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EVALUATION OF THE INNOVATION ACTIVITIES OF COMPANIES IN THE COMPETITIVE EU MARKET – EXTERNAL FACTORS

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Purpose: The purpose of this paper is to assess the innovation activities of companies in the EU countries, taking into consideration the external factors.
Design/methodology/approach: This article focuses on the analysis of the most frequently used factors determining the external conditions of the companies innovation activities with the use of taxonomic analysis. The research was conducted on the annual data for years 2017-2019 for the selected European countries. The data from the databases of OECD and Eurostat were used in the analysis.
Findings: The results of the conducted analysis allow to conclude that the state and organisation of innovation activities in the economy and thus, in the companies is strongly dependent on external factors. The averages and quartiles were calculated to show the dynamics of the factors. Moreover, Ward dendrogram was presented to show the similarities and differences in shaping the innovation activities. The synthetic indicator was used to determine the development path and the map of objects was drawn. There is a strict connection between the amount of expenditures on R&D and the employees' education concerning the implementation of the innovation activities in all analysed countries. In particular, it is visible in the Scandinavian countries and in Luxembourg. In Poland the innovation activities of companies is similar to the ones in the countries of Central and Eastern Europe. The low level of GERD causes that many companies have financial problems and despite high dynamics of industrial production, the innovativeness is still at a low level.
Research limitations/implications: The comparison of Poland with other countries would surely give a wider picture whether the innovation processes are performed in an efficient way. The accessibility of data, for each country, used in the research not only limited the period of analysis but also determined the selection of variables. The analysis was based on the data from the mentioned databases to make it more reliable.
Practical implications: The information obtained during the conducted analysis may facilitate the process of proper decision making referring to the management of innovations. The implementation of innovations guarantees not only the company development but also greater transparency in the information and knowledge flow among the workers.
Originality/value: The analysis of external factors of the innovation activities is really important as the investments in innovation activities are the more and more important GDP part and the numerical taxonomy methods enable to indicate, indirectly, these countries which should be models for Poland so that it could organise and manage the innovation processes. The analysis of innovation activities makes it possible to indicate desired directions of changes

in the management of Polish companies. Thus, it is a basis to take decisions in the competitive markets.

Keywords: innovativeness of enterprises, innovation policy, map of the objects, Ward's dendrogram.

Category of the paper: Research paper.

1. Introduction

The changes in particular countries caused that a big attention is paid to the introduction of new solutions in the company activity (Baruk, 2018). The implementation of these solutions guarantees that work is managed in a better way, the production costs are lowered and the competitive advantage is gained, which allows to satisfy the demand for manufactured goods and to meet the expectations of the consumers who buy the goods and services which are of appropriate kind and of high quality (Brodowska-Szewczuk, 2019; Kozioł et al., 2015).

The experiences of many countries show that the high level of economy may be achieved, among others, by using modern management tools and implementation innovations to all areas of company functioning. Innovation potential of companies is defined as the set of social and economic resources (in particular funds to run research and development activity, flow of information and knowledge and social capital), being the basis of the innovation activities of a company, gives the possibility to create and implement innovations (Thompson, 2018; Guckenbiehl et al., 2021). However, it should be remembered that innovations do not mean the company innovation activities even though the researchers often use these terms interchangeably (Hee-Jae, and Pucik, 2005). Whereas the innovations are connected with the product, the innovation activities are regarded as the company ability to introduce something new or as the changes in the company functioning (Hilami et al., 2010). This ability is strongly stimulated by the country policy of innovativeness (Alam, Arshad, and Rajput, 2013), creating general conditions of the company functioning in the fast changing environment (Yachmeneva, and Vol's'ka, 2014).

However, the competition in the global market is undoubtedly the crucial element driving the innovation activities of companies (Osieczko, and Stec, 2019; Agarwal 2018). Nevertheless, it is often also possible to see the statement that the implementation of new solutions in companies comes from the existence of competition in the market (Gryczka, 2016; Grossman, and Helpman, 1990; Dodgson, and Rothwell, 1994; Fagerberg, et al. 2006). Though according to the EU, the innovation activities are and will be the significant factor of the international competitiveness of economies in the future (Dyjach, 2011; Skrzypek, 2009), and in a consequence, will be the factor of providing the desired level of economic growth of the member states of the European Union. Such an approach caused the creation of the report Green

Paper on Innovation and acceptance of The First Action Plan for Innovation in Europe by the European Commission in 1996. The result of this article was that in 2000 the European Commission created the Lisbon Strategy in which innovations and innovation activities of companies were regarded as key factors of economic growth in the member states of the European Union (European Parlament, 2010). The innovation strategy described in the Lisbon strategy was aimed to make Europe the most dynamic and competitive region from 2010. However, due to the overestimation of Europe economic potential, the assumed result failed to be achieved. It caused that the assumptions were corrected and the new strategy Europe 2020 was created. This new document assumes the stimulation of innovation activities with the use of ICT and balanced use of resources.

However, it should be stressed that the framework programmes constitute the basic documents of innovation policy in the European Union (Defazio, Lockett, and Wright, 2009). Two programmes were performed in years 1998-2006: Fifth and Sixth Framework Programme and in years 2007-2013 Seventh Framework Programme.

Fifth Framework Programme was to increase the competitiveness of companies in the countries of the European Union and the associated states and improve the life conditions thanks to the development of work markets and the increase in the employment and strengthening of connections between science and industry (European Commission, 1999). The increase in the technological innovations was significant in this programme. 6th Framework Programme of the European Commission focused on the creation of the European Research Area, so called ERA (European Commission, 2002). Whereas 7th Framework Programme was the biggest programme to finance scientific research and technological development in Europe (European Communities, 2007).

The next programme was "Horizon 2020" (2014-2020) – this programme became the tool to implement Union Innovations in the scope of scientific research and innovations (Bartosiewicz, 2012). It is followed by the Union investment programme for years 2021-2027 in the scope of scientific research innovations "Horizon Europe" ("Horyzont Europa…", 2021). Within it, it is possible to achieve access to the newest solutions and research results in the work e.g. by the cooperation with international academic units. In order to increase the flexibility and synergy effect, the actions were divided into five clusters which contribute to meeting the sustainable growth objectives. Within "Global Challenges and European Industrial Competitiveness" it is possible to distinguish e.g. cluster "Digital, Industry and Space" which covers, among the intervention areas, among others: manufacturing technologies, circular industries, low carbon and clean industries. In pillar III "Innovative Europe" it focuses on:

- Promoting breakthrough innovation with scale-up potential at the global level (European Innovation Council).
- Creating more connected and efficient innovation ecosystems to support the scaling of companies, encourage innovation and stimulate cooperation among national, regional and local innovation actors (European Innovation Ecosystems).

- fostering the development of entrepreneurial and innovation skills in a lifelong learning perspective and support the entrepreneurial transformation of EU universities (European Institute of Innovation and Technology).

As it can be noticed the research on measuring the innovation activities is carried out at each level: the international (OECD, UN, EU) and national (Decyk, and Juchniewicz, 2013) and is based on the recommendations arising from the series of Frascati Family documents published by OECD in 1963, in particular Oslo Manual referring to the innovation policy. The determinants of the economy innovation activities are assessed by the European Commission every year and the results of the assessments are presented in the publication European Innovation Scoreboard. On this basis the European Commission draws up the European Innovation Index and the research of the innovation level in particular countries of the European Union has been carried out within the programme Trend Chart on Innovation in Europe since 2000.

Taking the above into consideration, the assumption was made that indirect factors (economic, social and technical ones) determining the company innovation activities affect the creation of new solutions in companies. Moreover, external factors refer, in particular, to the surrounding of economic subject the functioning of which depends on market mechanisms and creation of pro-innovation policy. Thus, the question arises which group of countries should Poland try to follow to improve its position concerning the development of innovation activities in the companies.

As a result, the following hypotheses were formed:

- The analysis of external factors affecting the company innovation activities enables to monitor the engagement of countries in the improvement of implementing new solutions.
- The results of the international comparisons provide information being the reference point to create innovation policy in every country.

Taking the above into consideration the purpose of this article is to evaluate the innovation activities of companies in the selected countries belonging to the EU and OECD in terms of their external factors. The method of cluster analysis and object map were the research tools that made it possible to perform this objective.

Thus, the presented paper is an attempt to meet this aim and constitutes a proposal thanks to which it will be possible to cluster and order the countries according to the accepted set of factors affecting the innovation activities of companies.

2. Method

The comparison of Polish companies to the companies in the EU seemed to be an important research subject in the previous analysis of innovation activities in this country. On this example it is possible to indicate which countries should be followed to improve the innovation activities of the companies in Poland.

Thus, the analysis of countries may also be useful when it comes to answering the questions in which the innovation activities of companies seem to be unsatisfactory in comparison to others in which the significant organisational changes should be performed and also to determine which region may be a model for others when it comes to the functioning of companies.

However, due to the complexity of this issue, the research was conducted in four parts. The first part focused on shaping the external factors of innovation activities in companies. The second one was aimed to order the countries, the third – drawing up the object map and development path and the fourth one – showing the clusters of countries in which the factor works in a simliar way.

The values of the selected external factors affecting the innovation activities of companies were calculated in the first part. The changes of their values show the changes in forming these factors in years.

In the second, third and fourth part of the conducted research the analysed objects were characterised taking into consideration twelve features. They constitute the basis in the description of the analysed issue and come from the commonly available data included in the statistical reporting kept by Eurostat. Thus, the analysed features included:

1. Human resources for innovations:
   - Participation of people at the age 25-64 in lifelong learning – X_1,
   - Graduates of scientific and technical universities per 1,000 people at the age of 20-29 – X_2,
   - People with higher education at the age 25-64 as a percentage of the total number of people at this age – X_3,
   - Level of young people's education as a percentage of the population at the age of 20-24 with at least secondary education – X_4.
2. Level and dynamics of social and economic growth:
   - GDP per capita according to PPP in USD – X_5,
   - Inflation rate in % – X_6,
   - Unemployment rate – X_7,
   - Dynamics of industry production expressed with the use of individual chain indexes of dynamics – X_8.

3. Research and development activity:
   - National gross expenditure in R&D activity as % of GDP – X_9,
   - The total number of scientific and research workers per 1,000 professionally active people in the equivalent of the full work time – X_{10},
   - Number of registered EPO patents per 10,000 people – X_{11},
   - Number of registered UPSTO patents per 10,000 people – X_{12}.

The article focuses on the above variables in order to consider the issue of innovation activities in a company, especially that such a selection is confirmed by the national and foreign researchers in this field (Barro, 1991; Cohen, and Soto 2007; Weresa, 2003; Jasiński, 2003; Grossman, and Helpman, 1991; Lin et al., 2020; Simao, and Franco, 2018; Audretscha, and Belitski, 2020; Sokołowski, 2018; Wołodkiewicz-Donimirski, 2011). Thus, these features represent the features of social, economic and technical nature.

In order to test the phenomenon, the classification was based on the cross-sectional data for years 2017-2019 and the suggested research methods focused around the numerical taxonomy methods. Thus, the research was aimed to determine the relations between the UE states, ordering them concerning the innovation activities of companies and dividing them into similarly functioning regions. In the analysis the object map was built on the basis of the value of a synthetic feature and the hierarchical agglomerative clustering method (Ward method) was used. This method enabled to present the creation of clusters of higher and higher ranks with a specific distances of bonds. The constructed dendrite made it possible to indicate similarities and differences between the tested objects concerning the analysed features.

Ordering the innovation activities in companies in the selected countries was started with the standardization of features with the use of quotient transformation (Malina, 2004). The standardization is usually used due to the possible scale differences between variables (Eszergár-Kiss, and Caesar, 2017), and thus standardization procedures make in possible to compare the features. In this case, due to the wide discrepancy of every feature, the standardization was performed by dividing particular values of variables by the constant value which consisted the respective average (Zeliaś, 2004). The features were given weights with the use of the ranking method based on the orthogonal projection in order to determine the level of their significance (Kolenda, 2006). The quartiles were used to determine the weights: the value of the third quartile for a given feature was the pattern and the value of the first quartile for a given feature was the anti-pattern. Having performed the calculations, the synthetic features were determined for each object, indicating in this way the country with the greatest potential of innovation activities. Using this feature, the development path was presented (with 12 selected features) in order to show, considering these twelve selected features, in which country the "innovation activities of companies work the best". The map of objects was presented in a form of a polar graph in which semicircles show the distance of the selected object from the others and radiuses – the positions of objects in the ranking. The objects with the highest rank are at the right side of the discussed graph and the worst ones – on the left side.

Thus, in order to determine the development path for a selected object, the pattern objects are indicated for it, which is significant when the analysed object goes to higher ranks. Then, the similarities of the level of innovation activities in countries were tested with the use of the cluster method according to which the countries were divided into groups and similar countries were included in each cluster and the different ones were included in other clusters.

Therefore, the distance matrix between countries was determined. The method of Euclidean distance was used to calculate it (Panek, 2009). The countries were clustered on the basis of the distance method featuring with "…the highest efficiency of recognising the structure in the matrix of data describing the analysed objects…" (Malina, 2004, p. 63), starting from the one-element cluster through the ones that connect the most similar countries and finishing on the one connecting all tested objects.

The states belonging both to the UE and OECD were included in the test group and the information was taken from the websites of Eurostat and OECD. The accessibility and completeness of data for all analysed countries determined the selection of the test period. In 2019 the number of recorded EPO and UPSTO patents was calculated as the average from the last two years. The values were given as the intensity indicators and each variable was given on the ratio scale and was the aggregate value within each country. The tests were performed in the programmes: Numeric Taxonomy and Statistica 13.3.

3. Results

The average, median, first and third quartiles were determined to indicate the change in shaping the external factors. It will enable to notice whether the change of the external factor of the innovation activities occurred. On the basis of the literature review (Wiśniewska, 2005; Janasz, and Kozioł, 2007; Haberla, and Kuźmińska-Haberla, 2013; Romanowska, 2016; Mardania et al., 2018; Audretscha, and Belitski, 2020; Di Vaio et al., 2021) the variables having the main influence on the innovation activities in companies and which represent various factors of the organisation surrounding were selected to the analysis (Table 1).

Table 1.
The changes of external factors in the selected EU group in years 2017-2019

Types of factors	Variable	2018/2017	2019/2018	2019/2017
Average				
Social factors	X_1	102.11	102.13	104.29
	X_2	101.72	102.55	104.32
Economic factors	X_5	105.04	104.28	109.54
	X_8	98.42	99.19	97.62
Technical factors	X_9	102.86	102.76	105.71
	X_{10}	103.90	103.32	107.36

Cont. table 1.

First quartile				
Social factors	X_1	89.33	110.45	98.67
	X_2	96.55	101.43	97.93
Economic factors	X_5	105.71	105.55	111.58
	X_8	98.15	98.61	96.78
Technical factors	X_9	99.88	103.51	103.39
	X_{10}	112.91	101.55	114.66
Median				
Social factors	X_1	107.14	100.95	108.16
	X_2	105.29	99.50	104.76
Economic factors	X_5	103.71	104.01	107.86
	X_8	98.36	99.02	97.40
Technical factors	X_9	110.03	108.35	119.21
	X_{10}	103.59	104.07	107.80
Third quartile				
Social factors	X_1	108.14	104.84	113.37
	X_2	101.79	103.95	105.80
Economic factors	X_5	103.78	101.70	105.55
	X_8	99.15	99.04	98.20
Technical factors	X_9	103.40	101.53	104.99
	X_{10}	103.52	100.63	104.17

Source: Own study based on Eurostat and OECD.

On the basis of the information presented in table 1, the fall of the industrial production may be noticed, which is not advantageous. However, it should be noticed that the values of other external factors improve and the biggest change was noticed in the case of technical factors. In years 2018-2019 the threshold of shaping the four external factors of the innovation activities in companies increased for half of the countries. It refers mainly to the value of expenditures on R&D measured as the percentage of GDP (growth by 8.35%) and the total number of scientific and research workers counter per 1,000 professionally active people, in the equivalent of the full work time (growth by 4.07%). This situation is strictly connected with the economic growth of the country calculated with the use of GDP per capita. In this case, there is also a growth but this value decreases with the higher quartile and fluctuates from 1.70 to 5.55%. The most probably it is connected with the problems which face the countries with the lowest level of income. In 2019 in comparison to 2018, the number of people at the age 25-64 participating in the lifelong learning as well as the number of graduates of scientific and technical universities calculated per 1,000 people at the age 20-29 increased for 75% of the countries. The first one increased by 4.84% and the other one was only 0.89 percentage point lower. In general, slight growths were noticed on average among described external factors, apart from the dynamics of industry – independently of compared years.

Taking into consideration the position of Poland among 23 EU countries (considering every variable), the following information was received:

- Poland took third place from the end before Greece and Slovakia and it was much less than the average for the EU states (variable X_1).

- Poland was over the average for the EU but there were fewer and fewer graduates per one thousand people in our country; it took 9th place in 2019 behind Portugal and before Slovenia (variable X_2).
- GDP per capita in Poland was at the level of PLN34,151.8 in 2019. Our country took the 5th place from the end with this result (variable X_5).
- Poland is in the group of countries with the highest dynamics of the industrial production; this dynamics increased by 4.2% in 2019 in comparison to the previous year (variable X_8).
- Poland's rank increased from 20 to in 2017 to 16 in 2019 obtaining the level of 1.32% of GDP in 2019; however, still its result was under the average for tested countries (variable X_9).
- the number of research and development workers in Poland is not big; 9.64 equivalents of the full work time per 1,000 professionally active people which ranked us before Estonia, Lithuania, Slovakia and Latvia (variable X_{10}).

Then the synthetic values were indicated as in this way, it is possible to order the European Union countries concerning the level of innovation activities in companies and concerning the accepted set of diagnostic features (Table 2).

Table 2.
The values of synthetic feature for the EU countries in years 2017-2019

Country	Symbol	2017	2018	2019
Belgium	BE	2,58	2,59	2,58
Czechia	CZ	1,25	1,27	1,21
Denmark	DK	4,26	4,09	4,16
Germany	DE	3,78	4,09	3,89
Estonia	EE	1,50	1,50	1,58
Ireland	IE	3,19	4,21	3,54
Greece	GR	1,33	1,35	1,28
Spain	ES	1,56	1,61	1,55
France	FR	2,77	2,74	2,78
Italy	IT	1,67	1,71	1,70
Latvia	LV	0,89	0,95	0,91
Lithuania	LT	1,02	1,07	1,08
Luxembourg	LU	7,27	5,92	6,69
Hungary	HU	0,93	0,97	0,95
Netherlands	NL	3,86	3,94	3,87
Austria	AT	3,37	3,47	3,37
Poland	PL	0,95	1,01	0,96
Portugal	PT	1,27	1,24	1,25
Slovenia	SI	1,78	1,66	1,72
Slovakia	SK	0,87	0,83	0,81
Finland	FI	4,75	5,06	4,89
Sweden	SE	5,45	5,01	5,35
United Kingdom	GB	2,10	2,17	2,14

Source: Own study based on Eurostat and OECD.

In each tested year, Luxembourg turned out to be the leading country with the synthetic indicator amounting to on average 6.63. Thus, it is possible to state that the innovation activities in companies are at the highest level in the smallest country of the EU. Also Sweden, Finland and Denmark characterised with the high average value of the synthetic feature. However, in 2018 Denmark took the fourth rank, just after Ireland. In these countries more and more people participated in the lifelong learning, the number of graduates of scientific and technical universities or the percentage of expenditures on R&D in the percentage of GDP were growing. Slovakia, Latvia and Hungary took the lowest ranks among the countries in 2017-2019. Poland may also be included in this group – concerning its innovation activities it takes the rank just before Hungary and it is 20th place. Portugal and Greece characterised with the smallest innovation activities among the countries of so called "old Union". Slovenia and Estonia took the first place in the countries of the "new Union". In the last year of the research in comparison to the previous one, their position increased and they took 12th and 14th place among the 23 analysed countries, respectively.

On the basis of the performed research, it is possible to notice that Sweden, Denmark, Germany, the Netherlands, Slovenia, Estonia and Portugal belonged to the countries of the growing rank in the last period. The position of Poland did not change and it shows that the actions should be intensified in our country to improve the innovation activities of companies or the whole economy.

Drawing up the so called "object map" was the next stage of the research. It is used to analyse the position of the selected object in the ranking and enables to find units that are better than that and the most similar to it. At the same time, it makes it possible to determine the pattern that is the basis for specifying the strategy of its development or create its development path.

The development path can be created for all objects. Only the object map for Poland was presented in the article as it is the most interesting for the author (Figures 1-3).

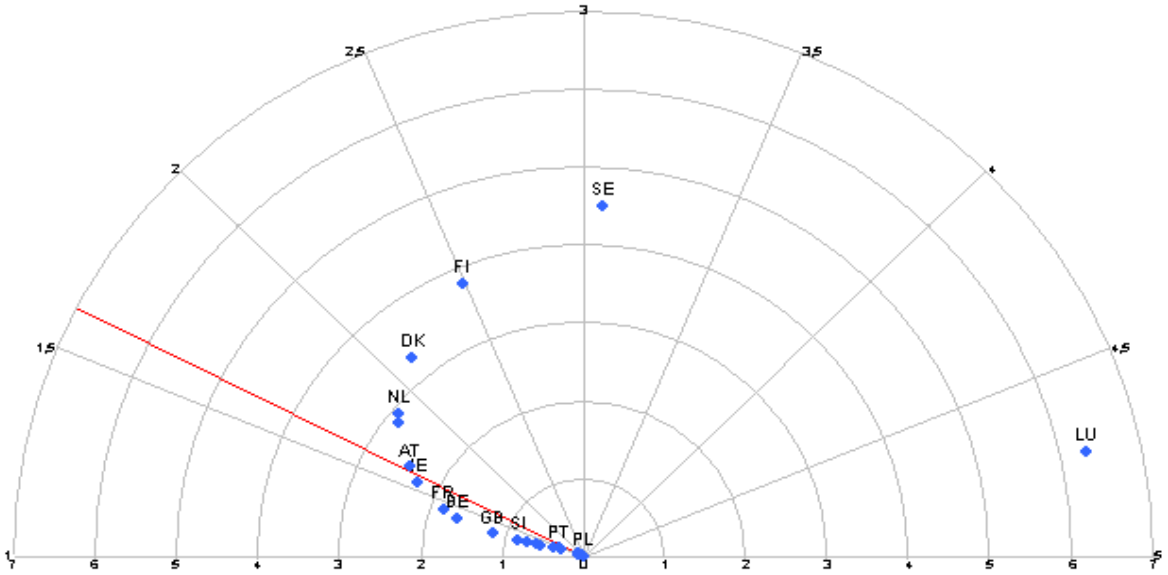

Figure 1. The map of objects for Poland in 2017. Source: Own study.

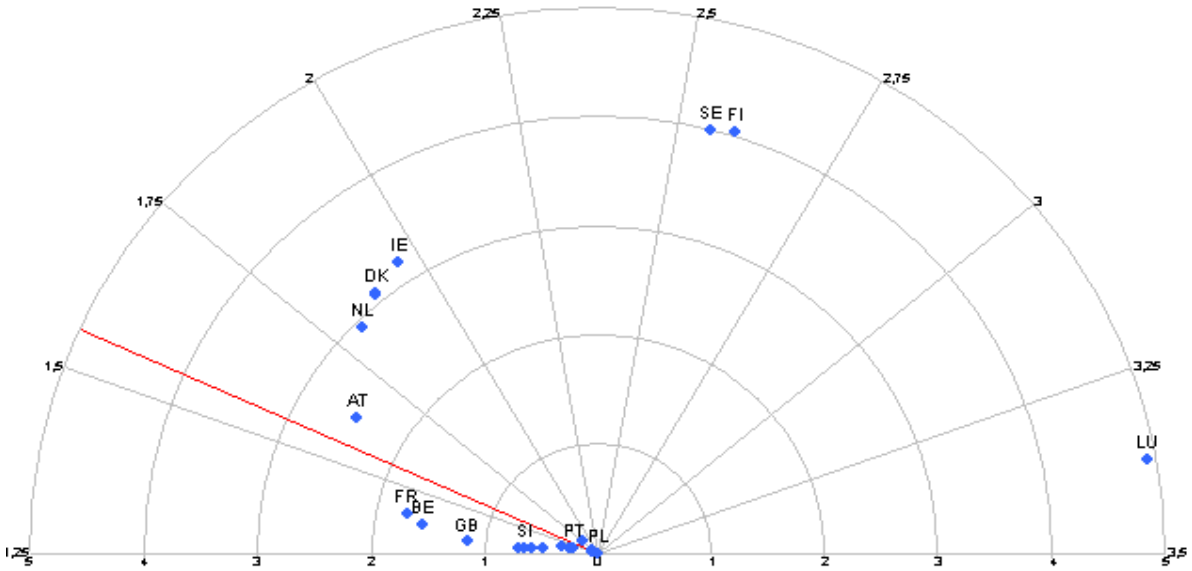

Figure 2. The map of objects for Poland in 2018. Source: Own study.

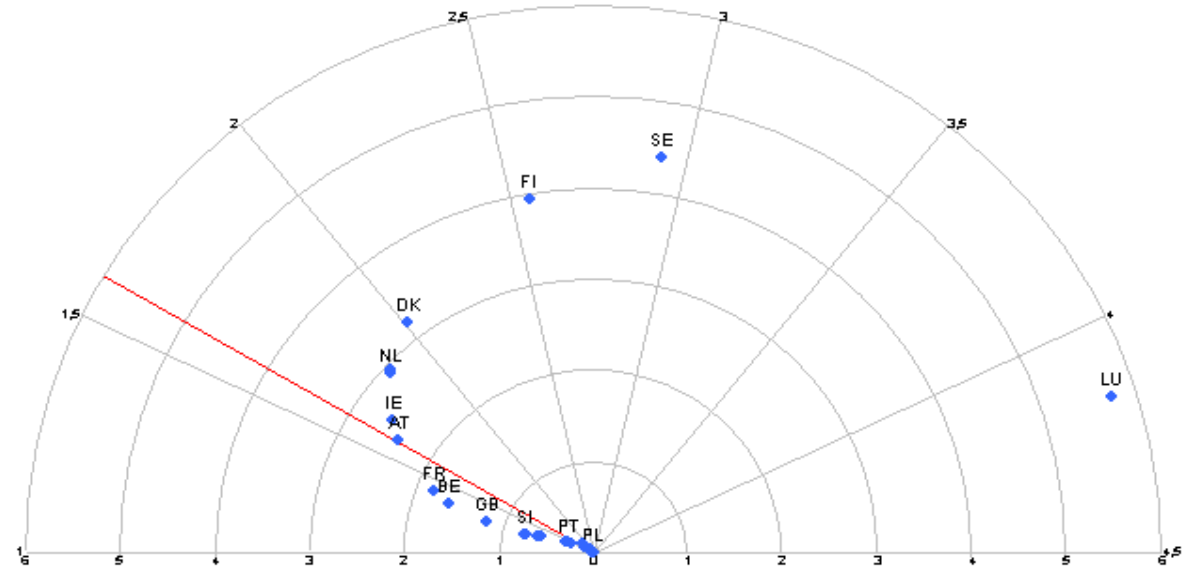

Figure 3. The map of objects for Poland in 2019. Source: Own study.

The conducted research shows that at first Luxembourg, Sweden and Denmark should be patterns for Poland in 2017. Their ranks were higher than the one indicated for Poland and the distances between them were relatively small. In 2019 Finland took the place of Sweden and in 2018 the Netherlands replaced Denmark. Austria, which may also be a model when it comes to the innovation activities in companies, is the "nearest" country for Poland each year. The distance of Poland to it decreased and the difference was bigger in 2018 than in 2017. The difference in the Euclidean distance was 0.05 (2018) and 0.02 (2017). It seems interesting that creating the development path, we should not try to catch up with Ireland, the Netherlands, Germany or Sweden in 2019. Probably it is not a good idea to get similar to these countries yet – the high factors specifying the determinants of the innovation activities differ too much from the ones specified for our country. The position of France, Belgium or the United Kingdom is surprising. Taking into consideration the set of features showing external factors, it turned out

that the situation of Poland and these countries is not clear. As the results show, although France, Belgium and the United Kingdom take higher positions in the ranking of the innovation activities in companies, we should not try to follow them creating our development path. Hungary is the country which takes the position nearest to Poland. It takes a lower position in the ranking of the innovation activities in companies and was not marked in pictures as showing it would make it difficult to read the picture (it is similar with other "undisclosed" countries).

Due to the fact that the significant reduction of indifferences through the increase in the technological abilities of the industry, strengthening the scientific research and increasing the expenditures on the research and development is one of the purposes of the sustainable growth (OECD, 2017), the author decided to complete the performed analysis. For that, the attempt was taken to assess which countries are similar to each other and which differ when it comes to the innovation activities in companies. The set of analysed features was considered. The Ward agglomeration method was used in this research because the results of clustering are the most often shown in a graphic form with the use of so called tree of connections called dendrogram Figures 4-6).

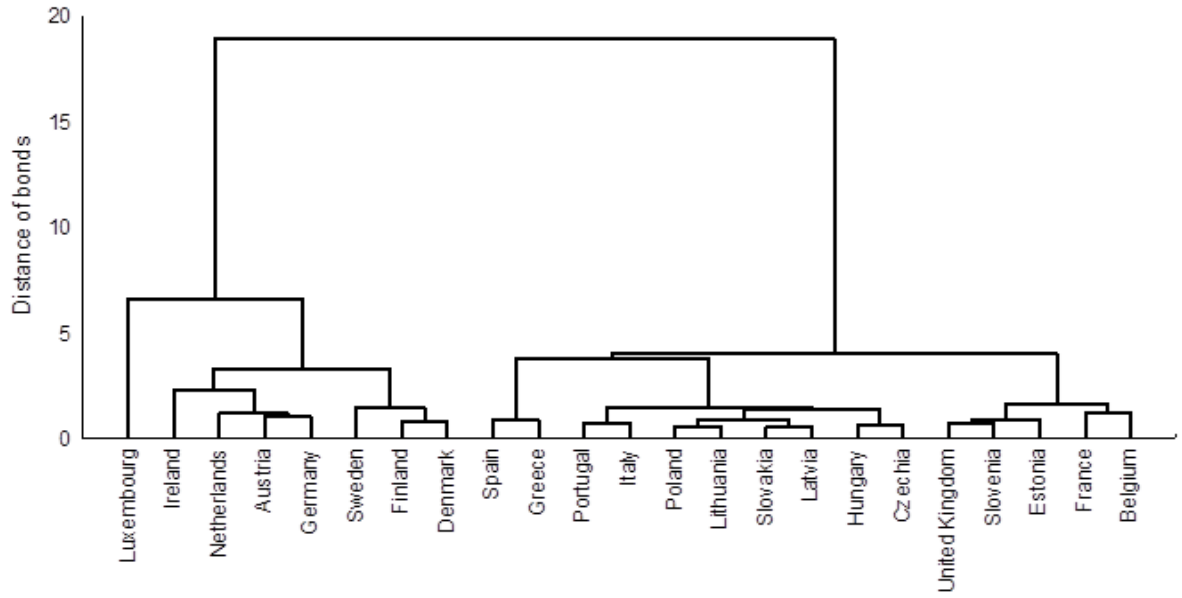

Figure 4. Ward dendrogram of the analysed European countries in 2017. Source: Own study based on Eurostat and OECD.

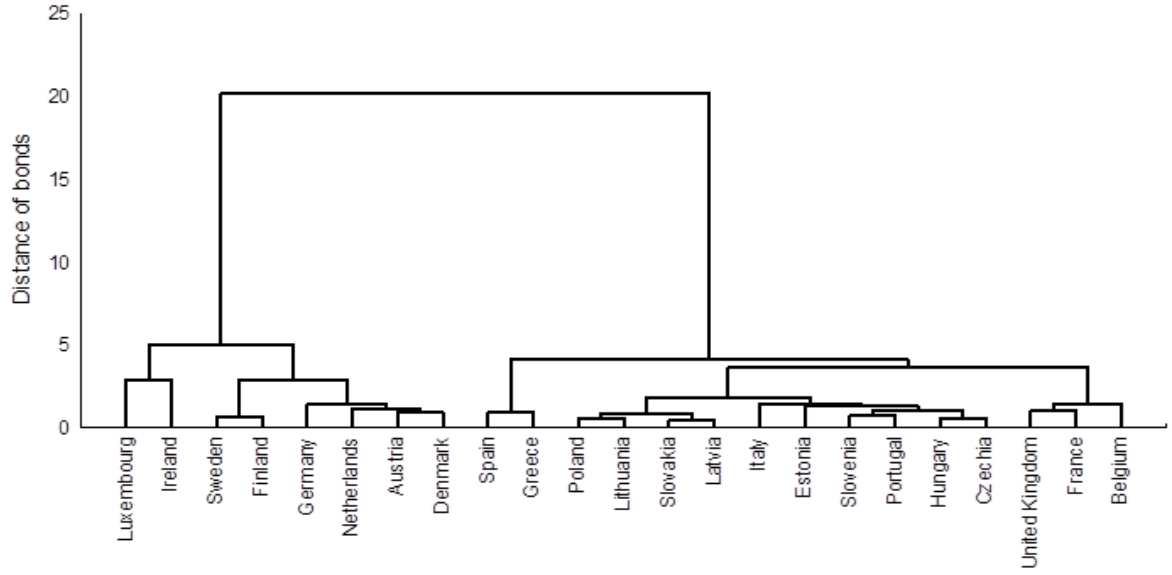

Figure 5. Ward dendrogram of the analysed European countries in 2018. Source: Own study based on Eurostat and OECD.

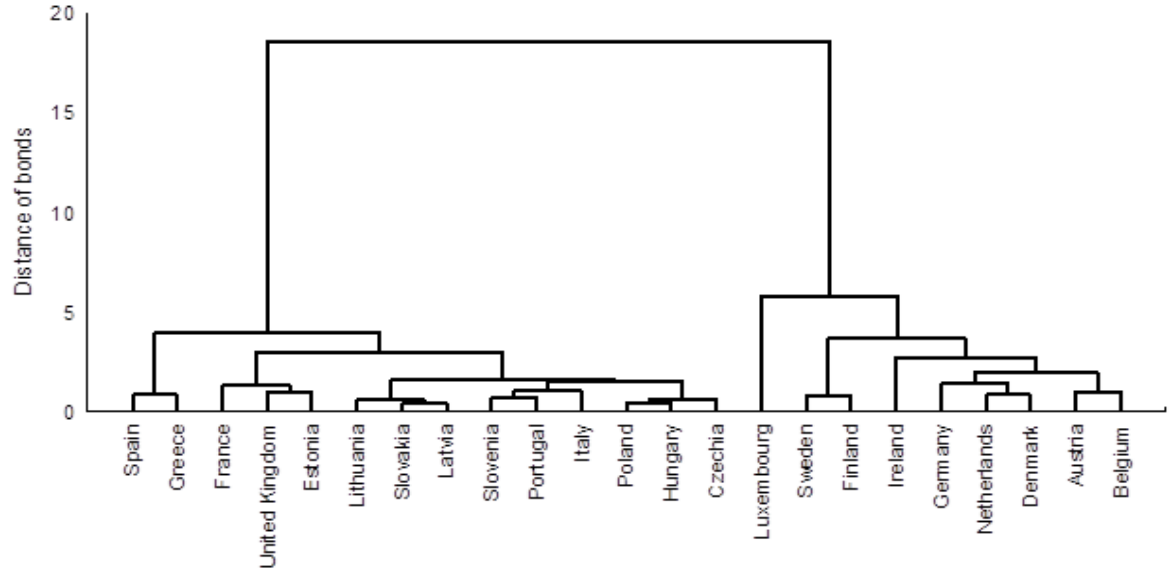

Figure 6. Ward dendrogram of the analysed European countries in 2019. Source: Own study based on Eurostat and OECD.

Analysing the above pictures it is possible to say that the countries of Central and Eastern Europe (Lithuania, Latvia, Hungary, Slovakia, the Czech Republic) showed the biggest similarity to Poland in 2018, taking into consideration the analysed features, and this group was smaller a year later – without Hungary and the Czech Republic. These two countries got more similar to Portugal or Slovenia considering the external factors of the innovation activities in companies. In 2019 Poland "connected" with Hungary and the Czech Republic again and the other countries (Lithuania, Latvia and Slovakia) created a separate group. As it can be observed, these countries of CEE created one cluster again but at the higher level of bonding. In years 2017-2019 Slovakia and Latvia were the most similar. The distances between these countries were the smallest concerning the analysed structure. In the case of clusters created by Poland

with other regions, it can be noticed that the similarity rate was smaller and smaller with years. Our country is still in the group of countries belonging to the EU since 2004 but the level of bonding is different. It shows that it is necessary to equalise the differences in the analysed external factors of the innovation activities, in particular when it comes to such countries as: Luxembourg, Sweden, Finland, Denmark, Austria, Germany, the Netherlands and Ireland. All these countries took higher position in the ranking than Poland, which created a cluster with them at the last level of bonding. Slovenia and the United Kingdom (2017), Finland and Sweden (2018) and Portugal and Slovenia (2019) showed the biggest similarity due to the analysed features from the countries that joined the EU before 2004. The country that took the first place in the ranking created a cluster with "old" EU member states, i.e. Denmark, Austria, the Netherlands, Germany, Finland, Sweden, Ireland in years 2017-2018 and Belgium joined this group in 2019. However, Ireland was the country that showed the greatest similarity (considering the analysed features) to Luxembourg. These two countries created a bond at the level 2.84.

The analysis of the external factors of innovation activities presented in pictures 4-6 shows that it is possible the same number of groups of countries having the similar structure of the innovation activities in companies with the bond distance from 0.97 to 1.02 but the elements of cluster differ from each other. However, the countries feature with the big similarity within analysed clusters concerning the analysed structure (Table 3).

Table 3.
Clusters of countries in years 2017-2019

Cluster number	2017	2018	2019
1	Latvia, Slovakia	Latvia, Slovakia	Latvia, Slovakia
2	Lithuania, Poland	Czechia, Hungary	Czechia, Poland
3	Czechia, Hungary	Lithuania, Poland	Czechia, Hungry, Poland
4	Slovenia, United Kingdom	Finland, Sweden	Latvia, Slovakia, Lithuania
5	Italy, Portugal	Portugal, Slovenia	Portugal, Slovenia
6	Denmark, Finland	Latvia, Slovakia, Lithuania, Poland	Finland, Sweden
7	Latvia, Slovakia, Lithuania, Poland	Greece, Spain	Greece, Spain
8	Greece, Spain	Denmark, Austria	Denmark, Netherlands
9	Estonia, Slovenia, United Kingdom	Czechia, Hungary, Portugal, Slovenia	Estonia, United Kingdom
10	Germany, Austria	France, United Kingdom	Belgium, Austria

Source: Own study.

The research shows that Polish sector changed the country to which it was the most similar last year – in years 2017-2018 it was Lithuania and in 2019 the Czech Republic. Taking into consideration the fact that the Czech Republic takes a higher position in the ranking (according to the synthetic feature), it is a beneficial situation.

4. Discussion

The development of companies is one of the key challenges of the sustainable growth because there is a strict dependence between the innovation policy of countries and implementation of new solutions in the company (Kamińska, 2017; Jędrzejczak-Gas, Barska, and Wyrwa, 2021). Thus, it is very important to improve the innovation activities in the context of sustainable growth of particular UE regions (Hermundsdottir, and Aspelund, 2021). The innovation activities depend on numerous issues, so they are connected with the environment, legal factors, economy or innovation policy of economies (Yachmeneva, and Vol's'ka 2014; Maradana et al., 2019). Therefore, it seems necessary to implement modern solutions as they contribute to creating a goodwill. Its development contributes to monitoring external factors of the company innovation activities e.g. by appropriate management of human resources.

Due to the fact that innovations are created by people, it is possible to state that the level of education affects the assessment and the flow of information about new solution (Bogdanienko, 2004; Grabowski, and Staszewska-Bystrova, 2020), and qualifications, knowledge, application of the appropriate management methods are the basic source of the competitive advantage or facilitate creating and implementation of achievements in the modern organisation (Pomykalski, 2001; Mardani et al., 2018). The company success depends not only on the cooperation of various departments in the organisation (Di Vaio et al., 2021) but on the quality of knowledge possessed and used by workers and employers in a greater and greater extent. Thus, trainings organised by organisations contribute to the increase in competences, abilities and motivation of workers (Janowska, 2002; Schweisfurth, and Raasch, 2018; Sharma et al., 2021) and it, from the company's point of view, affects the organisation activity to increase the competitiveness or organisation development in the dynamically changing surrounding (Butkiewicz-Schodowska, 2015; Mamuli, 2002; Müller, 2021). So, it is possible to state that the more educated workers, the higher is his relative tendency to adapt and implement new technological solutions more easily (Mardania et al., 2018). However, the high level of management staff's education is a very important issue because the people with higher education most frequently implemented the innovation activities in the companies managed by them (Mazgajska, 2002). It should be stressed that the development of information technologies and the implementation of new solutions in knowledge based organisations contribute to the production growth, improvement of the product quality, sale growth or reduction of production costs and thanks to it have influence on the way how consumers perceive the company and the products offered by it. Human factor not only affects the company but also the economic growth of the given country (Chlebisz, Gruszowski, and Igielski, 2019; Mamuli, 2002), as the company is a being that operates and exists in a given surrounding. Thus, it is possible to risk a statement that the level of society's education (Baro, 1991; Cohen, and Soto, 2001) and the quality of

education (Hanushek, and Komko, 2000) affect the development of the organisation and the micro, meso and macro level (Efendi, 2020).

However, due to the changes occurring in the company, not only human resources should be included but also economic conditions as the ones which may be included to the very important factors affecting the organisation surrounding. Undoubtedly, the amount of funds allocated by government or unit institutions insignificant among the determinant of the innovation activities in companies. It is mainly connected with the fact that the economy which characterises with low economic growth does not foster the growth in the scope of innovations (Guloglu, and Tekin, 2012). In the case of low economic prosperity, it is difficult to invest in new solutions and due to this fact, the possibilities to finance innovation activities are limited. Thus, the fact that companies possess sufficient funds may interest them in innovation activities, creating the research and development background and starting cooperation with other companies, universities or research institutes (Romanowska, 2016).

Although GDP is the most frequently used synthetic indicator of economic growth and development, its value does not show the level of development. Thus, it is necessary to include the population of the given country, i.e. include GDP per capita. In general, this indicator is used to assess the societies' wealth and possibilities to perform social and economic policies and finally to analyse the innovation activities in companies in international comparisons (Jasiński, 2003; Al-Qudah, Al-Okaily, and Alqudah, 2022). Apart from the GDP, the inflation and unemployment rates are frequently used (Lydeka, and Karaliute, 2021). The first one affects indirectly the height of the interest rate for investment credits as it affects the value of interest rates. The other one shows the economic state and may cause problems in the labour market (Dosi et al., 2018; Berzinskiene, and Juozaitiene, 2011). Moreover, the dynamics of industrial production is important as it specifies the rate of aggregate growth and physical level of economic production. High dynamics of production shows that the economy is in a good condition and the low one informs about unfavourable economic situation.

The factors representing the scientific and research potential (Audretscha, and Belitski, 2020) and technical equipment (Bogdanienko, 2004) cannot be omitted in the assessment of the innovation activities in companies. Any investment in research and development has influence on the increase in the work productivity e.g. by facilitating the knowledge exchange between the organisations (Audretscha, and Belitski, 2020). In practice, the structure of R&D expenditures is mainly assessed by the level of R&D expenditures and the number of scientific and research workers and the patents given by USPTO and EPO are the effect of R&D activity Baruk, 2018). Moreover, the level of R&D expenditures strongly conditions the innovation activities in companies and is determined by the general level of the given country wealth (Dyjach, 2011). It is confirmed in the research referring to the influence of the public support of R&D on the effects of innovation activities in companies (Grabowski, and Staszewska-Bystrova, 2020; Czarnitzki, and Hussinger, 2018; Szczygielski et al., 2017; Doh, and Kim, 2014).

The level of R&D expenditures or cooperation between companies, companies and universities is really significant when it comes to the perception of innovation abilities in companies. Thus, the growth of this ability or strengthening the company orientation on sustainable development comes from the volume of expenditures to finance R&D activities (Sudolska, and Łapińska, 2020), the worker's approach to create or implement the innovation activities in companies or the stability of social and economic situation.

However, the lack of financing or unfinanced support of commercialising the innovative products concerning their market testing (Portugal) or permanent economic or financial crises (Greece) do not contribute to the implementation of innovation activities (Koperek, and Koperek, 2018; Sporek, 2013). In general, the relatively low innovation activities in Polish companies are caused by the lack of funds on research and development or the lack of appropriate competences of management staff and at the same time high costs to prepare and implement innovation activities (Sopińska, and Wachowiak, 2016; Różański, 2020). It has a negative influence on taking innovation activities by companies and the low level of management infrastructure modernisation causes that Poland is still not regarded as innovative economy.

However, the fact should be considered that the external factors are not the only ones that affect the innovation activities in companies. Still they are crucial as human resources, level of expenditures on research and development activities and economic growth of the country are having bigger and bigger meaning in the innovation policy (Protasiewicz, 2020; AlQershi, Mokhtar, and Abas, 2021). These elements have influence on the factors of innovation activities in companies in which the use of information and communication technologies plays a big role (Miśkiewicz, 2021; Cvetanovic, Nedic, and Eric, 2014). Thus, there is a strict connection between the innovation activities of the economy and companies (Stefaniuk, 2019). Therefore, the innovation policy cannot be omitted while assessing the innovation activities because it is a significant factor stimulating the ability to implement innovation activities in a company (Kasperkiewicz, 2004). It causes that various strategies are introduced at the national and union level, which is to contribute to pro-innovation policy with the consideration of each country peculiarity (Głodek, 2011; Fedirko O., and Fedirko N., 2021). It is important as the activities of governmental entities do not focus on raising the expenditures on R&D per se but on the increase in the investment level (Hasana, and Tucci, 2010). It seems that it is the aim of the majority of economies, in particular due to the fact that the intensification of investments has influence on the development of innovation activities of companies, regions and in a consequence economies.

The comparison of Poland with other EU member states may contribute to the achievement of the sustainable growth objectives, e.g. by the introduction of new solutions in companies. The use of quantitative methods facilitating the decision making process may be one of the proposal to set up the directions of the innovation activities development. The strategy of the European Union for research on innovation activities may regulate the activities of international

and national institutions, especially in the matters of expenditures on research and development. According to the author, the analysis of determinants (workers' education, activities of subjects focused on creating innovations and economic factors) having influence on the innovation activities is very important nowadays when the progress is tested in this scope. It has a key meaning as the issues of financing and implementing the innovation activities are significant in the EU strategy. The presented comparisons may be used to assess the subjects introducing new solutions in the field of innovation activities in companies at local, national and international level.

5. Summary

In the period of the increasing competitiveness in the competitive European markets, conducting the thorough analyses of external factors of the innovation activities in companies guarantees the proper innovation policy is created. Thus, it seems to be necessary to use the quantitative methods to assess the situation in this sector, especially that the management of the innovation activities is connected with the decision making process and the decisions are usually taken in the conditions of uncertainty.

The higher the economic growth and development of the given country, measured in GDP per capita, is, the bigger are the expenditures on research and development, in general. However, their percentage in GDP is not high (it is on average 1.19% for Poland) and a big differentiation of expenditure volume contributes to the lack of financial stability. This situation is not favourable to run a business activity and it is particularly important to perform various investment (development) undertakings which enable the use of modern solutions. Moreover, the growing number of people with higher education also has influence on the innovation activities in companies by e.g. bigger percentage of more educated workers in creating and implementing innovation activities or registering bigger number of patents. However, analysing the stimulation of the innovation activities in companies, it is possible to state that financial situation plays the most important role here. The research showed that it is particularly visible in the case of Luxembourg and Finland or the countries of Central Europe. Furthermore, economic or political crises are important. On the example of Greece, it is difficult to pay attention on implementation of innovation activities in such periods. Thus, the financial support from the state is significant in this case.

The results obtained in the research are consistent with the ones published in European Innovation Scoreboard. In 2020 the Scandinavian countries, the Netherlands and Luxembourg were the leaders in innovations. Although the leaders did not change in EIS ranking in 2021, Poland was included in the group of emerging innovators (it is before Latvia and after Slovakia – years 2020 – 2021). In the previous ranking it closed the group "moderate innovators and

took the third place from the end behind Latvia. It means that the factor increased for our country, which is good information.

The presented analysis referring to the innovation activities in companies in the EU member states showed that Poland does not take a high position concerning every external factor of innovativeness. It results in a low position in the presented ranking among the analysed European Union states which confirms the common view that innovation activities are at a low level in companies in our country. It is not a favourable situation, especially when it comes to the country development.

The situation is different when it comes to the country with the highest value of the synthetic feature. This position proves that social, economic and technical factors had the biggest influence on the innovation activities and the funds were used in the best way. However, it should be stressed that the research results did not make it possible to state that the analysed expenditures were used in an optimal and effective way in Luxembourg.

On the basis of the presented test results it is possible to state that we should follow, at first, Austria and Denmark in our activities. In this case we should mainly pay attention to the dynamics of the industrial production and the value of R&D expenditures measured as the percentage of GDP.

Moreover, it is possible to say that the number of graduates of scientific and technical universities and permanent workers' training have a big influence on the innovation activities. Whereas we have a big number of people finishing technical universities, our workers are not always interested in trainings. The workers' financial situation does not contribute to it, as they usually have to cover the costs of training. Although the number of people with higher and secondary education increased in Poland, we are far behind Luxembourg (the difference amounts to about 0.33 percentage point for the disadvantage of Poland). In 2017 two countries were between Poland and in 2019 there were thirteen. Should such a tendency remain, the situation would not be optimistic. However, the situation is different when it comes to Austria. The difference in the percentage share in the population of people at the age 25-64 participating in lifelong learning amounted to approximately 0.04 percentage point (for the benefit of Austria).

On the basis of the information coming from the dendrogram, it is possible to state that when all countries are analysed together, the differentiation between countries is smaller and the distance between them is getting smaller. It is indicated by the fact that all countries create a final cluster at the lower and lower level with years (the last bond was at the level of about 18.89 in 2017 and two years later it was at the level of about 18.57). The level of the last bond was also lower in the two last years, the difference amounted to 1.52. Moreover, the conclusion may be taken that the clusters created and shown in dendrograms group countries with the similar level of expenditures on R&D or the number of people raising their qualifications and knowledge. Thus, the statement can be made that the innovation activities in companies require to verify the innovation policy according to the rules of sustainable development. It will be

a long lasting process and its results will surely depend on the level of economic growth. Especially that the company functioning depends on the state of economy and the policy of the government**.**

Summing up, the general conclusion which arises from the analysis of the presented indicators is that the situation is not satisfactory (low share of expenditures on R&D in the percentage of GDP, low number of patents). Moreover, the research showed a big differentiation between "new" and "old" EU member states. The countries of Central and Eastern Europe did not manage to catch up with the other European countries. Only Slovakia is the exception here. It may be a pattern for the countries belonging the EU since 2004. Thus, the verification of the innovation policy as well as the intensification of activities aimed to achieve the sustainable development seems to be necessary.

Nevertheless, the author wants to indicate that the presented analyses may be the starting material to further research on the innovation activities in companies, especially in the surrounding changing dynamically. The present research was limited due to the availability of data as the information was taken from one, possibly two sources. According to the author it is necessary to carry out more detailed analyses and including more variables in them so that it was possible to assess the real progress in equalising the differences in the innovation policy. The further research should also cover the assessment whether the objectives of the innovation activities are met when it comes to knowledge management, sustainable growth, cooperation of companies with the academic institutions, technological progress and sizes of companies operating in the market.

References

1. Agarwal, N. (2018). A study of innovations in instructional strategies and designs for quality enrichment in higher education. *Cosmos An International Journal of Art & Higher Education A Refereed Research Journal*, *Vol. 7*, *Iss. 2*, pp. 1-23. doi:10.5281/ zenodo.3942661.
2. Alam, A., Arshad, M.U, and Rajput, W.U. (2013). Relationship of Labor Productivity, Foreign Firect Investment and Economic Growth: Evidence from OECD Countries. *Journal of Business and Management Sciences*, *Vol. 1*, *Iss. 6*, pp. 133-138. doi:10.12691/ jbms-1-6-3.
3. AlQershi, N., Mokhtar, S.S.M., Abas, Z. (2021). The relationship between strategic innovations, human capital and performance: An empirical investigation. *Sustainable Futures*, *Vol. 3*, *100056*. doi.org/10.1016/j.sftr.2021.100056.
4. Al-Qudah, A.A., Al-Okaily, M., Alqudah, H. (2022). The relationship between social entrepreneurship and sustainable development from economic growth perspective:

15 'RCEP' countries. *Journal of Sustainable Finance & Investment*, *Vol. 12*, *Iss. 1*, pp. 44-61. doi.org.10.1080/20430795.2021.1880219.

5. Audretsch, D.B., Belitski, M. (2020). The role of R&D and knowledge spillovers in innovation and productivity. *European Economic Review*, *Vol. 123*, 103391. doi.org/10.1016/j.eurocorev.2020.103391.
6. Barro, R.J. (1991). Economic Growth In a Cross – Section of Countries. *Quarterly Journal of Economics*, *Vol. 106*, *Iss. 2*, pp. 407-443. doi.org/10.2307/2937943.
7. Bartosiewicz, A. (2012). Programowanie i planowanie rozwoju Unii Europejskiej. In: J. Stacewicz (Ed.), *Pomiędzy polityką stabilizacyjną i polityką rozwoju* (pp. 195-230). Warszawa: SGH – Oficyna Wydawnicza.
8. Baruk, J. (2008). Wybrane aspekty innowacyjności przedsiębiorstw funkcjonujących w UE. *Kwartalnik Nauk O Przedsiębiorstwie, Vol 46*, *Iss. 1*, pp. 87-98.
9. Baruk, J. (2018). Innowacyjność przedsiębiorstw funkcjonujących w państwach członkowskich Unii Europejskiej. *Scientific Papers of the Silesian University of Technology – Organization and Management*, *Iss. No. 118*, pp. 43-53. doi.org/10.29119/1641-3466.2018.118.
10. Berzinskiene, D., and Juozaitiene, L. (2011). Impact of Labour Market Measures on Unemployment**.** *Engineering Economics*, *Vol. 22, Iss. 2*, pp. 186-195. doi.org/10.5755/j01.ee.22.2.315.
11. Bogdanienko, J. (2004). *Innowacyjność przedsiębiorstw.* Toruń: Wydawnictwo UMK.
12. Brodowska-Szewczuk, J. (2019). Determinants of the development of enterprises' innovativeness in the aspect of competitiveness of the economy. *Entrepreneurship and Sustainability*, *Vol. 7*, *Iss. 2*, pp.1279-1295. doi.org/10.9770/jesi.2019.7.2(33).
13. Butkiewicz-Schodowska, A. (2015). Kapitał ludzki we współczesnym zarządzaniu przedsiębiorstwami. *Współczesne Problemy Ekonomiczne, nr 11, Zeszyty Naukowe USz, nr 858*, pp. 115-123. doi:10.18276/wpe.2015.11-11.
14. Chlebisz, A., Gruszowski, P., Igielski, K. (2019). Edukacja i szkolnictwo a rozwój gospodarczy w Polsce na tle wybranych krajów europejskich w latach 2005-2017. *Rynek – Społeczeństwo – Kultura*, *Iss. 1(32)*, pp. 54-58. Retrieved from https://bazekon.uek.krakow.pl/zawartosc/171599131, 26.05.2022.
15. Cohen, D., Soto, M. (2001). *Growth and Human Capital: Good Data, Good Results*, (*Technical papers, No. 179*). France: OECD Development Center.
16. Cohen, D., Soto, M. (2007). Growth and human capital: good data, good results, *Journal of Economic Growth*, *Vol. 12, Iss. 1,* pp. 51-76. doi.org/10.1007/s10887-007-9011-5.
17. Cvetanovic, S, Nedic, V., Eric, M. (2014). Information technology as a determinant of SMES collaboration and innovativeness. *International Journal for Quality Research*, *Vol. 8*, *Iss. 4*, pp. 465-480. ISSN 1800-6450.

18. Czarnitzki, D., Hussinger, K. (2018). Input and output additionality of R&D subsidies. *Applied Economics*, *Vol. 50*, *Iss. 12*, pp. 1324-1341. doi.org/10.1080/00036846.2017.1361010.
19. Decyk, K., Juchniewicz, M. (2013). Działania i instrumenty polityki innowacyjnej w opinii mikroprzedsiębiorców. *Zarządzanie Publiczne*, *Iss. 2(22)*, pp. 237-251. doi:10.4467/20843968ZP.13.020.1194.
20. Defazio, D., Lockett, A., Wright, M. (2009). Funding incentives, collaborative dynamics and scientific productivity: Evidence from the EU framework program. *Research Policy*, *Vol. 38*, *Iss. 2*, pp. 293-305. doi.org/10.1016/j.respol.2008.11.008.
21. Di Vaio, A., Palladino, R., Pezzi, A., Kalisz, D.E. (2021). The role of digital innovation in knowledge management systems: A systematic literature review. *Journal of Business Research*, *Vol. 123*, pp. 220-231. doi.org/10.1016/j.jbusres.2020.09.042.
22. Dodgson, M., Rothwell, R. (Eds.) (1994). The Handbook of Industrial Innovation. Aldershot: Edward Elgar Publishing.
23. Doh, S., Kim, B. (2014). Government support for SME innovations in the regional industries: The case of government financial support program in South Korea. *Research Policy*, *Vol. 43*, *Iss. 9*, pp. 1557-1569. doi.org/10.1016/j.respol.2014.05.001.
24. Dosi, G., Pereira, M.C., Roventini, A., Virgillito, M.E. (2018). The effects of labour market reforms upon unemployment and income inequalities: an agent-based model, *Socio-Economic Review*, *Vol. 16*, *Iss. 4*, pp. 687-720. doi.org/10.1093/ser/mwx054.
25. Dyjach K. (2011). Innowacyjność przedsiębiorstw jako czynnik konkurencyjności regionu. *Nierówności Społeczne a Wzrost Gospodarczy, Iss. 20*, pp. 219-231. Rzeszów: Wydawnictwo Uniwersytetu Rzeszowskiego.
26. Efendi, S. (2020). The Role of Human Capital in the Education Sector in Efforts to Create Reliable Organizational Human Resources. *International Journal of Science and Society*, *Vol. 2*, *Iss. 1*, pp. 405-413. doi.org/10.54783/ijsoc.v2i1.342.
27. Eszergár-Kiss, D., Caesar, B. (2017). Definition of user groups applying Ward's method. *Transportation Research Procedia*, *Vol. 22*, pp. 25-34. doi:10.1016/j.trpro.2017.03.004.
28. European Commission (1999). *The Fifth Framework Programme*. Retrieved from http://aei.pitt.edu/93861/1/Fifth-framework-programme-1998-2002.en.pdf, 06.05.2022.
29. European Commission (2002). *The Sixth Framework Programme in brief*. Retrieved from https://www.ices.dk/about-ICES/projects/EU-RFP/EU%20Repository/fp6-in-brief_en.pdf, 06.05.2022.
30. European Communities (2007). *FP7 in brief*. Retrieved from https://www.ehu.eus/documents/2458339/2849729/fp7-inbrief_en.pdf/84bd26a8-ab12-469a-8ed9-475917b36cd1?t=1411241328000, 06.05.2022.
31. European Parliament (2010). *The Lisbon Strategy 2000-2010 An analysis and evaluation of the methods used and results achieved*, Brussels. Retrieved from

https://www.europarl.europa.eu/document/activities/cont/201107/20110718ATT24270/20110718ATT24270EN.pdf, 06.05.2022.

32. *Eurostat*. Available online www.ec.europa.eu/eurostat, 28.04.2022.
33. Fagerberg, J., Mowery, D.C., Nelson, R.R. (Eds.) (2006). *The Oxford Handbook of Innovation*. New York: Oxford University Press.
34. Fedirko, O., Fedirko, N. (2021). Evolution of EU innovation policy. *The International Economic Policy*, *No. 2(35)*. pp. 76-99. doi:10.33111/iep.eng.2021.35.04.
35. Głodek, P. (2011). Polityka innowacyjna Unii Europejskiej – cele i instrumenty. In: P. Niedzielski, R. Stanisławski, E. Stawasz (Eds.), *Polityka innowacyjna państwa wobec sektora małych i średnich przedsiębiorstw w Polsce – analiza uwarunkowań i ocena realizacji* (pp. 59-73). *Ekonomiczne problemy usług, Iss. 70*. Szczecin: Wydawnictwo Naukowe Uniwersytetu Szczecińskiego.
36. Grabowski, W., Staszewska-Bystrova, A. (2020). The Role of Public Support for Innovativeness in SMEs Across European Countries and Sectors of Economic Activity. *Sustainability*, *Vol. 12(10)*, *4143*. doi.org/10.3390/su12104143.
37. Grossman, G., Helpman, E. (1991). *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.
38. Grossman, M., Helpman, E. (1990). Trade, Innovation, and Growth. *American Economic Review*, *Vol. 80*, *Iss. 2*, pp. 86-91.
39. Gryczka, M. (2016). Innowacyjność krajów członkowskich Unii Europejskiej w kontekście znaczenia czynnika społecznego. *Finanse, Rynki Finansowe, Ubezpieczenia*, *Iss. 3(81)*, pp. 91-103. doi:10.18276/frfu.2016.81-09.
40. Guckenbiehl, P., Corral de Zubielqui, G., Lindsay, N. (2021). Knowledge and innovation in start-up ventures: A systematic literature review and research agenda. *Technological Forecasting & Social Change*, *Vol. 172*, *121026*. doi.org/10.1016/j.techfore.2021.121026.
41. Guloglu, B., Tekin, R.B. (2012). A panel causality analysis of the relationship among research and development, innovation, and economic growth in high-income OECD countries. *Eurasian Economic Review*, *Vol. 2*, *Iss. 1*, pp. 32-47. doi:10.14208/BF03353831.
42. Haberla, M., Kuźmińska-Haberla, A. (2013). Wiedza jako kluczowy czynnik rozwoju innowacyjności przedsiębiorstw. *Nauki o Zarządzaniu*, *Iss. 2(15)*, pp. 62-72.
43. Hanushek, E.A., Komko, D.D. (2000). Schooling, Labour – Force Quality, and Growth of Nations. *American Economic Review*, *Vol. 90*, *Iss. 5*, pp. 1184-1208. doi:10.1257/aer.90.5.1184.
44. Hasana, I., Tucci, Ch.L. (2010). The innovation–economic growth nexus: Global evidence. *Research Policy*, *Vol. 39*, *Iss. 10*, pp. 1264-1276. doi.org/10.1016/j.respol.2010.07.005.
45. Hee-Jae, Ch., Pucik, V. (2005). Relationship between Innovativeness, Quality, Growth, Profitability, and Market Value. *Strategic Management Journal*, *Vol. 26*, *Iss. 6*, pp. 555-575. doi.org/10.1002/smj.461.

46. Hermundsdottir, F., Aspelund, A. (2021). Sustainability innovations and firm competitiveness: A review. *Journal of Cleaner Production*, *Vol. 280*, *Part 1*, 124715. doi.org/10.1016/j.jclepro.2020.124715.
47. Hilami, M.F., Ramayah, T., Mustapha, Y., Pawanchik, S. (2010). Product and Process Innovativeness: Evidence from Malaysian SMEs. *European Journal of Social Science*, *Vol. 16*, *Iss. 4*, pp. 556-564.
48. *Horyzont Europa – nowy program ramowy badań i innowacji UE*. Available online https://www.kpk.gov.pl/horyzont-europa-nowy-program-ramowy-badan-i-innowacji, 06.05.2022.
49. Janasz, W., Kozioł, K. (2007). *Determinanty działalności innowacyjnej przedsiębiorstw*. Warszawa: PWE.
50. Janowska, Z. (2002). *Zarządzanie zasobami ludzkimi.* Warszawa: PWE.
51. Jasiński, A.H. (2003). Czy innowacje mają wpływ na działalność gospodarki? Polskie doświadczenie w okresie transformacji. In: H. Brdulak, and T. Gołębiowski (Eds.), *Wspólna Europa. Innowacyjność w działalności przedsiębiorstw* (pp. 38-57). Warszawa: Difin.
52. Jędrzejczak-Gas, J., Barska, A., Wyrwa, J. (2021). Economic Development of the European Union in the Relation of Sustainable Development — Taxonomic Analysis. *Energies*, *Vol. 14*, 7488. doi.org/10.3390/ en14227488.
53. Kamińska, A. (2017). Kształtowanie potencjału innowacyjnego przedsiębiorstw w kontekście ich rozwoju. *Management Forum*, *Vol. 5*, *Iss. 2*, pp. 26-32. doi:0.15611/mf.2017.2.05.
54. Kasperkiewicz, W. (2004), Aktywność innowacyjna małych i średnich przedsiębiorstw w Polsce – uwarunkowania, instrumenty i tendencje. *Gospodarka w Praktyce i Teorii*, *Iss. 2*, pp. 5-16.
55. Kolenda, M. (2006). *Taksonomia numeryczna. Klasyfikacja, porządkowanie i analiza obiektów wielocechowych*. Wrocław: Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu.
56. Koperek, A., Koperek, J. (2018). Polityka społeczna Grecji w kontekście kryzysu gospodarczego państwa. *Seminare. Poszukiwania Naukowe*, *Vol. 39*, *Iss. 3*, pp. 117-128.
57. Kozioł, L., Kozioł, W., Wojtowicz, A., Pyrek, R. (2015). Diagnosis of innovation enterprises – study theoretical and empirical results, *Procedia – Social and Behavioral Sciences*, *Vol. 175,* pp. 137-145. doi:10.1016/j.sbspro.2015.01.1184.
58. Lin, Y-Ch., Chen, Ch-L., Chao, Ch-F., Chen, W-H., Pandia, H. (2020). The Study of Evaluation Index of Growth Evaluation of Science and Technological Innovation Micro-Enterprises. *Sustainability*, *Vol. 12*, *6233*. doi.org/10.3390/su12156233.
59. Lydeka, Z., Karaliute, A. (2021). Assessment of the Effect of Technological Innovations on Unemployment in the European Union Countries. *Engineering Economics*, *Vol. 32*, *Iss. 2*, pp. 130-139. doi.org/10.5755/j01.ee.32.2.24400.

60. Mamuli, C.L. (2020). Human Capital Development and Higher Education. *European Business & Management*, *Vol. 6*, *Iss. 4*, pp. 61-66. doi:10.11648/j.ebm.20200604.11.
61. Maradana, R.P., Pradhan, R.P., Dash, S., Zaki, D.B., Gaurav, K., Jayakumar, M., Sarangi, A.K. (2019). Innovation and economic growth in European Economic Area countries: The Granger causality approach. *IIMB Management Review*, *Vol. 31*, *Iss. 3*, pp. 268-282. doi.org/10.1016/j.iimb.2019.03.002.
62. Mardani, A., Nikoosokhan, S., Moradi, M., Doustar, M. (2018). The Relationship Between Knowledge Management and Innovation Performance. *Journal of High Technology Management Research*, *Vol. 29*, *Iss. 1*, pp. 12-26. doi:10.11648/j.hitech.2018.04.002.
63. Mazgajska, H. (2002). *Aktywność innowacyjna polskich małych i średnich przedsiębiorstw w procesie integracji z Unią Europejską*. Poznań: Wydawnictwo AE w Poznaniu.
64. Miśkiewicz, R. (2021). The Impact of Innovation and Information Technology on Greenhouse Gas Emissions: A Case of the Visegrád Countries, *Journal of Risk and Financial Management*, *Vol. 14*, *Iss. 1*, 59. doi.org/10.3390/jrfm14020059.
65. Müller, J.W. (2021). Education and inspirational intuition - Drivers of innovation. *Heliyon*, *Vol. 7*, *Iss. 9*, e07923. doi.org/10.1016/j.heliyon.2021.e07923.
66. OECD (2017). *Agenda na rzecz zrównoważonego rozwoju 2030: w kierunku pomyślnego wdrożenia w Polsce*. Retrieved from https://www.oecd.org/poland/Better-Policy-Series-Poland-Nov-2017-PL.pdf, 10.05.2022.
67. *OECD*. Available online www.oecd.org, 05.05.2022.
68. Osieczko, K., Stec, S. (2019). Poziom innowacyjności gospodarki Polski na tle krajów Unii Europejskiej. *Zarządzanie Innowacyjne w Gospodarce i Biznesie*, *Iss. 2(29)*, pp. 79-91. doi.org/10.25312/2391-5129.29/2019.
69. Pomykalski, A. (2001). *Zarządzanie innowacjami*. Warszawa-Łódź: PWN.
70. Protasiewicz, A. (2020). Innovativeness of enterprises in Poland and their capacity to absorb innovation. *Optimum. Economic Studies*, *Iss. 2(100)*, pp. 81-92. doi:10.15290/ oes.2020.02.100.06.
71. Romanowska, M. (2016). Determinanty innowacyjności polskich przedsiębiorstw. *Przegląd Organizacji*, *Iss. 2(913)*, pp. 29-35. doi:10.33141/po.2016.02.05.
72. Różański, J. (2020). Innowacyjność polskich przedsiębiorstw na tle europejskich systemów innowacyjności. *Przegląd Organizacji*, *Iss. 9(968)*, pp. 19-26. doi:10.33141/po.2020.09.03.
73. Schweisfurth, T.G., Raasch, Ch. (2018). Absorptive capacity for need knowledge: Antecedents and effects for employee innovativeness. *Research Policy*, *Vol. 47*, *Iss. 4*, pp. 687-699. doi.org/10.1016/j.respol.2018.01.017.
74. Sharma, K., Mangaroska, K., van Berkel, N., Giannakos, M., Kostakos, V. (2021). Information flow and cognition affect each other: Evidence from digital learning. *International Journal of Human-Computer Studies*, *Vol. 146*, 102549. doi.org/10.1016/j.ijhcs.2020.102549.

75. Simao, L., Franco, M. (2018). External knowledge sources as antecedents of organizational innovation in firm workplaces: a knowledge-based perspective. *Journal of Knowledge Management*, *Vol. 22*, *Iss. 2*, pp. 237-256. doi.org/10.1108/JKM-01-2017-0002.
76. Skrzypek, A. (2009). Innowacyjność i wiedza w procesie poprawy konkurencyjności przedsiębiorstw. *Organizacja i Zarządzanie: Kwartalnik Naukowy*, *Iss. 1(5)*, pp. 137-148.
77. Sokołowski, J. (2018). Kapitał intelektualny a innowacyjność przedsiębiorstwa. *Zarządzanie Innowacyjne w Gospodarce i Biznesie*, *Iss. 2(27)*, pp. 21-32. doi.org/10.25312/2391-5129.27/2018.
78. Sopińska, A., Wachowiak, P. (2016). Innowacyjność przedsiębiorstw działających w Polsce, *Przegląd Organizacji*, *Iss. 5(916)*, pp. 17-23. doi:10.33141/po.2016.05.02.
79. Sporek, T. (2013). Globalne konsekwencje kryzysu finansowego w Grecji. *Studia Ekonomiczne/UE w Katowicach*, *Iss. 172*, pp. 23-40.
80. Stefaniuk, K. (2019). Innowacyjność i jej znaczenie dla korporacji. *ZN WSH Zarządzanie*, *Iss. 1*, pp. 33-42. doi:10.5604/01.3001.0013.2418.
81. Sudolska, A., Łapińska, J. (2020.) Exploring Determinants of Innovation Capability in Manufacturing Companies Operating in Poland. *Sustainability*, *Vol. 12(17)*, 7101. doi.org/10.3390/su12177101.
82. Szczygielski, K., Grabowski, W., Pamukcu, M.T., Tandogan, V.S. (2017). Does government support for private innovation matter? Firm-level evidence from two catching-up countries. *Research Policy*, *Vol. 46*, *Iss. 1*, pp. 219-237. doi.org/10.1016/j.respol.2016.10.009.
83. Thompson, M. (2018). Social capital, innovation and economic growth. *Journal of Behavioral and Experimental Economics*, *Vol. 73*, pp. 46-52. doi.org/10.1016/j.socec.2018.01.005.
84. Weresa, M.A. (2003). Zdolność innowacyjna polskiej gospodarki: pozycja w świecie i regionie. In: H. Brdulak, and T. Gołębiowski (Eds.), *Wspólna Europa, innowacyjność w działalności przedsiębiorstw* (pp. 96-114). Warszawa: Difin.
85. Wiśniewska, J. (2005). Teoretyczne aspekty rozprzestrzeniania się innowacji. In: W. Janasz (Ed.), *Innowacje w działalności przedsiębiorstw w integracji z Unią Europejską* (pp. 64-84). Warszawa: Difin.
86. Wołodkiewicz-Donimirski, Z. (2011). Innowacyjność polskiej gospodarki na tle międzynarodowym. In: A. Zygierewicz (Ed.), Innowacyjność polskiej gospodarki (pp. 9-34). Warszawa: Wydawnictwo Sejmowe Kancelarii Sejmu – *Studia BAS, Iss. 1(25).*
87. Yachmeneva, V., Vol's'ka, G. (2014). Factors influencing the enterprise innovation. *Econtechmod. An International Quarterly Journal on Economics of Technology and Modelling Processes*, *Vol. 3*, *Iss. 1*, pp. 133-138.
88. Zeliaś, A. (2004). *Poziom życia w Polsce i krajach Unii Europejskiej*. Warszawa: PWE.