Research and Development Channel of Technology Transfer in Innovativeness of United States, United Kingdom, Germany and Poland

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ABSTRACT— ***This paper investigates research and development (R&D) channel of technology transfer in countries like Poland, Germany, United Kingdom and United States. The article examines the role of R&D in innovation process and advancement of these countries. The article also investigates the extent to which enterprises from chosen for the research countries engage in R&D channel in innovation process. Both the OECD and European Union support the idea of strong engagement in research and development processes. The results of investigation support the idea that countries with high development in research and development activities are more innovative and more open to new technologies and innovation. Also countries which are innovative are more adapted to the possibilities offered by the elaborate and risky R&D activity and investigate more in this kind of technology transfer.***

Keywords— innovation, technology transfer, R&D, technology channel

1. INTRODUCTION

In the modern, globalized world with a dominant of knowledge based economy, innovation is a basic prerequisite for economic development and the preservation of competitiveness. Both, the OECD and the European Union support the idea of strong industry-science linkages to maximize the returns from both private and public research investments and recognize a role for policy (OECD, 2004).

With regard to enterprises, the rate of creating and implementing innovations in largely part is determining their competitive advantage. Innovation is a necessary condition to obtain a favorable position not only in the global economy, but also on local markets. The experience of developed countries shows that innovative companies have greater internal effectiveness and positive impact on the dynamics of economic development.

The importance of technological progress has been raised by many economists. Adam Smith pointed out that innovation and technological change are an important tool for building a "wealth of nations". He believed that the real creators of progress are industrialists, capitalists and without their activity development is not possible (Smith, 1904).

The term ‘innovation’ appeared at the beginning of the 20th century. It was intensively studied by Austrian economist Joseph A. Schumpeter, who proposed five types of innovation:

- the introduction of new products
- the introduction of new methods of production
- the opening of new markets
- the development of new sources of supply for raw materials or other inputs
- the creation of new market structures in an industry (Schumpeter 1960).

The above definition is considered as a classic in the economic literature and is the starting point to define the concepts of innovation activity. The objective scope of this definition is very broad and includes, in principle, part of the most important changes in the economy, both of a technical nature and economically.

J. Schumpeter assumed that the market economy is the engine of innovation and entrepreneurs willing to bear the risk of their introduction. Those who decide to take such risk have a chance to achieve both very high profits and losses.

Innovation is the destructive force of a creative (Schumpeter, 1960).

H. Chesbrough also makes clear, that companies which do not introduce innovations simply die. According to the author in today's world the only constant is change. The fact of being innovative companie is a guarantee of its success and survival regardless of its size and sector of industry. Innovations are essential in maintaining and developing existing businesses as well as emerging entities (Chesbrough, 2003). For most theories of innovation starting point is undertaking enterprises (Dunning, 2000).

Innovation process needs all scientific activities, technological, organizational, financial and commercial - including investments in new knowledge - leading to the implementation of technology in new or improved products and processes. Research and development (R&D) activity is only one element among these activities and can be taken in different stages of the innovation process. R&D can serve as an essential resource for innovative ideas, but also as a way of solving problems, which can be canceled at any moment of innovation process (Frascati, 2002).

Sources of innovation in enterprises can be split in two groups: internal and external sources. Research and development activity is an internal source of innovation.

An enterprise to carry out in-house R&D activities must have the necessary capacity to tangible and intangible. Companies conducting R&D may have extracted for this purpose R&D departments, laboratories or departments, designing. The R&D potential of company also provides their staff, R&D and earmarked for such an activity expenditure in total as well as expenditures on such activity.

2. METHODOLOGY

The source of empirical data within this discourse were OECD, European Committee works, as well as national and foreign reports concerning innovativeness, technology transfer and research and development activity. The diagnosis of the enterprises innovativeness background is based on the analysis of the amount of information concerning results of statistics research by OECD in terms of innovation and development activity. The researches include enterprises within OECD data and OECD indicators on R&D expenditures, budgets and personnel that are derived from the OECD's Research and Development Statistics (RDS) database, which is based on the data reported to OECD and Eurostat in the framework of the joint OECD/Eurostat international data collection on resources devoted to R&D. The research include the data from Main Science and Technology Indicators database concerning enterprises from countries: Poland, Germany, United Kingdom, United States.

3. R&D AND INNOVATIVENESS OF ENTERPRISES

The Global Innovation Index (GII) 2015 covers 141 economies around the world and uses 79 indicators across a range of themes. GII 2015 presents a rich dataset to identify and analyze global innovation trends. Switzerland, the United Kingdom (UK), Sweden, the Netherlands, and the United States of America (USA) are the world's five most-innovative nations. The GII leaders have created well-linked innovation system where investments in human capital, combined with strong innovation infrastructures, contribute to high levels of innovativeness (GII, 2015).

The Global Innovation Index ranking which measures progress in innovation in all countries listed from all examined under the article countries United Kingdom on the first position, then United States, Germany and the last Poland. In the ranking of all countries all over the world United Kingdom was on the second place (only Switzerland was more innovative), United States took 5th place, Germany on the 12th position and Poland on the 46th (GII, 2015).

R&D is one of the key policy areas that can secure technological potential and, therefore, innovation and economic growth. In order to reach the income level of high-income countries, low- and middle- income countries need to expand their access to technology and their capacity to use it (GII, 2015).

By 2013, total research and development spending in the OECD area grew 2.7% in real terms to reach USD 1.1 trillion. Its share in GDP remained unchanged from 2012 at 2.4%. This increase was driven by business R&D. Innovation relies not only on investment in R&D, but also on complementary assets such as software, design and human capital - knowledge-based capital. Since the mid-1980s, OECD spending on basic research has increased faster than applied research and experimental development, reflecting many governments' emphasison funding scientific research. Basic research remains highly concentrated in universities and government research organizations. Firms investing in R&D are more likely to introduce innovations. In 2015, 28 OECD countries were using R&D tax incentives to support business R&D. This support accounted for nearly USD 50 billion in 2013. Demand also matters for innovation. Participation in procurement markets is more common among large firms than among SMEs, and is far more likely among innovative than non-innovative firms (OECD, 2015).

Gross domestic expenditure on research and development (GERD) is total intramural expenditure on research and development performed on the national territory during a given period. Gross domestic expenditure on R&D stood at euro 272 billion in the 28 European Union countries in 2013. It was a 0.7 % increase on the year before, and 43.8 % higher than 10 years earlier in the year 2003. The highest level of gross domestic expenditure on R&D was in United

states. In current PPP$ about 456877 (see chart 1). The rest of countries were far away from that level, Germany spend in current PPP$ 100991,37, United Kingdom 39858,83 and Poland 7918,12.

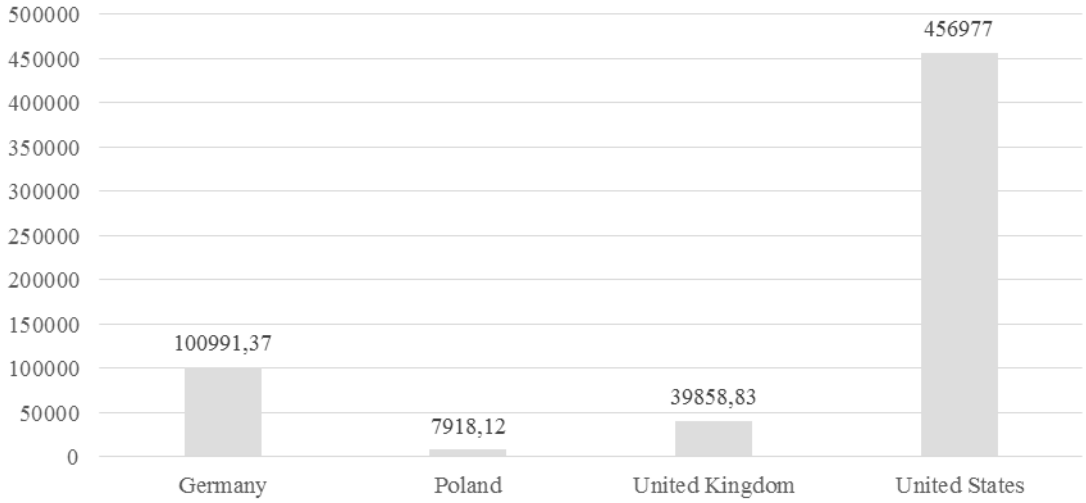

Chart 1: Gross Domestic Expenditure on R&D -- GERD (current PPP $)

Source: own elaboration based on OECD statistics, Main Science and Technology indicators.

The goals of European Union for growth strategy due to the Lisbon Strategy, Europe 2020 and the proscribing a spending of 3% of the national GDP on R&D. European Commission presents the vision of a pan-European research zone in which research activities are concentrated and funding is allocated irrespective of national borders according to the needs of the knowledge-based economy, economic growth and employment. The strategy to achieve this objective is directed towards, the knowledge based economies and R&D policies, innovation and competitiveness (EU, 2009).

In examined countries the highest share of GERD as a percentage of GDP in 2013 year was observed in Germany - 2,85%, on the second place was United States – 2,73%, then United Kingdom – 1,63 and the last among the examined group was Poland – 0,87% (see chart 1). Compering to the year 2003 it was respectively 2,46% in Germany, 2,55% in United States, 1,67% in United Kingdom, 0,54% in Poland.

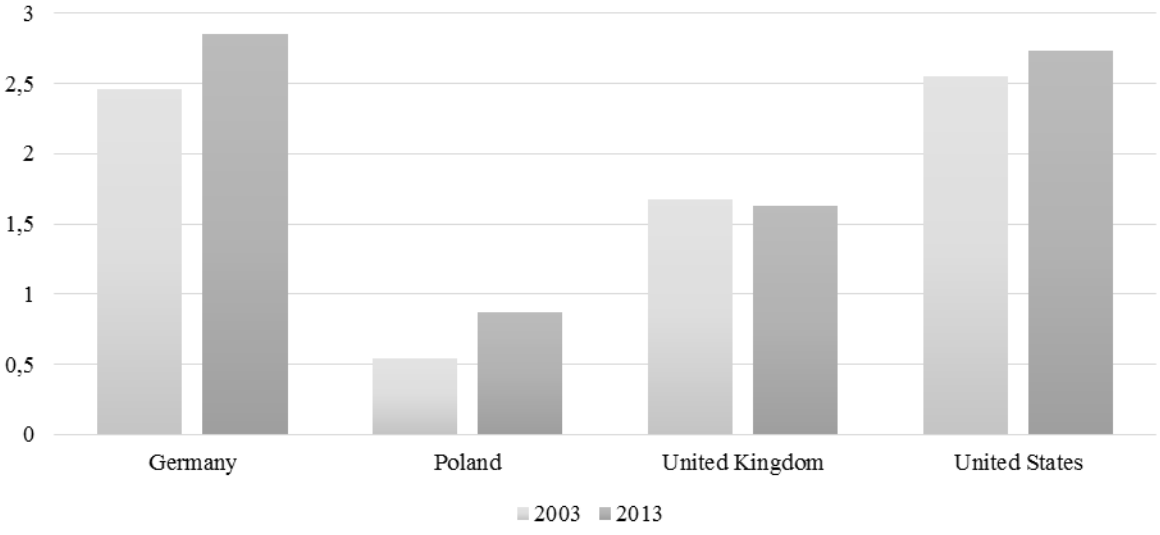

Chart 2: GERD as a percentage of GDP

Source: own elaboration based on OECD statistics, Main Science and Technology indicators.

For innovativeness level of the economy it is important how the enterprises from each country investigate their money in R&D activity. The highest percentage of GERD performed by the business enterprise sector was observed in the 2013 year in firms from United States. About 70,58% of GERD were performed in US by business enterprises. Companies from Germany performed about 66,91% of GERD and from United Kingdom 64,51%.

The huge disproportion in the share of GERD performed by business sector is observed from all examined countries and Poland where only 43,62% of GERD were performed by enterprises (chart 3). The average stage of GERD percentage performed by business enterprises in United States, United Kingdom and Germany was in the years 2003-2013 more or less constant. Due to Poland, it can be observed that the percentage of GERD performed by enterprises had been growing rapidly from the year 2010.

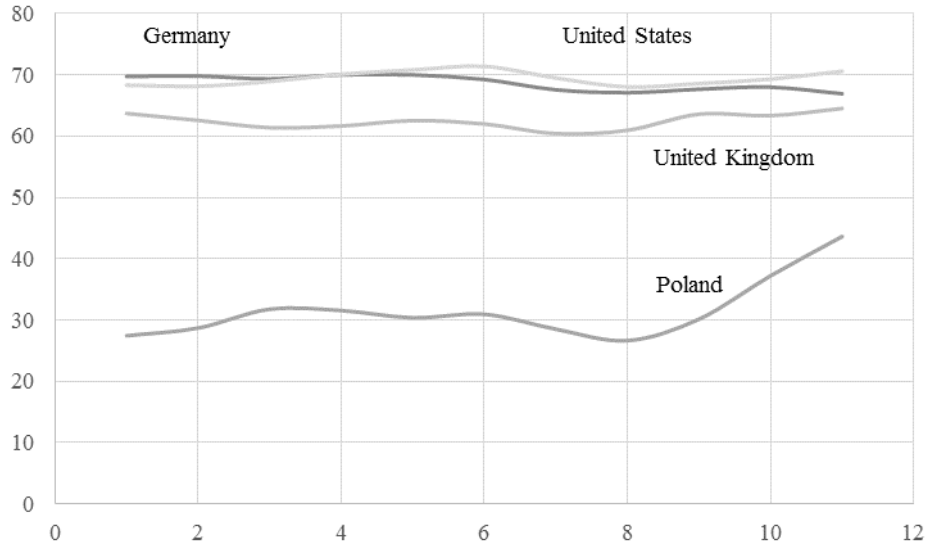

Chart 3: Percentage of GERD performed by the Business Enterprise sector from 2003-2013 year

Source: own elaboration based on OECD statistics, Main Science and Technology indicators.

From innovativeness point of view of countries it is also important what is the level of financing the GERD as a percentage of GDP by public sector - government. The highest public financing percentage was observed in 2013 in Germany which also grew from the year 2003 (chart 4). Next and the last country where the government-financed GERD as a percentage of GDP grew from 2003 year was Poland. In United Kingdom and United States the government-financed GERD as a percentage of GDP became smaller in the year 2013 than it was in 2003.

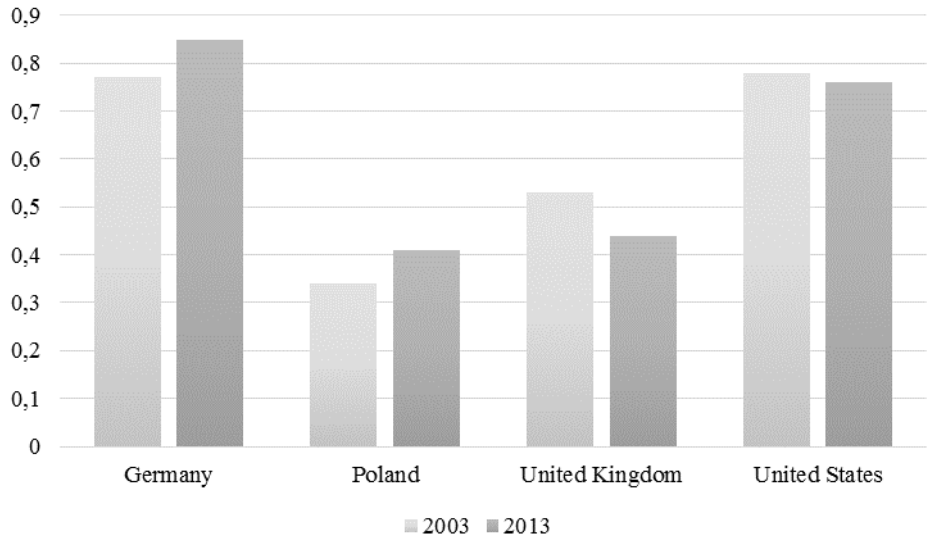

Chart 4: Government-financed GERD as a percentage of GDP

Source: own elaboration based on OECD statistics, Main Science and Technology indicators.

The performance of GERD performed by sectors differs in all examined countries (see table 2). The highest share of

government sector was in Poland, where it reached the level of 26,83% as well as the higher education sector which reached 29,26% of GERD performed by this sector. Private non-profit sector performed highest level of GERD in United States 4,1% as well as the business sector 70,58%. The highest percentage of GERD performed by abroad was in United Kingdom.

Table 2: Percentage of GERD performed by sector.

	Germany	Poland	United Kingdom	United States
Government sector	15,09	26,83	7,31	11,17
Higher Education sector	18	29,26	26,3	14,15
Private Non-Profit sector	No data	0,29	1,88	4,1
Industry	65,21	37,33	46,55	60,85
Business sector	66,91	43,62	64,51	70,58
By abroad	4,37	13,12	20,65	4,45

Source: own elaboration based on OECD statistics, Main Science and Technology indicators

Research and development activity is connected with intellectual property. Intellectual property is a blanket term for a number of different mechanisms for protecting the results of intellectual activity. The most common activity to protect the intellectual property is patent system. On the other hand data collected about quantity of patents allow to examine the level of innovativeness of examined under article countries.

The most successful in patenting activity in 2013 year were United States. They were much apart from the rest of examined countries. The number of patent applications filled under the PCT in 2013 year in US was 60066,54 and it grew importantly from the year 2003 (see chart 5). United Kingdom was not significant in patenting and Poland almost didn't have patent applications filled under PCT.

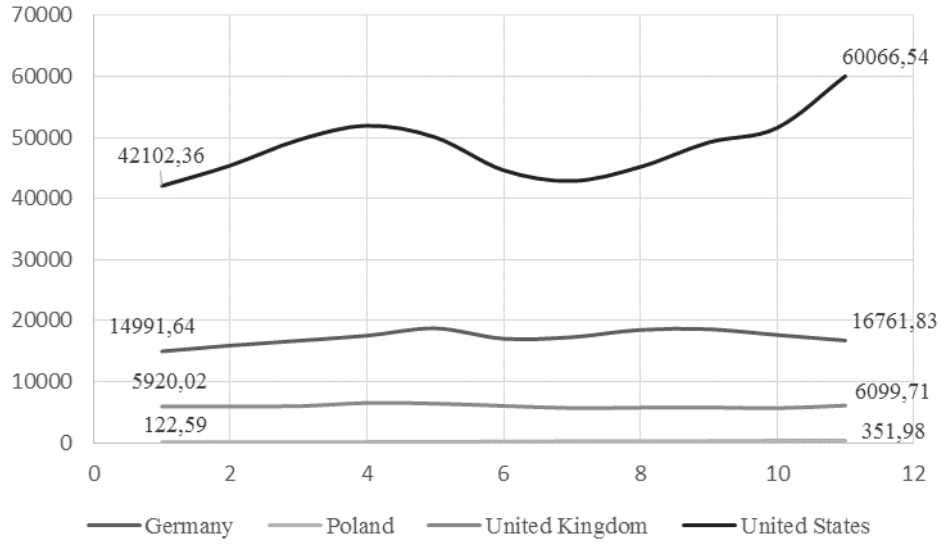

Chart 5: Number of patent applications filed under the PCT(priority year)

Source: own elaboration based on OECD statistics, Main Science and Technology indicators.

4. ACKNOWLEDGEMENT

The importance of research and development for the successful achievement of the Lisbon Strategy is clearly declared in several important strategic World and EU documents. Research and development system in the effective country policy should concern the interconnection and cooperation of the public and private sector in R&D, human resources for R&D, financing the R&D and innovation activity.

As the research showed, the innovative countries like United States, United Kingdom or Germany invest in research and innovation to develop products and new way of production that address their particular needs. From the surveyed countries only Poland is not presenting important innovative development.

From all the indicators and examined in the research data, it is visible that countries like United States and United Kingdom are much more innovative than the rest of the group.

Gross domestic expenditure on research and development in total intramural expenditure on research and development performed on the national territory were highest in United States and United Kingdom. The highest level of gross domestic expenditure on R&D was in United States. The highest share of GERD as a percentage of GDP in 2013 year was observed in Germany. It can be observed that countries which are very active in research and development activity reach higher innovation performance. On the other hand this countries also invest more in R&D their own expenditures. Countries like USA, UK or Germany do have financial potential to invest in risky and unsure research and development activity. Poland is a country which is not innovative in any international ranking. As the research showed the most important data connected with research activity are very low in this country. This can mean that countries that do not invest expenditures on own R&D activity and only invest in technology transfer from external sources are less innovative.

Strong competition among companies forces them to use innovation as a key source of competitive advantage. Only the innovation that is new from the national level is the promise of being innovative and competitive among other economies. To be able to compete companies must introduce new technologies, products, services and organizational systems. The dominant role of innovation as a development factor tends individual entities to seek opportunities to their widest possible use in its operations. For developed countries, which are innovative like USA or UK R&D activity is often and popular way of creating innovation and changes in technologies. On the other hand the dominant role of already existing technology transferred to non-innovative countries should be reduced and all the effort should be moved to more active R&D strategies.

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