

19th International Conference Enterprise and Competitive Environment 2016, ECE 2016, 10–11  
March 2016, Brno, Czech Republic

## Electronics Industry: R&D investments as Possible Factors of Firms Competitiveness

Nina Bočková<sup>a,\*</sup>, Tomáš Meluzín<sup>a</sup>

<sup>a</sup>*Faculty of Business and Management, BUT, Kolejní 2906/4, Brno 612 00, Czech Republic*

---

### Abstract

This paper aims at the impact of R&D investments on economic stability in the Czech enterprises. The authors study relationships between R&D investments and financial indicators and ratios for period 2007–2014. The empirical analysis is based on a sample of 103 Czech electronic industries innovative enterprises with R&D investments during the period 2007–2013. The paper deals with the hypothesis that R&D investments are utilized to increase economic efficiency. The second hypothesis is represented by an idea that enterprises invest systematically to be able to cope better with the effects of depressions. Financial indicators are analyzed and presented with the aim to verify these hypotheses.

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the organizing committee of ECE 2016

**Keywords:** Electronic industry; efficiency of firm; profitability ratio; structure ratio; R&D Investment

---

### 1. Introduction

In developed and developing economies is generally accepted an opinion that investment in research and development (R&D) is essential for the growth of the economy as a whole and at the same time it is an important factor for improving the performance, efficiency and competitiveness. The own innovative potential of enterprises, R&D cooperation and public R&D support in the EU are considered to be a suitable stimulant for the development of regions. Empirical studies made in Germany analysing data of 270 regions (from the total 295 regions) showed that innovative collaboration and public support for R&D investment are suitable policy measures to stimulate innovation

---

\* Corresponding author.

E-mail address: [bockova@fbm.vutbr.cz](mailto:bockova@fbm.vutbr.cz)

performance of regions (Broekel, 2015). The comparison of innovation active enterprises with so-called young highly innovative enterprises (Young innovative companies – YICS) in Germany showed that YICS among innovative companies are rare, but had significantly higher revenues from innovative sales. And this is despite the fact that R&D funding from their own resources of YICS is an important factor preventing from wider development of innovative activities. Connection with the growth of the innovation performance of public funds subsidized YICS compared with other innovative companies in German sample has not been proved (Schneider & Veugelers, 2010). In the study there was not demonstrated a significant effect of R&D investment for SMEs on capital investment and turnover growth. In the manufacturing industry there was a positive relationship between R&D activities and growth of the company. For parts with a low proportion of advanced technologies there was not found a positive effect, while somewhere it was also mentioned a negative trend (Schinke & Brenner, 2014). The focus of European policy on innovative SMEs and the impact of R&D support for output in the form of patents were studied in young innovative SMEs in the field of high-tech in Germany in the period 1994–2006. The effect of subsidies from public funds was most evident in the independent high tech SMEs. Independent high-tech companies did not have lower performance than independent low-tech SMEs and dependent – acting in clusters and the policy of funding R&D activities was effective in Germany (Czarnitzki & Delanote, 2015). Competitiveness and R&D investments are also linked with a skilled workforce. The Effects of innovation on firm growth in terms of employment growth was examined in Taiwan. Yang and Lin scientific findings are that innovations, measured by R&D investments and patent counts, have a positive impact on firm growth (Yang & Lin, 2007). Results of empirical study in the global electronics industry showed that firms spending more on R&D have higher gross profit, but do not have higher return on equity (ROE) and return on assets (ROA). The findings suggest that relationship of R&D to performance is mixed (Shin, Kraemer & Dedrick, 2009). Results of Korean analysis showed that R&D intensity does not affect either environmental responsibility or corporate financial performance. But the authors showed that the relationships between environmental responsibility performance and firms' ROE and ROA are positive and statistically significant (Lee, Cin & Lee).

Foreign economic literature deals mostly with examining the impact of R&D and innovation on business performance across the entire industry. The article focused on innovative companies based in the Czech Republic evaluating only one chapter the manufacturing industry. The chapter CZ-NACE 26 Manufacture of computers, electronic and optical products and equipment is among the most important chapters of the manufacturing industry. Electronics industry is one of the greatest industrial sectors in the world and it has still great potential in EU. On the other side it is besides manufacturing industry the sector the most affected by the world depression. The crisis caused a significant drop of production, sales, employment and other economic indicators (MIT, 2013). It is an important supplier to other industries, particularly the automotive industry and mechanical engineering. The products of the electrical industry are used practically in all spheres of human activities and their life cycles are getting always shorter. The production belongs to the category of high and medium-high technology. The chapter includes, on the one hand, labour-intensive production and on the other hand, the highly productive automated production.

The chapter includes the production of consumer electronics, measuring, testing, navigating and control equipment, irradiation, electro medicine and electrotherapeutic equipment, optical instruments and equipment and manufacture of magnetic and optical media. (MIT, 2015) It also is a chapter that is the most involved in the global value chains of multinational companies where the segmentation of activities is supposed to keep the R&D within the jurisdiction of the parent company with a higher knowledge level of employees. The own production and assembly is done in less economically developed countries. The chapter of CZ NACE 26 is characterized by high import intensity of exports (year 2014: 1 CZK of export was 0.79 CZK of import) in the manufacturing industry. This implies high sensitivity of the chapter to economic fluctuations and crisis phenomena. According to revenues, the chapter CZ NACE 26 is in 4th place in the manufacturing industry. The objective of the contribution is to analyse the differences in efficiency of companies investing in R&D regularly and efficiency of companies investing occasionally. The second aim is to compare the economic results of the both groups of enterprises with the whole sector of manufacturing industry and find how the innovative enterprises faced the depression and the period of economic stagnation which followed.

## 2. Methodology and data

The research itself was done among the Czech manufacturing companies of the chapter branch NACE 26 within the section C – Manufacturing industry. From the database of the Czech Statistical Office (CZSO) were obtained data

on enterprises which performed research financed from their own, public and foreign sources in the selected period 2007–2013. Information was limited to business corporations. Business corporations – cooperatives, and companies – limited companies and joint stock companies were entered to the file. The examined subjects will be named in the text as enterprises in accordance with § 420 and § 421 of Law no. 89/2012 of Civil Code. The database AMADEUS provided information about the ownership structure and economic efficiency indicators. This database contains registry, financial and trade information about 455,000 Czech companies (mainly, but not exclusively, corporation). In order to follow the same criteria used in other, we used the following characteristics to choose the sample companies: operating in the electronics industry; established as a corporation prior to 2007; last available balance sheet dated December 31, 2014. The sample, selected by applying the criteria set above, yielded 103 responding companies. These facts were subsequently verified in the annual reports of studied subjects and publicly available databases. The aim of the analysis was to compare the economic characteristics of selected indicators of economic performance (Kocmanová & Hřebíček, 2013) and determine differences or changes manifested in the period 2007 to 2014 and related to company size. The year 2007 was chosen as the start of a period because enterprises could actively make use of the R&D Tax Incentives. The Council for Research, Development and Innovation (RVVI) prepared fundamental changes in the system of public R&D support, and at the same time it was the last year in which the companies' activities were not affected by the rising crisis that hit all sectors. The year 2009 was a loss-making year for electronics industry companies. This chapter felt a recovery of the economy (in 2011) and positive developments and companies reached record profitability. Years 2013 and 2014 were followed as the years when the influence of R&D investments started in 2007 would have to be manifested.

The electronics industry enterprises were categorized according to the size in accordance with the definition of the size of the company according to the European Community. (European Commission, 2006) Number of microenterprises  $n_{Mi} = 209$ , the number of small enterprises  $n_S = 269$ , the number of medium enterprises  $n_M = 294$ ,  $n_L = 26$ .

The monitored issue can be formulated in two research hypotheses:

H1: *Implementation of own research in the manufacturing enterprise leads to performance and efficiency improvement of companies*

H2: *Implementation of annual research in longer term leads to better economic results than occasional research*

To confirm the established hypothesis assumption H1, the economic indicators of companies with R&D investments were compared to the average indicator for the selected chapter. Individual indicators are presented in tables by median and arithmetic average for the group according to the size. Evaluation of the hypothesis H1 is based on data from companies about funding R&D performed in the enterprise. To verify the second hypothesis H2 were defined two groups of companies, which differed in the course of R&D investment. There are companies which invested each year and such companies which invested occasionally. Due to the characteristics of data were selected non-parametric tests (Mann - Whitney) to compare different groups. The Mann-Whitney U test is a nonparametric statistical test equivalent to  $t$ -statistics for independent samples. It is used to test the null hypothesis that two samples have the same median or, alternatively, whether the observations belong have different medians. The Mann-Whitney test come into being from H.B. Mann and D. R. Whitney's proposal to generalize the Wilcoxon Two Sample Test and requires no assumptions about the symmetry of the two samples. Moreover, it can also be applied when the two samples have different sizes.

1. Step : Sorting data into two statistical samples  $(x_1, \dots, x_m)$  and  $(y_1, \dots, y_n)$ . The sum of the ranks of the two samples is:

$$T_1 + T_2 = \frac{(m + n)(m + n + 1)}{2}$$

We assume that we are observing a random variable  $X$  is continuous distribution with distribution function  $F$  provide statistical sample  $(x_1, \dots, x_m)$ . And the observation random variable  $Y$  with continuous distribution with distribution function  $G$  statistical sample  $(y_1, \dots, y_n)$ . We test the hypothesis  $H: F = G$ , i.e.,  $X$  and  $Y$  have the same

probability distribution against the alternative hypothesis  $\bar{H}: F \neq G$  i.e.  $X$  and  $Y$  have not the same probability distribution. We serve both samples into a statistical sample of the range of  $m + n$ .

2. Step: We denote  $T_1$  the sum of rank corresponding statistical sample  $(x_1, \dots, x_m)$  and  $T_2$  the sum of the rank corresponding statistical sample  $(y_1, \dots, y_n)$ . Statistics  $T_1$  assay criterion variants Wilcoxon Two Sample Test - Mann Whitney test. For this test, we calculate the value of statistic

$$U_1 = mn + \frac{m(m+1)}{2} - T_1$$

Hypothesis  $H: F = G$  disapproves, if  $U_1 \in \bar{W}_\alpha = \langle v_{\alpha/2} + 1, mn - (v_{\alpha/2} + 1) \rangle$ , where  $v_{\alpha/2}$  is  $(\alpha/2)$  – quantile of Mann-Whitney test. A test against unilateral alternative hypothesis was tested at a significance level  $\alpha = 0.05$ . In following Table I we report the definition of the financial variables that will be used in the empirical statement:

Table 1. Definition of variables

<b>Mi<sub>C</sub></b>	<b>Microenterprises with Annual Research</b>
<b>Mi<sub>R</sub></b>	Microenterprises with Occasional Research
<b>S<sub>C</sub></b>	Small Enterprises with Annual Research
<b>S<sub>R</sub></b>	Small Enterprises with Occasional Research
<b>M<sub>C</sub></b>	Medium Enterprises with Annual Research
<b>M<sub>R</sub></b>	Medium Enterprises with Occasional Research
<b>L<sub>C</sub></b>	Large Enterprises with Annual Research
<b>L<sub>R</sub></b>	Large Enterprises with Occasional Research
<b>ROE</b>	The amount of income before tax returned as a percentage of shareholders' equity
<b>ROA</b>	Ratio measuring the operating profitability of a firm, expressed as a percentage of the operating assets.
<b>CFOP</b>	Ratio of the Cash Flow to the Operating revenue
<b>SOLR</b>	Solvency Ratio, Ratio of the Shareholders funds to the Total Assets

The independent variables included ROE, ROA and ROS. The profitability variables measured the ability to produce income in relation to the capital invested, to the assets and consequently, to rewards funding sources. As anticipated, they are considered in the economic literature as the positive interaction effect on the relationship between R&D, gross profit, ROE and ROA (Shin, Kraemer & Dedrick, 2009). The balance ratios best express the operating result of a company (Creswell, 2009).

### 3. Results and interpretation

The results come from a set of companies with their own R&D, found from the reports VTR 5-01 for business subjects. The survey included all enterprises performing their own R&D with the main activity by classification CZ NACE, being classified into the manufacturing industry, chapter CZ NACE 26 Manufacture of computers, electronic and optical equipment. The research sample included a total of 103 companies. Corporation, which during the reporting period were included in the concern – one company from large enterprise category, and the two companies which had got into insolvency – one company of the category of small company category and one of medium-sized company category were eliminated from the file before effectiveness evaluation. Table II includes a number of annually and occasionally innovative enterprises from the total number of innovative enterprises in the chapter.

Table 2. Summary statistics for the period 2007–2013

Size of firm	Annual Research		Occasional Research	
	Number of firms	Share in the number of firms with R&D [%]	Number of firms	Share in the number of firms with R&D [%]
Micro	5	4.8	8	7.7
Small	16	15.5	22	21.3
Medium	22	21.4	20	19.4
Large	5	4.8	5	4.8

n=103

In Tab. II, the number of companies from the research sample and their percentage share in the total number of innovative manufacturing businesses, which in the reporting period were 103. Enterprises are divided into two groups: companies performing their own R&D at any time during the period from 2007–2013 at least once and enterprises implementing the research activity annually during the entire reporting period. The most represented in both groups are medium-sized enterprises. The less are represented the large enterprises. The total number of enterprises in the reported chapter of the manufacturing industry that meet the condition – the foundation before 2007 and that were active in the period 2007–2013 is 798.

Table 3. Number of innovative enterprises by size

Size of firms	Annual Research		Occasional Research	
	Number of firms	Percentage by size [%]	Number of firms	Percentage by size [%]
Micro	5	2.4	8	4.3
Small	16	5.9	22	8.2
Medium	22	7.1	20	6.8
Large	5	19.2	5	19.2

Tab. III shows the number of innovative enterprises and their share in the number of enterprises in the observed chapter according to the size. Calculations show that the large enterprises are the most frequent in case of occasional and annual research. The frequency of medium-size innovative enterprises which perform an annual research throughout the period is just above 7%, the number of small businesses is about 6%. The proportion of enterprises that invested at least once in R&D is very similar in case of SMEs. The frequency of innovative enterprises is similar to a study result of the use of external sources of financing activity (Dooley, Kenny, & Cronin, 2016).

Business activity throughout the chapter and frequency of enterprises performing the research is presented in Table IV.

Table 4. Share of innovative enterprises in the total number of enterprises in chapter

Size of firms	Annual Research		Occasional Research	
	Number of firms	Percentage [%]	Number of firms	Percentage [%]
Micro	5	0.6	8	1.1
Small	16	2.0	22	2.7
Medium	22	2.6	20	2.5
Large	5	0.6	5	0.6

The share of companies performing annually research in the chapter of CZ NACE 26 within the period is 5.8%. Microenterprises and large enterprises make one tenth, the others are divided among SMEs. If we assessed the research activity of enterprises according to their share in the total number, SMEs are the most active.

#### 4. Comparison of the effectiveness of the group of company with occasional research and annual research

Comparison of individual groups of enterprises is based on the share of frequency according to Tab. 1. The mutual comparison of financial results confirmed the stated hypotheses. Values of the selected indicators of financial analysis in the test groups were not normally distributed. To compare selected groups of businesses there was used nonparametric statistics to determine the average and median. The financial indicators ROE and ROA were compared within two groups of companies. The first group performed annual research the other group did it at least during one year in the period 2007–2013. The financial indicators were compared with the results of the entire sector according to (MIT 2015). The company values ROE by size are given in the Table V.

Table 5. Average: Variable ROE

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	50.17	6.42	23.57	−68.38	−5.04	36.22	28.59	20.51	15.30
2009	26.97	5.34	9.31	−1.13	−35.14	9.06	17.78	2.72	50.70
2011	18.88	9.37	23.22	20.19	−3.5	25.99	15.81	10.96	20.56
2013	−17.11	6.70	14.64	10.39	11.51	20.80	7.01	12.08	44.94
2014	8.37	10.68	18.11	7.42	*	7.34	14.67	16.44	26.46

Source: author's calculation, MIT, \* The figure has not been published yet

The presumption that investment in R&D leads to higher return on equity and higher business performance (measured by return on assets ROA) was proved in micro, small and medium-sized enterprises during the economic upturn. LC and LR groups were significantly above the indicator value published by MIT for the year 2007 and above the monitored part. During the economic crisis (2009) there was a significant decline in indicators for micro and medium-sized enterprises. Small companies suffered a decrease of profitability, on the contrary large enterprises improved the ROE significantly compared to 2007 and compared to an average value for the electronics industry. In 2014 it seemed that position of small and large companies would be strengthen when the group of enterprises with annual research improved the ROE average compared to the base year. Profitability of small enterprises fell significantly while the development indicator of large enterprises is variable. We supposed that the enterprises that already invested their own funds to R&D in 2007 would face better the post-crisis period. Return on equity is monitored and MIT as well as for the individual chapters of the manufacturing industry. Tab. V shows that the average value of the ROE indicator dropped in whole monitored chapter, although the monitored indicator in NACE 26 in the Czech Republic reached a positive value between 2011 and 2013. The development of median values ROE is shown in Table VI.

Table 6. Median: Variable ROE

	Annual Research 2007–2013				Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
n	5	16	22	5	8	22	20	5
2007	63.56	19.47	20.83	0.81	23.25	30.79	11.81	14.81
2009	45.44	5.39	14.76	3.43	8.38	16.10	5.67	7.17
2011	13.69	6.24	22.5	18.68	15.39	7.19	6.37	7.70
2013	13.67	4.14	11.07	13.93	19.15	3.88	10.50	36.85
2014	8.37	7.86	15.63	3.45	4.54	11.82	11.02	27.06

Source: author's calculation, MIT

If we assess the median for each size of enterprises, the explanatory power is similar to the development of the whole economy. In 2009 there was a decline, but in the following period the value of the ROE increased. However it did not reach its original value for any group of enterprises in 2007, and neither the average, nor the median. The assumption that companies with continuous R&D investment will have better capacity to economic recovery has not been proved in all groups. In 2011, when the crisis was over, the median ROE values reached lower values than in the last upturn (in 2007) for micro and small companies. Medium-sized enterprises (annual research) achieved the better values. MR achieved practically the same values in 2014. In the years 2009 and 2011 there are statistically significant differences in the group of medium-sized enterprises. The biggest difference was in the group of large enterprises when enterprises with annual research achieved the best result for the monitored period. There is a statistically significant difference between the ROE achieved by LC and LR for the year 2014. The development of the financial indicators ROA is shown in Table VII and Table VIII.

Table 7. Variable ROA – Average

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	27.74	13.63	10.61	−12.41	−1.53	21.75	22.40	13.81	4.98
2009	20.23	3.98	4.91	1.04	−6.78	6.25	15.78	2.00	5.55
2011	12.15	6.95	12.64	9.55	−0.55	18.75	14.30	6.80	1.63
2013	0.57	5.41	10.00	5.12	2.57	14.51	5.69	8.02	10.91
2014	3.21	6.43	9.66	3.00	*	5.35	10.48	12.19	11.85

Source: Own calculation, MIT, \* The figure has not been published yet

From the performance recovery point of view measured by return on assets, both groups of micro, small and medium-sized enterprises proved to be successful. In the monitoring period were the ROA indicators in the reference chapter significantly above the average. Thus the hypothesis H1 is confirmed.

Table 8. Variable ROA – Median

	Annual Research 2007–2013				Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
n	5	16	22	5	8	22	20	5
2007	37.99	7.10	8.72	0.27	11.07	21.83	8.58	4.14
2009	27.91	2.08	7.59	0.47	8.07	12.38	3.66	3.09
2011	7.52	3.41	11.12	9.81	1.14	6.08	5.35	2.08
2013	6.51	2.58	7.17	3.31	10.39	3.25	6.27	13.00
2014	3.21	5.74	8.77	2.02	4.01	5.02	9.65	11.95

Source: author's calculation

The large enterprises' profitability was below the average of the monitored chapter in the period of growing economy. In 2009 there was a decline in indicators for micro, small and medium-sized enterprises. On the contrary, large companies improved the return on assets as well as the ROE. The crisis had the smallest impact on micro innovative enterprises, where the average ROA indicator at 9 monitored companies was 8.07. Between 2011 and 2013 there was a decline in the value of the indicator. As in the case of the ROE, the group of innovative companies have the ROA indicator up to four times higher than is the average of the chapter. In the case of comparing the medians the values are more balanced. For the ROA there was shown statistically significant difference between group SC and SR in 2011.

Characteristics in Tables V.–VIII. describe the years 2007, 2009, 2011, 2013 and 2014. It is possible to observe what results were reached in group of companies in terms of economic growth (2007), during depression (2009), during the subsequent recovery (2011), during a period of moderate growth thanks to the intervention of the CNB (2013) and the significant growth in the sub-sector compared to the rest of the manufacturing industry (2014). A comparison of results of all groups of companies enables to verify the hypothesis H2. The assumption that continuous research leads to a higher return on equity ROE and higher business effectiveness, measured by ROA indicator was proved only on small and medium-sized enterprises. This assumption was confirmed in ROE during all years.

Another monitored indicator was the CFOR. In this calculation, the average of the indicator was calculated for the entire chapter from the database AMADEUS because the calculations of Czech Statistical Office neither MIT are not monitored.

Table 9. Variable Cash flow/Operating revenue – Average [%]

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	6.13	11.03	10.21	5.77	8.79	15.48	13.63	11.75	5.26
2009	10.13	8.77	11.33	9.49	6.43	8.03	12.04	7.67	4.93
2011	−0.48	7.51	14.06	17.78	7.67	16.33	10.63	9.93	1.27
2013	−4.97	8.85	10.20	14.74	8.42	15.38	10.73	12.97	4.81
2014	2.89	12.27	13.91	11.51	8.93	3.07	13.79	14.79	5.39

Source: author's calculation

The indicator  $S_C$  and  $L_C$  which started the research activity in 2007 was lower than the average of the monitored chapter. SME's had a higher value indicator than the average of the chapter. The economic crisis had an impact to the value decline of the entire branch, enterprises with occasional R&D investments decreased their indicator value

without any exception and enterprises of all groups performing annual research were above the average chapter while small companies only recorded a decline compared to 2007. Statistically significant differences appeared between  $Mi_C$  and  $Mi_R$  in 2013 and between  $L_C$  and  $L_R$  in 2011 and 2013. They are shown in Table XIII.

Table 10. Variable Cash flow/Operating revenue – Median [%]

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	7.33	9.38	9.99	4.83	7.15	10.34	14.92	11.49	5.75
2009	11.36	8.68	10.07	9.45	5.65	7.95	12.53	5.88	8.62
2011	4.68	8.45	12.65	14.23	7.18	15.62	10.03	6.87	4.27
2013	2.83	7.69	10.94	16.80	7.28	10.61	9.99	10.20	4.21
2014	2.89	8.42	10.91	10.65	8.51	8.77	13.61	15.75	4.90

Source: author's calculation

The coefficient of self-financing is the opposite of the total debt (the sum = 100%). It indicates to what extent the company is able to cover its needs from its own resources. This means the financial stability and independence of the company. If the solvency ratio is higher, the firm's ability to meet its obligations is better. In Tables XI and XII are shown the average values and median for each group of companies. The chapter value of average and median was obtained by calculation from the database AMADEUS.

Table 11. Variable Solvency ratio – Average [%]

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	57.14	62.14	58.46	37.70	49.46	54.69	72.53	67.58	21.91
2009	60.38	63.90	58.07	47.78	53.81	59.77	82.42	64.74	28.17
2011	61.74	58.48	62.52	47.51	52.88	52.18	82.94	65.37	29.28
2013	56.17	64.96	67.31	53.87	54.97	55.47	82.13	71.06	40.30
2014	42.83	67.19	65.14	55.16	56.30	56.90	76.74	71.77	46.94

Source: author's calculation

The SOLR shows the increase of the stability and self-reliance in financing of the SMEs and large enterprises. Small enterprises have been facing a decrease of monitored indicator values since 2011. Value indicator of both groups of large enterprises is below the chapter value.  $L_C$  has better values than  $L_R$ . However these differences are not statistically significant. Statistically significant differences are between the  $M_C$  and  $M_C$  in years 2009, 2011 and 2013. It is show in Table XIII with Mann-Whitney statistically significant difference.

Table 12. Variable Solvency ratio – Median [%]

	Annual Research 2007–2013					Occasional Research 2007–2013			
	Micro	Small	Medium	Large	Branch	Micro	Small	Medium	Large
n	5	16	22	5		8	22	20	5
2007	57.82	62.62	66.29	51.73	56.24	55.21	77.10	69.32	20.41
2009	61.44	62.99	62.40	52.26	60.10	63.14	88.21	64.91	33.99
2011	68.77	58.08	65.57	47.56	59.98	62.64	89.43	62.58	37.07
2013	56.93	66.57	74.46	63.87	64.56	71.25	86.81	80.55	43.50
2014	42.83	68.6	70.69	58.47	64.36	66.18	83.63	78.55	46.39

Source: author's calculation

The results for the all variables showing a statistically significant difference between medians according to the Mann-Whitney test are shown in Table XIII. Because of the small sample size, the nonparametric Mann-Whitney test was used in order to highlight the existence of statistically significant differences between the samples with annual or occasional research.

Table 13. Mann-Whitney statistically significant differences

ROE				ROA			
$Mi_C v. Mi_R$	$S_C v. S_R$	$M_C v. M_R$	$L_C v. L_R$	$Mi_C v. Mi_R$	$S_C v. S_R$	$M_C v. M_R$	$L_C v. L_R$
2007		0.046					
2009		0.021					
2011						0.034	
2013							
2014			0.22				
CL/OR				SOLR			
2007							
2009							
2011			0.035		0.018		
2013			0.035		0.005		
2014					0.008		

Source: author's calculation

To find out the existence of a statistically significant difference for the individual indicators a nonparametric statistics was used. The values of financial indicators ROE and ROA for groups of medium enterprises statistically differ significantly ( $p < 0.05$ ), it means that continuity in research and development has an impact on profitability indicators.

## 5. Conclusions

The article is based on my own research on the influence of research activities in production companies of the electronics industry and the subsequent evaluation of selected financial indicators in order to assess whether the effect of sustained investment in R&D can reflect on economic indicators and thus strengthen the competitiveness of the company. To evaluate the effectiveness only one chapter of the manufacturing industry MANUFACTURE OF COMPUTERS, ELECTRONIC AND OPTICAL DEVICES AND INSTRUMENTS was selected, with the intention to preserve the

homogeneity of the monitored sample. Enterprises were divided to a sample of enterprises with annual research in 2007–2013 and the enterprises that in the same period performed an occasional R&D investment. Financial results of enterprises by size groups were mutually compared in the period 2007–2014. In the published results were selected the years: 2007 – a period of economic growth and the initial year of the monitored firms investment in R&D, 2009 – a period of economic recession caused by the crisis in the US, year 2011 – there has been a revival of the economy and the years 2013, 2014. The assumption was not confirmed that R&D investments led to increase of the return on equity for micro, small and medium-sized enterprises during a period of 8 years. In 2014 any of these groups of companies did not reach the value of the ROE from 2007. In comparison with the results of the entire chapter, however, innovative companies of both groups reached better results until 2013, better values than the electronics industry. A significant increase in return on capital was reached in both groups of large enterprises which were significantly below the chapter average of the electronics industry in the last year of economic upturn. It can be assumed that innovative firms have greater capacity of recovery. While monitoring only the return on assets it would have been possible to confirm both hypotheses. Innovative companies of all sizes regardless of the continuity of the performed research confirmed the ability of the efficient use of their capital base. Hypothesis  $H_2$  was not confirmed for groups small and large enterprises. Formulated conclusions fully respond to innovative enterprises of the electronics industry. In spite of the scope of the data focused on one chapter of the manufacturing industry it cannot be possible to establish conclusions about the impact of R&D investment on the performance and efficiency throughout the economy, which was not even the aim of the research. Other valuable information could be provided by monitoring of the impact of R&D investment from both public and own resources and define thus other factors that affect performance, efficiency and competitiveness of enterprises in macroeconomic context.

## References

- Broekel, T.(2015). Do Cooperative Research and Development (R&D) Subsidies Stimulate Regional Innovation Efficiency? Evidence from Germany *Regional Studies*. 49 (7), 1087–1110.
- Czarnitzki, D.& DELANOTE, J..(2015). R&D policies for young SMEs: input and output effects. *Small Bus Econ*. 45, 465–485
- Creswell, J. (2013). *Research Design*. Fourth Edition. SAGE Publications: SAGE Publications, Inc.
- Dooley, L., Kenny, B. & Cronin, M.(2015). Interorganizational innovation across geographic and cognitive boundaries: Does firm size matter? *R and D Management* 45(9). Scopus. [Online]. Accessible at: <http://onlinelibrary.wiley.com/doi/10.1111/radm.2015.45.issue-5/issuetoc>. [Accessed: 2015, November 30].
- EUROPEAN COMMUNITIES.© 2006. *New definition of SMEs*. [ in Czech: *Nová definice malých a středních podniků*]. [Online]. Available at [https://www.szif.cz/cs/CmDocument?rid=%2Fapa\\_anon%2Fcs%2Fdokumenty\\_ke\\_stazeni%2Fefrid%2F1182414202559.pdf](https://www.szif.cz/cs/CmDocument?rid=%2Fapa_anon%2Fcs%2Fdokumenty_ke_stazeni%2Fefrid%2F1182414202559.pdf). [Accessed 2015-12-02]
- Kocmanová, A., Hřebíček, J. et al. (2013). *Měření podnikové výkonnosti*. Brno: Littera.
- Lee, K., Cin, B. & Lee, E.. (2016). Environmental Responsibility and Firm Performance. *Business Strategy and the Environment*, 25 (1), 40–53.
- MIT.2019. *Panorama of the manufacturing industry in 2007* [in Czech: *Panorama zpracovatelského průmyslu 2007*]. [Online]. Available at: <http://www.mpo.cz/dokument56081.html>. [Accessed: 2015, November 10].
- MIT.2011. *Panorama of the manufacturing industry in 2009* [in Czech: *Panorama zpracovatelského průmyslu 2009*]. [Online]. Available at: <http://www.mpo.cz/dokument84178.html>. [Accessed: 2015, November 10].
- MIT.2013. *Panorama of the manufacturing industry in 2011* [in Czech: *Panorama zpracovatelského průmyslu 2011*]. [Online]. Available at: <http://www.mpo.cz/dokument107939.html> [Accessed: 2015, December 03].
- MIT.2014. *Panorama of the manufacturing industry in 2013* [in Czech: *Panorama zpracovatelského průmyslu 2013*]. [Online]. Available at: <http://www.mpo.cz/dokument154179.html>. [Accessed: 2015, November 10].
- MIT.2015. *Panorama of the manufacturing industry in 2014* [in Czech: *Panorama zpracovatelského průmyslu 2014*]. [Online]. Available at: <http://www.mpo.cz/dokument161359.html>. [Accessed: 2015, November 10].
- Shin, N., Kraemer, K.L. and Dedrick, J. (2009). R&D, value chain location and firm performance in the global electronics industry. *Industry and Innovation*. 16 (9), 315–330
- Schinke, A. & Brenner, T.(2014). The role of R&D investments in highly R&D-based firms, *Studies in Economics and Finance*, 31, 3–45
- Schneider, C.& Veugelers, R. (2010). On young highly innovative companies: why they matter and how (not) to policy support them. *Industrial and Corporate Change*. 19 (4), 969–1007
- Yang, Ch. and Lin, Ch. (2007). Developing employment effects of innovations: microeconomic evidence from Taiwan. *The developing Economies*. 46, 109–134.