VERSITA

10.2478/cer-2013-0021

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Comparison of R&D Expenditures in Selected Countries

Abstract

This paper analyzes the level of innovation expenditures and R&D fund sources in selected countries of the world in the period of 2000 – 2010. The issues presented indicate significant differences between the discussed countries with respect to the factors analyzed. The European countries at the top were apparently Finland, Denmark and Sweden. High R&D expenditures, with a significant share in business enterprise sector, and a large number of patent applications reflected on the strong economic growth in these countries. The level of R&D investments in these countries was sometimes greater than in the USA or Japan. Dynamic growth in both R&D and patent activity has also been observed in South Korea. Special attention has been paid in this paper to the new European Union members – Central Eastern European Countries. Among this group of countries Slovenia definitely had the highest position, where R&D expenditures were the largest and the structure of R&D funds by source reflected a business-dominance type. Estonia, Czech Republic and Hungary were the countries 'catching up' – where growth in R&D expenditures has been observed as well as better dynamics of growth and higher patent activity. Romania, Bulgaria, Lithuania, Poland, Slovakia and Latvia had relatively disadvantageous situations in respect of R&D development and the innovative activity of business enterprises.

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1. Introduction

Nowadays, economic transformation processes lead to accelerated growth and sustainable development. Knowledge, innovation and information in industrial processes has attained a particular significance in the contemporary economy. The ability to create new knowledge and to transform it into new technologies, products, and services results in competitive advantages for companies and for the economy as a whole. A key role in the creation of qualitative competitive advantage is played by research and development projects. According to the OECD (Frascati Manual, OECD 2002) research and experimental development (R&D) include creative works undertaken on a systematic basis in order to increase the stock of knowledge, including human knowledge, society and culture, and the use of this stock of knowledge to devise new applications. All technological innovation activities comprise scientific, technological, organizational, financial and commercial steps, including investments in new knowledge. These steps lead to, or at least are intended to lead to, the implementation of technologically new or improved products and processes. R&D is only a part of these activities and may be carried out at different phases of the innovation process. R&D intensity (R&D expenditure as a percentage of GDP) is used as an indicator of an economy's relative degree of investment in generating new knowledge.

The European Union, in the frameworks of both the Lisbon Strategy and, later, the Europe 2020 Strategy (called ‘A European Strategy for smart, sustainable and inclusive growth’). made the assumption that R&D intensity should attain the value of 3%.

The aim of the paper is to analyze both the level of R&D activity and its fund sources in selected countries and to compare these indexes with patent activity and innovativeness between 2000 and 2010.

The paper is structured as follows. Section two explains the methodological approach, key assumptions, and data used in the analysis. Section three presents empirical results and discussion, and this section is divided into three parts. The first part elaborates a classification of countries with respect to R&D expenditures, and also makes a comparison of expenditures on R&D as a share of GDP. The second part of Section three is devoted to a classification of countries with respect to the structure of R&D funds by source. It analyzes four sources of expenditure on R&D i.e. the government sector, the business sector, the higher education sector, and the sector of non-profit organizations. In part three of Section two the results of R&D activities are confronted with patent and innovation activities of enterprises in different countries. The final section of the paper presents conclusions.

2. Research Method

The subject of interest is the analysis of the R&D investments in European countries and selected non-European countries, i.e. the United States of America, Japan, and South Korea. These three countries represent have the most significant leaders world-wide with respect to R&D[1] and patent activity.

To illustrate the similarities and divergences between R&D expenditures in the selected countries, the Ward's hierarchical cluster analysis has been applied. This hierarchical cluster analysis method is appropriate for quantitative variables, and there is no *a priori* information about the group or cluster membership for any of the objects, which means that groups or clusters are suggested by the data, not defined *a priori*.

The method starts out with the assumption that every unit (object) is a separate cluster. Then individual objects being the most similar to one another are step-by-step combined into groups, and the procedure is continued until only one cluster, consisting of all the observations, is left.

The Ward's hierarchical cluster analysis is considered effective because of the analysis of variance approach to evaluate the distances between clusters: objects in the same cluster are homogeneous and there is heterogeneity across clusters (Ward 1963).

For the first classification connected with R&D expenditure levels, eleven variables, connected with the R&D expenditure level per capita over the period 2000-2010, have been applied. In the second model, eleven variables concerning the period 2000-2010 have been used to characterize R&D expenditure by different sources of funds: business enterprises, government, higher education, and non-profit organizations. Thus 44 variables have been used in the whole system.

The data come from Eurostat's database.

The statistical analysis was recalculated using Statistica 10 and Excel.

3. Classification of Countries with Respect to R&D Expenditures

Research and development activity is of great importance in obtaining quality standards as a source of competitive advantage. The level of R&D expenditures in individual countries is diversified, although a tendency to reduce

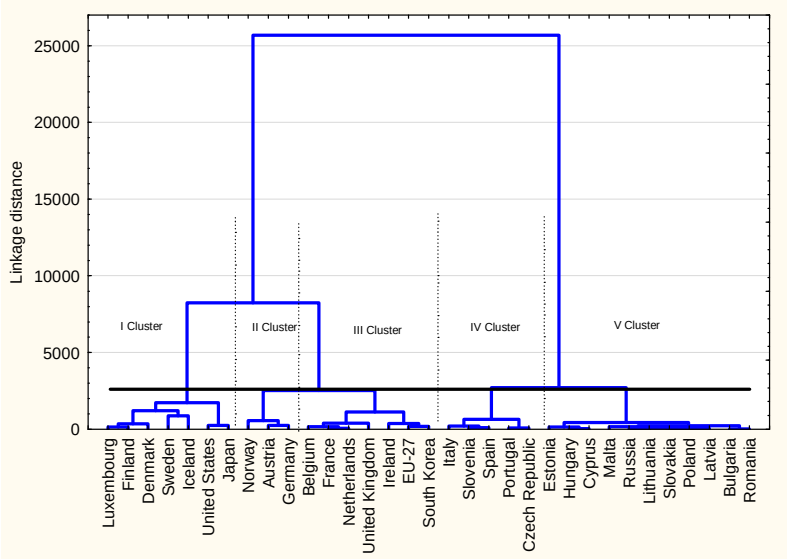
[1] The Author considers China, one of the world's largest R&D investors in 2011, as particularly noteworthy, but the data provided for this country in the Eurostat base were insufficient to include it in this analysis.

the differences can be observed. The coefficient of variation for R&D expenditures between the countries being analyzed was 82.57% in 2010, whereas it had been 89.60% in 2005 and 99.73% in 2000. (It is known that if the coefficient of variation for any cluster is higher than 65%, this data set is considered as having great variability.)

The cluster analysis with respect to the level of R&D expenditures resulted in the formation of five groups of countries. These groups are called clusters. The cutting point of the dendrogram (using Ward's method) was the node at the linkage distance 2650, based on the graph of node distance in relation to the node steps. At this linkage distance, the first distinct abrupt increase of agglomeration distance was observed.

The dendrogram (Fig.1) analysis in terms of expenditures on R&D activity may lead to conclusion that the cluster separation is determined by the expenditure level. The countries gathered on the left side of the tree have larger R&D expenditure levels than those on the right side.

Figure 1. Clusters formed by the countries in terms of investment in R&D activities, 2000-2010, euros



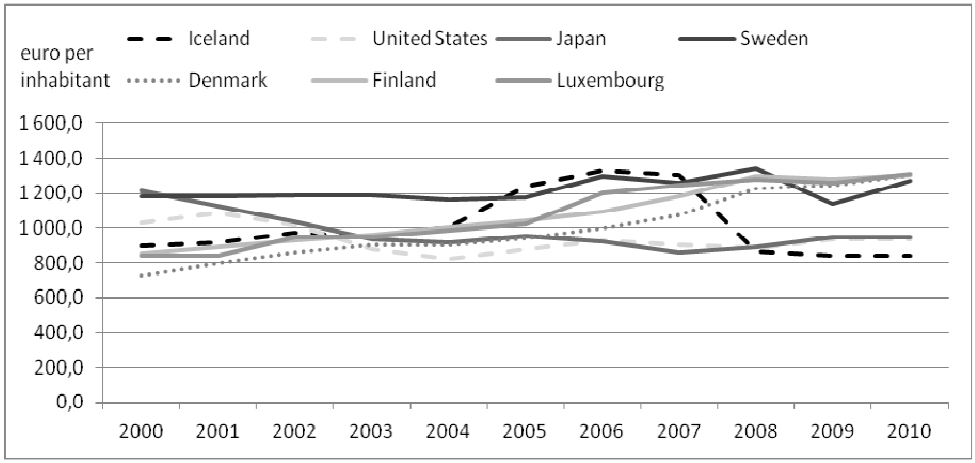
Source: authors' own calculations based on the Eurostat 2012a.

The first cluster consists of Luxembourg, Finland, Denmark, Sweden, Iceland, the United States and Japan (Fig. 2). These countries had the greatest R&D expenditures per inhabitant: from 844 euros in Iceland in 2010 to approximately 1310 euros in Luxembourg. During 2000 – 2010 R&D

expenditures decreased in three countries within the analyzed cluster, i.e. by more than 6% in Iceland, almost 14 % in the USA, and more than 26 % in Japan. At the same time, the R&D expenditures increased in the other analyzed countries – by approximately 8% in Sweden to over 78% in Denmark.

Within the analyzed cluster, Denmark, Finland and Sweden managed to achieve the level of 3% intensity for R&D investment, in accordance with the planned EU growth strategy. R&D intensity varied from about 3.1% of GDP in Denmark to almost 3.9% of GDP in Finland. In Luxembourg it was only 1.6 % of GDP. Luxembourg seems to be special: this country had relatively low R&D investment, but high in absolute terms and was near the top with respect to R&D spending per capita. The low relative share was due to the extremely high GDP per capita. The small population of Luxembourg makes it not representative in terms of the EU average.

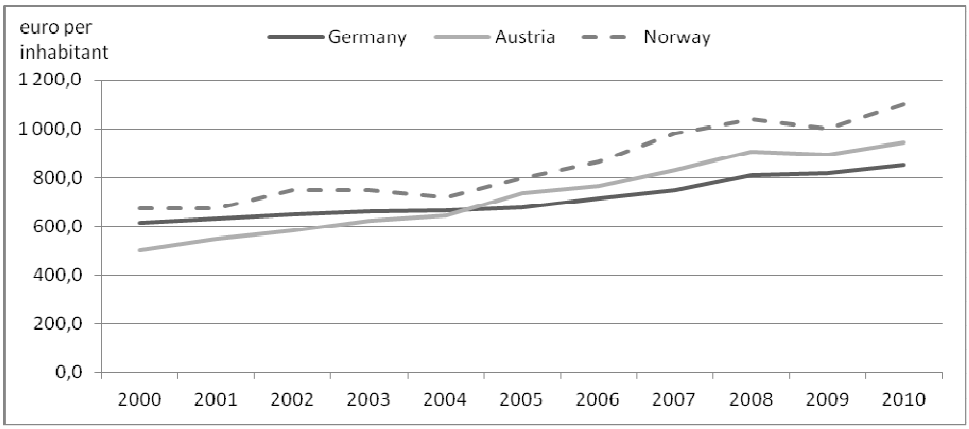
Figure 2. Expenditures on R&D activities in the 1st cluster countries, 2000-2010, euro per capita



Source: as in Figure1

The 2nd cluster comprises three countries, i.e. Germany, Austria and Norway (Fig. 3). The R&D expenditures per capita in these countries were relatively high, in 2010 they were between 853 euros in Germany to almost 1100 euros in Norway. Between 2000 and 2010, the pace of progress in R&D intensity varied across the countries in this cluster, increasing by 1.4 times in Germany and even by 1.9 times in Austria. In 2010 R&D intensity achieved values ranging from 1.7 % in Norway to 2.8% in Germany and Austria.

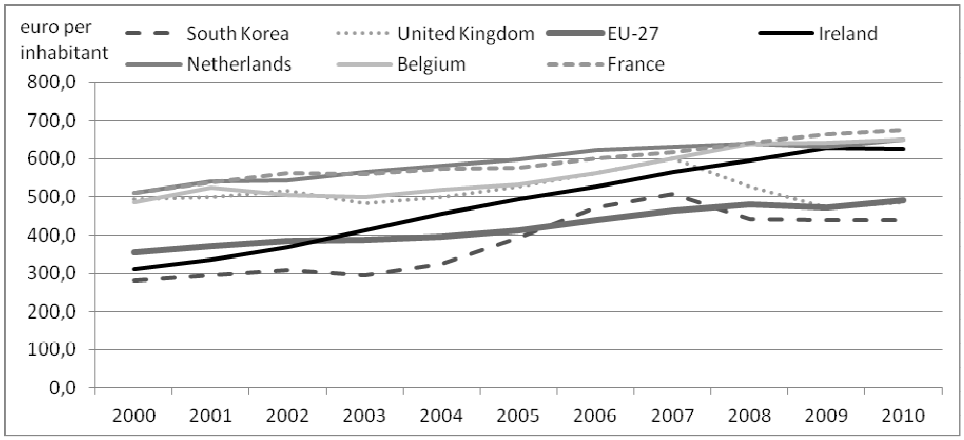
Figure 1. Expenditures on R&D activities in the 2nd cluster countries, 2000-2010, euro per capita



Source: as in Figure 1.

The 3rd cluster contains the following countries: South Korea, the United Kingdom, Ireland, the Netherlands, Belgium, France and the average of European Union – 27 (EU-27) countries (Fig. 4). The expenditures in these countries oscillated near the average for the EU-27 (490 euros per capita in 2010). The greatest expenditures were in Belgium and the Netherlands (about 650 euros per inhabitant) and the least in South Korea (about 442 euros per inhabitant in 2008). The increase in the expenditures from 2000 to 2010 varied from 1.3 times in Belgium the Netherlands to 2.0 in Ireland. Related to GDP, the R&D intensity varied between 1.8% (2010) in the United Kingdom and Ireland to 4,0% in South Korea.

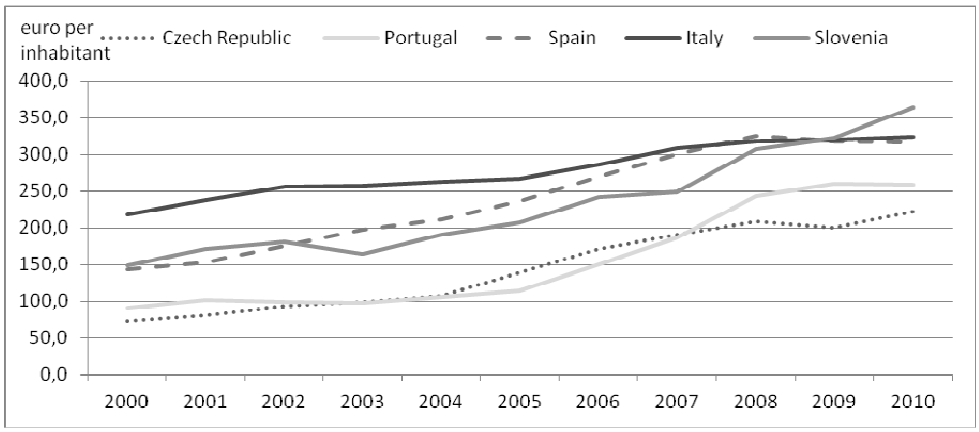
Figure 2. Expenditures on R&D activities in the 3rd cluster countries, 2000-2010, euro per capita



Source: as in Figure 1.

The 4th cluster includes the Czech Republic, Portugal, Spain, Italy and Slovenia (Fig. 5). In all of these countries the R&D expenditures were situated below the average for the EU-27. In 2010 the R&D expenditures ranged from 222 euros per capita in the Czech Republic to above 364 euros per capita in Slovenia. In this group of countries R&D expenditures increased various factors: from 1.5 times in Italy to 3.1 in the Czech Republic. The R&D intensity remained in a range from 1.3% in Italy to 2.1% in Slovenia.

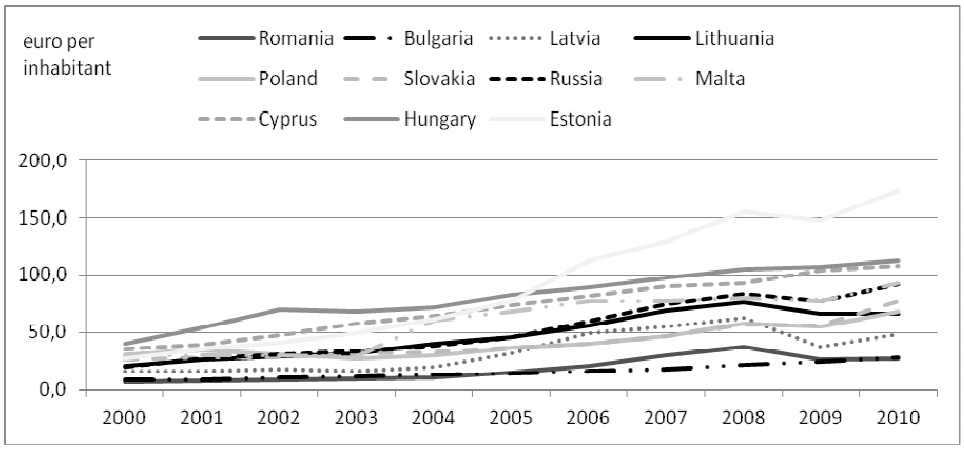
Figure 3. Expenditures on R&D activities in the 4th cluster countries in, 2000-2010, euro per capita



Source: as in Figure 1.

The 5th cluster is the largest and contains 11 countries having the lowest R&D expenditures, i.e., Bulgaria, Latvia, Lithuania, Poland, Slovakia, Russia, Malta, Cyprus, Romania, Hungary and Estonia (Fig. 6). In 2010, R&D expenditures in these countries varied from 27 euros per capita in Romania and 28 euros per capita in Bulgaria to over 173 euros per capita in Estonia. However, within this cluster, in comparison to the others, the greatest growth in R&D expenditures can be observed. The growth factors in 2010 compared to 2000 ranged from 2.2 times in Poland to 6.4 in Estonia. The R&D intensity was from 0.5% (2010) in Cyprus and Romania, 0.6% in Romania, to 1.6% in Estonia.

Figure 4. Expenditures on R&D activities in the 5th cluster countries, 2000-2010, euro per capita



Source: as in Figure 1.

The new EU members, which joined the bloc during the fifth enlargement wave (2004-2007) exhibited an awareness of the importance of R&D expenditures. The disproportion vis-à-vis Europe within this category was quickly made up by Estonia. In this country the growth factor from 2000 to 2010 was the largest. Significant growth factors could be observed also in Romania (over 4.0 times), Bulgaria, Cyprus, Latvia, and Malta (over 3.0 times in all these countries). In Poland, Slovenia and Slovakia, R&D expenditures increased at a slower pace – the growth factor did not exceed 2.0 times for these countries.

4. Classification of Countries Regarding the Structure of R&D Funds by Source

An important component of R&D expenditure analysis is the structure of R&D investments by source of funds. There are four essential sources of funds: business enterprises, government, higher education, and private non-profit organizations. The experiences of many countries show that the most advantageous situation is when the greatest R&D expenditures come from business enterprises. The studies on economic competitiveness prove that the business enterprise sector is the one that should participate the most actively in R&D investment. The Lisbon Strategy assumes that the relation between the business enterprise and public sector expenditures on R&D should be 2:1. It has been pointed out (Grabski 2006, p. 34) that business enterprise expenditures on

R&D comprising less than 30% are specific for countries with non-industrial economies and poor innovation activities.

On the other hand, it is also maintained (Smith 1954, p. 441) that governments are obliged to maintain public institutions that decide about economic development and what may be profitable for society, but this obligation can be fulfilled only when the society is not well-off enough itself to cover these expenses.

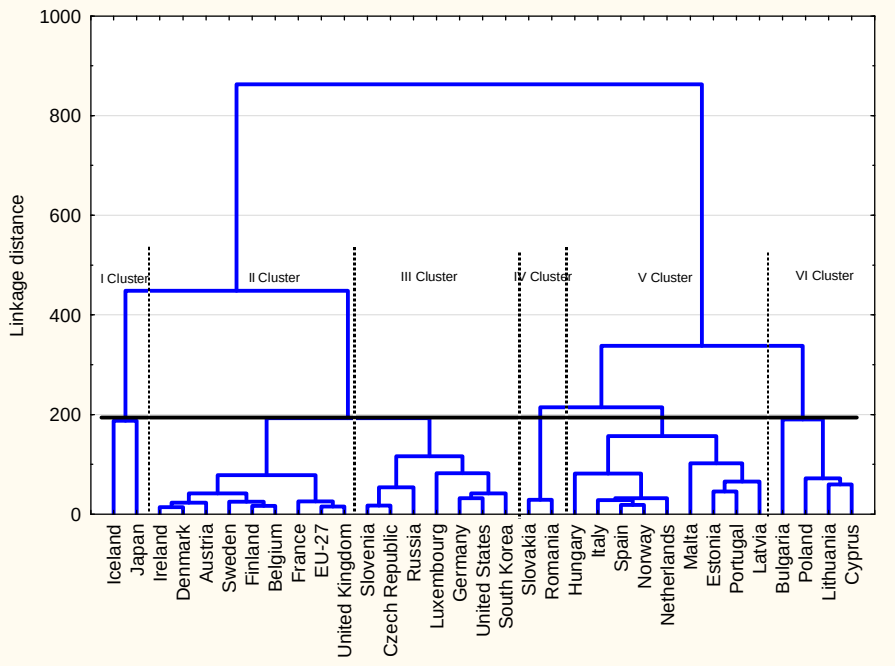
Business sector participation differed widely across the analyzed countries. However, it has been observed that in the first decade of the twenty-first century the disparities in business enterprises' share of funding decreased. At the beginning of the described period, the coefficient of variation for the mentioned countries, regarding the business enterprise share in R&D expenditures, was 34.16% (in 2000). Five years later it was 29.41%, and in 2010 it decreased to 26.24%. These values show that business enterprise funds were moderately diversified.

R&D governmental funding was much more diverse. The coefficient of variation for particular countries was 67.00% in 2000, 68.34% in 2005, and 59.82% in 2010. The coefficients of variation for the higher education sector decreased from 55.46% in the first years to 42,95% in the last years of the analyzed decade. The greatest diversification was seen in private non-profit funding of R&D – in this sector coefficients of variation reached over 150% in the analyzed period.

The cluster analysis with respect to R&D funding by sector resulted in the formation of six groups of countries. The dendrogram has been cut at the linkage distance 200, based on the graph of node distance in relation to the node steps. At this linkage distance, the first distinct abrupt increase of agglomeration distance was observed.

The dendrogram (Fig.7) analysis in terms of R&D funding sectors may lead to conclusion that this criterion determines cluster separation. The countries gathered on the left side of the tree have larger R&D business enterprise funding than those on the right-side.

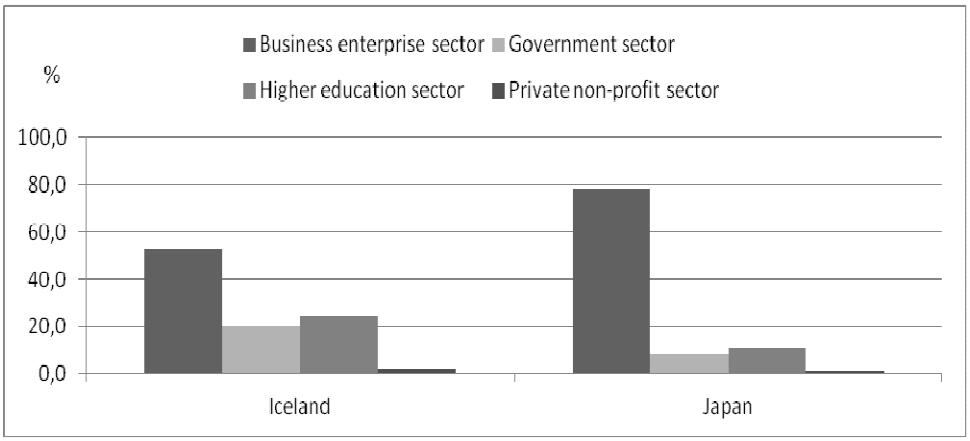
Figure 5. Clusters formed by the countries in terms of structure of R&D funding by source, 2000-2010



Source: as in Figure 1.

The first cluster comprises two countries: Iceland and Japan (Fig. 8). In Iceland, in 2009 more than half of R&D activity was financed by the business enterprise sector, about ¼ by the higher education sector, and about 1/5 by government. In Japan, the business enterprise sector funded over ¾ of R&D investments, while government and higher education participated in fractions about 1/10 each. Both of these countries had high R&D expenditures per capita, although their R&D expenditures decreased over the period 2000 - 2010. In Iceland, the decrease in 2009 compared to 2000 was 3.5 percentage points with respect to the business enterprise sector and 3.5 percentage points with respect to the government, whereas the higher education sector increased their R&D expenditures by 8.6 percentage points. In Japan, in 2008 compared to 2000 the business enterprise sector expenditures on R&D increased by 7.5 percentage points, while the other sectors' share in expenditures declined.

Figure 6. Source of funds for R&D activities in the 1st cluster countries, 2000-2010, percent

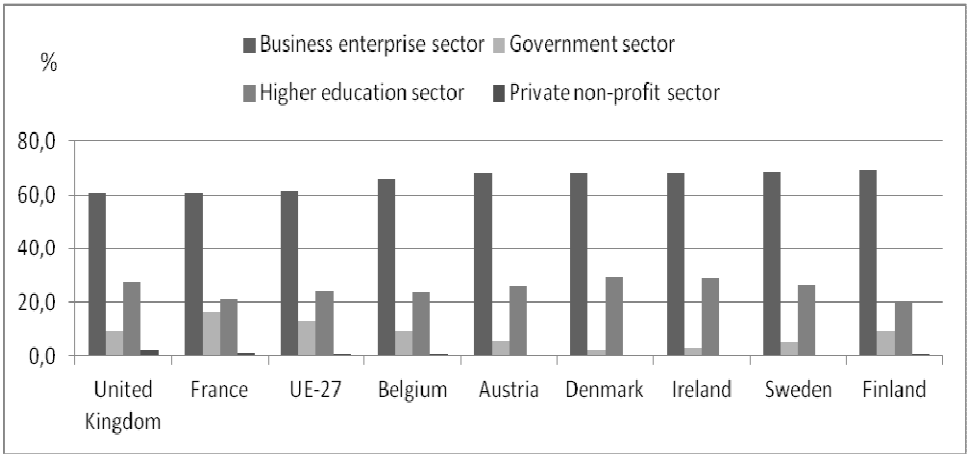


Source: as in Figure 1.

The 2nd cluster covers the United Kingdom, France, Belgium, Austria, Denmark, Ireland, Sweden and Finland, and also includes the average of the EU-27 (Fig. 9). The shares of particular sectors were favorable: the share of R&D expenditures by the business enterprise sector varied from about 61 % in the United Kingdom and France to almost 70% in Finland.

The share of the higher education sector was between 1/5 and ¼ of abovementioned expenditures, and the government sector's contributions ranged from 2% in Denmark to 16 % in France. Comparing the statistics from 2010 with 2000 shows that only in Austria and Denmark did the business enterprise sectors not reduce their share of expenditures, and the greatest decline in these sector's funding activities was observed in Sweden – by 8.8 percentage points. In six countries (with the exception of Belgium and Sweden) a decrease in the government's share was also noted, the most significant in Belgium, by 10.6 percentage points. The majority of countries – except Austria – maintained growth in the share of the higher education sector, ranging from 2.5 percentage points in France and 3.1 percentage points in Belgium to 9.6 percentage points in Denmark.

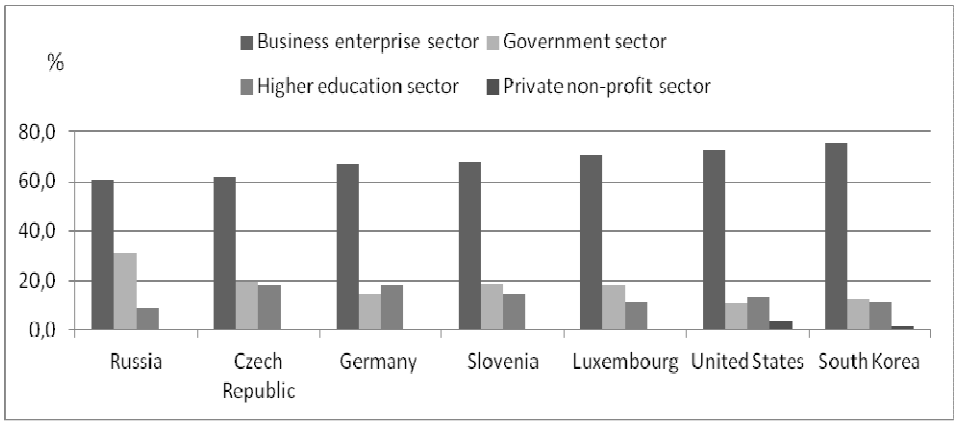
Figure 7. Source of funding for R&D activities in the 2nd cluster countries, 2000-2010, in percentages



Source: as in Figure 1.

The 3rd cluster is comprised of the following countries: Russia, the Czech Republic, Germany, Slovenia, Luxembourg, the United States and South Korea (Fig. 10). The share of the business enterprise sector in total R&D expenditures for these countries oscillated from about 61 % in Russia to 73 % in the United States and 75 % in South Korea. Over the period 2000 – 2010 both increases and decreases of the share of the business enterprise sector in overall R&D expenditures were observed. The most dramatic decrease between 2000 and 2010 was noted in Luxembourg – by 21.7 percentage points, followed by Russia – 10.2 percentage points. Decreases at the level of 2-3 percentage points were observed in Germany and the United States. In the other countries growth was noted, the largest in Slovenia – by 11.5 percentage points. Growth in the share of higher education sector in overall R&D expenditures was observed in all the countries in the cluster except Slovenia – the most significant growth occurring in Luxembourg, by 11.2 percentage points.

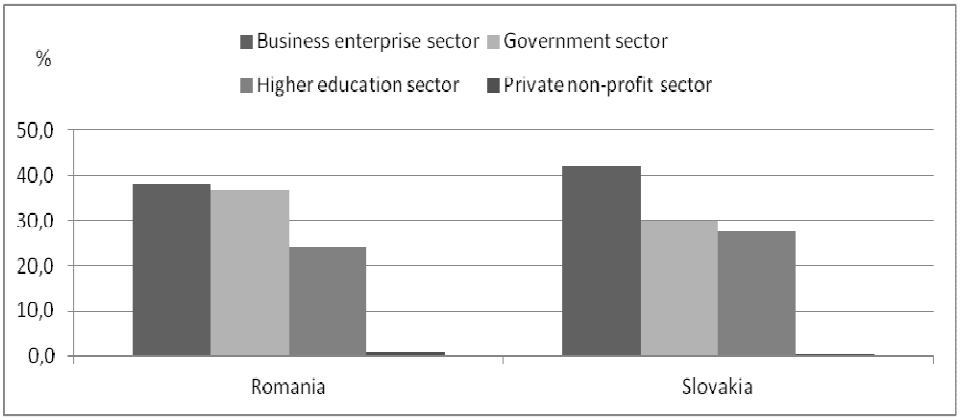
Figure 8. Source of funding for R&D activities in the 3rd cluster countries, 2000-2010, in percentages



Source: as in Fig. 1.

The 4th cluster is comprised of Romania and Slovakia (Fig. 11). In these countries the share of business enterprise sector in total R&D expenditures was about 40%, and both demonstrated a fairly significant share of governmental funds (about 1/3), with the share of the higher education sector at about ¼. In 2010 in comparison to 2000 the share of the business enterprise sector in R&D expenditures decreased by 31.5 percentage points in Romania and 23.6 percentage points in Slovakia. In Romania the government sector had the most significant activity, resulting in an increase of 18.5 percentage points.

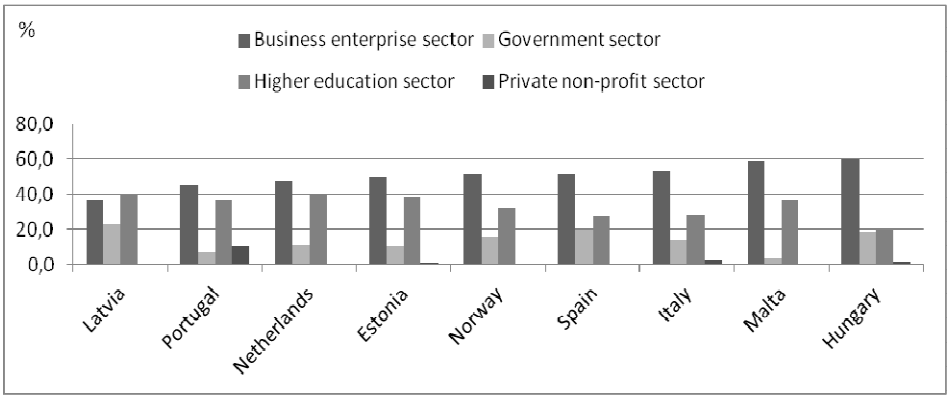
Figure 9. Source of funding for R&D activities in the 4th cluster countries, 2000-2010, in percentages



Source: as in Fig. 1.

The 5th cluster contains the greatest number of countries, i.e., Latvia, Portugal, the Netherlands, Estonia, Norway, Spain, Italy, Malta and Hungary (Fig. 12). R&D activities funded and carried out by business in 2010 accounted for 37% in Latvia up to 60% in Hungary. The most significant growth factor in the business enterprise sector share, in 2010 compared to 2000, took place in Malta (34.7 percentage points) and in Estonia (27.4 percentage points). However, in the same period of time, in Latvia, the Netherlands, Norway and Spain a decline in the share of the business enterprise sector was observed – from 2.2 to 8.4 percentage points. The share of participation of the higher education sector in total R&D expenditures ranged from 20 % in Hungary to 41% in the Netherlands, whereas the government sector's share ranged from less than 4% in Malta to 23 % in Latvia.

Figure 10. Source of funding for on R&D activities in the 5th cluster countries, 2000-2010, in percentages

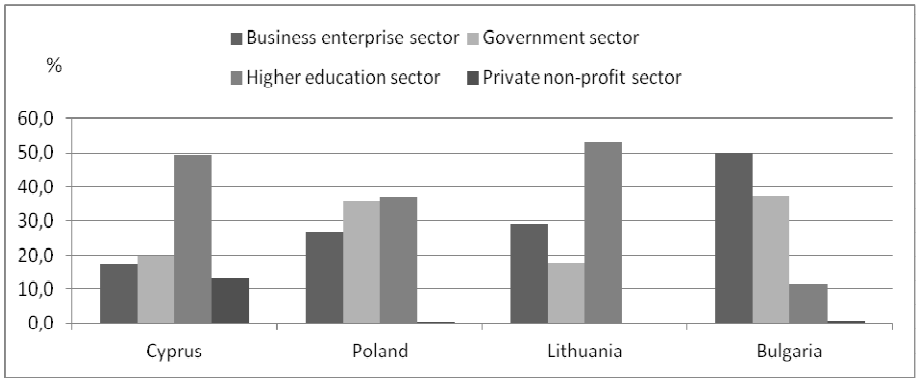


Source: as in Figure 1.

The 6th cluster contains the countries with the lowest share of participation by the business enterprise sector in total R&D expenditures, i.e. Cyprus, Poland, Lithuania and Bulgaria (Fig 13). In the first three above-mentioned countries, the share of the business enterprise sector in total R&D expenditures amounted to 18-29%, while for Bulgaria it was 50%. The government had a considerable share in total R&D expenditures in Bulgaria and in Poland (36-37%), while the higher education sector in had a considerable share in Lithuania and Cyprus (50-53%). In Cyprus the share of private non-profit organizations was 13.4% in 2010. Comparing the shares of expenditures in 2010 with 2000, it can be seen that the share of the business enterprise sector in R&D expenditures decreased in Poland (by 9.5 percentage points) and in Cyprus (by 4.0 percentage points). Apart from Poland, there was also decline in the share of government funds, from 24.2 percentage points in Lithuania to 31.6 percentage points in Bulgaria. In Romania

the government sector exhibited the most significant increase in activity, resulting in an increase of its share in overall R&D funding by 18.5 percentage points. In all the countries included in this cluster, the higher education sectors increased their shares in overall R&D funding: from 1.3 percentage points in Bulgaria to 24.8 percentage points in Cyprus.

Figure 11. Source of funding for R&D activities in the 6th cluster countries, 2000-2010, percent



Source: as in Figure 1.

It can be concluded that countries on the left side of the dendrograms had higher R&D expenditures per capita and exhibited a greater share of the business enterprise sector in R&D expenditures. The leading position and the models among the European Union countries were Denmark, Sweden and Finland. These countries, at the beginning of the analyzed decade, showed high R&D expenditures, together with significant share of the business enterprise sector as a funding source. Gradual growth in R&D expenditures in the above-mentioned countries made these countries, in 2004-2005, comparable to Japan and The United States with respect to R&D spending per capita. Germany and Austria also have a high level of R&D expenditures. In South Korea, because of the large population R&D expenditures per capita are on the level similar to UE average, but the absolute value of R&D expenditures was at high level. In addition, the ratio of R&D spending to GPD and the share of the business enterprise sector in R&D expenditures made this country one of most dynamic in the world.

The countries on the right side of the dendrograms had relatively smaller R&D expenditures and less advantageous shares of funding sources, i.e. smaller shares of the business enterprise sector in R&D expenditures. In order to increase the competitiveness in these countries the business enterprise sector should become significantly more committed to R&D investment. Fortunately, some changes can be observed in this group of countries. For example the contribution of the business sector increased more rapidly than the governments' contributions,

and the dynamics per capita, starting from 2000, increased considerably in Estonia (1421% in business sector and 295% in government sector), Bulgaria (747% and 177% respectively), Lithuania (427% and 133%), Hungary (382% and 202%) and Cyprus (247% and 127%).

In Portugal, the share of the business enterprise sector in R&D expenditures increased 4.6 times, while the share of government funding declined by 25%. However, in several countries the net growth dynamics were negative with respect to the business sector, i.e. the increase in business enterprise expenses was smaller than the government's, for example in Romania (expenditure dynamics per capita in 2010 related to 2000 were 817 % and 222%, respectively), in Slovakia (354% and 186%, respectively), Latvia (317% and 284%, respectively), and also in Poland (245% and 163%, respectively). The reason this situation could not be improved in Central and Eastern European countries was usually the bad financial condition of companies (Piekut 2011a).

5. Patents and Innovative Enterprises

One of the key determinants in the effectiveness of R&D activity is the innovative performance of countries and firms, especially reflected in patent applications. The correlation between the number of patent applications and R&D expenditures was 0.8857, and between the number of patent applications and the R&D intensity - 0.8890. An analysis of the patent applications filed in European Patent Office (EPO), computed per one million inhabitants in a country, showed that in 2010 the top position in the ranking was occupied by Sweden, with 300 patent applications per one million inhabitants, followed by Germany, Denmark and Finland, within the range of 220 to 270 patent applications per one million inhabitants (Eurostat 2012b). The next category, with over 130 patent applications per one million inhabitants, was made up of Belgium, France, Luxembourg, Austria and the Netherlands. In Lithuania, Latvia, Slovakia, Poland and Portugal, the ratio of patents to one million inhabitants ranged from 6.0 to 10.7. At the bottom of the ranking were Bulgaria and Romania, with only 1.9 patent applications per million inhabitants. This confirms the thesis that higher investment in R&D activity results in a greater number of patent applications.

Among the non-European countries, the greatest number of patent applications filed at EPO in 2008 (no data was available for subsequent years) came from Japan (over 148 per million inhabitants) and from the USA (about 97 per million inhabitants). The case of South Korea was singular. The absolute number of patent applications ranked this country at seventh place among all the

analyzed countries. However, dividing this number per million inhabitants gave South Korea a position below the EU average, due to its large population.

Regarding the patents filed at The United States Patent and Trademark Office (USPTO), the United States achieved the leader position with 265 patent applications per million inhabitants in 2006 (Eurostat 2013). In second place was Japan (261 per million inhabitants), South Korea occupied third place (185 per million inhabitants). Among the EU countries, the greatest activity at the USPTO was exhibited by: Finland (115 per million inhabitants), Sweden (112 per million inhabitants) and Germany (99 per million inhabitants). In 2006 the smallest number of patents granted by USPTO came from Poland, Portugal, Romania and Lithuania, with only 0.9 – 1.0 per million inhabitants.

It is worth mentioning that a unitary patent protection system is to be adopted under the EU's legislative procedure. The entry into force of this Act will reduce the competitiveness of companies in countries with low patent activity (Nowicka 2011 pp. 85-86). This policy of the unitary patent protection will be most advantageous for the countries that are highly advanced in technology and have a great number of patents coming from business enterprises. In the countries of former Eastern European bloc, economic activity will be restricted by property rights. Their domestic business enterprises will have to take into account complaints alleging infringement of patent rights, because – in contrast to the current situation – the patent descriptions will not be accessible in their native languages.

One of the indicators illustrating a country's development level is, apart from R&D investments and the number of patents, the share of innovative business enterprises in the overall number of businesses. Information on the innovativeness of different sectors and regions is collected by Community Innovation Surveys (CIS) throughout the European Union. The correlation between the number of innovative firms and R&D expenditure was 0.5874, and between the number of innovative enterprises and R&D intensity - 0.6655.

CIS surveys have shown that the largest percentage of innovative enterprises are in Germany (over 79%). In Luxembourg, Iceland, Belgium and Portugal at least 60% business enterprises are considered innovative (Eurostat 2012c). Unfortunately, there are no data for Japan, the USA and South Korea, so comparison of these indexes with the data for EU countries is not possible.

According to Grabski (2006, p. 34), the main innovation indicator and economic stimulator is the amount of innovation R&D expenditures made by business enterprises, not by government. For the majority of countries with a high share of innovative enterprises, high R&D expenditures were also observed, with at least one-half coming from business enterprise sector. The only exception is Portugal, but still a profitable dynamic of growth in the business enterprise sector

in R&D investment was observed in this country. The lowest share of innovative enterprises were found to be in Bulgaria, Poland, Latvia, Romania, Hungary and Lithuania – with levels ranging from only 27% to 35 %.

The concept of open innovation has grown in popularity both in business practice and in the academic environment. This concept, elaborated by Henry Chesbrough (2006 p. 16), should be spread to the entrepreneurs in the EU so as to raise the level of their innovative activity. The main focus of the concept is the importance of analyzing a company's business needs. Enterprises should use their own ideas in order to acquire inventions or intellectual property from other companies to advance the business model. They should also spread their own knowledge by the sale of licenses, and create consortia when added value is expected to be generated. The openness of innovative activity and making the good use of intellectual property all over the world may be considered as excellent factors for stimulating less developed economies and intensifying their growth, so that the current differences between countries could be reduced.

6. Conclusions

The issues presented and discussed above indicate significant diversification in both the level of R&D expenditures in different countries and their sources of funding. The top European countries are Finland, Denmark and Sweden, in which R&D expenditure levels are similar to the United States and Japan. High R&D expenditures, together with a significant share of business enterprise sector funding and large number of patent applications reflect the strong economic development in these countries. Also Germany and Austria must be considered successful, as they are countries which have increased their R&D expenditures year after year, with meaningful participation of the business enterprise sector, and occupy a high position in terms of the number of patent applications processed through the grant procedure in EPO. Dynamic growth was also observed in South Korea, both with respect to its rapid increase in R&D expenditures and growing number of patent applications, which together place this country among the world's leaders.

Romania, Bulgaria, Lithuania, Poland, Slovakia and Latvia are countries with relatively disadvantageous situations with respect to both the pace of R&D growth and innovative activity by business enterprises. Among the eastern European countries, the highest position is definitely occupied by Slovenia, where R&D expenditures are the largest and the shares of funding sectors more advantageous. Estonia, the Czech Republic and Hungary may be considered as

countries which are catching up – growth in R&D expenditures can be observed there, as well as better dynamics and higher patent activity.

The conducted research has shown that it is necessary to encourage the entrepreneurs in Central and Eastern Europe to be more intensely involved in R&D activity. They must be aware of the importance of R&D activity to the development of their enterprises. This can help them attain better market positions. EU funding may be of great assistance, as it can support science and technology in connection with business development, and highlight the experiences gained by innovation leaders, which reveal that the main determinant for the innovative activity of business enterprises and the economy is strengthening the connection between R&D and business sectors and creating cooperative alliances (Piekut 2011b). EU funds offer the opportunity to obtain financial support for various forms of cooperation between business and technology (science), as well as for the legal protection of innovative solutions.

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Streszczenie

PORÓWNANIE NAKŁADÓW NA DZIAŁALNOŚĆ B+R W RÓŻNYCH KRAJACH

Celem artykułu była analiza poziomu i struktury finansowania działalności badawczo-rozwojowej w wybranych krajach oraz skonfrontowanie tych wskaźników z aktywnością patentową i innowacyjnością przedsiębiorstw. Okres badawczy stanowiły lata 2000-2010. Do zobrazowania podobieństw i różnic w nakładach na działalność B+R pomiędzy analizowanymi krajami zastosowano analizę skupień metodą Warda. Poziom finansowania działalności B+R polaryzuje Europę. Kraje Europy Północnej i Europy Zachodniej charakteryzują większe nakłady na B+R i większy udział przedsiębiorców w finansowaniu tych działań. Kraje będące w czołówce to Finlandia, Dania i Szwecja. Korzystne wyniki osiągają też Niemcy i Austriacy. Rumunia, Bułgaria, Litwa, Polska, Słowacja, Łotwa i Węgry to kraje z relatywnie niekorzystną sytuacją w zakresie rozwoju działalności B+R i innowacyjności podmiotów gospodarczych. Spośród krajów wschodniego regionu zdecydowanie wyższe pozycje w tym kontekście zajmuje Słowenia. Realizacja celów polityki UE w wielu krajach jest jeszcze odległa. Dalsze analizy powinny koncentrować się na znalezieniu optymalnego poziomu inwestycji w B + R w różnych sektorach.