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Public Finance versus Economic Innovation*

Abstract. *The following paper is a limited attempt to analyse public finances in regard to their influence on the Polish economy when compared with the European Union between the years 2006-2013. In EU countries there are significant differences as far as the levels of development and innovation are concerned, together with the level and the sources of financing research and development activities. Distinct progress in innovation, which is the source of change in product quality and costs of product manufacturing, is the prerequisite sustainable growth for the EU, which implies product and whole economy competitiveness. The most significant determinants of innovation are financial resource accessibility and widely understood human potential. Both these factors are undoubtedly places within the scope of public finance. The following analysis does not exhaust the subject matter, but is sufficient to draw conclusions that with reference to the needs of the Polish economy, the direct public spending on research and development is too low. The decrease in public expenditure (GDP share) on education and health care, when compared with other EU countries, does not support the improvement in the quality of human capital. On the other hand, the results of the following study show that the outlays from public levies on these two mentioned above functions are positively correlated with innovation of the economy.*

Keywords: *innovation, Summary Innovation Index, Global Innovation Index, innovation versus economic growth, GBOARD (Government Budget Outlays and Appropriations for Research and Developments), GERD (Gross Domestic Expenditure on R&D), public expenditure on R&D, Spearman's rank correlation coefficient*

* The paper translated by Krzysztof Sajon.

Introduction

Innovation is most frequently understood as the implementation of a new or a significantly upgraded product, process, organizational or marketing method into the practice of economic activity. Thus, it is an activity which is dynamically and multi-dimensionally determined by not only the economic, social and political factors but also by the historical, sociological and philosophical ones. It is the market itself that plays the crucial role in the process, as it finally verifies all the undertaken actions in terms of innovation. Innovations being the source of shifts and diversification in product quality and manufacturing costs imply the changes in the market potential of particular economies.

Access to the internal and external financial resources and widely understood human resources are among the most significant innovation determinants.

According to the strategic document EU 2020 published by the European Council, one of the major goals of the EU is to reach the level of 3% GDB spent on R&D in 2020. According to the document 1/3 of the outlays on research and development is to be financed with public resources of the member states and 2/3 from the private sources.

The forecast for Poland prepared by the Ministry of Education based on various variants of finance allocation from structural funds in the years 2013-2020 together with the increase in the private outlays on research and development activity from the present 30% to 50% determined the target value of GERD with reference to GDP for Poland at the level of 1.7% assuming the equal participation of public and private sectors.

The purpose of the following paper is the attempt to analyze the influence of public finance onto the increase in innovation of Polish economy when compared with the EU in the years 2006-2013. Moreover, the author attempts to verify two hypotheses:

– the first hypothesis assumes maintaining high differences of innovation in particular EU economies;

– the latter assumes the existence of strong correlation between public financing of research and development activity and real gross domestic product per capita.

1. Innovation of Polish economy when compared with the EU

There is no single measurement of innovation. According to *Frascati Manual* research and development activity is defined as systematically conducted crea-

tive activity undertaken in order to increase the knowledge and the ways of its implementation[1]. Innovation is undoubtedly connected with widely understood knowledge and the expression of this knowledge. Different innovations can reflect different level of knowledge acquired both in the formal education system and from experience. This direct connection between knowledge and innovation is one of the basic criteria differentiating innovation, particularly its significance for the competitiveness of the economy. Different classifications of innovation have been widely discussed in Polish and foreign literature [e.g. Balcerowicz & Wziątek-Kubiak 2009; Kozioł 2007; Francik & Pocztowski 1991]. The measurement of innovation of particular economies is not a simple process. It requires interdisciplinary knowledge and experience.

In Europe SII – *Summary Innovation Index,* published within the annual report *Innovation Union Scoreboard* (IUS) is mainly applied as the measurement of economic innovation. *European Innovation Scoreboard* (EIS) is an annual report assessing innovative achievements of the member states of the EU on the basis of SII. It is calculated as weighted arithmetic mean of 29 partial ratios for 28 EU countries together with Turkey, Island, Norway, Switzerland, the USA and Japan. SII ratio has values from 0 to 1 and the closest its value is to 1 the higher is the level of the given country's innovation. This ratio is created on the basis of partial ratios including both the outlays on innovation and their outcomes.[2] The former are described by means of the ratios referring to financing, education, corporate investment and the infrastructure of their functioning. The latter, on the other hand, mainly concern the economic results of the companies implementing innovations.[3] Differences in the innovation indices in the years 2006-2013 in the European Union are presented graphically in Chart 1.

According to SII index – in accordance with *Innovation Union Scoreboard* – countries were divided into four groups: innovation leaders, followers, moderate innovators and innovators with small results. Poland was included into the third group. In 2011 an increase in the value of the index was observed, unfortunately it did not have a permanent character.

The values of synthetic innovation indices for Poland, means in the EU and the indices of the highest and lowest values in the EU countries in the years 2006-2013 are presented in Table 1.

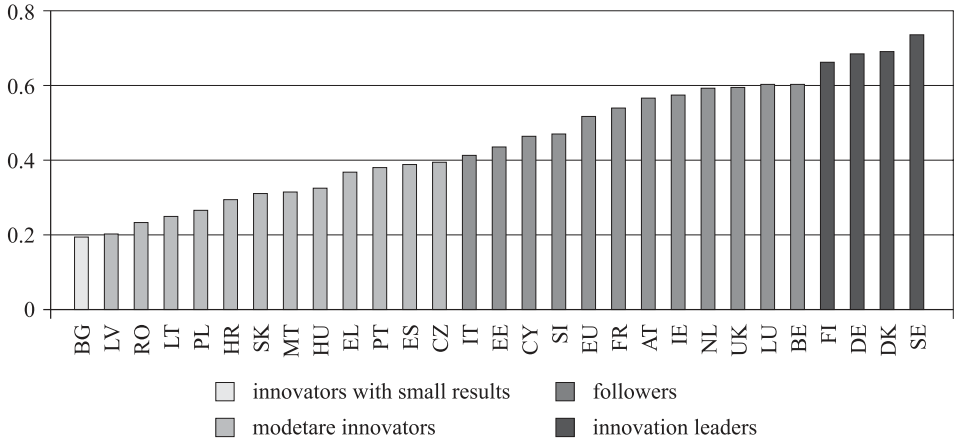
The analysis of the index in the years 2006-2013 indicates that it underwent a number of multi-direction changes. However, the shifts between the highest and

[1] *Frascati Manual* is the very first methodological manual containing guidelines concerning statistical research in science and technology. Cf. www.nauka.gov.pl/g2/oryginal/2013_05/08935db1c9f7adf15c087d07720a984f.pdf [access: 11.11.2014].

[2] The number of indicators in particular reports changed from 22 to 30.

[3] The indicators on the basis of which SII was created are described in detail: Wołodkiewicz-Donimirski 2011.

Chart 1. Average SII indices in EU countries in the years 2006-2013



Source: own work on the basis of Innovation Union Scoreboard 2014.

Table 1. SII for selected EU countries

Specification	2006	2007	2008	2009	2010	2011	2012	2013
EU	0.493	0.506	0.504	0.516	0.531	0.532	0.545	0.554
BG (min in 2013)	0.158	0.168	0.189	0.198	0.216	0.228	0.191	0.188
SE (max in 2013)	0.732	0.729	0.732	0.737	0.739	0.746	0.752	0.750
PL	0.263	0.275	0.265	0.276	0.272	0.282	0.268	0.279

Source: Innovation Union Scoreboard 2014.

lowest values of SII in the two extreme years of the period under examination were relatively small. In 2006 index for Bulgaria was 4.6 times as low as the index for Sweden – the country with the highest SII, in 2013, on the other hand it, was 4 times lower. The change for Poland was even less favorable. In 2013 the value of the index regarding Poland was 2.8 times as low as the index for Sweden, and in the last year it was 2.7 times lower.

The differences in the levels of economic innovation for different EU countries are still very high. Assuming that the average EU index = 100, the relations of the joint innovation index for Poland with relation to three EU countries with the highest and lowest values of the index are presented in Table 2.

The joint shift in the index in the analyzed years shows how different the changes in innovation of particular EU economies measured by means of the accumulated SII increase were; which is presented in Table 3.

The highest change in the values of the innovation index were reported in Estonia, Portugal, Cyprus, Slovenia and Austria, while the lowest values were

Table 2. SII for the selected EU countries with the assumption that EU = 100

Specification	2006	2007	2008	2009	2010	2011	2012	2013
UE	100	100	100	100	100	100	100	100
SE	148	144	145	143	139	140	138	135
DK	139	137	130	130	133	131	132	131
DE	131	130	133	133	132	130	130	128
PL	53	54	53	53	51	53	49	50
BG	32	33	38	38	44	44	35	34
LV	35	37	39	41	41	43	43	40
RO	42	43	48	50	45	48	42	43

Source: own calculations on the basis of Innovation Union Scoreboard 2014.

Table 3. Accumulated increase in the synthetic innovation index in the EU in the years 2007-2013

Specification	SII 2013	Change in SII index
EE	0.502	0.114
PT	0.410	0.096
CY	0.501	0.087
SI	0.513	0.086
AT	0.599	0.083
LU	0.646	0.076
NL	0.629	0.068
DE	0.709	0.063
IT	0.443	0.063
EU	0.554	0.061
FI	0.684	0.054
FR	0.571	0.054
HU	0.351	0.053
CZ	0.422	0.048
LT	0.289	0.048
LV	0.221	0.047
DK	0.728	0.044
MT	0.319	0.041
BE	0.627	0.039
IE	0.606	0.039
ES	0.414	0.039
SK	0.328	0.032
EL	0.384	0.031
BG	0.188	0.030
RO	0.237	0.029
UK	0.613	0.023
SE	0.750	0.018
HR	0.306	0.016
PL	0.279	0.016

Source: own calculation on the basis of Innovation Union Scoreboard 2014.

reported in Poland, Croatia, Sweden, Great Britain and Romania. Thus, both in the upper and the lower part of the table one can find countries exhibiting very different wealth levels measured by means of GDP per capita. Countries with the lowest change in SII in the analyzed seven years exhibit its accumulated change which is nine times as low as in Estonia – the country with the highest level of innovation increase.

While comparing the EU economies with the leading, in terms of innovation, Swiss economy, one can notice even greater differences. Its SII value increased from 0.752 in 2006 to 0.835 in 2013, while the lowest change of the average EU index was from 0.493 to 0.554. Table 4 presents the comparison between the EU countries that are placed at the top three and the lowest three positions together with the innovation of Polish and Swiss economies.

Table 4. SII for selected EU countries assuming that CH = 100

Specification	2006	2007	2008	2009	2010	2011	2012	2013
CH	100	100	100	100	100	100	100	100
SE	97	94	92	92	90	91	89	90
DK	91	90	83	84	86	85	86	87
DE	86	85	85	85	85	84	84	85
PL	35	36	33	34	33	34	32	33
RO	28	28	31	32	29	31	27	28
LV	23	24	25	26	26	28	28	26
BG	21	22	24	25	28	28	23	23

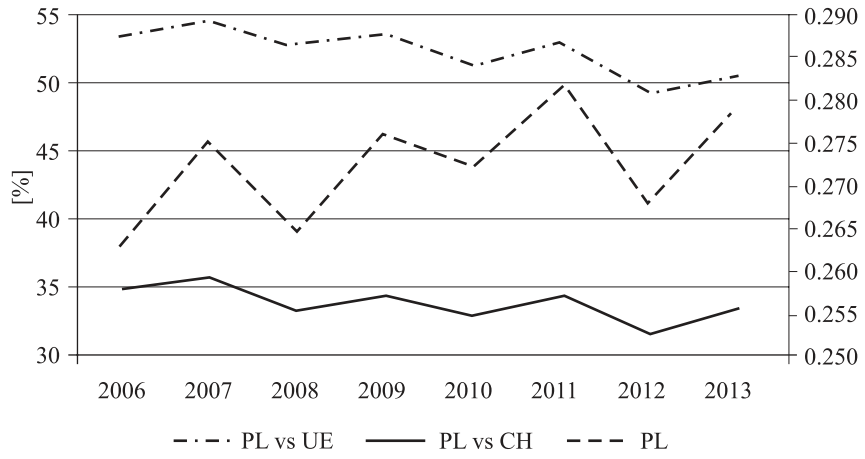
Source: own calculation on the basis of Innovation Union Scoreboard 2014.

In 2013 SII for Sweden accounted for 90% of the Swiss index and the difference between the country with the highest value and the lowest value in the last year under the analysis was 67 points. Synthetic index of Polish economy innovation in 2013 accounted for 50% of the average index for the EU and for only 33% of SII value for the Swiss economy. In 2006 the values of these indices for Poland were higher and accounted for 53% of the EU index (UE = 100) and for 35% of the Swiss index (CH = 100). Relative differences between the values of the indices and their changes are presented in Chart 2.

These negative assessments of Polish economy are also confirmed by GII – *Global Innovation Index* created in 2007.[4] Currently, this index is used as the measurement of innovation of 143 economies worldwide by means of 84 different indicators. The measurements building up this index can be divided into two basic groups:

[4] The Global Innovation Index 2014, The Human Factor in Innovation, Cornell University, INSEAD, WIPO, www.globalinnovationindex.org/userfiles/file/reportpdf/GII-2014-v5.pdf [access: 20.11.2014]

Chart 2. SII for Poland, EU-28 = 100 and CH = 100 in the years 2006-2013
(innovation index – right-hand axis, relation to EU = 100 and CH = 100 left-hand axis)



Source: own calculation on the basis of Innovation Union Scoreboard 2014.

– factors of innovation input comprising: institutions, human potential, ICT and infrastucture, market advancement, business activity advancement;

– results of innovation output, including the results of scientific and creative activity.

It is also Switzerland that holds the top position in this ranking, which results from favorable conditoning influencing both innovation input and output.

Polish economy, apart from accumulated high GDP dynamics, was not accompanied by the adequate increase in innovation. Analyses based on GII place Poland at the lowest places of the ranking list in the region. In 2013 in the Global Innovation Ranking Poland was classified at 45th position, while in 2012 it was palced at 44 position. In comparison with other EU countries, it is only Romania that had a worse result – it was placed at position 55. On the basis of the indicators regarding innovation input Poland was placed at posion 40, ahead of Hungary, Greece, Slovakia, Bulgaria and Romania. While taking into consideration the second criterion – innovation output – Poland was placed at position 48 and it was only Greece that had a lower position.

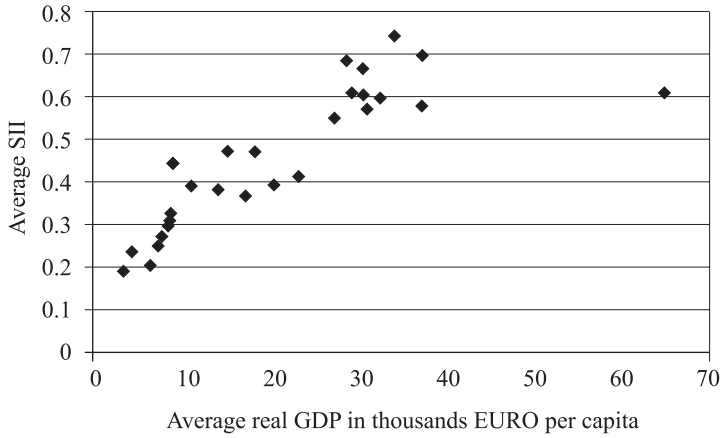
GII methodology made it possible to identify strengths and weaknesses of Poland in terms of particular innovation indicators. Advancement of the business environment, low measurement of trade barriers, relatively favorable conditions of getting credit, and above all, the number of students, are the strengths of our innovation.

Poland's weaknesses in terms of innovation include slim electronic access to public services, very low quality of public infrastructure (ICT and infrastructure), inefficient law and high legal burden (institutions), together with low tendency to cooperate within clusters (business advancement/innovation ecosystem).

2. Innovation versus economic growth

Innovation determining economic competitiveness is one of the major factors determining longterm economic growth. The comparison of the real gross domestic product per capita, which is not free from flaws but, apart from that, is the most often used measurement of the country's wealth, and the average joint innovation index in the years 2006-2013 is presented in Chart 3 [Ziółkowska 2014].

Chart 3. Average real GDP in thousands of EURO per capita and the average SII in the years 2006-2013



Source: own calculation on the basis of Eurostat and Innovation Union Scoreboard 2014.

It indicates that there is a positive correlation between real gross domestic product per capita and synthetic innovation index. The strength of this correlation was calculated by means of Spearman's rank correlation coefficient which confirmed the existence of very strong positive correlation of 0.92 indicating that the increase in innovation is accompanied by the increase in GDP.[5] Simultaneously, one can notice that up to a certain limit innovation index grows at a slower pace

[5] Four-grade assessment scale was adopted: below 0.2 weak correlation, 0.2-0.4 weak correlation, 0.4-0.6 moderate correlation, 0.6-0.8 strong correlation, 0.8-0.9 very strong correlation, 0.9-1.0 nearly complete interdependence.

than GDP, and with its higher values per capita, the increase in innovation exceeds the changes in GDP. Such almost complete interdependence might be, however, infected with the short period under analysis and with the methodological over-simplification that SII cannot be freed from. For Central and Eastern European countries this statistical interdependence was slightly weaker – 0.80.

In Poland in the period under analysis real GDP per capita was 7.9 thousand EURO on average with the innovation index of 0.273. The change in innovation by 0.016 in 2013 in comparison with 2006 was accompanied by the increase in GDP by 1.9 thousand EURO. With reference to GDP per capita Poland was placed in the European Union at position 24 in 2006 and at position 23 in 2013, while with the reference to SII the posions were 24 and 25 respectively.

In Germany the average real GDP per capita (29.2 thousand EURO) was accompanied by the innovation index of 0.684. The increase in innovation in the following years by 0.063 was accompanied by the decrease in GDP by 2.2 thousand EURO, which was definitely due to the economic crisis.

At the same time Swiss economy with the GDP per capita of 34.7 thousand EURO and the innovation index of 0.740 was marked with the increase in the index by 0.018 and in GDP per capita – by 1.3 thousand EURO.

Six out of all the years under discussion were marked by economic slowdown for the EU countries or even recession. That is why, together with the discussed above examples, the relationship between the degree of innovation and the pace of development of particular economies in the years 2006-2013 was examined. The correlation between the average synthetic innovation index and the average dynamics of the GDP, although it was positive, was at the same time very weak and did not exceed the first bracket grade from the six-bracket scale. Such result of the study if it comprised longer time series might lead to a quite controversial conclusion that the degree of innovation of a particular economy did not influence its resistence to external shocks and the limitation of the recent global economic and financial and debt crisis results.

Polish economy enters the second twenty-five-year period of building new social and economic order with the innovation index of 0.279 and GDP per capita of 8.7 thousand EURO. Within the twenty-five years the nominal GDP per capita increased from 2.1 billion PLN in 1991 to 42.5 billion PLN in 2013, which enabled to reduce the development distance from highly developed countries. In 2013 GDP per capita measured by means of the spending power parity was 68 with EU = 100 and was higher by 20 points in comparison with 2002. This result is due to the mixture of multiple factors, one of which was undoubtedly the adopted developmental model for Poland based on technology implementation and simple economic, social and organizational patterns adopted from developed countries.

This "immitative" development model according to many theorists and practitioners seems to be currently exhausting its possibilities.[6]

The prerequisite of the continuation of positive developmental tendencies of Polish economy seems to be considering structural policy aimed at economic competitiveness as the top priority. The authors of the mentioned above Report mention the necessity of the shift to the formula of creative diffusion being the creative not just imitative adoption of imported technologies and managerial solutions [Gordecki et al. 2012: 82-96].

That is undoubtedly a rational approach, much more accurate than creating illusions that we can be creators of such innovations that would create totally new markets and could be defined as radical innovations.

Technology import by means of the purchase of machinery and equipment, which was the driving force of increasing our economy's productivity, especially in the first years of transformation, is no longer sufficient to catch up with the western countries. This is indicated by the measurements of Polish economy innovation when compared with other, mainly EU, countries. We will also soon have more limited access to the EU resources. Thus, it is high time to change the main function from "pro-demand" to "pro-supply," which can only be created under the conditions of gradual increase in competitiveness of Polish economy by the increase in its innovation. This process requires a particular activity on the part of the state. The activity which is understood not only as the process of generating financial resources directly contributing to science, reasearch and development by both the public and private sectors but also the whole infrastructure determining the innovative activity of companies. That is in particular broadly understood process of learning, creating thinking, openness towards novelties and risk. The necessity of continuous multidimensional self-education understood not only as the process of achieving particular formal levels but also as the ability to make contacts and to benefit from one's own and somebody elses's experience. The significance of accumulation of human capital in both quantitative and qualitative respect, which is one of the determinants innovation cannot be underestimated but simultaneously is very hard to assess [Balcerowicz & Wziątek-Kubiak 2009].

In order to get out of the trap of "small growth" it is necessary not only to determine the role of the state in terms of innovation but also to demand its fulfillment on the part of the institutions responsible for the process. Public authorities have at their disposal direct and indirect instruments determining innovative processes that should be actively used particularly when companies do not have sufficient resources to conduct costly research actitity [Piekut 2011]. The state can jointly finance research and development not only due to the fact that these

[6] Important and inspiring discussion on the new social and economic development model in Poland is presented in the Report: Gordecki et al. 2012.

outlays are for private subjects too costly and therefore risky, but also due to the fact that direct enaging public resources enables the state to influence the research activity in such a way so that the areas concerned reflect the long-term country's and its citizents interests, such as health or safety. It is always the market that verifies the allocation of both public and private resources into particular areas. Public sector usually gets engaged in financing basic research, which, due to its character, does not bring direct benefits in practice, which is why it is not the area of interest for the private sector. The state can also motivate to get engaged in innovative activity by means of grants, tax reliefs, tax deductions from the tax base or from the tax itself.

3. Public sector outlays on research and development

According to the purpose of the following paper the author examines the progress in Polish economy innovation from the angle of engaging public resources in the process of financing research and development activity.

In order to present the expenditure on research and development activity two measurements were used: GBOARD (*Government Budget Outlays and Appropriations for Research and Developments*) and GERD (*Gross Domestic Expenditure on R&D*) partially financed by the government sector and the sector of higher education disregarding the business sector and non-profit organizations sector. GBOARD data concern the year of allocating budget resources while GERD registers the year in which these resources were really used.

According to Frascati Manual GBOARD presents all the expenses covered by public levies. Therefore GBOARD measurement comprises research and development activity:

– financed by the government and conducted by the institutions subordinate to the government;

– financed by the government in the remaining three domestic sectors (enterprises, higher education, private non-commercial institutions) and „foreign" sector.

Expenditure on research and development activity measured by means of GBOARD in the years 2006-2013 undergo multidimensional changes, which is presented in Table 5.

In 2013 GBOARD expenditure in % GDP in the country with the highest share, that is in Finland, was over seven times as high as in the country with its lowest share in GDP, that is Latvia. In 2006 GBOARD in % GDP in Finland was only four times as high as in Latvia. GBOARD expenditure in % GDP in Poland in 2013 in comparison with 2006 with relation to its average share in the EU slightly improved. It is, however, over twice as low as in the EU.

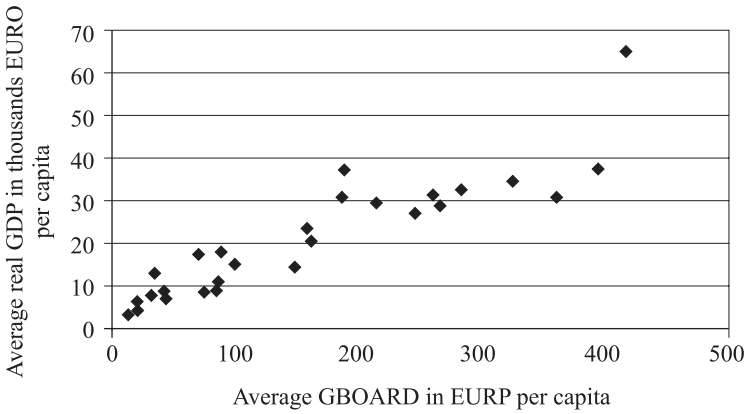
Table 5. GBOARD in % GDP

Specification	2006	2007	2008	2009	2010	2011	2012	2013	Joint change
EU average	0.69	0.68	0.78	0.78	0.75	0.73	0.70	0.69	0.00
LV (min in 2013)	0.27	0.30	0.29	0.21	0.16	0.15	0.15	0.14	–0.13
FI (max in 2013)	1.02	0.97	0.98	1.12	1.16	1.10	1.07	1.03	0.01
PL	0.32	0.32	0.30	0.34	0.37	0.32	0.36	0.37	0.05

Source: own calculation on the basis of Eurostat.

The interdependence between the average GBOARD expenditure in EURO and real average GDP per capita in the EU countries is presented in Chart 4 (correlation scatter chart).

Chart 4. Average real GDP in thousands EURO per capita and average GBOARD in EURO per capita in the years 2006-2013



Source: own calculations on the basis of Eurostat and Innovation Union Scoreboard 2014.

In 2013 in the EU average budgetary outlays per capita in EURO according to GBOARD increased by nearly 10% in comparison with 2006. Moreover, during the economic crisis in the years 2008-2013 they were higher than in the years 2006-2007. In Poland, except for the fact that they increased by almost 66% – in 2013 they were still five times as low as the average outlays in the EU. What is more, although with reference to GDP per capita in EURO the decrease was not observed in any of the years under examination in comparison with the previous year, the dynamics was negative according to GBOARD per capita in 2009 and in 2011.

The highest average budgetary outlays in the EU countries per capita in EURO in the years 2006-2013 were observed in Luxemburg (417.0), Denmark (393.3),

Finland (359.8) and Sweden (324.6), while the lowest were observed in Bulgaria (13.1), Romania (18.3), Latvia (19.5) and in Poland (30.3). While disregarding Luxemburg, the difference in outlays according to GBOARD between the highest and the lowest values in EURO is thirty-fold and significantly exceeds the differences in GDP which is almost eleven times bigger.

The significance of the interdependence between the average GBOARD and GDP outlays per capita in the analyzed period was also examined with the use of Spearman's rank correlation coefficient. A strong positive correlation of 0.94 was observed. Correlation for Eastern and Central Europe countries was also positive, however, its strength was lower but still significant – 0.78 (the third bracket of the scale).

The necessity of engaging the state in both financing and conducting research and development activity is thus undisputable. A more important measurement of outlays on research and development is GERD. According to Frascati Manual, GERD includes internal outlays on research and development only on the territory of a particular country in a particular year. These outlays are divided according to the financing sources into five different sectors: government entities outlays (resources from the state budget and budgets of territorial self-government entities), higher education, enterprises, non-commercial private institutions, and foreign sector. In particular countries the share of these sectors differs significantly. R&D activity is financed as statutory activity and with the use of grants, contracts and subsidies.

Expenditure according to GERD in relation to GDP in Poland, EU averages and the averages in the countries with the minimum and maximum shares are presented in Table 6.

Table 6. GERD in % GDP

Specification	2006	2007	2008	2009	2010	2011	2012	2013	Joint change
EU average	1.78	1.78	1.85	1.94	1.93	1.97	2.01	2.02	0.24
RO (min in 2013)	0.45	0.52	0.57	0.46	0.45	0.49	0.48	0.39	–0.06
FI (max in 2013)	3.34	3.35	3.55	3.75	3.73	3.46	3.43	3.32	–0.02
PL	0.55	0.56	0.60	0.67	0.72	0.75	0.89	0.87	0.32

Source: own calculation on the basis of Eurostat.

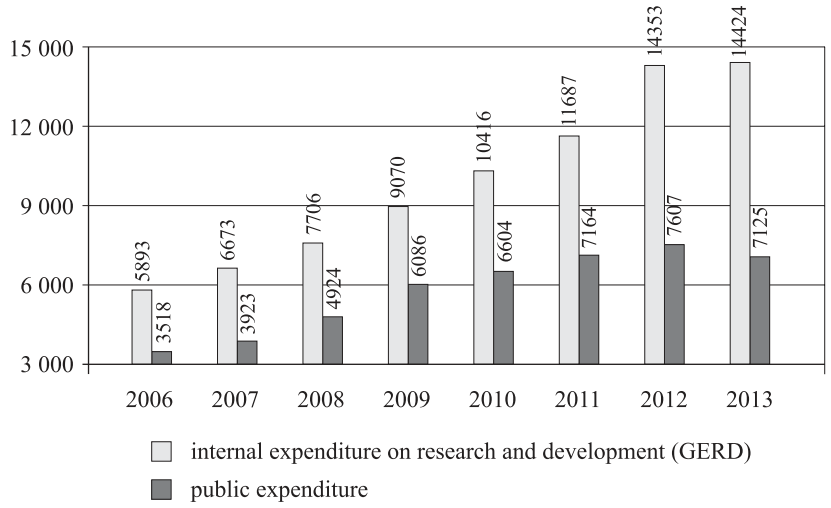
In 2013 maximum GERD share in GDP in Finland was over 8.5 times as high as in Romania. In 2006 this relations was lower – only 7.5 times. In Poland this share in comparison with the EU averages in the two extreme years of the examined period improved. In 2006 it was over 3-times lower, while in 2013 the share of outlays according to GERD in % GDP was over 2 times as low as the EU average.

The expenditure on research and development has significantly increased in Poland in recent years. However, the level of R&D expenditure as % of GDP is still relatively low. In 2013 in Poland it was 0.87% of GDP after a rise to 0.89% of GDP in 2012.

The average value for the EU was 2.02% of GDP in 2013. The European leaders of innovation spent much more on R&D: 3.21% of GDP in the case of Sweden, 3.05% in Denmark, 2.94% of GDP in Germany, 2.81% in Austria.

The amount of internal expenditure on research and development in total and public outlays in the analyzed years in Poland is presented in Chart 5.

Chart 5. GERD in total and public outlays in millions of PLN in the years 2006-2013



Source: The Central Statistical Office, Statistical Office in Szczecin, Szczecin, November 2011, 2012, 2013, 2014.

According to the sources of financing Polish outlays on research and development are characterized by a relatively large, although declining, share of government sector which is presented in Table 7.

Table 7. Government expenditure in % GERD in total

Specification	2006	2007	2008	2009	2010	2011	2012	2013	Joint change
EU average	33.6	33.3	33.8	34.9	34.8	33.3	32.8	31.9	–1.7
FI (min in 2013)	25.1	24.1	21.8	24.0	25.7	25.0	26.7	26.0	0.9
RO (max in 2013)	64.1	67.1	70.1	54.9	54.4	49.1	49.9	52.3	–11.8
PL	57.5	58.6	59.8	60.4	60.9	55.9	51.4	47.3	–10.2

Source: own calculation on the basis of Eurostat.

The analysis of the structure of the financing sources of research and development activity shows that in the countries with the higher share of GERD in GDP it was accompanied with the lower share of government outlays. This interdependence did not refer to the second source of public expenditure – higher education. The highest and still increasing expenditure of this sector, accounting for 4.5 % of expenditure according to GERD in the last year under examination, was observed in Cyprus – the EU averages were five times lower. In Poland the share of higher education accounted for 2.1% of GERD and fluctuated in the years under examination from 6.7% to 0.2%.

A more precise measurement of spending public resources on research and development activity seems to be the expenditure per capita which for Poland when compared with countries with the highest and lowest values are present in Table 8.

Table 8. Public expenditure on R&D in EURO per capita in selected EU countries

Specification	2006	2007	2008	2009	2010	2011	2012	2013
UE	154.8	162.9	171.6	176.2	182.1	184.6	189.9	190.8
DK	342.2	319.6	364.6	381.9	416.8	431.9	461.0	471.4
SE	325.2	342.1	345.3	334.7	396.7	427.7	467.6	462.0
FI	307.6	320.8	326.8	356.7	386.8	384.3	387.0	374.9
BG	11.6	12.6	15.0	17.2	14.2	13.8	13.2	14.1
RO	10.5	17.9	27.4	16.2	17.3	20.7	19.4	19.2
HU	44.5	46.2	47.9	43.6	43.2	43.3	41.6	41.9
PL	27.0	32.1	39.7	39.3	49.9	51.2	55.5	50.0

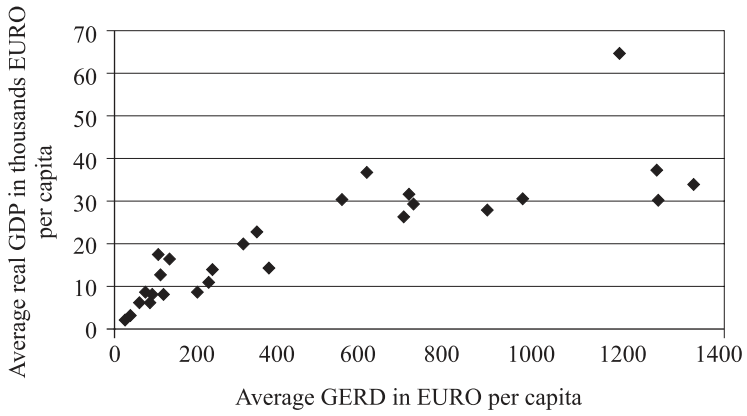
Source: own calculation on the basis of Eurostat and Innovation Union Scoreboard 2014.

The highest, that is exceeding EU averages more than twice, public expenditure according to GERD per capita was incurred in Denmark and Sweden. 13 times lower expenditure was in Bulgaria and about 10 times lower expenditure – in Romania. In Poland this expenditure per capita in comparison with the EU was almost four times lower, but with reference to Denmark this relation was over nine times lower.

The dynamics of public expenditure on R&D per capita also differed with respect to the level and the direction. The highest aggregated increase in the years 2006-2013 was observed in Romania – 101.9%, that is in the country placed at the 27th position in the EU with regard to public spending according to GERD per capita. Simultaneously, Bulgaria, which is placed at the very bottom, exhibited five times lower dynamics of these outlays. Denmark, which is placed at the top ranks with reference to the analyzed expenditure per capita, kept its relatively high increase of 39.1% with the EU average of 21.3%. Similar tendency was observed in Finland – 20.6% and in Sweden – 37.4%. In Poland the aggregated dynamics of public expenditure on R&D was 69.7%.

It is also the interdependence between the average public outlays according to GERD in EURO and the average real GDP per capita in thousands EURO in the years 2006-2013 that was examined. It is presented as correlation scatter chart in Chart 6.

Chart 6. Interdependence between average public expenditure (GERD) and average real GDP per capita in the years 2006-2013 for the UE



Source: own calculation on the basis of Eurostat and Innovation Union Scoreboard 2014.

This figure depicts the positive interdependence between the analyzed variables whose strength, which is calculated by means of Spearman's rank correlation coefficient, turned out to be very high. For the EU countries it was 0.92, while for the Eastern and Central Europe it was 0.60. The same examination conducted with reference to internal expenditure on research and development for all the sectors, not just the public sector, exhibited a very similar significance of positive correlation – 0.93.

Weaker interdependence between the examined variables in the countries that joined the European Union in 2014 and later results, among other things, from the fact that the efficiency of R&D expenditure depends upon the achieved development level measured by means of GDP per capita. This is confirmed by the empirical data from the countries with the top level of innovation, such as: Denmark, Sweden, Finland or Germany. Eastern and Central European countries present a much lower development level. This higher "return" from GERD measured by means of GDP per capita with the higher level of the country's development certainly results from different structures of the economies in question and multiple linked to each other factors. Higher share of private resources in the expenditure on R&D in the countries with the highest GDP per capita whose allocation might be more effective due to stronger motivation and more efficient measurement in-

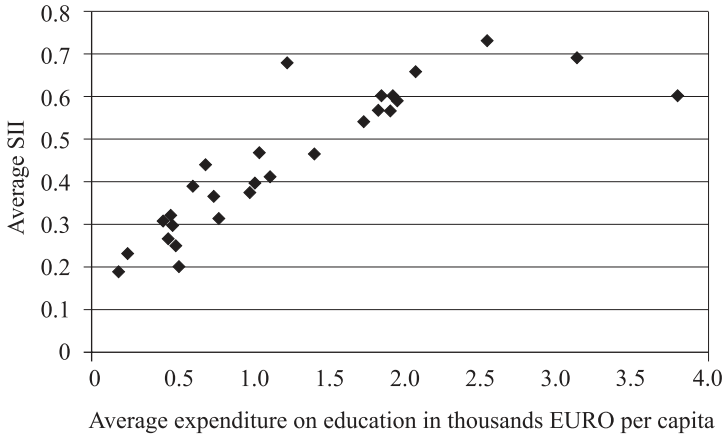
struments is often considered to be one of the causes. However, this explanation does not comply with the fact that Spearman's coefficient in which the variable is the total expenditure according to GERD, is quite similar to the strength of the examined interdependence for public expenditure only, that is 0.93.

Therefore, it might be more important to explain this difference on the basis of the assumption that the policy of public authorities in highly developed economies is more pro-innovative as a rule. Moreover, together with the higher economic development the expenditure on research and development is allocated to more profitable enterprises.

Broadly understood human potential is another determinant of innovation which is as important as financial resources and is related to them. It is human potential that is decisive in terms of efficiency and effectiveness of using private and government expenditure on R&D, which means that it determines the return from the invested into research financial resources. Therefore, the human factor is taken into consideration with respect to all the measurements of innovation. Accumulation of broadly understood human capital cannot be underestimated.

Although it is not analyzed in the following paper, it seems reasonable to pay attention to the existence of very strong (0.93 – the top bracket of the scale) correlation based on Spearman's rank coefficient between SII and public expenditure on education measured in EURO per capita with reference to the whole European Union. Slightly weaker – 0.73, but still significant interdependence between these variables placed at the bottom of the fourth bracket of the 6-bracket scale concerns the countries of Eastern and Central Europe. This interdependence is presented as correlation scatter chart in Chart 7.

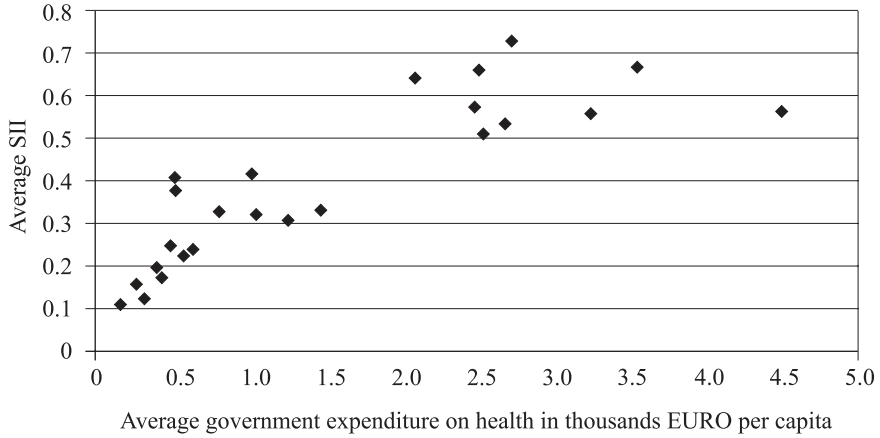
Chart 7. Interdependence between average public expenditure on education in thousands EURO and average SII index in EU in the years 2006-2013



Source: own calculation on the basis of Eurostat and Innovation Union Scoreboard 2014.

It is also the relationship between SII and public expenditure on health which in a particular way determines economy productivity and the quality of life. In this case correlation scatter chart also indicated that there is positive correlation between the examined variables – this is presented in Chart 8.

Chart 8. Relation between average public expenditure on health in thousands EURO per capita and average SII index in the EU in the years 2006-2013



Source: Own calculation on the basis of Eurostat and Innovation Union Scoreboard 2014.

The strength of correlation of these variables is slightly weaker than in the case of outlays on education, but it is still high – 0.89 for the EU countries and 0.60 for the Eastern and Central European countries.

Conclusion

It seems to be obvious that public finance, innovation and the level of economic growth are economic categories which are interrelated. The strength of this interdependence cannot be examined in an simple way leading to unambiguous conclusions. This is due to the fact that these interdependences are conditioned in multifaceted way, some variables are not easily measurable and, moreover, the period of the examination was too short in order to formulate assessments beyond doubt. Thus, the conducted analysis is far from being complete, however, it is possible to draw the following conclusions:

1. The period under analysis (2006-2013) is the period of increasing differences in the levels of EU economies innovation, which, in the context of integration processes within the European Union and differences in the development of particular world regions cannot be the source of optimism.

2. The study conducted with the use of correlation scatter charts and Spearman's rank coefficient proved the existence of very strong and strong, 0.92 for the whole EU and 0.80 for the Eastern and Central European countries, positive significance of correlation between the synthetic innovation index and the average real GDP per capita.

3. Expenditure on research and development activity is among the most significant determinants of innovation. The existence of very strong positive correlation between average expenditure according to GERD in the public part and GBOARD and the value of the real gross domestic product per capita proves the significance of public resources in financing research and development activity. In the case of the first measurement this interdependence was 0.92, and in the case of the second one – 0.94 for the EU, and for the Eastern and Central European countries – 0.60 and 0.78 respectively.

4. The differences in the significance of all the correlations under examination between so called 15 and the new EU members – so called 13, undoubtedly result from the development level of their economies and related differences in the economy structure and adopted developmental strategies. However, one should bear in mind, that the division of the sources of finance into public and private is of limited importance. The basis for such reasoning is the existence of equally strong (0.93) correlation interdependence between GDP and financial outlays in all GERD sectors in EURO per capita.

5. It is not only the direct amount of public outlays on research and development that is significant for the economy's innovation, but also the structure of public expenditure in total, including spending on education and health whose importance for human capital is widely acknowledged. Additional study proved that there is a strong interdependence between public expenditure on education and health and synthetic innovation index.

6. Expenditure on research and development in Poland has increased in recent years, however, its share in GDP remains relatively low and in 2013 it was only 0.87%. Public expenditure according to GERD in 2013 in comparison with 2006 was by almost 70% higher. However, the synthetic innovation index changed in the examined period by only 0.016, which indicates change nine times as low as in the case of Estonia which recorded the highest aggregated change of this index. In 2013 SII for Poland was almost three times as low as the highest value in the EU, that is the value for Sweden. This lower return from internal outlays on R&D in Poland is due to a mixture of different factors.

One of them is the level of economic development measured by means of GDP per capita. However, there are countries with similar Gross Domestic Product per capita in the years 2006-2013 which achieved a significantly higher advancement in economy innovation, for example, Hungary, Estonia, Slovakia, Lithuania and Latvia.

A relatively high share of public expenditure assuming its lower allocation efficiency according to GERD does not seem to be the decisive factor either. There are countries, such as Denmark, Sweden, Finland that have the highest public outlays on R&D per capita and they achieve the highest values of innovation indices.

Therefore, it is the structure of the economy that is of high significance, the adopted model of its development and widely understood aggregated human potential. And although here has been a significant improvement in this area, which can be observed on the basis of qualitative categories that are difficult to measure, but it is inadequate to the needs of Polish economy. Widely publicized successes of Polish scientists and practitioners do not become a permanent tendency.

It seems that with regard to the needs of our economy direct public expenditure on research and development activity is too low. The decrease in the GDP share of public expenditure on education and very low, in comparison with other countries, outlays on health do not support the quality improvement of human capital. As it was proved by the conducted study the outlays from public levies on these two state functions are characterized by a strong positive correlation significance with the economy innovation.

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Finanse publiczne a innowacyjność gospodarki

Streszczenie. *W artykule podjęto próbę analizy finansów publicznych pod kątem ich wpływu na innowacyjność polskiej gospodarki na tle Unii Europejskiej w latach 2006-2013. W państwach UE występują istotne różnice w poziomie rozwoju i innowacyjności gospodarek oraz wysokości i źródeł finansowania działalności badawczo-rozwojowej. Tymczasem warunkiem zrównoważonego rozwoju UE jest wyraźny postęp w innowacyjności, która jest źródłem zmian jakości produktów oraz kosztów ich wytwarzania, a zarazem konkurencyjności produktów i całych gospodarek. Wśród determinant innowacyjności istotne, jeśli nie najważniejsze, miejsce zajmują dostępność środków finansowych oraz szeroko rozumiany potencjał ludzki. Oba te uwarunkowania mieszczą się w obszarze wpływów finansów publicznych. Analiza nie wyczerpuje tematu, ale upoważnia do wnioskowania, że w stosunku do potrzeb naszej gospodarki bezpośrednie wydatki publiczne na działalność badawczo-rozwojową są zbyt niskie. Poprawie jakościowej kapitału ludzkiego nie sprzyja również spadek udziału w PKB wydatków publicznych na edukację oraz ciągle porównywalnie niskie z innymi krajami nakłady na zdrowie. Tymczasem – jak wykazało przeprowadzone badanie – nakłady z danin publicznych na te dwie funkcje państwa cechuje silna dodatnia istotność korelacyjna z innowacyjnością gospodarki.*

Słowa kluczowe: *innowacje, Summary Innovation Index, Global Innovation Index, innowacje a wzrost gospodarczy, GBOARD, GERD, publiczne wydatki na B+R, współczynnik korelacji rang Spearmana*