ECONOMETRIC ANALYSIS OF SMEs IN EUROZONE

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ABSTRACT

The purpose of this paper is to empirically investigate the relationship between labour productivity (LP) and government spending on research and development (R&D) in the Eurozone. In particular, its purpose is to investigate this relationship in the case of small and medium enterprises (SMEs). By utilizing causality tests and error correction models, the results suggest that support of research and development is the cause of labour productivity growth in the long-term period. However, for the short-term period changes in labour productivity precede changes in government spending on research and development. Based on the findings, the study has several theoretical and practical implications. The data sources were the Eurostat database. The data used have the character of annual time series in the period between 2004 and 2015. GRETL software was used for the calculations.

KEY WORDS

Error correction model, expenditure on R&D, Granger causality, labour productivity, regression analysis, small and medium-size enterprises, Solow model.

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Introduction

Around 340 million citizens in 19 countries live in the euro area, and this number will increase as future enlargements of the euro area continue to spread the benefits of the single currency more widely in the European Union. The euro area consists of Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. Small and medium-sized enterprises represent 99% of all businesses in the Eurozone. The definition of an SME is important for access to finance and EU support programmes targeted specifically at these enterprises (SMEs are defined in the EU recommendation 2003/361).

Given these facts, this paper examines the effect of research and development (R&D) subsidies on labour productivity (LP) of small and medium enterprises (SMEs) within the Eurozone. Governments can subsidise private research and development indirectly with tax incentives and directly with subsidies. European policy makers are actively promoting innovation policies designed to enhance R&D in SMEs. R&D investments and related technological improvements could be a major source of LP. This article deals with relationship between

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R&D and LP in the Eurozone's countries as a whole, unlike the studies of authors such as: Cin et al. (2014), Karhunen and Huovari (2015), Irwin and Klenow (1996), Criscuolo et al. (2012), Cerqua and Pellegrini (2014), who were exploring this relationship in individual countries: Korea, Finland, the U.S.A., Great Britain, Italy.

The theory has not clarified yet whether R&D support is the cause of the growth of LP or its impact. The results of this study show that support of R&D is the cause of LP growth in the long-term period. For the short-term period, however, changes in LP precede changes in R&D. However, the increase in R&D expenditure as an end in itself is not a guarantee of the prosperity.

The core of this paper is the analysis of two hypotheses concerning the relationship between government spending on R&D and LP of small and medium enterprises within the Eurozone:

H1: There is a long-term relationship between government spending on R&D and LP.

H2: There is a short-term relationship between government spending on R&D and LP.

The positive relationship between the variables is assumed. Specifically, there are discussed SMEs in the industry, construction, trade, and services sectors. They do not include "non-financial business economies".

This paper contributes to the existing research on R&D subsidies by examining their effect on productivity.

1. Theoretical review

Small and medium-sized enterprises are an important part of the healthy economy of every advanced state. Therefore, in the interest of every state to encourage as much as possible the emergence and development of these companies. They predominate over large corporations and are a factor of development stability and dynamics. In addition, they can quickly and flexibly adapt to changes that can occur on the market (Veber, Srpová 2012). They affect significantly middle class growth and employment. At the same time, the increase in employment also reduces the state spending on unemployment benefit payment.

The topic of relationships between expenditures on R&D and labour productivity was analysed by a number of researchers. For example, Cin et al. (2014) empirically explored the R&D promotion policy effects on SME in Korean manufacturing firms. The authors found significant evidence for positive productivity effect of the public R&D subsidy. The subsidy has successfully raised the R&D expenditure and value-added productivity of Korean manufacturing SMEs.

In turn, Karhunen and Huovari (2015) examined the effect of R&D subsidies on LP. There were used firm-level data on Finnish SMEs from 2000 to 2012 and applied a combined matching and difference-in-differences method to control for selection bias. There were found no significant positive effect on labour productivity over the five-year period after a subsidy is granted. However, the results vary over time and indicate a 2-4 % negative effect on SMEs' annual productivity growth one to 2 years after the subsidy year.

European policy makers are actively promoting innovation policies designed to enhance R&D in SMEs (Ortega-Argilés et al. 2009). A growing number of studies examine subsidies' effects on firm productivity, which is a key factor in firm success. The results of these studies are, however, inconclusive. The productivity effect of R&D subsidies is found to be insignificant in high-tech firms in the U.S. (Irwin, Klenow

1996). Similarly, no evidence is found that regional subsidies improve firm productivity in Great Britain (Criscuolo et al. 2012) or in Italy (Cerqua, Pellegrini 2014). In Finland, Einiö (2014) finds that R&D subsidies from the European Regional Development Fund (ERDF) have a positive effect on productivity three years after the subsidy is granted. Finally, Koski and Pajarinen (2015) evaluate all business subsidies in Finland, and the results indicate that different subsidies (including R&D) have a small negative or insignificant effect on productivity growth.

2. Method

The economic performance of a country, expressed in terms of gross domestic product per capita (GDP per capita) and other indicators, is undoubtedly influenced by R&D. There are complicated links between R&D and economic level. However, based on long-term experience, the government spending on R&D are considered as growth-friendly investments and seen as a factor leading to an increase in the LP by standard economies at level of practical policies. In order to increase the LP, SMEs must specialize in fields, in which the R&D result usage is useful and effective.

When analysing the economic growth, the emphasis is placed on labour productivity and human resources, research and development as the source of technological progress and the quality of institutional environment as an important determinant of entrepreneurial activities.

The Solow-Swan model is the most famous neoclassical model focusing on these factors. Essentially, this model is an extension of Cobb-Douglas Production Function to technological advances that have an impact on the production function shape over a long period of time:

$$Y=F(K, AL) \quad (1)$$

where Y represents total production, K is capital, L is work. A refers to labour-augmenting technology or "knowledge", thus AL represents effective labour.

For function *F*, it must apply that it depends positively on the production function. In addition, the function *F* has constant yields from the scope and the law of decreasing marginal yields applies. Solow considers the law of declining marginal yields from the capital up to a steady state.

The model shows that the economy is growing in particular with labour productivity growth, but it is not able to explain why some countries grow faster and some slower. The Solow Model leads to the following statements. Increasing the level of technology used has a beneficial effect on labour productivity, growth in production and growth in capital stock. Average labour productivity increases as a result of new technology introduction, both directly and indirectly. If the economy is in a stable state, average labour productivity is equal to the rate of increase in technological progress. The Solow Model thus proves that technological progress is a source of constantly increasing living standard, as Mach (2001) stated.

3. Data

The practical part of the paper analyses the data obtained from the Eurostat database. These are annual data between 2004 and 2015. R&D for the Eurozone is referred as RD_EURO. R&D is the percentage of gross domestic product. LP in the Eurozone is referred as LP_EURO. Labour productivity in this case is labour productivity per person employed and hour worked (EU28=100). Labour productivity per hour worked is calculated as real output per unit of labour input (measured by the total number of hours worked). Meas-

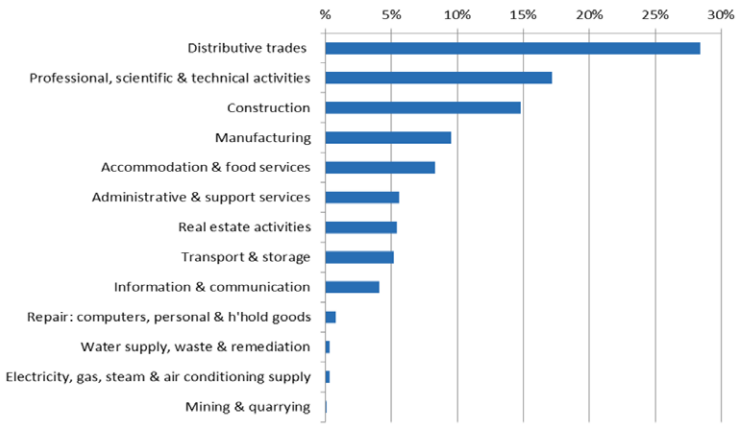
uring labour productivity per hour worked provides a better picture of productivity developments in the economy than labour productivity per person employed, as it eliminates differences in the full time/part time composition of the workforce across countries and years. Specific characteristic about SMEs in Eurozone in 2014 is presented in Figure 1 and Table 1. These data refer to the "non-financial business economy", which includes industry, construction, trade and services. The total number of SMEs in the Eurozone non-financial business was estimated as 16.5 million in 2015 (Table 1).

Table 1. The total number of SMEs in the Eurozone (in million)

2010	2011	2012	2013	2014	2015
15.4	15.1	15.6	15.8	16.3	16.5

Source: Eurostat 2017 b.

Figure 1. Breakdown of number of SMEs within the non-financial business



Source: Eurostat 2017 b.

SMEs represent 99% of all businesses in the Eurozone. SMEs in the Eurozone employ 66.8% of employees, while the large enterprises employ 33.2% of employees.

Table 2. Eurozone expenditure on R&D

State	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Austria	2.17	2.38	2.37	2.43	2.59	2.61	2.74	2.68	2.93	2.97	3.6	3.7
Belgium	1.81	1.78	1.81	1.84	1.92	1.99	2.5	2.16	2.36	2.44	2.46	2.45
Cyprus	0.34	0.37	0.38	0.4	0.39	0.44	0.45	0.45	0.43	0.46	0.48	0.46
Estonia	0.85	0.92	1.12	1.7	1.26	1.4	1.58	2.31	2.12	1.73	1.45	1.5
Finland	3.31	3.33	3.34	3.35	3.55	3.75	3.73	3.64	3.42	3.29	3.17	2.9
France	2.9	2.4	2.5	2.2	2.6	2.21	2.18	2.19	2.23	2.24	2.24	2.23
Germany	2.42	2.42	2.46	2.45	2.6	2.72	2.71	2.8	2.87	2.82	2.89	2.87
Greece	0.53	0.58	0.56	0.58	0.66	0.63	0.6	0.67	0.7	0.81	0.84	0.96

Ireland	1.18	1.19	1.2	1.23	1.39	1.61	1.6	1.54	1.56	1.56	1.51	1.53
Italy	1.5	1.5	1.9	1.13	1.16	1.22	1.22	1.21	1.27	1.31	1.38	1.33
Latvia	0.4	0.53	0.65	0.55	0.58	0.45	0.61	0.7	0.67	0.61	0.69	0.63
Lithuania	0.75	0.75	0.79	0.8	0.79	0.83	0.78	0.9	0.89	0.95	1.3	1.4
Luxembourg	1.62	1.59	1.69	1.61	1.64	1.71	1.51	1.47	1.28	1.31	1.28	1.31
Malta	0.49	0.53	0.58	0.55	0.53	0.52	0.62	0.67	0.83	0.77	0.75	0.77
Netherlands	1.81	1.79	1.76	1.69	1.64	1.69	1.72	1.9	1.94	1.95	2	2.1
Portugal	0.73	0.76	0.95	1.12	1.45	1.58	1.53	1.46	1.38	1.33	1.29	1.28
Slovakia	0.5	0.49	0.48	0.45	0.46	0.47	0.62	0.66	0.8	0.82	0.88	1.18
Slovenia	1.37	1.41	1.53	1.42	1.63	1.82	2.6	2.42	2.58	2.6	2.38	2.21
Spain	1.4	1.1	1.17	1.23	1.32	1.35	1.35	1.33	1.29	1.27	1.24	1.22

Source: Eurostat, 2017 a.

The European Union should invest 3% of GDP on research and development, as stated by European Commission (2015). This is one of the objectives of the Europe 2020 strategy. Table 2 shows the percentage of gross domestic product invested in research and development in SMEs in the Eurozone. It may be observed that the largest share of GDP is invested in research and development in Finland. As the only one, this country has exceeded the threshold of 3 %. In turn countries such as Austria, Belgium, France and Germany invest 2-3% in R&D. The others like Cyprus, Greece, Latvia, Lithuania, Malta, and Slovakia invest the least amount in R&D (average expenditure does not exceed 1%).

The countries analysed were divided into three groups according to the similar the LP and R&D expenditure. In the first group, there are countries that do not have high LP and governments of these states do not invest much in R&D expenditure. In the second group, there are countries in which R&D expenditure is around 1.5%. The third group comprises countries that are characterized by high spending on R&D and at the same time with high LP (Cyprus, Lithuania and Belgium do not belong to any of the groups).

1st group: Latvia, Slovakia, Malta, Greece

2nd group: Ireland, Spain, Portugal, Estonia, Italy a Lucembourg

3rd group: Finland, Germany, Austria, France, Netherlands, Slovenia

Regression analysis has been performed in each group. Each group of countries has been fitted with a line where the LP has been chosen as the dependent variable and the R&D has represented an independent variable. The regression analysis results are shown in Table 3.

Table 3. Regression models

Group	Model	Significance b1	Determination coefficient
1	$y = 112.4 + 27.26x$	0.059	0.195
2	$y = 120 + 35.29x$	0.371	0.062
3	$y = 101.7 + 8.32x$	0.049**	0.212

** statistical significance at the 0.05 level

Source: Own elaboration.

The regression analysis has showed that the LP did not grow with increase in R&D investments for countries in the first and second groups. A significant positive relationship between variables is only in the model for the third group of countries, which are characterized by high investments in R&D as well as high LP. If the R&D increased in these countries, LP of SMEs would no longer change significantly (value of coefficient b_1 = 8.32). On the contrary, it is possible that if R&D is reduced, LP would remain at the same level. In the following, the relationship for the Eurozone as a whole is analysed.

4. Testing the long-term and short-term relationship

This part of the article deals with the cointegration test of the model, which will be used to analyse the long-term and short-term relationship between LP and government spending on R&D in the Eurozone. Its purpose is to investigate this relationship in the case of SMEs. The positive relationship between the variables is assumed.

Stationarity of the time series was investigated and null hypothesis (H_0: there is a unit root) were not rejected, indicating the presence of a unit root in each time series, therefore non-stationarity, which is a prerequisite for the cointegration test, as indicated by Arlt (1999) or Arlt and Arltová (2006). Stationarity was observed after the first difference for time series of labour productivity of SMEs in the Eurozone *D*(*LP_EURO*) and time series of government spending on research and development in the Eurozone *D(RD_EURO)*, as shown in Table 4.

Table 4. Augmented Dickey-Fuller test

Data	Test Statistics	Significance	Result
RD_EURO	– 2.37	0.368	Nonstationary TS
LP_EURO	– 2.39	0.381	Nonstationary TS
D(RD_EURO)	– 3.09	0.059*	Stationary TS
D(LP_EURO)	– 4.37	0.008***	Stationary TS

* statistical significance at the 0.1 level
*** statistical significance at the 0.01 level

Source: Own elaboration.

Testing the hypothesis H1

This part of paper deals with the testing of the number of cointegration relationships in VAR(2) model for the endogenous variables (*RD_EURO; LP_EURO*) using the Johansen's method, as shown in Johansen (1991). The trace test in the Table 5 indicates 1 cointegrating relationship for VECM(1) model at the 0.05 level, one can see in Johansen (1995). This is a model that includes unlimited level constant and restricted trend component. The other information can be found in Enders and Granger (1998) and Enders and Siklos (2001). The values of information criterions are: AIC (Akaike information criterion) = – 3.66; SC (Schwarz information criterion) = – 3.36; LR (Likelihood ratio, which is based on the principle of maximum likelihood) = 28.32.

Table 5. Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Significance
None*	0.474	6.408	15.494	0.0482
At most 1	0.114	1.173	3.841	0.2792
Normalized cointegrating coefficients (standard error in parentheses) RD_EURO LP_EURO 1.000 – 0.121 (0.0101)				

* denotes rejection of the hypothesis at the 0.05 level

Source: Own elaboration.

The results of Table 5 indicate that the system contains 1 cointegration vector based on trace statistics statistic. Existence of one long-term bond can be specified by a cointegration equation:

$$EQ1 = RD\_EURO_t - 0.121 LP\_EURO_t. \quad (2)$$

A cointegration vector expressing the equilibrium relationship between *RD_EURO* and *LP_EURO* is (1.000; – 0.121). This means that a 1% increase in *LP_EURO* will cause an increase in *RD_EURO* by 0.121%. This conclusion is in line with the assumption, because a positive relationship is assumed between the variables.

In the first model, we test whether the change in LP of SMEs in the Eurozone is the cause of the change in government spending on R&D. Results of the VEC model can be found in the Table 6.

Table 6. Model results

	Coefficient	Std.error	t-ratio	Significance
Constant	4.174	9.008	0.463	0.6594
D(RD_EURO(-1))	– 0.054	0.623	– 0.086	0.9337
D(LP_EURO(-1))	– 0.005	0.046	– 0.113	0.9137
EC1	– 0.288	0.625	– 0.461	0.6614
Durbin-Watson statistic	1.923			

Source: Own elaboration.

Giving into the equation

$$D(RD\_EURO_t) = \beta_0 + \beta_1 \cdot D(RD\_EURO_{t-1}) + \beta_2 \cdot D(LP\_EURO_{t-1}) + \beta_3 \cdot rez_{t-1} + \varepsilon_t, \quad (3)$$

where $\varepsilon_t \sim N(0,\sigma)$, rez_t is residual component, we get

$$D(RD\_EURO_t) = 4.174 - 0.054 \cdot D(RD\_EURO_{t-1}) - 0.005 \cdot D(LP\_EURO_{t-1}) - 0.288 \cdot rez_{t-1} + \varepsilon_t, \quad (4)$$

The value of EC1 coefficient is not statistically significant, so changes in LP of SMEs in the Eurozone will not cause changes in government spending on R&D in the long term.

In the second model, we test whether the change in government spending on R&D is the cause of the change in LP of SMEs in the Eurozone. Results of the VEC model can be found in the Table 7.

Table 7. Model results

	Coefficient	Std.error	t-ratio	Significance
Constant	123.164	92.954	1.325	0.2335
D(RD_EURO(-1))	0.459	0.221	2.086	0.0531*
D(LP_EURO(-1))	0.021	0.009	2.163	0.0437**
EC2	4.565	1.656	2.755	0.0414**
Durbin-Watson statistic	1.79			

** statistical significance at the 0.05 level
* statistical significance at the 0.1 level

Source: Own elaboration.

Giving into the equation

$$D(LP\_EURO_t) = \beta_0 + \beta_1 \cdot D(RD\_EURO_{t-1}) + \beta_2 \cdot D(LP\_EURO_{t-1}) + \beta_3 \cdot rez_{t-1} + \varepsilon_t, \quad (5)$$

where $\varepsilon_t \sim N(0,\sigma)$, rez_t is residual component, we get

$$D(LP\_EURO_t) = 123.164 + 0.459 \cdot D(RD\_EURO_{t-1}) + 0.021 \cdot D(LP\_EURO_{t-1}) + 4.565 \cdot rez_{t-1} + \varepsilon_t, \quad (6)$$

Causality is captured by the statistically significant value EC2 (4.565), which indicates that this variable will be modified by 456.5% within 1 year in case of long-term instability of LP of SMEs in the Eurozone. In other words, complete elimination of instability would last approximately 0.2 year (1/4.565), it means 2.4 months. Regarding the regression coefficients, it can be argued that LP is positively related to government spending on R&D, with a one-year delay, i.e. increase in government spending on R&D is followed by an increase in LP after one year. The positive relationship between the variables is in line with the assumption.

The Table 8 shows testing results of the assumptions of the model (6). Doornik – Hansen test is applied in order to test normality, and it does not reject the null hypothesis of normality of residues. Ljung – Box test does not reject the null hypothesis of absence of autocorrelation. ARCH – LM test does not reject the null hypothesis of absence of heteroscedasticity. The tests were performed at the significance level of 0.05.

Table 8. The assumptions of the model

	Autocorrelation	Heteroscedasticity	Normality
Null hypothesis	H_0: absence of autocorrelation	H_0: absence of heteroscedasticity	H_0: normality of residues
Test	Ljung – Box	ARCH – LM	Doornik – Hansen
Significance	0.976	0.553	0.848

Source: Own elaboration.

Therefore one can state that hypothesis H1 was confirmed.

Testing the hypothesis H2

In general, the Granger causality test is constructed such that it reveals mutual movement of time series through time changes, not literally "causality" in a sense that one time series is a cause of the second one. The meaning of the expression "Granger cause" is equivalent to the expression "precede" more than "cause". Results in the Table 9 indicate that changes in LP_EURO precede changes in RD_EURO by 3 years. Thus changes in LP_EURO can be used as predictor of short-run trend in RD_EURO movement.

Table 9. Pairwise Granger causality tests - Probability

	Lag		
Null Hypothesis:	1	2	3
D(RD_EURO) does not Granger Cause D(LP_EURO)	0.2576	0.7986	0.9195
D(LP_EURO) does not Granger Cause D(RD_EURO)	0.4498	0.1378	0.0498

Source: Own elaboration.

Therefore one can state that hypothesis H2 was confirmed.

5. Discussion of the research results

The theory has not clarified yet whether government spending on R&D is the cause of the growth of the LP or its impact. The results of this study show that there is a long-term relationship between R&D and LP, and it can be argued that the change in R&D in the Eurozone is the cause of change in LP. In the short-term period, it has been shown that changes in LP precede the change in R&D.

The results achieved correspond with the study of Cin et al. (2014) who found significant evidence for positive productivity effect of the public R&D subsidy. One can state that the results achieved partly confirm the results of Lach (2002) study, who founds that subsidies stimulate LP only in small firms as well as González and Pazó (2008) reporting that public financing is more efficient in small firms that operate in the low-technology sector.

On the other hand, the results of this research don't confirm the findings achieved by other researchers, such as Karhunen and Huovari (2015), Koski and Pajarinen (2014), Irwin and Klenow (1996), Criscuolo et al. (2012), Cerqua and Pellegrini (2014).

When dividing the Eurozone countries into three groups based on similar LP and R&D values, we get the following result. A significant positive relationship between variables is only in the model for the group of countries, which are characterized by high investments in R&D as well as high LP. If the R&D increased in these countries (Finland, Germany, Austria, France, Netherlands, Slovenia), LP of SMEs would no longer change significantly. On the contrary, it is possible that if R&D is reduced, LP would remain at the same level.

Most studies (e.g. Catozzella and Vivarelli 2011; Cappelen et al. 2012; Czarnitzki and Licht 2006; Garcia and Mohnen 2010), addressing this issue state that increase in government spending on R&D is not a guarantee for LP growth.

Conclusions

This paper analysed the impact of R&D expenditures on labour productivity of SMEs in Eurozone's countries. Its purpose was to confirm or reject two hypotheses: H1: There is a long-term relationship between government spending on R&D and LP for SMEs within the Eurozone. H2: There is a short-term relationship between government spending on R&D and LP for SMEs within the Eurozone. Both hypotheses have been accepted. In the long-term period, R&D is the cause of a change in LP. In the short-term period, it has been shown that changes in LP precede the change in R&D.

Johansen cointegration test results confirmed the existence of cointegration relationship, and the assumption of existence of a long-term relationship between the analysed time series was also confirmed. The used Vector Error Correction model allowed for detecting both long and

short-term relationships between the examined times series. The resulting model (6) showed that there is a positive relationship between labour productivity of SMEs in the Eurozone and government spending on research and development.

The paper contributes to the existing literature through analysis of relationship between R&D and LP in the Eurozone countries as a whole. In particular, SMEs should aim to increase the labour productivity and use the possibilities of funding from the structural funds. As the direct support is not the only tool for business support, it is up to each country to try to create better conditions that would affect the quality of the business environment.

In future research, it would be valuable to identify the different channels through which R&D subsidies affect LP in more detail.

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References

Arlt, T. (1999), Moderní metody modelování ekonomických časových řad, Praha: Grada.

Arlt, T., Arltová, M. (2006), Ekonomické časové řady, Praha: Grada.

Cappelen, Ĺ., Aknerud, A., Rybalka, M. (2012), The effects of R&D tax credits on patenting and innovations, Research Policy, 41: 334-345.

Catozzella, A., Vivarelli, M. (2011), Beyond additionality: Are innovation subsidies counterproductive?, Bonn: IZA – Institute of Labour Economics DP No. 5746, available at: http://ftp.iza.org/dp5746.pdf (accessed 30 January 2018).

Cerqua, A., Pellegrini, G. (2014), Do subsidies to private capital boost firms' growth? A multiple regression discontinuity design approach, Journal of Public Economics, 109: 114-126.

Cin, B.C., Kim, Y. J., Vonortas, N. S. (2014), The impact of government R&D subsidy on firm performance: Evidence from Korean SMEs, OECD Conference Entrepreneurship, Innovation and Enterprise Dynamics, December 1989, available at: http://www.oecd.org/sti/inno/5_3_Cin-Kim-Vonortas_Final.pdf (accessed 30 October 2017).

Criscuolo, C., Martin, R., Overman, H., Reenen, J.V. (2012), The causal effects of an industrial policy, NBER Working Paper, No. 17842, National Bureau of Economic Research.

Czarnitzki, D., Licht, G. (2006), Additionality of public R&D grants in a transition economy, The Economics of Transition, 14(1): 101-131.

Einiö, E. (2014), R&D subsidies and company performance: Evidence from geographic variation in government funding based on the ERDF population-density rule, The Review of Economics and Statistics, 96(4): 710-728.

Enders, W., Granger, C.W.J. (1998), Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates, Journal of Business and Economic Statistics, 16: 304-311.

Enders, W., Siklos, P. (2001), Cointegration and threshold adjustment, Journal of Business & Economic Statistics, 19(2): 166-176.

European Commission (2015), Cíle strategie Evropa 2020, available at: http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_cs.htm (accessed 25 April 2017).

Eurostat (2017a), Gross domestic expenditure on R&D, available at: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_20 (accessed 25 April 2017).

Eurostat (2017 b), available at: http://ec.europa.eu/eurostat/statistics explained/index.php/ Structural_business_statistics_overview (accessed 30 October 2017).

Garcia, A., Mohnen, P. (2010), Impact of government support on R&D and innovation, Maastricht: UNU-MERIT Working Paper 2010-034.

González, X., Pazó, C. (2008), Do public subsidies stimulate private R&D spending?, Research Policy, 37: 371–389.

Irwin, D.A., Klenow, P.J. (1996), High-tech R&D subsidies. Estimating the effects of Sematech, Journal of International Economics, 40: 323-344.

Johansen, S. (1991), Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models, Econometrica, 59(6): 1551-1580.

Johansen, S. (1995), Likelihood-based inference in cointegrated vector autoregressive models, Oxford: Oxford University Press.

Karhunen, H., Huovari, J. (2015), R&D subsidies and productivity in SMEs, Small Business Economics, 45(4): 805-823.

Koski, H., Pajarinen, M. (2015), Subsidies, the shadow of death and labor productivity, Journal of Industry, Competition and Trade, 15(2): 189-204.

Lach, S. (2002), Do R&D subsidies stimulate or displace private R&D?, The Journal of Industrial Economics, 50: 369-390.

Mach, M. (2001), Makroekonomie II, Praha: Melandrium.

Ortega-Argilés, R., Vivarelli, M., Voigt, P. (2009), R&D in SMEs: a paradox?, Small Business Economics, 33: 3-11.

Veber, J., Srpová, J. (2012), Podnikání malé a střední firmy, Praha: Grada.

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