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The role of venture capital funds in developing innovative activities of the European Union countries

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The role of venture capital funds in developing innovative activities of the European Union countries

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The role of venture capital funds in developing innovative activities of the European Union countries

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Abstract

Venture capital funds are very important in the development of innovative activity of economic entities. 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 2010 and 2015 periods. The results confirm the assumption that venture capital funds operate most effectively in the most innovative economies of the EU.

Introduction

It is important to emphasize that today, especially in highly developed and catching up countries, the issue of innovation plays a bigger role than ever before (Anokina, Peck, 2016, p.4744-4749). The conditions for the development of innovative enterprises are not the same everywhere. Many of them have to deal with the problem of capital gaps, the inability to raise capital for their own development. This problem is particularly acute in countries with less developed capital market.

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, p. 1125-1129). It is defined as an independently managed, purposeful equity fund targeted at investing in private equity with high growth potential (Gompers, Lerner, 1999, p. 349). According to J. Węclawski (1997, p. 17), 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.

Venture capital funds are an important part of the process of creating innovation (Moritz *et al.*, 2016, p.118). 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 (Jakussonoka 2016, pp. 248-256). There are more economically attractive innovations, whose minor refinement and commercialization are a chance for funds to make above-average profits (Groh, Wallmeroth, 2016, p.130).

Countries belonging to the structures of the 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, p. 819), 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, p. 75).

Table 1 Expenditures on innovation activities in the European Union countries in 2010, 2015

			GDP (billion PPS)		PE investme nt as % of GDP		Business R&D expendit ures as % of GDP		Public R&D expendit ures as % of GDP		Venture capital investme nts 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 ...2015, (20.03.2017).

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 PPSE)
- ☐ PCT patent applications in societal challenges per billion GDP (in PPSE)
- ☐ Community trademarks per billion GDP (in PPSE)
- ☐ Community designs per billion GDP (in PPSE)
- ☐ 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).

Scandinavian countries, United Kingdom, Germany use funds to finance projects at the initial stage of development, ie 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, Łukowski, 2014, p. 288).

Methodological basis of the study

The DEA (Data Envelopment Analysis) (Kao *et al.*, 2011, p. 310) 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. 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, Nowak, 2009, p. 6).

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, p. 573-610, Sawang *et al.* 2012, p. 110-125, Karaganov 2008, pp. 133-146). 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, p. 123). 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.

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 activity

Table 2 Effects of innovation activity-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 PPSE)
y4	PCT patent applications in societal challenges per billion GDP (in PPSE)
y5	Community trademarks per billion GDP (in PPSE)
y6	Community designs per billion GDP (in PPSE)
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 ...2015, (20.03.2017).

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 from given names y1 to y10. For this purpose, the Pearson linear correlation coefficient (r coefficient) was calculated to obtain the results set out in Table 3.

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 PPSE)	0,2947	0,2734	-7,2%
y4	PCT patent applications in societal challenges per billion GDP (in PPSE)	0,2109	0,3272	55,2%
y5	Community trademarks per billion GDP (in PPSE)	0,5980	0,2828	-52,7%

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.

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 relationship¹. 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). In 2010 it was higher than in 2015, with no linear relationship ($r < 0.2$). The highest correlation coefficient was obtained for y10 (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.

¹ The absolute value of the correlation coefficient, ie $|r_{xy}|$, tells us of the strength of dependency. If the absolute value $|r_{xy}|$:

- 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 J. 2012, Statistical analysis for behavioral sciences 2nd edition, Cohen, Cambridge University Press

Only variables that have a clear linear relationship and slight variation in the periods analyzed (change in correlation coefficient below 15%²) were selected for the next step. Based on this assumption, the following variables are left as the effects of the effort we are discussing. VCI: 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 Correlation index for the variables with the strongest correlation

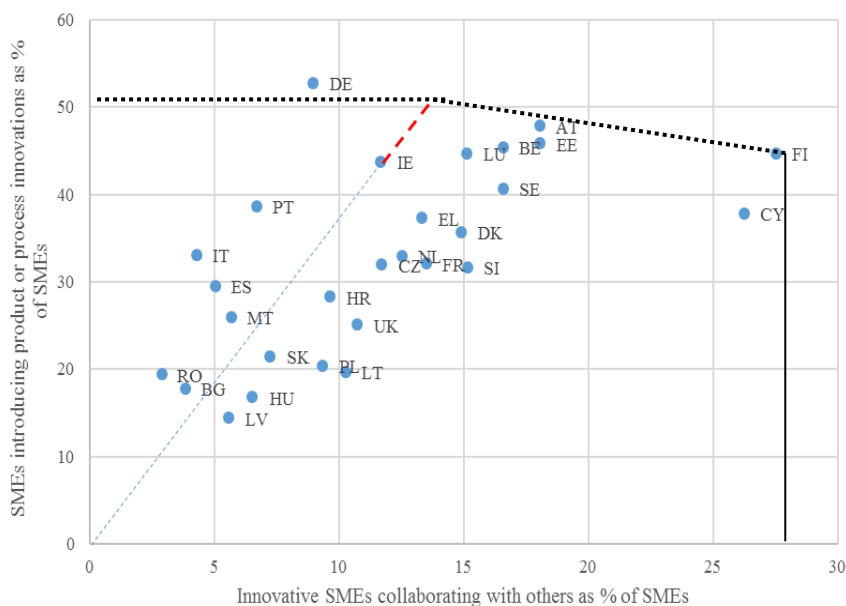
Variables	Correlation index
SMEs innovating in-house as % of SMEs and Innovative SMEs collaborating with others as % of SMEs (y ₁ i y ₂)	r = 0,6253 (2010) r = 0,5342 (2015)
SMEs innovating in-house as % of SMEs and SMEs introducing product or process innovations as % of SMEs (y ₁ i y ₇)	r = 0,9791 (2010) 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) - figure 1 and 2.

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

² 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%.



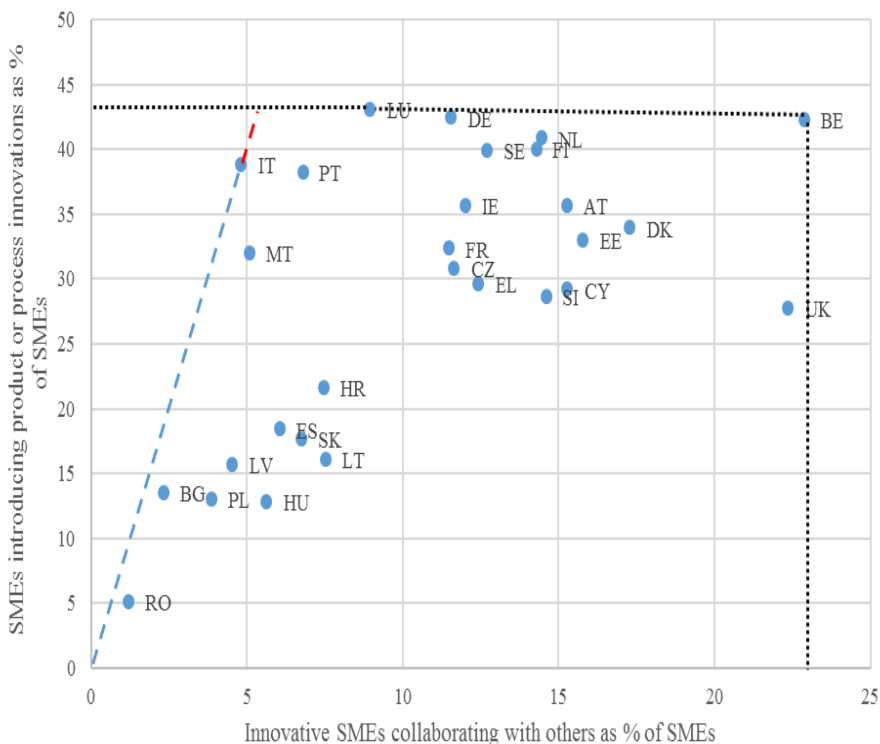
Source: own calculations.

The figure 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, Shia, Luxembourg, Denmark. Latvia, Bulgaria, Romania, Hungary, Poland, Lithuania and Slovakia are countries that are the least efficient, adopting innovations and transferring technology (Ciborowski 2016, p. 75.). 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 weren'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 the table below.

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

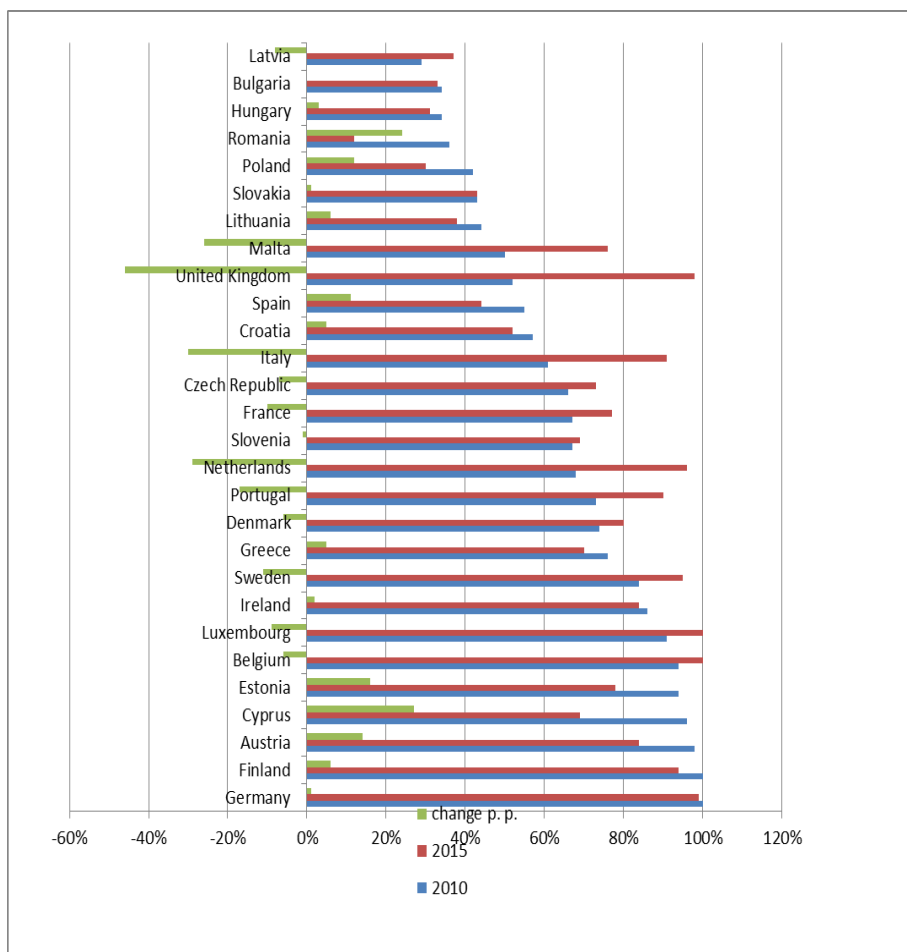
Countries		2010	2015	change p. p.
DE	Germany	100%	99%	1%
FI	Finland	100%	94%	6%
AT	Austria	98%	84%	14%
CY	Cyprus	96%	69%	27%

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.

Conclusion

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. 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 (EROPEN Innovation

Innovation Scoreboard 2015, The Innovation Index 2015), are the most innovative innovations 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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