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R&D INVESTMENTS AS POSSIBLE FACTORS OF COMPANY'S COMPETITIVENESS

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Abstract

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This article describes the impact of R&D investment to on the economic stability in the Czech electronics industry in the period 2007–2014. Increasing the competitiveness of companies is conditional on the systematic investments, development and stability of companies. Searching for competitive advantage through innovation may be one of the ways of how to obtaining a stab. market position in the industry. The aim of this article was is to determine whether there are relations between changes of economic indicators and the reporting process of research activities for innovative companies in the electronics industry. The research was conducted among 103 companies based in the Czech Republic, which invested in R&D in 2007–2013. The comparison was made between companies which invested in the 2007–2013 in the annual or occasional R&D. Two subgroups were established and companies in each subgroup were monitored companies according to their size. Spearman's rank correlation was used to assess if relationships among R&D Expenditure and Operating Revenue were preserved across periods. Two hypotheses were formulated and verified on the basis of statistical data processing of innovative companies. The results showed that innovative companies had the ability to better capitalize on their asset base, and they are better able to cover their needs from their own resources better than other companies of in the electronics industry. Their ability to provide a return on equity varies by according to company size. Innovative companies showed an ability to reach a positive outcome from operating activities. The coefficient of self-financing for SMEs is for SMEs constantly above the industry mean and increases with the length of period of time. This trend was not confirmed for micro-companies and large companies this trend was not confirmed.

Keywords: electronic industry, efficiency of firm, profitability ratio, structure ratio, R&D Investment

INTRODUCTION

In developed and developing economies, the opinion is generally accepted 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 performance, efficiency and competitiveness. The growth of firms has positive macro and micro-economic effects. There exists a wide range of factors that are found to affect company performance. At the end of the 20th century, the impact was on importance of innovations and creation of competitive advantage and keeping the competitiveness of a company. A magnitude of studies maintains that firms with a strong pledge to R&D and new technology-based innovations tend to have higher growth rates and economic performance than firms with a weaker pledge or with no R&D activities. Incremental product innovation is an important competitive factor to growing companies (Banbury & Mitchell, 1995). Innovation is the work of company, not the government. Encouraging innovation is not a question of money, but the motivation stand out (Zelený, 2011). A company's own innovative potential of companies, R&D cooperation and public R&D support in the EU are considered to be a suiTab. stimulant for the development of a region. Empirical studies made in Germany analysing data of 270 regions (from a total of 295 regions) showed that innovative collaboration and public support for R&D

investment are suitable policy measures to stimulate innovation performance of the regions (Broekel, 2015). The comparison of innovation-active companies with so-called young highly innovative companies (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 the wider development of innovative activities. Connecting the growth of the innovation performance of public funds subsidized YICS compared with other innovative companies in the German sample has not been proved (Schneider & Veugelers, 2010). In the study no significant effect of R&D investment for SMEs was demonstrated on capital investment and turnover growth. In the manufacturing industry there was a positive relationship between R&D activities and growth of a company. For parts with a low proportion of advanced technologies no positive effect was found, while somewhere else a negative trend was noticed (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 a 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 company growth in terms of employment growth was examined in Taiwan. Yang's and Lin's scientific findings are that innovations, measured by R&D investments and patent counts, have a positive impact on company growth (Yang & Lin, 2007). The results of empirical study in the global electronics industry showed that firms spending more on R&D have a higher gross profit, but do not have a higher return on equity (ROE) and return on assets (ROA). The findings suggest that the 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. However, the authors showed that the relationships between environmental responsibility performance and companies' ROE and ROA are positive and statistically significant (Lee, Cin & Lee).

Moreover, it was found that the impact of R&D described above is influenced by the company size as well as the sector and industry. For example, large companies are better able to exploit the results of R&D activities and companies in a high-tech industry to put much more emphasis on R&D activity than firms in low-tech industries do. In our case, we mainly deal with European (large-sized) firms with large investment in research and development. Therefore these companies are more likely to pursue an international strategy in the market for investment in rural development in foreign locations. Consequently, foreign investment in R&D may to influence innovation performance, as well as the growth of local companies and vice versa (Arvantis & Hollenstein, 2011).

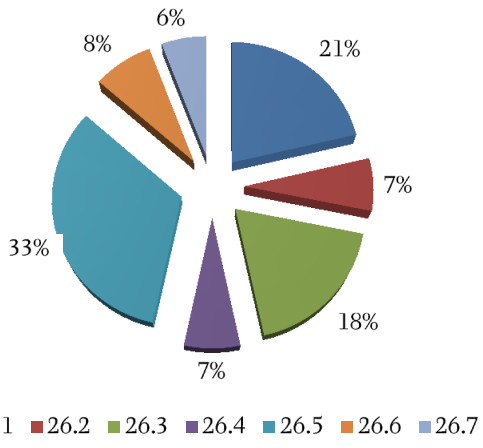
Foreign economic literature deals mostly with examining the impact of R&D and innovation on business performance across the entire industry. This article focuses on innovative companies based in the Czech Republic evaluating only one branch the manufacturing industry. The branch CZ-NACE 26 *Manufacture of computers, electronic and optical products and equipment* is one of the most important branches in the manufacturing industry. The electronics industry is one of the greatest industrial sectors in the world and it still has great potential in EU. On the other hand it is besides the manufacturing industry the sector most affected by the global depression. The crisis caused a significant drop in 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 constantly growing shorter. Production belongs to the category of high and medium-high technology. This branch includes, on the one hand, labour-intensive production and on the other hand, highly productive automated production.

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

MATERIALS AND METHODS

The research itself was conducted among the Czech manufacturing companies of the branch CZ NACE 26 within the section C – Manufacturing industry. From the database of the Czech Statistical Office (CZSO) data were obtained on companies which performed research financed from their own, public and foreign sources in the period 2007–2013. The names of the companies were taken from the AMADEUS database. This database contains registry, financial and trade information of some 455,000 Czech companies (mainly, but not exclusively, corporations). These facts were subsequently verified in the annual reports of the subjects studied and publicly available databases. Information was limited to business corporations. Business corporations – cooperatives, and companies – limited companies and joint stock companies were entered in the sample companies. In order to follow the same criteria used in others, 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 subjects examined will be named in the text as companies in accordance with § 420 and § 421 of Law no. 89/2012 of the Civil Code. The area of the study chosen, the electronics industry, resulted from the aggregation of seven subsectors: 26.1–26.7 (Registry of CZ NACE). The sample, selected by applying the criteria set above, yielded 103 responding companies. The structure of sample is shown in Fig. 1.

In particular, the sample showed a large concentration in the manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks (34 companies), few companies in manufacture of electronic components and boards (22 companies) and in the manufacture of communication equipment (19 companies), and several in the manufacture of irradiation, electro medical and electrotherapeutic equipment (8 companies), the manufacture of computers and peripheral equipment and the manufacture of consumer electronics (both 7 companies). The smallest sector is that of optical instruments and photographic equipment (6 companies). The electronics industry companies 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 companies – microcompanies n_{Mi} = 209, the number of small companies n_S = 269, the number of medium companies n_M = 294, n_L = 26.



1: *Sample structure*
Source: Author's own work

Statistical analysis

The issue monitored can be formulated in two research hypotheses:

- H1: *Implementation of a company's own research in manufacturing company leads to performance and efficiency improvement of companies*
- H2*: Implementation of annual research in the 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 mean indicator for the selected branch. Individual indicators are presented in tables by median and arithmetic mean for the group according to the size. Evaluation of the hypothesis H1 is based on data from companies about on funding R&D performed in the company. To verify the second hypothesis H2, two groups of companies were defined, which differed in the course of R&D investment. There are companies which invested each year and companies which invested occasionally. Due to the characteristics of data, tests were selected (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 came into being from H.B. Mann and D. R. Whitney's proposal to generalize the Wilcoxon Two Sample Test and requires no assumptions on the symmetry of the two samples. Moreover, it can also be applied when the two samples have different sizes.

1st step: sorting data into two statistical samples $(x_1, \ldots, x_m)$ and $(y_1, \ldots, y_m)$. 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 of continuous distribution with distribution function F providing statistical sample $(x_1, \ldots, x_m)$. And the observation random variable Y with continuous distribution with distribution

function G statistical sample $(y_1, \ldots, y_m)$. 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 $m + n$.

2nd step: we denote T_1 as the sum of rank corresponding statistical sample $(x_1, \ldots, x_m)$ and T_2 the sum of the rank corresponding statistical sample $(y_1, \ldots, y_m)$. Statistics T_1 assay criterion variants Wilcoxon Two Sample Test – Mann Whitney test. For this test, we calculate the value of the statistic

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

Hypothesis $H: F = G$ not proved if $U_1 \in \bar{W}_\alpha = v_{\alpha/2} + 1, mn - (v_{\alpha/2} + 1)$, where $v_{\alpha/2}$ is $(\alpha/2)$ – quantile of Mann-Whitney test.

A test against unilateral alternative hypothesis was tested at a significance level $\alpha = 0.05$. For the purposes of achieving the main objective of the study, the authors used the Spearman's rank correlation. Correlation coefficients can take the value in the interval $\langle -1; 1 \rangle$, whereas the positive or negative values signal the dependence direction. The absolute value expresses the strength of the dependence.

Variables

The aim of the analysis was to compare the economic characteristics of selected indicators of economic performance (Kocmanová & Hřebíček, 2013) and to 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 the period because companies 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 branch felt a recovery of the economy (in 2011) and positive developments and companies reached record profitability. The years 2013 and 2014 were followed as the years when the influence of R&D investments started in 2007 would have to be manifested.

In the following Tab. I we report the definition of the financial variables that will be used in the empirical statement:

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 results which will fund the 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).

RESULTS

The results come from a set of companies with their own R&D, found in the reports VTR 5-01 for business subjects. The survey included all companies performing their own R&D with the main activity by classification CZ NACE, being classified into the manufacturing industry, branch CZ NACE 26 Manufacture of computers, electronic and optical equipment. The research sample included a total of 103 companies. Corporations, which were included in the concern during the reporting period-one company from a large corporate category, and the two companies which had fallen into insolvency – one company of the small company category and one of the medium-sized companies category were

I: *Definition of variables*

Mi_A	Micro-companies with Annual Research
Mi_O	Micro-companies with Occasional Research
S_A	Small Companies with Annual Research
S_O	Small Companies with Occasional Research
M_A	Medium Companies with Annual Research
M_O	Medium Companies with Occasional Research
L_A	Large Companies with Annual Research
L_O	Large Companies with Occasional Research
ROE	Return on equity, Ratio of after-tax profit/loss to equity [%]
ROA	Return on assets, Ratio of after-tax profit/loss to assets in total [%]
ROS	Return on sales, Ration of after-tax profit/loss to the sum of revenues from sale of own goods, services, and goods resale [%]
CFOP	Ratio of the Cash Flow to the Operating revenue [%]
SOLR	Solvency Ratio, Ratio of the Shareholders funds to the Total Assets [%]
OPRE	Operating revenue

eliminated from the file before an effectiveness evaluation was conducted. For a summary of the statistics see Tab. II.

The companies are divided into two groups: companies performing their own R&D at any time during the period from 2007–2013 at least once and companies implementing the research activity annually during the entire reporting period. The most represented in both groups are medium-sized companies. The less are represented the large companies. The total number of companies in the reported industrial branch of the manufacturing industry that meet the condition – the foundation before 2007 and that were active in the period 2007–2013 is 798. Tab. III shows the number of innovative companies and their share in the number of companies in the observed industrial branch according to the size.

Calculations show that the large companies are the most frequent in case of occasional (OR) and annual research AR). The frequency of medium-size innovative companies which perform an annual research throughout the period is just above 7%, the number of small businesses is about 6%. The proportion OR of companies is very similar in case of SMEs. The frequency of innovative companies is similar to a study result of the use of external sources of financing activity (Dooley, Kenny, & Cronin, 2016).

Business activity throughout the industrial branch and frequency of companies performing the research is presented in Tab. IV.

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

The aim of Europe Strategy 2020 is to achieve an R&D Intensity with the required division of funding: 2% of the business sector and 1% of the government sector. Companies of Czech electronics industry reached the highest percentage of R&D expenditure in 2007 (0.72 %). See Fig. 1.

The highest R&D expenditures (0.72%) were in the last year of economic growth before the crisis. After a slump in 2010 (0.46%), the share of R&D expenses slowly increased up to 0.51% in 2013. Companies in electronics industry are underinvested in the long term.

II: *Summary statistics for the period 2007–2013*

	Annual Research 2007–2013		Occasional Research 2007–2013	
Size of firm	**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

Source: author's calculation, n = 103

III: *Number of innovative firms by size*

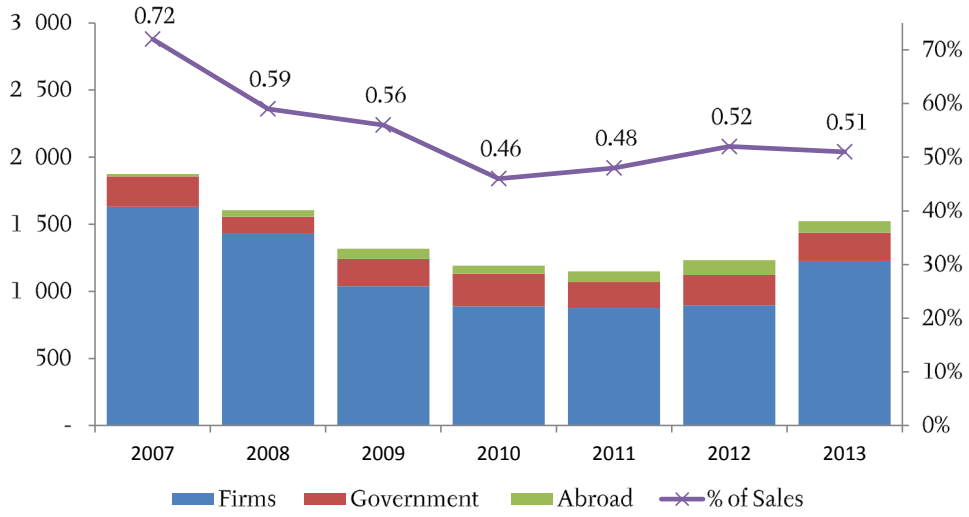
	Annual Research 2007–2013		Occasional Research 2007–2013	
Size of firms	**Number of firms**	**Percentage by size [%]**	**Number of firms**	**Percentage by size [%]**
Micro	5	2.4	9	4.3
Small	16	5.9	22	8.2
Medium	22	7.1	20	6.8
Large	5	19.2	5	19.2

Source: author's calculation

IV: *Share of innovative companies in the total number of companies in the industrial branch*

	Annual Research 2007–2013		Occasional Research 2007–2013	
Size of firms	**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

Source: author's calculation



2: *Development of R&D spending in electronics industry (in mil. CZK)*
Source: Own processing based on the data of CZSO

Comparison of the effectiveness of the group of companies with occasional research and annual research

Comparison of individual groups of companies is based on the share of frequency according to Tab. I. The mutual comparison of the financial results confirmed the stated hypotheses.

Values of the selected indicators in the financial analysis in the test groups were not normally distributed. See Tab. V.

To compare selected groups of companies' nonparametric statistics was used to determine the mean, median and quartiles which were used for the graphic representation of the box charts. The Annual Research R&D expenditure indicator is generally correlated with other indicators (Operating revenue in selected years) as it could be expected. In the case of AR R&D expenditure indicators, the Spearman's correlation coefficient is positive which means that the higher the R&D expenditure, the higher the Operating Revenue in the following years.

The financial indicators ROE and ROA were compared within two groups of companies. The first group performed AR 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 the Czech Statistical Office (CZSO). The company values ROE by size are given by size in the Tab. VI.

The presumption that R&D expenditures lead to a higher return on equity and higher business performance (measured by return on assets ROA) was proved in micro, small and medium-sized companies during the economic upturn. L_A and L_O groups were significantly above the indicator value published by the MIT for 2007 and above the monitored part. During the economic crisis (2009) there was a significant decline in indicators for micro and medium-sized companies. Small companies suffered a decrease of profitability on the contrary, large companies improved their ROE significantly compared to 2007 and compared to a mean value for the electronics industry. In 2014 it seemed that the position of small and large companies would be strengthened when the group of AR improved the ROE mean compared to the base year. Profitability of small companies fell significantly while the development indicator of large companies is variable. We supposed that the companies that already invested their own funds to R&D in 2007 would better face the post-crisis period. Return on equity is monitored and MIT as well as for the individual industrial branches of the manufacturing industry. Tab. V shows that the mean value of the ROE indicator dropped in the whole branch, although the indicator in NACE

V: *Spearman's correlations between alternatively-constructed measures of each index*

	Research and Development versus Operating Revenue*									
	2007 X 2009	**2007 X 2011**	**2007 X 2013**	**2007 X 2014**	**2009 X 2011**	**2009 X 2013**	**2009 X 2014**	**2011 X 2013**	**2011 X 2014**	**2013 X 2014**
AR & OR	0.366	0.374	0.358	0.359	0.416	0.434	0.382	0.412	0.429	0.563
AR	0.701	0.666	0.642	0.635	0.562	0.532	0.528	0.589	0.629	0.761
OR						0.331				0.440

*Correlation coefficients statistically significant at the significance level 0.05
Source: author's calculation

VI: *Variable ROE, ROA and ROS*

		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**
ROE					Mean					
	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
					Median					
	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
ROA					**Mean**					
	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	12.65	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	9.65	3.00	*	5.35	10.48	12.19	11.85
					Median					
	2007	37.99	7.10	8.72	0.27		11.07	21.83	8.58	4.14
	2009	27.91	2.08	7.58	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	7.19	3.31		10.39	3.25	6.27	13.00
	2014	3.21	5.74	8.76	2.02		4.01	5.02	9.65	11.95
ROS					**Mean**					
	2007	5.55	7.50	7.64	-31.20	**5.95**	8.70	9.42	5.97	1.99
	2009	6.78	3.19	9.35	0.85	**0.98**	4.40	7.99	-1.14	-0.42
	2011	0.28	2.97	11.10	10.34	**3.59**	11.36	6.71	4.99	-1.71
	2013	-5.08	4.66	7.85	5.87	**4.47**	10.77	0.76	7.52	4.89
	2014	0.32	7.38	8.39	2.91	**3.98**	0.29	10.18	9.28	5.15
					Median					
	2007	5.99	4.03	7.66	0.40		7.26	10.12	4.73	1.51
	2009	7.36	3.54	6.41	0.61		5.51	9.07	2.00	0.72
	2011	2.05	2.94	8.06	6.28		1.16	4.22	3.74	1.26
	2013	2.06	3.76	9.33	3.32		9.96	4.61	4.16	3.11
	2014	0.32	3.86	7.82	3.82		6.39	5.70	7.71	5.33

Source: author's calculation based on the data of AMADEUS

26 in the Czech Republic reached a positive value between 2011 and 2013. If we assess the median for each size of companies, 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 companies in 2007, neither the mean 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 companies practically achieved the same values. In the years 2009 and 2011 there are statistically significant differences in the group of medium-sized companies. The biggest difference was in the group of large companies when companies with continuous research achieved

VII: *Variable Cash flow/Operating revenue [%]*

	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**
					Mean				
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
					Median				
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 based on the data of AMADEUS

the best result for the monitored period. There is a statistically significant difference between the ROE achieved by L_A and L_O for the year 2014. See Tab. VI.

From the performance recovery point of view measured by return on assets, both groups of micro, SMEs proved to be successful. ROA in the reference industrial branch were significantly above the mean. Thus the hypothesis H1 is confirmed. The large companies' **profitability was below the** mean of the monitored industrial branch. In 2009 there was a decline in indicators for micro and SMEs. On the contrary, large companies improved the ROA as well as the ROE. The crisis had the smallest impact on micro innovative companies, where the mean ROA indicator for 8 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 the mean of the industrial branch. In the case of comparing the medians the values are more balanced. For the ROA there was shown statistically significant difference between the group S_A and S_O in 2011.

For the ROS indicator, the sector mean value is published by the Czech Statistical Office. The company values ROE by size are given in the Tab. VI.

ROS based on net profit generated per one CZK. Despite the global crisis in 2009 Mi_A managed to create the highest profit in the period. Since 2011, ROS values are the lowest of all monitored groups and also lower than the values of the entire section. An statistically significant difference among the groups was found in medium-sized companies in 2009 and 2011. The companies M_A were able to cope most quickly with the consequence of the recession and in 2011 they reached the highest profitability. In the year of profitability growth of the electronics sector, M_O companies increased their ROS value, but in years 2009–2013 they did not manage to reach the same profit as in 2007. A statistically significant difference was generated among large companies and which happened in 2011. L_A created profit significantly above the value of the whole section (6.28). L_O companies had the lowest value for the entire period.

Another monitored indicator was the CFOR. In this calculation, the mean of the indicator was calculated for the entire industrial branch from the database AMADEUS. For the means and medians see Tab. VII.

The indicator S_A and L_O was lower than the mean of the branch. SME's had a higher value indicator than the mean of the branch. The economic crisis had an impact on the value decline of the entire branch, OR companies decreased their indicator value with no exception and AR companies were above the mean of the branch while small companies only recorded a decline compared to 2007. A statistically significant difference appeared between Mi_A and Mi_O in 2013 and between L_A and L_O in 2011 and 2013, they are shown in Tab. X.

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 indicates the financial stability and independence of the company. If the solvency ratio is higher, the firm's ability to meet its obligations is better. For the mean values and medians see Tab. VIII. The industrial branch value was obtained by calculation from the database AMADEUS.

The SOLR shows the increase of the stability and self-reliance in financing of the SMEs and large companies. Small companies have been facing a decrease of monitored indicator values since 2011. The value of the indicator of both groups of large companies is below the branch value. L_A has better values than L_O. However these differences are

VIII: *Variable Solvency ratio [%]*

	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**
					Mean				
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
					Median				
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

not statistically significant. Statistically significant differences are found between the M_A and M_O in the years 2009, 2011 and 2013. Operating revenues of companies in medians are specific for every monitored group. See Tab. IX.

The sales of Mi_A and M_{iO} decrease. Since 2007 the S_A sales had been decreasing. Until 2014 no company reached the values from 2007. M_A and L_A significantly increase the difference between annual research and occasional research. The AR companies have stable sales without important fluctuations. A statistically important difference is evident between groups M_A and M_O in 2009. There were found no statistically important difference between companies from other groups. To find the existence of a statistically significant difference for the individual indicators a nonparametric statistics were used. Tab. X compares all monitored samples and the Mann-Whitney U test results by ROE, ROA, ROS, CL/OR, SOLR and OP.

The results show significant differences in the perception of the burden imposed by R&D expenditures. The values of financial indicators ROE, ROA, ROS and CL/OR for groups of medium companies are statistically different significantly ($p < 0.05$), which means that continuity in R&D has an impact on profitability indicators. There are no statistically significant differences between the measured samples, especially in turnover.

DISCUSSION

The basic results of the groups of companies compared according to size and development of R&D expenditures are summarized in Tabs. VI–IX. The comparison is based primarily on return on equity and efficiency. Apart from basic comparison some of the factors which are reflected in ROE can be analyzed later. Characteristics in Tables VI–IX describe the years 2007, 2009, 2011, 2013 and 2014. It is possible to observe what results were reached in the group of companies in terms of economic growth (2007), during the recession (2009), during the subsequent recovery (2011), during a period of moderate growth thanks to the intervention of the CNB (2013) and significant growth in the sub-sector compared to the rest of the manufacturing industry (2014). A comparison of results of both samples enables us to verify the hypothesis H2. The assumption that AR leads to a higher return on equity ROE and higher companies effectiveness, measured by ROA and

IX: *Operating revenue – Median (th EUR)*

	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	286.53	1,602.92	5,161,16	64,503.74	343.11	1,140.70	5,106.15	14,601.51
2009	390.80	1,547.40	6,419.95	65,340.71	283.87	1,442.31	4,514.05	23,151.10
2011	327.44	1,587.42	6,417.68	73,891.39	290.69	1,562.50	5,053.20	41,161.43
2013	226.75	1,357.57	6,422.39	78,590.89	270.01	1,944.94	5,261.59	44,951.57
2014	185.33	1,507.89	7,788.40	75,856.70	209.14	2,123.90	5,715.91	78,013.40

Source: author's calculation

X: *Mann-Whitney statistically significant difference*

	Mi_A v. Mi_O	S_A v. S_O	M_A v. M_O	L_A v. L_O	Mi_A v. Mi_O	S_A v. S_O	M_A v. M_O	L_A v. L_O	Mi_A v. Mi_O	S_A v. S_O	M_A v. M_O	L_A v. L_O
	ROE				**ROA**				**ROS**			
2007			0.046									
2009			0.021								0.044	
2011							0.034				0.011	0.022
2013												
2014				0.22								
	CL/OR				SOLR				OPRE			
2007												
2009												
2011			0.018			0.018						
2013			0.005			0.005						
2014			0.008			0.008						

Source: author's calculation

ROS indicators was proved only on SMEs. This assumption was confirmed in ROE for all years.

A statistically significantly different median was observed in M_A and M_O in the boom year (2007). For a period of recession (2009) there was an assumption that companies which were able to invest in R&D had a strong competitive position and could better face the consequences of the economic crisis. This assumption was confirmed only in five M_A and M_O. Small companies investing annually were not as profiTab. for owners as companies investing occasionally during this period. In the group of large companies there was a statistically significant difference in 2014 when the performance of the electronics industry considerably exceeded the mean of the manufacturing industry. The indicator ROA shows similar results. Indicators dropped considerably between 2007 and 2009 in the group of M_A and S_O, large companies coped better with the crisis. M_A and M_O compared to the last year of economic growth before the crisis (2007) reached similar values of ROA. Micro and small companies significantly decreased their return on assets. L_A increased performance in the boom period in 2011, but L_O significantly improved the value of ROA in 2013 and 2014. For this indicator there was a statistically significant difference in the groups M_A and M_O in 2011. As an explanation to clarify the rapid recovery and achievement of a similar level of profitability of AR companies, the most obvious cause is rapid growth, or renewal and increase of the previous high levels of ROS – return on sales. This was increased slightly only in groups of M_{IA} and L_A between 2007 and 2009, but since 2009 the indicator has grown especially in S_A and S_O. S_A in 2014 was marked by a decline compared to 2011 and 2013. S_O increased the indicator value significantly, compared to 2007.

CONCLUSION

The article is based on our own research on the influence of research activities in production companies in 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 be reflected in the economic indicators and thus strengthen the competitiveness of the company. To evaluate the effectiveness only one branch of the manufacturing industry MANUFACTURE OF COMPUTERS, ELECTRONIC AND OPTICAL DEVICES AND INSTRUMENTS was selected, with the intention of preserving the homogeneity of the sample monitored. Companies were divides into a sample of companies with annual research and occasional R&D investment. Financial results of companies by size groups were mutually compared in the period 2007–2014. The data were analysed using Spearman's rank non-parametric correlations. In the results published, the years were selected: 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, 2011 – there was a revival of the economy and the years 2013and 2014. The assumption was not confirmed that R&D investments led to an increase of the return on equity for micro and SMEs during the period of 8 years. In 2014 none of these groups o reached the value of the ROE from 2007. In comparison with the results of the entire branch, 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 companies which were significantly below the branch mean in the last year of the 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 research performed confirmed the ability of the efficient use of their capital base. The conclusions formulated fully respond to innovative companies of the electronics industry. In spite of the scope of the data focused on one branch of the manufacturing industry it cannot be possible to establish conclusions on the impact of R&D investment on the performance and efficiency throughout the economy, which was not the aim of the research. Other valuable information could be provided by monitoring the impact of R&D investment from both public and own resources and define thus other factors that affect performance, efficiency and competitiveness of companies in macroeconomic context.

REFERENCES

ARVANTIS, S. and HOLLENSTEIN, H. 2011. How do different drivers of R&D investments in foreign locations affect domestic firm performance? An analysis based on Swiss panel micro data. *Industrial & Corporate Change,* 15(2): 605–640.

BANBURY, C. and MITCHELL, W. 1995. The effect of introducing important incremental innovation on market share and business survival. *Strategic Management Journal,* 16:161–182.

BROEKEL, T. 2015. Do Cooperative Research and Development (R&D) Subsidies Stimulate Regional Innovation Efficiency? Evidence from Germany *Regional Studies,* 49(7): 1087–1110.

CRESWELL, J. 2013. *Research Design*. Fourth Edition. SAGE Publications: SAGE Publications, Inc.

CZARNITZKI, D. and DELANOTE, J. 2015. R&D policies for young SMEs: input and output effects. *Small Bus Econ*, 45: 465–485.

CZSO. © 2015. *Economic Results of the Industry of the CR – 2013* [in Czech: *Ekonomické výsledky průmyslu v ČR – 2013*]. [Online]. Available at: https://www.czso.cz/csu/czso/economic-results-of-the-industry-of-the-cr-2013. [Accessed 2016, January 12].

DOOLEY, L., KENNY, B., and CRONIN, M. 2015. Interorganizational innovation across geographic and cognitive boundaries: does firm size matter? 46(1): 227–243.

EUROPEAN COMMUNITIES.© 2006. *New definition of SMEs.* [in Czech: *Nová definice malých a středních podniků*].[Online]. Avaiable at: https://www.szif.cz/cs/CmDocument?rid=%2Fapa_anon%2Fcs%2Fdokumenty_ke_stazeni%2Feafrd%2F1182414202559.pdf [Accesed 2015, December 2].

KOCMANOVÁ, A., HŘEBÍČEK, J. et al. 2013. *Měření podnikové výkonnosti.* Brno: Littera.

LEE, K.H., CIN, B.C. and LEE, E.Y. (2014). Environmental responsibility and firm performance: The application of an environmental, social and governance model. *Business Strategy and the Environment.*

MIT.2009. *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 3].

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].

Registry of CZ-NACE [in Czech: Seznam CZ-NACE]. [Online]. Available at: http://wwwinfo.mfcr.cz/ares/nace/ares_nace.html.cz. [Accessed: 2015, November 16].

SCHINKE, A. and 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. and 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.

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.

YANG, Ch. and LIN, Ch. (2007). Developing employment effects of innovations: microeconometric evidence from Taiwan. *The developing Economies,* 46: 109–134.

ZELENÝ, M. (2011). *Search own way.* [In Czech: *Hledání vlastní cesty*]. 1st Edition. Brno: Computer Press.

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