result in an improvement in purchase dynamics of licenses, research and development projects, automation of production processes, consulting services, and other technologies by the enterprises.

Certainly, the effects of the use of EU funds are distributed over time. It is possible, therefore, that the positive consequences of the implementation of projects financed from European funds will become apparent in later years. A synergy effect may be expected, to which the financial support provided for Poland in the 2014-2020 will certainly contribute (See for more detail: Kosztowniak, 2014b). Achieving these effects will be possible if the instruments to stimulate an increase in innovation have a greater focus on the following:

Developing cooperation between enterprises (SMEs and large) and scientific and research units in the form of consortia, public-private partnerships, and other forms of cooperation;

Reducing the financial gap that is apparent at the intersection between research and implementation projects, that is, during the period between project testing and its commercialization – by extending the system of securities and guarantees, that is to say, non-financial instruments supported at earlier stages by financial instruments (preferential loans, extended time for due payments) loan and grant instruments for radical investments;

Using the existing R&D infrastructure in Poland extensively;

Boosting the operation of companies specialized in the preparation and implementation of EU projects (investment and research and development);

Increasing awareness (among beneficiaries of EU and national support instruments) in terms of methods of commercialization and implementation, including the income aspects and means of funding at earlier stages of development.

LITERATURE

Baczko T. (ed.) (2005-2012), Reports on the innovativeness of the Polish economy (in Polish), Institute of Economics Polish Academy of Sciences (INE PAN), Warsaw.

- Borras S., Edquist C. (2013), The Choice of Innovation Policy Instruments, *Technological Forecasting and Social Change*, Volume 80, Issue 8, 1513-1522.
- Chen D., Dahlman C., 2005, *The Knowledge Economy*, the KAM Methodology and World Bank Operations, The World Bank, Washington DC.
- Drucker, P.F. (1985) "The Practice of Entrepreneurship", *Innovation and Entrepreneurship Practice and Principles*, Harper & Row, New York
- Dutta S., *The Global Innovation Index 2012*, (2012), *Stronger Innovation Linkages for Global Growth*, INSEAD-WIPO.
- Etzkowitz H., Leydesdorff L. (2000), The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations, *Research Policy* 29/200.
- Freeman C.(1982), Technology, Progress and the Quality of Life, *Science Public Policy*, Issue 18, No. 6.
- Godin B. (2003), The Most Cherished Indicator: Gross Domestic Expenditures on R&D (GERD), *Project on the History and Sociology of S&T Statistics*, Working Paper No. 22, Canadian Science and Innovation Indicators Consortium, CSIC, Canada.
- Górak K (2007), Współpraca przedsiębiorstw ze sferą B+R – bariery i ryzyko, identyfikacja partnerów, z którymi przedsiębiorstwo może nawiązać współpracę, PARP.
- Grudzewski W.M., Hejduk I.K. (2008), Zarządzanie technologiami. Zaawansowane technologie i wyzwania ich komercjalizacji, Centrum Doradztwa i Informacji Difin sp. z o.o., Warszawa [za:] Świdurska A. (2010), Efektywność rozwoju przedsiębiorstw produkcyjnych wysokiej techniki w Polsce, *Prace Komisji Geografii Przemysłu* Nr 15, Warszawa-Kraków.
- Hollanders H., Tarantola S. (2011), *Innovation Union Scoreboard 2010 – Methodology report*, MERIT (Maastricht University), Joint Research Centre (JRC), Unit G3.
- Innowacje i transfer technologii. Słownik pojęć, pod red. K. B. Matusiaka (2011), PARP, Warszawa.
- Izsák K., Markianidou P., Radošević S. (2013), *Lessons from A Decade of Innovation Policy*, Final Report, European Commission.
- Janasz W. (red.) (2006), *Zarys strategii rozwoju przemysłu*, Difin, Warszawa.
- Jasiński A. H. (red.), *Innowacyjność polskiej gospodarki w okresie transformacji. Wybrane aspekty*, Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego, Warszawa 2010.
- Kalecki M., *Observations on the theory of growth*, *Economic Journal*, 72, 134-153.
- Kardas M. (2011), Inteligentna specjalizacja – (nowa) koncepcja polityki innowacyjnej, *Optimum. Studia Ekonomiczne*, nr 2.
- Kosztowniak A. (2014a), Ocena skuteczności wybranych instrumentów wsparcia innowacyjności stosowanych w Polsce w latach 2007-2013, z uwzględnieniem analizy porównawczej efektów wdrożeniowych osiągniętych w latach 2004-2006. *Opracowanie badawcze, ITeE-PIB, Radom*, p. 1-74.
- Kosztowniak A. (2014b), Rola instrumentów wspierania innowacyjności w obszarach wzrostu aktywności przedsiębiorstw w sferze B+R oraz komercjalizacji wyników B+R. *Analiza porównawcza instrumentów Wielkiej Brytanii, Niemiec i Polski. Problemy innowacyjności oraz rekomendacje dla Polski na lata 2014-2020, Ekspertyza badawcza, ITeE-PIB, Radom* 2014, p. 1-54.
- Lundvall B.-Å. (1992), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London.
- Marciniak S. (2010), *Innowacyjność i konkurencyjność gospodarki*, Wydawnictwo C. H. Beck, Warszawa.
- Metcalfe S (1995), *The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives*, [w:] P. Stoneman (ed.) *Handbook of The Economics of Innovation and Technical Change*, London, Blackwell.
- Nauka i technika za lata 2006-2012, GUS, Warszawa 2006-2012.
- Niosi J. et al. (1993), *National Systems of Innovation: In search of a workable concept*, *Technology in Society*, Vol. 15.
- Podręcznik Oslo (2008), *Zasady gromadzenia i interpretacji danych dotyczących innowacji*, OECD, 1997 – 2005, [za:] Wydanie MNiSW, Warszawa.
- Porter M. E. (1991), *Towards a dynamic theory of strategy*, *Strategic Management Journal*, Vol. 12, 95-117, p. 95-117.
- Reid A., Peter V. (2008), *TECHNOPOLIS Group (Brussels), Sectoral Innovation Systems: The Policy Landscape in the EU25, Final Report, SYSTEMATIC study*, February.
- Rybiński K. i in. (2011), *Go Global! Raport o Innowacyjności Polskiej Gospodarki*, Warszawa.
- Sacio-Szymańska A. (2011), *Pozycja Polski w świetle wybranych metodyk oceny innowacyjności konkurencyjności*, *Problemy Eksploatacji* 3/2011, ISBN/ISSN: 1232-9312.
- Sacio-Szymańska A. (2013a), *The report: „Porównanie rodzajów narzędzi wspomagania innowacyjności stosowanych w Polsce i wybranych krajach” nr RC/5/I.4.3/PS z realizacji zadania badawczego I.4.3. Monitorowanie skuteczności wprowadzanych na poziomie kraju systemowych uregulowań w zakresie innowacyjnych rozwiązań technicznych i organizacyjnych wspomagających procesy wytwarzania i eksploatacji obiektów technicznych. ITeE – PIB, Radom*.
- Sacio-Szymańska A (2013b), *Factors influencing Innovation and Competitiveness – a Comparative Analysis of Selected Economies*, *Proceedings of the 8th European Conference in Innovation and Entrepreneurship - ECIE 2013*, Academic Publishing Limited, Reading, UK, ISBN: ISBN: 978-1-909507-59-3.
- Sacio-Szymańska A. (2013c), *Innovation policy as a driver of a country's competitiveness*, *Problemy Eksploatacji* 4/2013, p. 41 -54.
- Sacio-Szymańska A. (2014), *Determinanty innowacyjności i konkurencyjności gospodarek – analiza porównawcza i rekomendacje*, *Optimum Studia Ekonomiczne*, 2014, 1(67), 128-152.
- Schumpeter J. (1950), *Capitalism, Socialism, and Democracy*. New York: Harper & Row; 3rd Edition, 1950.
- Sala-i-Martin X., Artadi E.V. (2004), *The Global Competitiveness Index*, [w:] *The Global Competitiveness Report 2004–2005*, Palgrave Macmillan, Hampshire.
- Solow R. (1956), *A Contribution to the Theory of Economic Growth*, *Quarterly Journal of Economics* 70 (February), p. 65–94.

- Szultka St. (red.) (2008), Badanie barier i stymulatorów dotyczących mechanizmów tworzenia i transferu innowacji ze środowiska naukowego do sektora przedsiębiorstw (IBnGR).
- Weresa M.A. (2007), Unia Europejska- innowacyjne centrum czy peryferia świata, [w:] E. Kawecka-Wyrzykowska (red.) (2007), Unia Europejska w gospodarce światowej - nowe uwarunkowania, SGH, Warszawa, p. 89-113.

INTERNET

1. <http://www.statista.com>
2. <http://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS>
3. http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages
4. <http://manufacturing.gov/nmni.html>
5. <http://stats.oecd.org>

6. <http://strateg.stat.gov.pl/Home/Strateg>
7. <http://www.ec.europa.eu/europe2020/>
8. <http://www.funduszeuropejskie.gov.pl/>
9. <http://www.globalinnovationindex.org/gii>
10. <http://www.manufuture.org>
11. <http://www.ncbir.pl>
12. <http://www.poig.gov.pl>
13. <http://www.sbir.gov>
14. <http://www.weforum.org/issues/global-competitiveness>

Appendix 1.

Indicators of innovation and competitiveness creation	Performance measurement indicators for innovation
<ol style="list-style-type: none"> 1. Business expenditure on R&D (% of GDP). 2. Industrial companies that cooperated in the field of innovative activity in % of businesses active in innovation (share in %). 3. Gross national expenditure (GERD), government expenditure, and the expenditure of enterprises R&D (BERD) in Poland in the years 1990-2012 (set prices in USD millions, PPPs). 4. Government and companies spending on R&D and expenditure financed by the domestic industrial sector in the years 1987-2012 (in % of the domestic expenditure on R&D, GERD) 5. Expenditure of branches of foreign companies on R&D operating in Poland in the years 2000-2009 (in percent of total business expenditure). 6. Government spending on research in Poland in 2004-2011 (in percent the national total expenditure). 7. R&D gross national expenditure (GERD) Poland in the years 1992-2012 (annual percentage changes). 8. Gross national expenditure on R&D in Poland in the years 2001-2011 (in % of GDP). 9. Sectoral sources of funding business expenditure in Poland in the years 1994-2011 (in million USD, at set prices, PPPs). 10. Expenditure of the enterprises according to the type of research funded in Poland in the years 2005-2010 (in million USD) at set prices, PPPs). 11. Gross fixed capital spending in Poland in the years 1994-2013 (in percent of GDP, annual change in %, in set prices). 12. Enterprises in the sector of SME introducing product innovations or process in terms of innovative activity in Poland in the years 2003-2012 (in percent). 13. Industrial companies undertaking expenditure on innovation activities - number of companies with 50 employees and more in Poland in the years 2003-2012 (in percent). 	<ol style="list-style-type: none"> 1. The number of patent applications to the USPTO (per million people). 2. The number of companies that have bought and sold: licenses, research and development work, means of production processes automation, consulting services, and other technologies 3. Net income from the sale of high and medium-high technology products in industrial processing companies (in % of net income). 4. Position of Poland in the international rankings 5. The number of technological ICT patents registered by Poland in the USPTO (ICT patent grants) from 1980 to 2010, per number of inhabitants (number per million inhabitants). 6. The number of patents (triadic patents families) registered by Poland in the years 1985-2012 (number). 7. The number of patents (triadic patents families) reported by Poland in the years 1985-2012 (in number, in % Global applications). 8. The total number of patent applications (tradic patents families) in 1985-2011 in Poland per number of inhabitants (number per million inhabitants). 9. The number of patents (triadic patents families) reported by Poland in the years 1984-2010 to the Patent Cooperation Treaty, PCT) (number). 10. The net income from the sale of the innovative products belonging to high and medium-high technology 11. Share of high technology exports in Poland in the years 2003-2012 (net income from the sale of the total sales in industrial enterprises in manufacturing (in percent) in the number of enterprises and in the total exports (in percent). 12. The structure of exports of industrial products of high, medium, and low Polish technology in 1994-2011 (in percent). 13. Market structure of innovative enterprises in Poland in the years 2003-2012 (in percent)