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The Impact of Venture Capital Funds on Innovative Activities: The Case of European Union Countries

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***Abstract**:*

***Purpose:** The purpose of the article is to assess the extent to which venture capital funds can affect the development of innovative activities in selected European Union countries. This is important from the point of view of the development of a country that strives for rapid economic development by raising the level of innovation.*
***Design/Methodology/Approach:** The study uses the DEA method belonging to the group of non-parametric decision-making methods (DMU), which was used to demonstrate the role of venture capital funds in the development of innovative enterprises. In this study, the DEA methodology was used to create a ranking of EU states (decision-makers) by determining the effectiveness of innovation activities. Efficiency in nonparametric methods is defined as the relation of actual productivity to the greatest possible productivity. Statistical data comes from The Invest Europe Yearbook and covers the years 2010-2015.*
***Findings:** Thanks to this method, the degree of effectiveness of individual European Union countries in using venture capital funds to develop innovative activity was measured. It has been confirmed that there is a noticeable difference between EU countries in the use of risk capital. The results confirm the assumption that venture capital funds operate most effectively in the most innovative economies of the EU.*
***Practical Implications:** The results of the study may have practical application and serve as an instrument of innovation policy, industrial policy to prevent or quickly detect imperfections in the use of vc in the development of innovation activities of individual countries.*
***Originality/Value:** The article indicates the methods and scope of acquiring knowledge on the use of venture capital funds in EU.*

***Keywords:** Innovativation, venture capital, innovative activity, efficiency, Data Envelopment Analysis.*

***JEL Classification:** C33, C39, O16, O31.*

***Paper Type:** Research article.*

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1. Introduction

The most important source of economic growth and social well-being are the innovative capabilities of entities operating in the national economy. Innovations affect the competitiveness of enterprises, they are responsible for upgrading production processes, increasing productivity and productivity, and improving that process. Running innovative business enables the creation of new solutions that build the technological potential of the state and stimulate enterprises to follow innovative behaviors. here are many factors that influence the development of innovative activities. One of them is capital. Most often, the demand is high, while the opportunities to get it are limited.

There are many ways to raise capital to develop innovative activities. Venture capital funds are one of them. Those are the institutions, which are designed to fill the financial gap created in the course of the project or task. Although the financial instruments belong to a relatively young because they flourished in the 80s, it was and is one of the sources of competitiveness and success, for example, US economy in the second half of the twentieth century. The governments of many European countries trying to create this kind of a market. Venture capital funds are a financial intermediary specializing in investments in companies with high growth potential and an equally high risk. The funds contribute to closing the equity gap in the financing of innovative companies.

The purpose of the study is to show the role that venture capital funds play in the development and functioning of business entities in EU companies. DEA (Data Envelopment Analysis), a non-parametric decision making unit (DMU), was used to examine the relationship. The study covered the years 2010 and 2015. In the opinion of the author, this is an important period in the functioning of VC on the financial market and in the economy due to the fact that the global economy emerged from the crisis in 2007-2009 and it is worth paying attention to VC. The results confirm the assumption that Venture Capital funds operate most effectively in the most innovative economies of the EU.

2. Literature Review

It is important to emphasize that today, especially in highly developed and developing countries, the issue of innovation plays a bigger role than ever before (Anokin *et al.,* 2016). The determinants of such phenomena and state of affairs may be sought in the diminishing role and importance of traditional competitive advantage in favor of progressive globalization, the progress of the ubiquitous computerization and the speed of information (Audretsch, 1998). Implementing improved technology, organization, and technology solutions in organization is justified, and even required, if it delivers positive results. The above-mentioned solutions should be searched primarily on the economic, technical, social and environmental level (Motyka, 2011; Thalassinos, 2008). However, innovative

approaches in businesses require that products, services, processes, organizational changes, and marketing communications be properly tailored to meet the needs of present and potential customers. Such actions allow to increase the impact of business and, as a result, achieve strategic and financial goals (Janasz, 2009). Thus, companies have to spend on innovation for various reasons, such as the desire to increase productivity, output or employment. In addition, some of the actors implement new solutions because they are the result of changing legislation (Szopik-Depczynska, 2014; Thalassinos and Thalassinos, 2018).

It should therefore not be surprising that the modern, richest economies of the world are at the same time the most innovative. It should be stressed that the very strong position in this group of countries are small and medium enterprises, which are somehow the catalyst of the business environment (Ayyagari *et al*., 2007). However, the conditions for the development of innovative small and medium enterprises are not the same everywhere. Many of them have the problem of capital gaps, seems the inability to raise capital for their own development. This problem is particularly acute in countries with less developed capital markets.

Among the factors affecting the level of innovativeness of individual economies are usually the amount and structure of R&D spending, the level of higher education and its cooperation with the business sector, as well as solutions adopted to protect intellectual property rights and cultural determinants. Significant, if not the greatest, is financing of innovative activities.

Among the available entrepreneurs, both in developed and developing countries, sources of financing innovative activities may be listed: own funds (most often used) (Carpenter, 2002), bank loans, funds received from the budget, funds raised from abroad, funds from venture capital funds, (Janasz, 2009; Moritz *et al*., 2016).

Venture capital funds have grown to varying degrees in Europe, in particular, depending on the economic level of the country, the system, the propensity of risk capital holders, and many other socio-economic factors (Sokołowska, 2016). It is defined as an independently managed, purposeful equity fund targeted at investing in private equity with high growth potential (Gompers *et al.*, 1999). According to Węcławski (1997), venture capital is an activity consisting of raising capital for a limited period by external investors to small and medium enterprises having an innovative product, method of production or service that has not yet been verified by the market. They pose a high risk of investment failure, but at the same time - in the case of a successful investor-management venture - ensure a significant increase in the value of the invested capital that is realized by the sale of the shares. The willingness of the capitalists to take this type of risk in return for multiplying the invested funds was a powerful driver of technical progress.

Venture capital funds are an important part of the process of creating innovation. Due to the possibility of providing additional non-financial support, these

institutions are particularly valuable partners for innovative enterprises at certain stages of their development. From the innovation point of view of the whole economy, a positive outlook for funds is the quick and effective search on the market for the most promising young companies. On the other hand, the cyclical nature of the investments made, the concentration on several selected industries, the lack of investment opportunities from other industries, should be included.

Moreover - which is not a charge against the funds themselves - they are not a source of capital to replace the state in research and development spending. Venture capital funds are more widespread in those countries where higher R&D is spending (Jakusonoka, 2016). There are more economically attractive innovations, whose minor refinement and commercialization are a chance for funds to make above-average profits (Groh *et al.*, 2016).

The availability of venture capital funds is also important, as a significant facilitation for the commercialization of risky but potentially very promising business ideas. Venture capital funds are financial intermediaries who invest capital directly from the investors in selected companies. In exchange for the funds provided, the funds receive shares in companies, and the possible increase in the value of these shares is the main source of funds (Czerniak, 2010). Successful investment cycles of venture capital funds usually end with capital withdrawals by introducing public companies' shares into the stock market (Metrick, 2007).

3. Innovative Activities, Effects

Countries belonging to European Union use available finances in various ways. In developed countries, where the capital market has a long history of existence and strong support from the government, bank lending is complementary to venture capital (Czerniak, 2010), which is different for country like Poland or other developing countries. In addition, countries classified in the group of innovating and technology-transferring economies (not belonging to the innovators) spend less than 1% of GDP on research and development. This is a different situation for highly developed countries (innovators), where expenditure of this type is over 2% of GDP and even more than 3% in countries like Sweden, Denmark, Germany (Ciborowski, 2016).

The effects of innovative activity that can be financed by venture capital funds have different uses and characteristics. They can be seen as a new product marketed by an enterprise, a new production method, or even an increase in the workplace of an enterprise applying a new marketing strategy. As already mentioned, it largely depends on the economic situation of the country. For the purposes of this study, the effects of innovative activities are:

- SMEs innovating in-house as % of SMEs;
- Innovative SMEs collaborating with others as % of SMEs;

- PCT patents applications per billion GDP (in PPS€);
- PCT patent applications in societal challenges per billion GDP (in PPS€);
- Community trademarks per billion GDP (in PPS€);
- Community designs per billion GDP (in PPS€);
- SMEs introducing product or process innovations as % of SMEs;
- SMEs introducing marketing or organisational innovations as % of SMEs;
- Sales of new to market and new to firm innovations as % of turnover;
- Employment in fast-growing enterprises (average innovativeness scores).

Table 1. *Expenditures on innovation activities in the European Union countries in 2010 and 2015*

			GDP (billion PPS)		PE investment as % of GDP		Business R&D expenditures as % of GDP		Public R&D expenditures as % of GDP		Venture capital investments as % of GDP	
			2010	2015	2010	2015	2010	2015	2010	2015	2010	2015
1	EU	EU	11517	14635	0,314	0,3	1,2	1,3	0,73	0,72	0,096	0,063
2	BE	Belgium	290	378	0,266	0,34	1,31	1,76	0,65	0,7	0,124	0,072
3	BG	Bulgaria	66	96	0,228	0,1	0,15	0,52	0,35	0,27	0,158	0,015
4	CZ	Czech Rep	190	259	0,133	0,01	0,73	1,12	0,56	0,87	0,163	0,013
5	DK	Denmark	155	202	0,165	0,65	2,14	1,95	0,91	1,08	0,102	0,059
6	DE	Germany	2221	2933	0,186	0,22	1,84	1,95	0,88	0,91	0,068	0,049
7	EE	Estonia	19	28	0,176	0,09	0,62	0,63	0,74	0,8	0,068	0,136
8	IE	Ireland	141	193	0,5	0,31	1,11	1,11	0,51	0,4	0,227	0,086
9	EL	Greece	233	220	0,001	0,14	0,23	0,28	0,43	0,54	0,013	0,001
10	ES	Spain	1018	1221	0,276	0,14	0,7	0,65	0,65	0,58	0,090	0,043
11	FR	France	1606	2020	0,335	0,38	1,36	1,46	0,77	0,76	0,099	0,083
12	HR	Croatia	58	70	0,027	0,02	0,34	0,38	0,5	0,41	0,014	0,054
13	IT	Italy	1438	1663	0,1	0,16	0,65	0,72	0,53	0,54	0,045	0,022
14	CY	Cyprus	17	19	0	0	0,09	0,08	0,3	0,32	0,084	0,071
15	LV	Latvia	26	37	0,029	0,15	0,16	0,25	0,29	0,45	0,051	0,098
16	LT	Lithuania	41	61	0,006	0,13	0,2	0,3	0,62	0,72	0,003	0,081
17	LU	Luxembou	26	44	0,222	1,25	1,3	0,66	0,42	0,59	0,402	0,047
18	HU	Hungary	146	192	0,068	0,15	0,65	0,98	0,47	0,38	0,032	0,055
19	MT	Malta	8	11	0	0	0,33	0,5	0,19	0,33	0,011	0,000
20	NL	Netherlan	509	625	0,333	0,5	0,79	1,11	0,89	0,87	0,107	0,096
21	AT	Austria	239	314	0,246	0,32	1,78	2,11	0,82	0,86	0,038	0,051
22	PL	Poland	441	757	0,192	0,21	0,19	0,44	0,48	0,5	0,027	0,029
23	PT	Portugal	194	237	0,1	0,09	0,75	0,59	0,7	0,66	0,061	0,069
24	RO	Romania	171	323	0,1	0,09	0,18	0,16	0,31	0,22	0,073	0,013
25	SI	Slovenia	40	49	0,019	0,03	1,79	1,85	0,64	0,54	0,011	0,007
26	SK	Slovakia	74	119	0,022	0,02	0,2	0,33	0,28	0,56	0,010	0,008
27	FI	Finland	141	170	0,325	0,5	2,68	2,15	1,05	1	0,191	0,107
28	SE	Sweden	259	347	0,775	0,38	2,45	2,12	1	1,04	0,171	0,081
29	UK	United Kir	1750	2051	0,75	0,48	1,05	1,09	0,65	0,57	0,170	0,103

Source*: Study based on European Private Equity Activity 2015.*

Scandinavian countries, United Kingdom, Germany use funds to finance projects at the initial stage of development, when conducting basic research, hypothesis

building, which is different from, for example, Poland, which uses VC to finance, for example, the distribution stage (Przybylska- Kapuścińska *et al.,* 2014).

4. Research Methodology

The DEA (Data Envelopment Analysis) (Kao *et al.,* 2011) methodology, which belongs to the group of non-parametric decision making (DMU) methods, was used to demonstrate the role of venture capital funds in developing innovative enterprises. Efficiency in nonparametric methods is defined as the relation of actual productivity to the greatest possible productivity (Helta, 2009). The main advantage of the DEA method is that, as a nonparametric method, it does not require knowledge of the functional dependency to evaluate the effect of multiple input variables on multiple output variables, thereby enabling multi-criterion evaluation, while eliminating procedural and interpretative problems arising from the use of parametric methods. The structure of the model is adapted to the data, which makes it more flexible compared to parametric methods (Ćwiąkała-Małys *et al.,* 2009).

Productivity, as previously mentioned (Nazarko *et al.,* 2008), is defined as the quotient of the weighted sum of effects to the weighted sum of inputs. As a result of the productivity measurement, it can determine the effectiveness of the use of inputs against other objects. As a result of efficiency estimates, the ranking of analyzed objects is obtained. Model units are used to determine effectiveness limits (Guzik, 2009). Master objects achieve 100% efficiency. In the method, the terms *best practice frontier*, that is, the efficiency limit, the efficiency limit or the production limit, which is the technological boundary of production possibilities achievable for a given operator (Kozuń-Cieślak, 2011). According to the boundary efficiency, all units should be able to operate at the assumed level of productivity, determined by the effective units operating in the sector. Units lower productivity levels from the border are ineffective. The extent to which their effectiveness is improved is determined by referring their results to the results of the effective units (Nazarko *et al.,* 2008).

Data Envelopment Analysis (DEA) enables to reduce the mentioned disadvantages of the traditional approaches. This is a group of methods which represents a special area of application of linear programming. DEA measures the efficiency of the various entities or organizational units. Investigation of efficiency is not only related to profitability of entity in a private sector. In general, one can examine the effectiveness of any entity that transforms an input to an output in some way.

In a study by Emrouznejad *et al.* (2017) authors state that DEA analysis is most often applied in the following sectors: agriculture, banking, supply chain management, transportation, and public policy. The popularity of the method has increased significantly in recent years. In the mentioned study the authors show that to 2016 there were 9881 scientific papers with DEA applications registered in Scopus and WoS databases. In the first phase, 1978-1994, only several dozen of

papers per year were published. In the second phase, 1995-2003 the average number of published papers was about 134 per year. Interesting is the last phase 2004-present, where there is an exponential increase of published articles. Even within the three year period of 2014, 2015 about 1,000 scientific applications of the method per year were published (Balcerzak *et al.*, 2017).

In this study, the DEA methodology was used to create a ranking of EU states (decision-makers) by determining the effectiveness of innovation activities. For the purposes of this article, the definition of the effectiveness of innovative activities, measured by the influence of venture capital funds (input) on the manifestations and consequences of innovative work, such as the number of patents, the number of trademarks, the number of companies using innovations, has been adopted.

It should be added that the analysis of the literature of innovative activity is relatively rarely discussed (Chaney *et al*, 1991; Bloch, 2005; Sawang *et al*., 2012; Karaganov, 2008). Authors addressing this problem are primarily trying to define the effectiveness of innovative activity (usually with respect to defining the effectiveness of other types of enterprise activity) and use classic performance measures, based mostly on measurable attributes of innovation (Bijańska, 2011). Such an approach may produce some results in the case of a single innovation project, but it seems insufficiently useful in trying to assess the overall performance of an innovative enterprise or, perhaps, the industry or even the economy as a whole.

5. The Effects of Venture Capital in the European Union

As mentioned earlier, in this article the considered objects (DMU) will be the countries belonging to the structures of the European Union. The first step of the analysis consisted in the substantive selection of the data. A group of variables was identified which for the purposes of this paper was adopted as a result of innovative activities.

Table 2. *Effects of innovation activities-selection of variables*

Starting variable	Specifying the effects of the innovative activity
y1	SMEs innovating in-house as % of SMEs
y2	Innovative SMEs collaborating with others as % of SMEs
y3	PCT patents applications per billion GDP (in PPS€)
y4	PCT patent applications in societal challenges per billion GDP (in PPS€)
y5	Community trademarks per billion GDP (in PPS€)
y6	Community designs per billion GDP (in PPS€)
y7	SMEs introducing product or process innovations as % of SMEs
y8	SMEs introducing marketing or organisational innovations as % of SMEs
y9	Sales of new to market and new to firm innovations as % of turnover
y10	Employment in fast-growing enterprises (average innovativeness scores)

Source: *Study based on European Private Equity Activity 2015.*

The purpose of this article was to present the role and significance of venture capital in the creation of the effects of innovative activity. Therefore, from the assumption of significant influence of Venture capital investments as% of GDP (impact) on the effectiveness of innovation activity, given names y1 to y10. For this purpose, the Persona linear correlation coefficient (r coefficient) was calculated to obtain the results set out in Table 3.

For the purposes of interpreting the data in Table 3, the correlation value of 0.2 was used as a measure of the existence of the relationship[2]. By analyzing the Pearson's linear correlation coefficient, most of the positive relationship between VCI and the variables analyzed can be seen. These are rope, clear dependencies. Only variable y9 in both periods shows a negative direction of dependence (if the venture capital is growing, then the sales of new firms are decreasing). It was higher in 2010 than in 2015, with no linear relationship ($r < 0.2$). The highest correlation coefficient was obtained for y10 (Employment in fast-growing enterprises (average innovativeness scores), because it was 0.708 in 2010, indicating a significant linear relationship with VCI.

However, in the following period, VCI's impact on Employment in fast-growing enterprises (average innovativeness scores) decreased by 60.4%. The strong correlation is observed with the variable y5, Community trademarks per billion GDP (PPS €), whose correlation coefficient in 2010 was 0.598. However, it is interesting to reduce this dependency in 2015 (a decrease of 52.7%). The stability of the relationship is dominated by two variables: y3 (PCT patents applications per billion GDP (in PPS €)) and y7 (SMEs introducing product or process innovations as% of SMEs).

Table 3. *Pearson's Linear Correlation Coefficient. Effects of innovation*

Variables		r (2010)	r (2015)	Change (%)
y1	SMEs innovating in-house as % of SMEs	0,3456	0,3965	14,7%
y2	Innovative SMEs collaborating with others as % of SMEs	0,2900	0,2358	-18,7%
y3	PCT patents applications per billion GDP (in PPS€)	0,2947	0,2734	-7,2%
y4	PCT patent applications in societal challenges per billion GDP (in PPS€)	0,2109	0,3272	55,2%
y5	Community trademarks per billion GDP (in PPS€)	0,5980	0,2828	-52,7%

[2]*The absolute value of the correlation coefficient, ie | rxy |, tells us of the strength of dependency. If the absolute value |(rxy):*
- *is less than 0.2, practically no linear relationship between the features tested,*
- *0.2 - 0.4 - linear but pronounced but low,*
- *0.4 - 0.7 - moderate linear dependence,*
- *0.7 - 0.9 - Significant linear relationship,*
- *above 0.9 - linear relationship very strong (Cohen, 2012).*

y6	Community designs per billion GDP (in PPS€)	0,3019	0,2332	-22,8%
y7	SMEs introducing product or process innovations as % of SMEs	0,3751	0,4209	12,2%
y8	SMEs introducing marketing or organisational innovations as % of SMEs	0,1769	0,3565	101,6%
y9	Sales of new to market and new to firm innovations as % of turnover	-0,2400	-0,0724	-69,8%
y10	Employment in fast-growing enterprises (average innovativeness scores)	0,7080	0,2805	-60,4%

Source: *Own calculations.*

Only variables that have a clear linear relationship and slight variation in the periods analyzed (change in correlation coefficient below 15%[3]) were selected for the next step. Based on this assumption, the following variables are left as the effects of the effort and we are discussing them. Those are: SMEs innovating in-house as% of SMEs and SMEs introducing product or process innovations as% of SMEs. For the selected variables, Pearson's linear correlation coefficient (table below) was calculated. The obtained results show that there is a moderate linear relationship between the variables y1, y2 and y7, with a very strong correlation between the variables y1 and y7 (coefficient r greater than 0.9). On the basis of these considerations, it is decided to choose two variables y7, SMEs introducing product or process innovations as% of SMEs and y2, Innovative SMEs collaborating with others as% of SMEs.

Table 4. C*orrelation index for the variables with the strongest correlation*

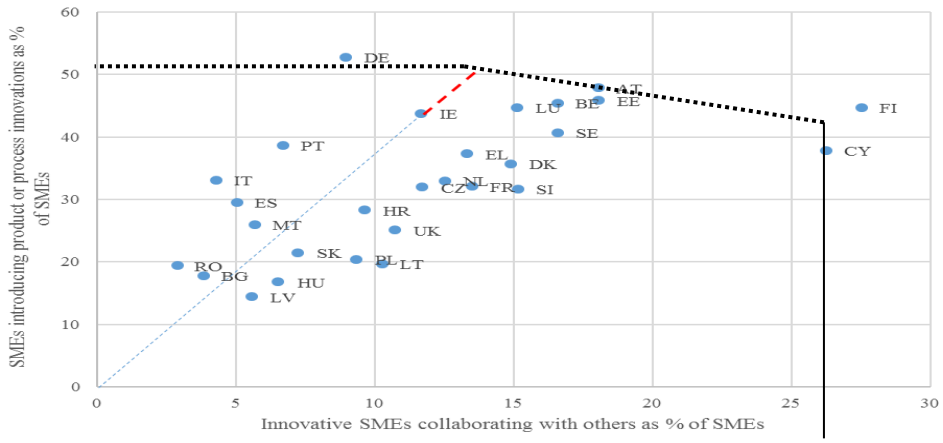
Variables	**Correlation index**
SMEs innovating in-house as % of SMEs and Innovative SMEs collaborating with others as % of SMEs (y_1 i y_2)	r = 0,6253 (2010) r = 0,5342 (2015)
SMEs innovating in-house as % of SMEs and SMEs introducing product or process innovations as % of SMEs (y_1 i y_7)	r = 0,9791 (2010) r = 0,9797 (2015)
Innovative SMEs collaborating with others as % of SMEs and SMEs introducing product or process innovations as % of SMEs (y_2 i y_7)	r = 0,6227 (2010) r = 0,6072 (2015)

Source: *Own calculations.*

The next section assesses the effectiveness of EU countries, depending on the size of the VCI transformed into SMEs introducing product or process innovations as% of SMEs and Innovative SMEs collaborating with others as% of SMEs. Each time a group of countries were selected that set the performance boundary for the rest (master units on the data boundary). Constant resources have been established in the form of VCI (effects-oriented model) - Figures 1 and 2.

[3]*The value was assumed on the basis of the calculation of the correlation coefficient in the consecutive periods analyzed (change column in Table 3), taking the quartile I, which means that 25% of the observations showed a change of less than 15%.*

Figure 1. *Effectiveness of innovative activities of UE Member States in 2010*



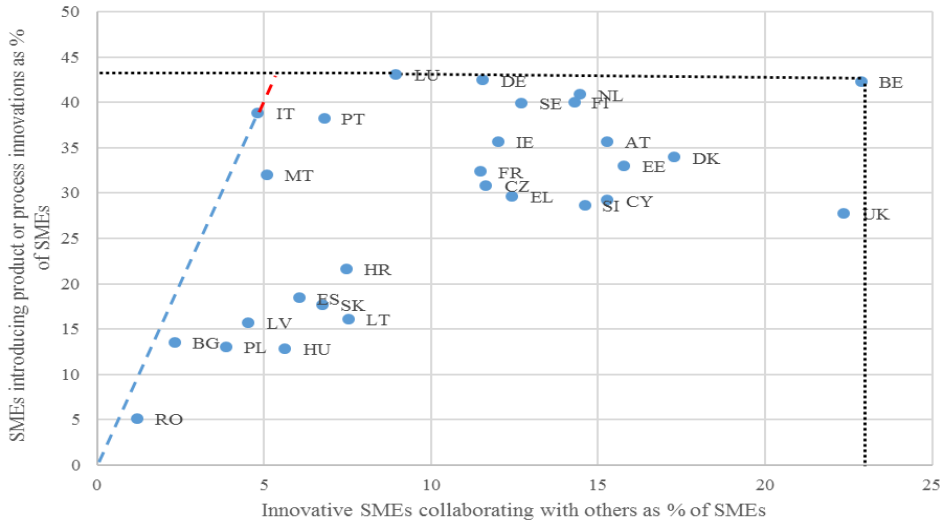
Source*: Own calculations.*

Figure 1 illustrates the effectiveness of innovative activities in EU countries, using an impact-oriented model (in this case, SMEs introducing product or process innovations as% of SMEs and SMEs innovating in-house as% of SMEs). The envelopes included countries such as Germany and Finland, which proved to be the most effective.

Very close to the efficiency limit is also Austria. Larger countries are represented by countries such as Belgium, Estonia, Cyprus, Luxembourg, Denmark. Latvia, Bulgaria, Romania, Hungary, Poland, Lithuania and Slovakia are countries that are the least efficient, adopting innovations and transferring technology (Ciborowski 2016). In the case of Ireland, a straight line is shown which illustrates the inefficiency of the state, that is, the distance of the point on the graph that represents it, to the bounding box defined by the patterns (segment marked with a dashed red line).

The situation is quite different in 2015. The countries that are in the envelope are Luxembourg and Belgium. Very close to the border are Germany (the country shows a change compared to 2010 by 1%), Great Britain, which compared to 2010, shows an increase in efficiency by 46% and the Netherlands, an increase of nearly 30% (Table 5). There werent't countries like Germany, Finland on the envelope, with the distance 1% or 6%. The countries below are (as in 2010) Estonia, Sweden, Austria, Denmark, Ireland. Similar situation as in 2010 is in countries like Romania, Bulgaria, Hungary, Poland, Lithuania, Latvia and Slovakia, because they are very far to the best of the country.

Figure 2. *Effectiveness of innovative activities of EU Member States in 2015*



Source*: Own calculations.*

Mathematical formulas have been used to calculate the distance from the point and the distance from the origin to the coordinate system. The results are shown in Table 5 below.

Table 5. *Distances from the envelope for EU countries in 2010 and 2015*

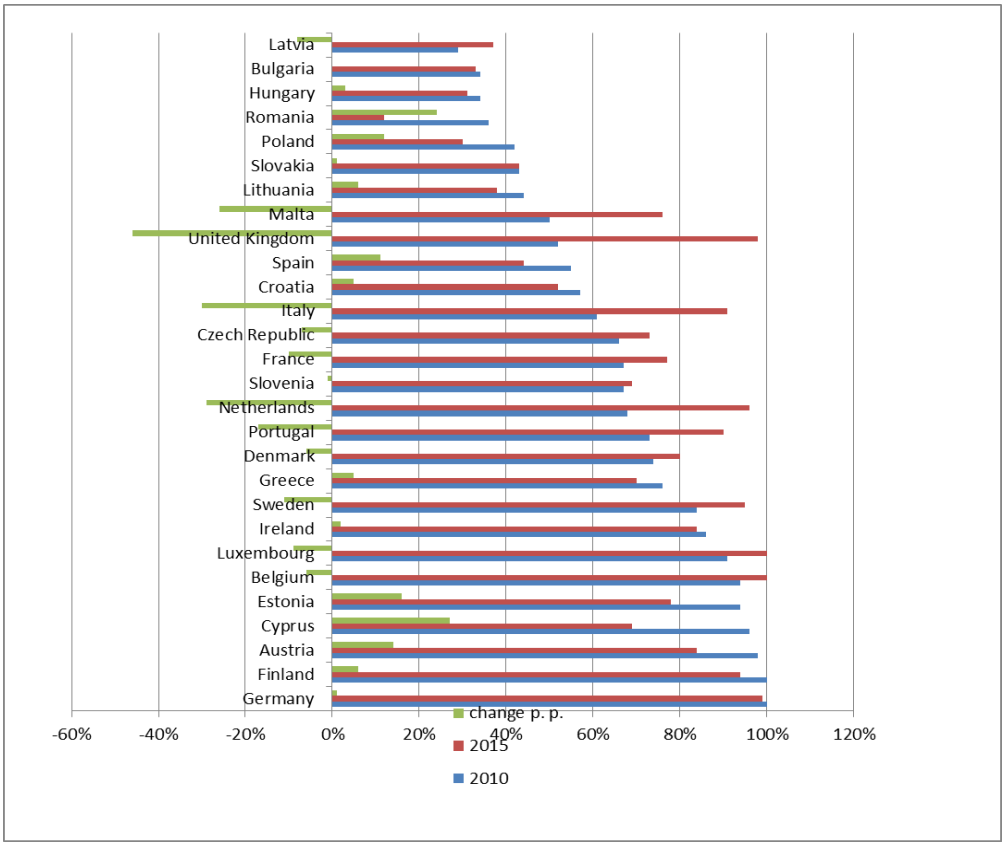
	Countries	**2010**	**2015**	**change p. p.**
DE	Germany	100%	99%	1%
FI	Finland	100%	94%	6%
AT	Austria	98%	84%	14%
CY	Cyprus	96%	69%	27%
EE	Estonia	94%	78%	16%
BE	Belgium	94%	100%	-6%
LU	Luxembourg	91%	100%	-9%
IE	Ireland	86%	84%	2%
SE	Sweden	84%	95%	-11%
EL	Greece	76%	70%	5%
DK	Denmark	74%	80%	-6%
PT	Portugal	73%	90%	-17%
NL	Netherlands	68%	96%	-29%
SI	Slovenia	67%	69%	-1%
FR	France	67%	77%	-10%
CZ	Czech Republic	66%	73%	-7%
IT	Italy	61%	91%	-30%
HR	Croatia	57%	52%	5%
ES	Spain	55%	44%	11%
UK	United Kingdom	52%	98%	-46%
MT	Malta	50%	76%	-26%

LT	Lithuania	44%	38%	6%
SK	Slovakia	43%	43%	1%
PL	Poland	42%	30%	12%
RO	Romania	36%	12%	24%
HU	Hungary	34%	31%	3%
BG	Bulgaria	34%	33%	0%
LV	Latvia	29%	37%	-8%

***Source**: Own calculations.*

It can be observed that Germany maintained the strongest position in the top of the ranking both in 2010 and 2015. Finland was equally strong, but in this case, the use of venture capital funds fell by 6% compared to 2015. In turn, countries such as Belgium and Luxembourg in 2015 were higher than in 2010, raising the index accordingly 6% and 9%. Countries such as Great Britain (up 46%), Italy (up 30%) and the Netherlands (up 29%) showed the greatest increase. The greatest decrease in the use venture capital are in Cyprus (27% decrease).

***Figure 3.** Change in use of venture capital funds in 2010 and 2015*



***Source:** Own calculations.*

6. Conclusion

The article presents the results of empirical research on the relationship between venture capital funds and the development of innovative activities. The study used the DEA method which was used to demonstrate the role of venture capital funds in developing innovative enterprises The results obtained confirm that there is a relationship between the most innovative economies and venture capital financing. These institutions could play a key role in the processes of innovative development of both the most innovative countries, and perhaps above all those who want to belong to the said group.

Venture capital funds play an important role in developing the innovative activity of EU countries. Those institutions are financial intermediaries, specializing in investments in capital companies with high growth potential and equally high risk. Funds contribute to closing the capital gap in financing innovative businesses, which is an essential element in their development. Their involvement in the development of individual entities, and consequently of economies, depends on the degree of development of a given country, as indicated in the foregoing considerations.

The study presents an assessment of the effectiveness of EU countries. The figures presented in the present discussion confirm the assumption that the most innovative countries of the European Union (EUROPEAN Innovation Scoreboard 2015, The Innovation Index 2015), are the most innovative according to the DEA method and they can use venture capital most effectively.

Germany, Switzerland, Sweden, United Kingdom, Finland, Ireland, Denmark, the Netherlands, Belgium, Luxembourg are among the most innovative countries in the list. These state in recent years are at the top positions in terms of innovation and development of innovative activity. The countries that use venture capital funds most effectively in both 2010 and 2015 are Germany, Finland, Belgium and Luxembourg, and in particular the United Kingdom in 2015.

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