# Analysis of the Relationship between Research and Development Intensity and Sectoral Performance: The Case of Czech Republic

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**Abstract**

*The authors decided to verify the axiom of the key positive impact of research, development and innovation on a firm's prosperity. A sample of companies, the main scope of business of which is CZ-NACE M72 Research and development, were analyzed. Based on a comparison of economic results of this sample with average values of the other 10 branches, two hypotheses were verified. Analysis of the sample of companies in the branch of research and development showed that intensity of research and development need not impact a firm's performance in a dominant way. This is confirmed by variable results of the reached values of return on equity, return on assets, the spread of economic value added in years 2014 to 2017 and assets turnover ratio, gross profit margin, value-added in revenues and value-added per worker in years 2015 to 2017. The investigation did not confirm the continuously higher level of performance of companies in the research and development branch with statistical significance even in the subsequent elimination of possible property interconnections within subsidiaries and parent companies.*

**Keywords:** *research, development, innovation, efficiency, prosperity, competitiveness*

**JEL Classification:** 032, M21, L25

**DOI:** https://doi.org/10.31577/ekoncas.2021.07.03

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## Introduction

Due to globalization processes, competitiveness has been observed in the long term. Being an irreversible process, globalization spreads in any life sphere of our society and makes such entities compete which would have never been competing before, especially because of technological, logistics, political and legal barriers. The development of technologies has created a new commercial reality – the rise of global markets. In the world, there are approximately 40 000 supranational companies, which dominate thanks to their standardized products and brands (e.g. ŠKODA AUTO, Samsung Electronics, Microsoft). The companies strive for improving competitiveness via various tools and they must also monitor the factors which can affect the competitiveness. The main factors include financial and human resources, logistics, rivalry in the branch, suppliers' and consumers' negotiating force and research, development and innovation.

Research, development and innovation can help jump ahead of the competitors, and they should form inseparable parts of company life and thus create the conditions for the present, as well as future prosperity and productivity. And this is the reason why numerous top managers from globally successful companies follow the quote 'Innovate or die!' including Bill Gates, and innovator and founder of Microsoft, which belongs among the most successful companies in the world in the long term. Scientific experts do not overlook the key position of research, development and innovation within competitors' fight and they have dealt with this issue for tens of years (see Matson, 1981; Drucker, 2002). Undoubtedly, they consider the positive impact of research, development and innovation (hereinafter referred to as RDI) on a company's competitiveness to be nearly an axiom, which need not be verified in practice. As a consequence, there are just a few studies that would quantify the relation between the degree of involvement, resp. investments in RDI and the company's performance.

For example, Tubbs (2007) explored the relation of R&D and a company's performance in general, Cho et al. (2008) dealt with the relationship between investments in R&D and performance in Korea, and Bond and Guceri (2016) examined this issue in the UK. Bobillo et al. (2006) focused on the competitiveness and performance of Spanish industrial firms; their thesis revealed a positive relationship between prosperity and research and development (hereinafter referred to as R&D). Hall et al. (2009) explored the impact of innovation and R&D on the productivity of small-sized and medium-sized companies in Italy. They found a positive impact of innovation on a firm's productivity, especially process innovation. Reid (2012) dealt with performance and innovations in Canada, and El Elj (2012) explored the issue in Tunis. Some authors have focused their theses on a specific branch, e.g. Sharma (2012) concentrated on the pharmaceutical

industry in India and Nivoix et al. (2012) studied that topic in Japan. The study (see Ghaffar and Khan, 2014) monitored the impact of research and development on a firm's performance and confirmed the strong correlation between R&D and ROE (correlation coefficient 0.897). The correlation was explored through a sample of Pakistani companies running a business in the pharmaceutical industry. On the contrary, Beldon's thesis (see Beldon, 2014) found a negligible correlation (0.079) between RDI and prosperity. Measurement was done with ROA. Even some empirical studies show that R&D activity hurts firm performance (e.g. see Chan et al., 1990). Mank and Nystrom (2001) argue that R&D spending has a decreasing return in the computer industry, contradicting those previous findings.

The aforementioned studies bring ambiguous results. Their authors ask how much R&D or RDI is crucial for a firm's performance, and how much other factors affect, which may even overshadow RDI success or support it on the way to prosperity.

The aim of the research, the results of which are presented in this article, is to quantify the performance of branches in the Czech Republic and thus confirm or disconfirm the impact of RDI degree in the branches on performance in the branches. Based on achieved prosperity and productivity, single branches are compared and two hypotheses are verified. The first hypothesis is focused on confirmation of the dominant influence of RDI on a firm's performance and thus on confirming the fact that the branch with the highest degree of RDI shows the highest performance, too. The second hypothesis verifies that the manufacturing industry shows higher values of performance indicators because it heads the list of investments in RDI and it also increases the values of its results commercially through repeated production. The hypotheses will be verified by comparing a statistically significant sample of companies working within the field of research and development (18.52%) with branch statistics of the other 10 branches.

## 1. Theoretical Background, Research Objective

Innovation is a consequence of research and development; this applies to technical innovation unambiguously. Innovation (and not only the technical one but also process and marketing innovation, etc.) is considered to be a key tool for competitiveness as well as a key tool for prosperity, which go hand in hand. Despite some definitions of competitiveness pass the term of RDI over (e.g. see Chursin and Makarov, 2015; Pitra and Mohelská, 2015). In general, a firm's competitiveness is the ability to gain a competitive advantage in a market, strongly turbulent environment via cost reduction, or differentiation and application of the world's

best practices. Chursin and Makarov (2015) state that it includes elements of productivity, cost efficiency and profitability, and it is understood as a collection of strategic and tactic measures which result in gaining the competitive advantage. A firm's competitiveness is an ability that allows the firm to succeed in competition with other entities that strive for reaching the same or very similar objectives.

Innovation (results of research and development) is one of the important competitiveness factors. The task of innovation is crucial for the maintenance of productive economies and it enables companies of advanced countries, which must face competitors from developing economies, to succeed in globalized markets. The companies must more often compete with unique production, specific know-how and innovation, they must transfer their activities to research-intensive and knowledge-intensive production, which requires high qualification and adaptability of the labour force. RDI should help competitiveness and it should have a positive economic impact. This fact was highlighted by experts since the last century (e.g. see Schumpeter, 1960; Long and Ravenschraft, 1993) until now (e.g. see Vivero, 2002; Engel, 2015).

Engel (2015) says that innovation leaders are more successful in their branch than their competitors are and that they can generate up to four times as higher value for their companies than average competitors in the branch. Innovation represents a crucial element for the further development of a company and improvement of competitiveness within the present globalized market. And it is closely related to research and development which provide the required primary platform for the creation and implementation of innovation, especially with the focus on the production of new products and services. R&D plays a key role in a firm's productivity, growth and long-term performance (Long and Ravenscraft, 1993; Vivero, 2002).

Among others, the performance also includes prosperity and productivity, which is according to (see Veber, 2004) expression of the performance of the worker, machine, equipment, or the entire company per a unit of time. Helfert (1994), Bowlin (1998) and Carton and Hofer (2006) dealt with measurement of performance through financial analysis, in the past. Those studies use profitability and activity indicators because they are crucial for the companies and they also express the level of prosperity and productivity.

Based on (CZSO, 2018), in the years 2015 – 2017, 42% of companies out of the total number of economically active firms performed some innovation activities in the Czech Republic. Large enterprises employing more than 250 people were the most active ones within the implementation of innovations (share of 77.2% out of all the companies of this size group); followed by medium (59.1%) and small enterprises (35.2%).

Within the manufacturing industry, even 80.3% of large enterprises executed innovation activities. Share of those companies which innovated falls down again along with smaller size. The innovation leaders are the companies that deal in the production of other means of transport or equipment. In this branch, 74.3% of companies implemented some innovations. Companies working within petrochemical and chemical industries innovate highly above standard, too (73.1%). Among CZ-NUTS regions, Prague (52.2%) and Central Moravia (51.5%) innovate most, and vice versa Northwest (33.3%) and Southwest (43.4%) innovate least.

Foreign studies (see PwC, 2014) highlighted the importance of innovation. The surveys were realized via interviews with 1757 executives and managers of companies from 25 countries and 30 sectors, and 41 top managers worked within the chemical industry from 12 countries in total (e.g. from the USA, Netherlands and Germany).

92% of companies all over the world confirmed the influence of innovation in the present; and 98% confirmed that in the next 5 years (see PwC, 2014). The importance of innovation for a firm's productivity is also supported by studies (see Rao et al., 2001; Gkikas et al., 2014).

Furthermore, the areas to which the innovations apply were examined. The responding companies say that incremental innovation (of an already existing product or service) is crucial for systems and processes (54%), and radical innovation is crucial for the area of customer experience (15%). However, the highest priority belongs to products (28%) and services (23%).

The key indicator of research and innovation performance is R&D intensity, which is also documented in the studies (see Yabuuchi et al., 2014; Banker et al., 2016).

This indicator was measured in the Czech Republic in 2012 for the last time, and it reached 1.88% (in comparison with EU 2.07% and USA 2.79%). Another indicator is Innovation output which was developed to compare national innovation policy and to monitor EU performance and performance of main EU business partners. This is to measure how much innovative thoughts can stand the market, provide better jobs and increase European competitiveness. Kleis et al. (2012) and Schwartz et al. (2012) focused on the innovation output.

The indicator consists of four areas – patents, jobs, long-term global competitiveness and business opportunities. In 2012, the Czech Republic reached 89.7 points and the EU reached 101.6 points. Research and Innovation performance in CR (2014) says that the Czech system of innovations is characteristic of continuous financing of R&D from public resources, of a high number of new S&E and PhD graduates and of the high incidence of R&D in working foreign affiliates.

Undoubtedly, RDI has a positive impact on a firm's performance. This fact has been proven in practice and experts can agree with that. So, is it possible to assume automatically that companies with the highest degree of RDI should report the highest performance, too?

Hypothesis 1: *The branch of Research and Development reports the highest values of performance indicators, as it reaches the highest level of R&D within its activities*.

Hypothesis 2: *The branch of manufacturing industry reports higher values of performance and productivity indicators, as it takes the first place in investments in RDI and it also increases the value of its results commercially*.

## 2. Methodology and Data

### 2.1. Applied Indicators

Performance in the branches is to be measured by selected standard and modern tools of financial analysis. Authors regard liquidity indicators as very general and often misleading scale of solvency; indebtedness indicators do not reflect the stability of earnings and returns and market value ratios include a lot of subjective effects, and what is more, they apply just to a fraction of Czech companies. This was the reason why the indicators of return on investment and indicators of activity, representing the scale of prosperity and productivity, were applied to analyze the development of performance. The indicators are the following, to be the specific return on equity (ROE), return on assets (ROA), spread (EVA spread), asset turnover (AT), gross profit margin (GPM), value-added/revenues (VAR), workforce productivity (WFP).

ROE indicator certainly belongs among the standard indicators of a firm's performance; it expresses return on capital invested by shareholders or company owners. The calculation is following, e.g. according to (see Kuběnka, 2018):

$$\text{ROE} = \text{earnings after taxes (EAT)} / \text{equity} \quad (1)$$

The study (see Ghaffar and Khan, 2014) monitored the impact of research and development (R&D) on a firm's performance and affirmed the strong correlation between R&D and ROE (correlation coefficient 0.897). The correlation was explored via a sample of Pakistani companies running their business within the pharmaceutical industry.

On the contrary to the study (see Ghaffar and Khan, 2014) and Beldon's study (see Beldon, 2014) describes negligible correlation (0.079) between RDI and prosperity, which was measured through ROA this time. And this is not the

only reason, why the next selected indicator is the return on assets (ROA). This indicator was chosen as it describes the company's ability to evaluate its assets, regardless of the resources from which the assets were financed from.

$$\text{ROA} = \text{EBIT} / \text{total assets} \tag{2}$$

The authors ask how much R&D or RDI is crucial for a firm's performance, and how much other factors affect, which may even overshadow RDI success or support it on the way to prosperity.

Nevertheless, some other studies confirm positive impacts of RDI on a firm's performance, e.g. (see Belderbos et al., 2004; Aguiar and Gagnepain, 2013; Pantagakis et al., 2012).

SPREAD (resp. EVA SPREAD) means the percentage of the created economic value added (EVA) out of the total equity. A positive value of EVA presents returns of the company which cover common and extra costs, explicit costs on foreign capital and implicit costs of the firm's equity. So the creation of economic value-added does not require only a positive return on equity, but it also requires a return on equity that exceeds implicit costs of equity (re). The formula is following:

$$\text{EVA} = (\text{ROE} - \text{re}) * \text{VK} \tag{3}$$

The calculations below will use the values from branch statistics released by MPO, where calculation of implicit costs of equity ($r_e$) uses build-up model, which is based on INFA® rating model which specifies the total remuneration for investment risk in the form of risk rates, similarly as rating agencies do. The applied SPREAD calculation method, which will specify the percentage of EVA out of equity, is following:

$$\text{SPREAD} = \text{ROE} - r_e \tag{4}$$

This is an indicator of a firm's prosperity, thanks to which investors can find out whether their capital is reproduced with due intensity corresponding to the risk rate of the subject of business, which is described by the value re. Other selected performance and productivity indicators are:

$$\text{Assets turnover ratio (ATR)} = \text{sales/total assets} \tag{5}$$

$$\text{Gross profit margin (GPM)} = \text{sales/total assets} \tag{6}$$

$$\text{Value added in revenues (VAR)} = \text{value added/sales} \tag{7}$$

$$\text{Value added per worker (VAW)} = \text{value added/total no. of staff} \tag{8}$$

### 2.2. Ways of Verification of Hypotheses

This study aims to analyze the situation in the selected branches of the national economy and to verify the dominant impact of research and development on the firm's economy. Hypothesis 1 ($H_1$) will be affirmed or rejected in most branches classified by CZ NACE. The group to be tested includes the branches below in Table 1. The branch data is retrieved from the statistics of the Ministry of Industry and Trade and a sample of commercial companies running their business in the branch of Research and Development. Performance and productivity of the individual branches will be evaluated based on the selected indicators (see chapter 2.1) and the final ranking list will be created with the use of points, which will specify the place of the branch in terms of the individual indicators. The final ranking will be based on the sum of points reached for the single indicators. If the branch of Research and Development reaches the highest sum of points, then $H_1$ will be confirmed.

The manufacturing industry invests in RDI in the highest range and it also deals in production which helps increase the value of its results commercially. However, there is a question if the manufacturing industry can report higher performance and productivity thanks to that than the branch M72 Research and Development, where research and development is the main scope of activity. Calculation of confidence intervals for the sample of companies from the M72 branch will verify if the reached values of the selected indicators (ROE, ROA, SPREAD) differ statistically, if so hypothesis 2 ($H_2$) will be confirmed. Confidence interval is already a classic and frequently used method.

$$P(p - z_{1-\frac{\alpha}{2}} * \sqrt{\frac{p(1-p)}{n}} < \pi < (p + z_{1-\frac{\alpha}{2}} * \sqrt{\frac{p(1-p)}{n}}) = 1 - \alpha \qquad (9)$$

where

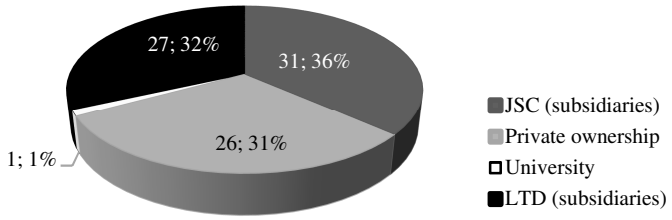
$p$ – reached percentage of ROE, ROA or SPREAD in the branch of research and development,
$n$ – number of the tested sample of companies,
$\alpha$ – selected level of importance.

### 2.3. Analyzed Data Sample

Database of economic entities Bisnode MagnusWeb says that over 1100 active entities with turnover above 5 mils CZK/year exist in the branch M74 Research and Development in the present (August 2018). 600 of them are legal entities and there are 459 commercial entities (mostly with the legal form Ltd. and JSC), the core business of which includes research and development. Within this investigation, 85 financial statements (balance sheet, profit and loss statement)

were retrieved after elimination of extreme values and missing data; the statement was analyzed and used for calculations in formulas (1), (2) and (4). The documents included statements from 85 firms for the period of four last available years (2014 – 2017). The sample of 85 companies thus represents 18.5% out of the firms the core business of which is research and development in the field of natural and engineering science and which are active in 2018. The sample includes 14 joint-stock companies and 61 limited companies. Some companies are owned by private persons, but most by legal entities. This may affect the amount of reported profit. Especially in the case of a foreign owner, companies often try using transfer pricing to ensure tax optimization.

Figure 1
**Sample Decomposition According to Ownership Structure**




*Source:* Authors.

Naturally, the sample of 85 companies includes companies that are property-related to others. It is not uncommon for so-called subsidiaries to have distorted accounting information, as the valuation of their output depends on the pricing and tax policies of other related companies. Therefore, the sample is decomposed into companies without property connections (an owner is a natural person) and subsidiaries that are controlled by the parent company (especially JSC, university, Ltd. and other Ltd equivalents as GmbH, s.r.o., B.V., LLC). The analysis monitors how different the financial situation of independent and subsidiary companies in the field of RDI differs.

## 3. Results and Discussion

### 3.1. Performance in Branches and Verification of Hypothesis $H_1$

A total of 11 branches were analyzed to monitor the performance of the single branches. The difference among the reached values of the applied indicators should confirm the key impact of RDI on the performance of companies, resp. branches. Performance was measured with the selected indicators, especially in the category of prosperity and productivity; for details see Table 1 and Table 2.

T a b l e 1
**Performance in Branches Based on Return on Capital and EVA SPREAD** (in %)

| NACE | Branch | Year | ROE | ROA | $r_e$ | SPREAD |
|---|---|---|---|---|---|---|
| A | Agriculture, forestry and fisheries | 2015 | 5.25 | 5.53 | 6.33 | –1.08 |
| | | 2016 | 5.39 | 5.43 | 15.36 | –9.97 |
| | | 2017 | 6.83 | 7.01 | 14.73 | –7.90 |
| B | Mining and quarrying | 2015 | 9.08 | 5.97 | 13.64 | –4.56 |
| | | 2016 | –1.16 | 1.18 | 9.34 | –10.50 |
| | | 2017 | –3.01 | –0.91 | 8.46 | –11.47 |
| C | Manufacturing | 2015 | 12.12 | 7.98 | 12.43 | –0.31 |
| | | 2016 | 10.37 | 7.03 | 11.86 | –1.49 |
| | | 2017 | 14.42 | 9.98 | 10.26 | 4.16 |
| D | Electricity, gas, steam and air conditioning | 2015 | 19.30 | 3.97 | 11.98 | 7.32 |
| | | 2016 | 16.00 | 5.58 | 10.69 | 5.31 |
| | | 2017 | 6.79 | 3.75 | 10.15 | –3.36 |
| E | Water supply; wastewater, waste management and remediation | 2015 | 4.08 | 3.61 | 10.68 | –6.60 |
| | | 2016 | 3.80 | 3.08 | 10.59 | –6.79 |
| | | 2017 | 5.20 | 4.33 | 8.87 | –3.67 |
| F | Construction | 2015 | 6.76 | 3.32 | 11.58 | –4.82 |
| | | 2016 | 5.97 | 2.28 | 13.08 | –7.11 |
| | | 2017 | 5.87 | 3.00 | 11.04 | –5.17 |
| G | Wholesale and retail trade; repair of motor vehicles | 2015 | 8.85 | 3.17 | 17.34 | –8.49 |
| | | 2016 | 7.20 | 2.98 | 15.73 | –8.53 |
| | | 2017 | 9.31 | 3.63 | 13.46 | –4.15 |
| H | Transportation and storage | 2015 | 4.08 | 3.81 | 12.33 | –8.25 |
| | | 2016 | 3.34 | 3.32 | 12.60 | –9.26 |
| | | 2017 | 4.61 | 3.62 | 13.06 | –8.45 |
| I | Accommodation and food service | 2015 | –11.72 | –0.20 | 25.71 | –37.43 |
| | | 2016 | –27.89 | 2.11 | 13.43 | –41.32 |
| | | 2017 | 0.80 | 4.22 | 21.88 | –21.08 |
| J | Information and communication | 2015 | 15.32 | 11.81 | 8.99 | 6.33 |
| | | 2016 | 10.70 | 9.50 | 8.31 | 2.39 |
| | | 2017 | 10.09 | 7.88 | 8.70 | 1.39 |
| M72 | Research and development | 2015 | 10.27 | 5.43 | 10.10 | 0.17 |
| | | 2016 | 5.11 | 3.44 | 9.34 | –4.23 |
| | | 2017 | 11.74 | 7.65 | 7.62 | 4.12 |

*Note*: The values of ROE, ROA, $r_e$, SPREAD for NACE A to J are retrieved from MIT statistics. The values of ROE, ROA, SPREAD for NACE 72 were calculated from the sample of companies. The value of $r_e$ for NACE M72 was retrieved from MIT statistics.

*Source*: MIT (2016; 2018); own calculation.

Authors of the survey presumed that branch M72 Research and Development would take the first place and that the second-highest performance would be reported by the Manufacturing industry because it is the most innovating branch in the long term (see CZSO, 2018).

Table 1 includes the indicators ROE, ROE and SPREAD for years 2015 up to 2017. Additionally, it also includes the value of the implicit cost of equity (re), as this is the crucial component for the calculation of the percentage of the economic value added (spread). The reached values of the single indicators in individual years often show conflicting trends, although it holds generally that firm's performance is increased along with the increasing value of the indicator.

Performance of the branches was evaluated also based on indicators such as assets turnover ratio, gross profit margin, value-added in revenues and value-added per worker. In this case, the reached values show a conflicting trend, too. None of the branches takes first place in all the analysis areas in the last monitored year, either. It only can be deduced that the first places are taken again by C Manufacturing industry, G Wholesale and retail trade, repair of motor vehicles, J Information and communication activities and M72 Research and Development.

T a b l e 2

**Performance in Branches Based on ATR, GPM, VAR, VAW**

| NACE | Branch | Year | Assets turnover ratio | Gross profit margin (%) | Value-added/ revenues (%) | Workforce productivity* |
|---|---|---|---|---|---|---|
| A | Agriculture, forestry and fisheries | 2015 | 0.26 | 21.38 | 37.94 | 1142658 |
| | | 2016 | 0.24 | 22.18 | 39.32 | 1105339 |
| | | 2017 | 0.26 | 27.03 | 44.09 | 1256062 |
| B | Mining and quarrying | 2015 | 0.55 | 10.82 | 43.53 | 1282608 |
| | | 2016 | 0.50 | 2.35 | 38.06 | 1080420 |
| | | 2017 | 0.58 | –1.57 | 37.33 | 1073842 |
| C | Manufacturing | 2015 | 1.42 | 5.64 | 18.07 | 1016706 |
| | | 2016 | 1.27 | 5.54 | 18.43 | 1045387 |
| | | 2017 | 1.36 | 7.31 | 19.23 | 1191230 |
| D | Electricity, gas, steam and air conditioning | 2015 | 0.82 | 4.85 | 10.69 | 5345033 |
| | | 2016 | 0.77 | 7.20 | 12.63 | 5779854 |
| | | 2017 | 0.68 | 5.49 | 12.53 | 5274285 |
| E | Water supply; wastewater, waste management and remediation | 2015 | 0.55 | 6.61 | 33.05 | 848394 |
| | | 2016 | 0.50 | 6.11 | 33.93 | 856892 |
| | | 2017 | 0.51 | 8.43 | 33.94 | 888346 |
| F | Construction | 2015 | 0.89 | 3.75 | 18.13 | 848066 |
| | | 2016 | 0.82 | 2.77 | 16.96 | 850578 |
| | | 2017 | 0.90 | 3.35 | 16.70 | 926130 |
| G | Wholesale and retail trade; repair of motor vehicles | 2015 | 2.20 | 1.44 | 7.59 | 807562 |
| | | 2016 | 2.09 | 1.42 | 7.55 | 807000 |
| | | 2017 | 2.25 | 1.61 | 7.52 | 833267 |
| H | Transportation and storage | 2015 | 0.62 | 6.14 | 24.91 | 578426 |
| | | 2016 | 0.58 | 5.71 | 24.64 | 631199 |
| | | 2017 | 0.58 | 6.19 | 25.24 | 657082 |
| I | Accommodation and food service | 2015 | 0.37 | –0.54 | 40.39 | 622191 |
| | | 2016 | 0.40 | 5.25 | 41.34 | 640186 |
| | | 2017 | 0.42 | 10.01 | 42.16 | 718363 |
| J | Information and communication | 2015 | 0.77 | 15.24 | 47.14 | 2648477 |
| | | 2016 | 0.76 | 12.55 | 44.87 | 2431653 |
| | | 2017 | 0.77 | 10.25 | 44.63 | 2385715 |
| M72 | Research And development | 2015 | 0.51 | 10.68 | 51.41 | 943284 |
| | | 2016 | 0.40 | 8.66 | 43.89 | 667278 |
| | | 2017 | 0.90 | 8.54 | 48.71 | 736257 |

*Source*: MIT (2016; 2018); own calculation.

To confirm or reject hypotheses $H_1$ and $H_2$, it is necessary to determine the final order of performance in the analyzed branches. Since the selected indicators show different results, confirmation or disconfirmation of the hypotheses will

be determined based on places pointed according to values reached by single indicators (ROE, ROA, SPREAD, ATR, GPM, VAR, VAW). Because a total of 11 branches was evaluated, the evaluating scale includes positive points in the interval <1; 11>, see the reached points in Table 3. The branch which was awarded the highest number of points takes first place, which is order number 1 (CZ-NACE J).

To eliminate possible fluctuation of values in 2017, the authors of the survey decided to apply the scoring system also to two previous periods and to create an arithmetic mean of the reached points. The final values are indicated in Table 4. It is obvious in rows 5. to 7. that the top-performing branch is NACE J Information and communication activities with the highest total of points reached in all the monitored years.

T a b l e 3

**Points Allocated to Values Reached for 2017**

| NACE | A | B | C | D | E | F | G | H | I | J | M72 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Return on equity (ROE) | 7 | 1 | 11 | 6 | 4 | 5 | 8 | 3 | 2 | 9 | 10 |
| Return on assets (ROA) | 8 | 1 | 11 | 5 | 7 | 2 | 4 | 3 | 6 | 10 | 9 |
| SPREAD (EVA spread) | 4 | 2 | 11 | 8 | 7 | 5 | 6 | 3 | 1 | 9 | 10 |
| Asset turnover (AT) | 1 | 4.5 | 10 | 6 | 3 | 8.5 | 11 | 4.5 | 2 | 7 | 8.5 |
| Gross profit margin (GPM) | 11 | 1 | 6 | 4 | 7 | 3 | 2 | 5 | 9 | 10 | 8 |
| Value added/revenues (VAR) | 9 | 7 | 4 | 2 | 6 | 3 | 1 | 5 | 8 | 10 | 11 |
| Workforce productivity (WFP) | 9 | 7 | 8 | 11 | 5 | 6 | 4 | 1 | 2 | 10 | 3 |
| Sum of points in2017 | 49 | 23.5 | 61 | 42 | 39 | 32.5 | 36 | 24.5 | 30 | 65 | 59.5 |
| **Final order in 2017** | **4.** | **11.** | **2.** | **5.** | **6.** | **8.** | **7.** | **10.** | **9.** | **1.** | **3.** |

*Source*: Own calculation.

T a b l e 4

**Points Allocated to Values Reached in Years 2015 to 2017**

| Row | NACE | A | B | C | D | E | F | G | H | I | J | M72 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Sum of points in 2017 | 49 | 23.5 | 61 | 42 | 39 | 32.5 | 36 | 24.5 | 30 | 65 | 59.5 |
| 2. | Sum of points in 2016 | 46 | 26.5 | 54 | 60 | 39.5 | 36 | 34 | 31 | 21.5 | 69 | 44.5 |
| 3. | Sum of points in 2014 | 46 | 53.5 | 52 | 52 | 33 | 33 | 27 | 28.5 | 16 | 68 | 52 |
| 4. | Sum of points 2015 – 2017 | 141 | 103.5 | 167 | 154 | 111.5 | 101.5 | 97 | 84 | 67.5 | 202 | 156 |
| 5. | Final order in 2017 (X) | 8 | 1 | 10 | 7 | 6 | 4 | 5 | 2 | 3 | 11 | 9 |
| 6. | Final order in 2016 (Y) | 8 | 2 | 9 | 10 | 6 | 5 | 4 | 3 | 1 | 11 | 7 |
| 7. | Final order in 2015 (Z) | 6 | 10 | 8 | 8 | 4.5 | 4.5 | 2 | 3 | 1 | 11 | 8 |
| 8. | Mean of points ((X+Y+Z)/3) | 47 | 34.5 | 55.7 | 51.3 | 37.2 | 33.8 | 32.3 | 28 | 22.5 | 67.3 | 52 |
| **9.** | **Final order (2015 – 2017)** | **5.** | **8.** | **2.** | **4.** | **6.** | **7.** | **9.** | **10.** | **11.** | **1.** | **3.** |

*Source*: Own calculation.

Classification of economic entities CZ-NACE says that the branch J Information and communication cover the following activities: J58 Publishing activities, J59 Motion picture, video and television programme production, sound recording and music publishing activities, J60 Programming and broadcasting activities, J61 Telecommunications, J62 Computer programming, consultancy

and related activities, J63 Information service activities. The J branch always took the first place in each year to be analyzed, i.e. it reached 11 points in any period. In terms of the total mean of points reached (Table 4, row 8.) the branch M72 Research and Development only took 4th place. The aforementioned information and communication activities (CZ-NACE C), manufacturing industry (CZ-NACE C) and Electricity, gas, steam and air conditioning supply and manufacture (CZ-NACE D) seem to be more performing branches.

So, the investigation does not confirm that the branch of Research and Development reports the highest values of performance indicators, as it reaches the highest level of R&D within its activities. This is the reason why $H_1$ must be rejected.

### 3.2. Performance in Branches and Verification of Hypothesis $H_2$

$H_2$ says that 'the branch of manufacturing industry reports the highest values of performance indicators, as it takes the first place in investments in RDI and it also increases the value of its results commercially'. When applying the selected set of indicators (ROE, ROA, SPREAD, ATR, GPM, VAR, VAW) this hypothesis has not been confirmed. The authors came to such a conclusion based on the total mean of reached points indicated in Table 4 (row no.8) and final order (row no. 9).

If we restrict the term 'performance' only to reached prosperity, we can only focus on the indicators ROA, ROE and SPREAD. Elimination of the remaining indicators (ATR, GPM, VAR, VAW) results in the elimination of particulars of the single branches. The branch J Information and communication activities took the first place in the performance score list, so it will be compared to the branch M72 Research and Development as the first one.

The reached values of ROE, ROA and SPREAD were compared for the analyzed years 2014 to 2017. These are indicated in columns a) and c) in Table 5. Their difference (R&D-ICA) is indicated in column e), Table 5. Indices of inter-year changes are stated in col. b) and col. d). Column f) (**CI) indicates if a statistic difference was proven between the values in columns a) and c). The cross means that statistically significant difference could not be confirmed.

The confidence intervals calculated for $ROE_{R\&D}$ coincide with the values $ROE_{ICA}$ in the individual years. The statistical difference of ROE among the branches has not been confirmed (col. f)). Indices of ROE growth were calculated additionally in both of the branches. The indices unambiguously indicate that excess of $ROE_{R\&D}$ above $ROE_{ICA}$ in 2017 was caused by the enormous inter-year increase of ROE from 11.94% to 13.61% with the index of 1.14 (as compared to index $ROE_{ICA}$ of 0.94).

T a b l e 5

**Prosperity in a branch of J Information and communication activities (ICA) vs. M72 Research and Development (R&D)**

| Ratio | Information and communication activities | | Ratio | Research & Development | | R&D – ICA* | CI** |
|---|---|---|---|---|---|---|---|
| | col. a) (%) | col. b) | | col. c) (%) | col. d) | col. e) (%) | col. f) |
| ROE 2014 | 15.41 | Index $ROE_{ICA}$ | ROE 2014 | 15.30 (11.84) | Index $ROE_{RD}$ | –0.11 (–3.57) | x |
| ROE 2015 | 15.32 | 0.99 | ROE 2015 | 13.67 (19.42) | 0.89 | –1.65 (4.10) | x |
| ROE 2016 | 10.70 | 0.70 | ROE 2016 | 11.94 (12.59) | 0.87 | +1.24 (1.89) | x |
| ROE 2017 | 10.09 | 0.94 | ROE 2017 | 13.61 (19.48) | 1.14 | +3.52 (9.39) | x |
| ROA 2014 | 12.40 | Index $ROA_{ICA}$ | ROA 2014 | 7.93 (7.52) | Index $ROA_{RD}$ | –4.47 (–4.88) | x |
| ROA 2015 | 11.81 | 0.95 | ROA 2015 | 10.55 (15.24) | 1.33 | –1.26 (3.53) | x |
| ROA 2016 | 9.50 | 0.80 | ROA 2016 | 9.25 (10.86) | 0.88 | –0.25 (1.36) | x |
| ROA 2017 | 7.88 | 0.83 | ROA 2017 | 8.13 (8.12) | 0.88 | +0.25 (0.24) | x |
| SPREAD2014 | 6.33 | $SPREAD_{ICA}$ (t+1)–t | $SPREAD_{2014}$ | 1.05 (–2.41) | $SPREAD_{RD}$ (t+1)–t | –5.28 (–8.74) | YES |
| SPREAD2015 | 6.33 | 0.00% | $SPREAD_{2015}$ | 4.14 (9.89) | 3.09% | –2.19 (3.56) | x |
| SPREAD2016 | 2.39 | –3.94% | $SPREAD_{2016}$ | –2.14 (–1.49) | –6.28% | –4.53 (–3.88) | YES |
| SPREAD2017 | 1.39 | –1.00% | $SPREAD_{2017}$ | –2.12 (3.75) | 0.01% | –3.51 (2.36) | x |
| $r_e$ 2014 | 9.08 | $Index_{ICA}$ $r_e$ | $r_e$ 2014 | 14.25 | $Index_{RD}$ $r_e$ | +5.17 | x |
| $r_e$ 2015 | 8.99 | 0.99 | $r_e$ 2015 | 9.53 | 0.67 | +0.54 | x |
| $r_e$ 2016 | 8.31 | 0.92 | $r_e$ 2016 | 14.08 | 1.48 | +5.77 | x |
| $r_e$ 2017 | 8.70 | 1.05 | $r_e$ 2017 | 15.73 | 1.12 | +7.03 | YES |

*Note:* *R&D means the branch of research and development. ICA means branch J Information and communication activities. **CI indicates if the statistical difference of economic results of the analyzed branches based on the intersection of the confidence interval (with the specified significance level of 5%) of the values ROE, ROA and SPREAD of the R&D branch with ICA values was confirmed. The ICA values are considered to be fixed because these are retrieved from MIT statistics. Values for private ownership are given in parentheses (the test sample containing 26 firms).

*Source*: MIT (2016; 2018) and own calculation.

In the years 2015 to 2017, the prosperity of the branch Research and Development is similar to the mean value in the branch Information and communication activities (col. e)) concerning ROA indicator. Only in 2014, the branch Information and communication activities dominate with the reached $ROA_{ICA}$ value of 12.44% (col. a)) and exceeds $ROA_{R\&D}$ by 4.47% (col. e)). Only the index $ROA_{R\&D}$ 2014/2015 reports a significant inter-year increase with index 1.33 as compared to any other ROA indices, which reported the value below 1. The calculated confidence intervals did not confirm a statistically significant difference for return on assets either (Table 5. col. f)).

On the contrary to two previous indicators, SPREAD makes provision for the implicit cost of equity ($r_e$), which decreases the final value of ROE even by a risk which was born by company owners when investing in a company with such a scope of business. Economic value added of the company, which is expressed in the form of SPREAD, can be then easily compared not only among the companies in the specific branch but also among the branches themselves. When comparing the mean value of SPREAD in the branch Information and communication activities and the mean value of SPREAD in the branch Research and Development (col. e)) we can conclude that economic value added was in all the analyzed years significantly lower in the branch of research and development and 2016, it was even statistically significant (CI**. col. f)). However, we cannot state that the level of application of research and development is a dominant factor of prosperity, either. In all the analyzed years, the average value of SPREAD in the branch Information and communication activities was higher, and in 2014 and 2016 (col. f)) it was even statistically significant through confidence interval. Even with the elimination of possible property connections (a sample of 26 companies), the continuously better financial condition in the R&D branch based on ROE, ROA, SPREAD with statistical significance was not proven.

In Table 6, the branch of research and development in the first three years of the analyzed period reaches higher values of ROE, the trend of which is decreasing, though. In 2017, the mean value of ROE in the branches of the manufacturing industry even exceeds the mean value in the sample of companies, the main scope of business of which is research and development, by 2.13% (see Table 1. col. e)). Confidence intervals calculated for $ROE_{R\&D}$ agree with the values $ROE_{MI}$ in individual years. Statistic difference of the level of prosperity among the branches based on ROE was not confirmed. Additionally, the indices of ROE increase were calculated for both of the branches, which indicates that excess of $ROE_{MI}$ above $ROE_{R\&D}$ in 2017 was caused by the enormous inter-year increase of $ROE_{MI}$ from 10.81% to 15.74% with the index 1.46 (as compared to index $ROE_{R\&D}$ of 1.14).

Surprisingly, ROA reports similar development despite this indicator according to (2) uses earnings before taxation, including cost interests, and total assets. In the years 2014 to 2017, this indicator indicates that the prosperity of the branch of research and development is higher than the mean value of the manufacturing industry, and it is higher by 0.73 to 2.82% (col. e)). In 2017, the manufacturing industry newly (similarly to ROE indicator) dominates and exceeds $ROA_{R\&D}$ by 1.53% (col. e)) with the reached value $ROA_{MI}$ of 9.66% (col. a)). Index $ROA_{MI}$ 2016/2017 reports a strong inter-year increase to 1.34 as compared to index $ROA_{R\&D}$ 2016/2017, which reports 0.88 just like in the previous period 2015/2016. The difference with statistical significance was not confirmed through calculated intervals for return of assets, either (Table 6. col. f)).

T a b l e 6
**Prosperity in Manufacturing Industry (MI) vs. Research and Development (R&D)**

| Ratio | Manufacturing Industry | | Ratio | Research and Development | | R&D – MI* | CI** |
|---|---|---|---|---|---|---|---|
| | col. a) (%) | col. b) | | col. c) (%) | col. d) | col. e) (%) | col. f) |
| ROE 2014 | 11.52 | Index $ROE_{MI}$ | ROE 2014 | 15.30 (11.84) | Index $ROE_{RD}$ | 3.78 (0.32) | x |
| ROE 2015 | 11.78 | 1.02 | ROE 2015 | 13.67 (19.42) | 0.89 | 1.89 (7.64) | x |
| ROE 2016 | 10.81 | 0.92 | ROE 2016 | 11.94 (12.59) | 0.87 | 1.13 (1.78) | x |
| ROE 2017 | 15.74 | 1.46 | ROE 2017 | 13.61 (19.48) | 1.14 | –2.13 (3.74) | x |
| ROA 2014 | 7.20 | Index $ROA_{MI}$ | ROA 2014 | 7.93 (7.52) | Index $ROA_{RD}$ | 0.73 (0.32) | x |
| ROA 2015 | 7.73 | 1.07 | ROA 2015 | 10.55 (15.34) | 1.33 | 2.82 (7.61) | x |
| ROA 2016 | 7.22 | 0.93 | ROA 2016 | 9.25 (10.86) | 0.88 | 2.03 (3.64) | x |
| ROA 2017 | 9.66 | 1.34 | ROA 2017 | 8.13 (8.12) | 0.88 | –1.53 (–1.54) | x |
| $SPREAD_{2014}$ | –2.14 | $SPREAD_{MI}$ (t+1)–t | $SPREAD_{2014}$ | 1.05 (–2.41) | $SPREAD_{RD}$ (t+1)–t | 3.19 (–0.27) | YES |
| $SPREAD_{2015}$ | –0.31 | 1.83% | $SPREAD_{2015}$ | 4.14 (9.89) | 3.09% | 4.45 (10.20) | YES |
| $SPREAD_{2016}$ | –1.30 | –0.99% | $SPREAD_{2016}$ | –2.14 (–1.49) | –6.28% | –0.84 (–0.19) | x |
| $SPREAD_{2017}$ | 4.63 | 5.93% | $SPREAD_{2017}$ | –2.12 (3.75) | 0.01% | –6.75 (–0.93) | YES neg. |
| $r_e$ 2014 | 13.66 | Index $r_e$ | $r_e$ 2014 | 14.25 | Index $r_e$ | 0.59 | x |
| $r_e$ 2015 | 12.09 | 0.89 | $r_e$ 2015 | 9.53 | 0.67 | –2.56 | x |
| $r_e$ 2016 | 12.11 | 1.00 | $r_e$ 2016 | 14.08 | 1.48 | 1.97 | x |
| $r_e$ 2017 | 11.11 | 0.92 | $r_e$ 2017 | 15.73 | 1.12 | 4.62 | x |

*Note:* *R&D means the branch of research and development. MI means the branch of the manufacturing industry. **CI indicates if the statistical difference of economic results in the analyzed branches was confirmed via the intersection of confidence interval (with the selected significance level of 5%) of the value ROE. ROA and SPREAD of the branch R&D with values of MI, which are considered to be fixed concerning large sample. Values for private ownership are given in parentheses (the test sample containing 26 firms).

*Source:* MIT (2016; 2018) and own.

When comparing the mean value of SPREAD in the manufacturing industry and the mean value of SPREAD in the branch of research and development (col. e)) we can conclude that in 2014 and 2015, the prosperity of the branch of research and development was higher by 3.19% and 4.45% even with statistical significance (CI**, col. f)) confirmed by calculation of confidence interval for the values of SPREAD reached in the branch of research and development. However, we cannot unambiguously say that research and development are the dominant factors of prosperity, because in years 2016 and 2017, the average value of SPREAD in the manufacturing industry was higher and in 2017 (col. f)) it was higher even with statistical significance verified via confidence interval. Even with the elimination of possible property connections (a sample of 26 companies), the continuously better financial condition in the R&D branch based on ROE, ROA, SPREAD with statistical significance was not proven.

In the last analyzed year (2017), the manufacturing industry reaches better economic results in all the analyzed branches. The year 2017 is a breakthrough within this investigation, as it unambiguously rejects the presumption of research and development being the dominant factor of company prosperity.

## Conclusion

The investigation was focused on confirmation of the decisive influence of intensity of research and development on a firm's performance. The manufacturing industry is ranked among the top places in the field of investments in research, development and innovations in the Czech Republic. Despite this, it is obvious that in the area of research and development, this cannot be compared with companies the main scope of business of which is just research and development. And this is the same for the remaining 9 analyzed branches.

Analysis of the sample of companies in the branch of research and development showed that intensity of research and development (resp. amount of R&D investments); need not impact a firm's performance in a dominant way. This is confirmed by variable results of the reached values of ROE, ROA, SPREAD in years 2014 to 2017 and ATR, GPM, VAR, VAW in years 2015 to 2017. It may be stated that the best performance values are reached by the branch CZ-NACE M72 Research and development, CZ-NACE C Manufacturing industry and CZ-NACE J Information and communication activities in the individual years. The analysis does not confirm the permanently higher prosperity of companies running their business in the branch of research and development. The researchers came to the same conclusion even after the elimination of subsidiaries, which are property-linked and threaten to optimize their tax burden through transfer pricing.

The score awarded for prosperity and productivity of the branch for the last three years even indicates that CZ NACE M72 takes third place after reaching 52 points. But it practically shares this position with CZ-NACE D Production and distribution of electricity, gas, steam and air. The $H_1$ has not been confirmed.

Results of all the selected return indicators in the first two years of the analysis (2014 and 2015) show that the prosperity of the branch of research and development is higher than the average prosperity of the manufacturing industry. SPREAD reports such results even with statistical significance. If this analysis had been focused on those two years only, it could have been declared that the axiom of the unambiguous impact of RDI on prosperity was confirmed. However, the investigation was focused even on two following years for which financial data of companies could be retrieved. The results of the analysis for 2016 indicate decreasing economic performance of the branch of research and development,

and increasing performance of the manufacturing industry. So, the output includes contradictory results of ROE. ROA and SPREAD, which cannot determine if the prosperity of research and development was higher than the prosperity of the manufacturing industry. In the last analyzed year (2017), the manufacturing industry reaches even better economic results in all the analyzed areas. The year 2017 is a breakthrough within this investigation, as it unambiguously rejects the presumption of research and development being the dominant factor of company prosperity. The manufacturing industry dominates in ROE, as well as in ROA; however, statistical significance has not been confirmed. Although the manufacturing industry reaches higher values for SPREAD, even with statistical significance. This implies that $H_2$ has not been confirmed, either. Likewise, $H_2$ was not confirmed in the sample of 26 companies that are not subsidiaries.

Values of return and productivity are significantly affected also by other factors, which allow transferring the results of research and development into economic results of the company.

## References


AGUIAR. L. – GAGNEPAIN, P. (2013): European Cooperative R&D and Firm Performance. Evidence Based on Funding Differences in Key Actions (No. 9426). [CEPR Discussion Papers.] London: CEPR.

BANKER, R. D. et al. (2016): R&D Intensity, Ability Indicators and Executive Compensation. Available at: <http://dx.doi.org/10.2139/ssrn.1910134>.

BELDERBOS, R. et al. (2004): Cooperative R&D and Firm Performance. Research Policy, *33*, No. 10, pp. 1477 – 1492. Available at: <https://doi.org/10.1016/ j.respol.2004.07.003>.

BOBILLO, A. M. et al. (2006): Innovation Investment, Competitiveness, and Performance in Industrial Firms. Thunderbird International Business Review, *48*, No. 6, pp. 867 – 890. Available at: <https://doi.org/10.1002/tie.20126>.

BOND, S. R. – GUCERI, I. (2016): R&D and Productivity: Evidence from Large UK Establishments with Substantial R&D Activities. Economics of Innovation and New Technology, *26*, No. 1 – 2, pp. 108 – 120. Available at: <https://doi.org/10.1080/10438599.2016.1203525>.

BOWLIN, W. F. (1998): Measuring Performance: An Introduction to Data Envelopment Analysis (DEA). The Journal of Cost Analysis, *15*, No. 2, pp. 3 – 27. Available at: <http://dx.doi.org/10.1080/08823871.1998.10462318>.

CARTON, R. B. – HOFER, Ch. W. (2006): Measuring Organizational Performance: Metrics for Entrepreneurship and Strategic Management Research. Northampton: Edward Elgar.

CZSO (2018): Czech Statistical Office. [Retrieved February 19, 2018.] Available at: <https://www.czso.cz/csu/czso/home>.

DRUCKER, P. (2002): Management in the Next Society. New York: Griffin.

ENGEL, K. (2015): Masters of Innovation: Building the Perpetually Innovative Company. London: LID.

EL ELJ, M. (2012): Innovation in Tunisia: Empirical Analysis for Industrial Sector. Journal of Innovation Economics & Management, *9*, No. 1, pp. 183 – 197. Available at: <https://doi.org/10.3917/jie.009.0183>.

GHAFFAR. A. – KHAN, W. A. (2014): Impact of Research and Development on Firm Performance. International Journal of Accounting and Financial Reporting, *4*, No. 1, pp. 357 – 367. Available at: <https://doi.org/10.5296/ijafr.v4i1.6087>.

GKIKAS, A. et al. (2014): Effectiveness and Importance of Innovation on Business Performance in an Uncompetitive Region: Evidence from High-Growth SMEs in Wales. [59th ICSB World Conference, Dublin, 11 – 14 June 2014.] Available at: <http://eprints.uwe.ac.uk/25615>.

HALL, B. H. et al. (2009): Innovation and Productivity in SMEs: Empirical Evidence for Italy. Small Business Economics, *33*, No. 1, pp. 13 – 33. Available at: <http://dx.doi.org/10.1007/s11187-009-9184-8. ISSN 0921-898x>.

HELFERT, E. A. (1994): Techniques of Financial Analysis: A Practical Guide to Managing and Measuring Business Performance. 8th ed. Burr Ridge: Irwin.

CHAN, S. H. et al. (1990): Corporate Research and Development Expenditures and Share Values. Journal of Financial Economics, *26*, No. 2, pp. 255 – 276. Available at: <https://doi.org/10.1016/0304-405X(90)90005-K>.

CHO, S. et al. (2008): R&D Investment and Performance in Korea: Korean R&D Scoreboard 2005. Asian Journal of Technology Innovation, *16*, No. 1, pp. 143 – 160. Available at: <https://doi.org/10.1080/19761597.2008.9668651>.

CHURSIN, A. – MAKAROV, Y. (2015): Management of Competitiveness. Cham: Springer International Publishing.

KLEIS, L. et al. (2012): Information Technology and Intangible Output: The Impact of IT Investment on Innovation Productivity. Information Systems Research, *23*, No. 1, pp. 42 – 59. Available at: <https://doi.org/10.1287/isre.1100.0338>.

KUBĚNKA, M. (2018): Improvement of Prosperity Prediction in Czech Manufacturing Industries. Engineering Economics, *29*, No. 5, pp. 516 – 525. Available at: <http://dx.doi.org/10.5755/j01.ee. 29.5.18231>.

LONG, W. F. – RAAVENSCRAFT, D. J. (1993): LBOs, Debt and R&D Intensity. Strategic Management Journal, *14*, No. 1, pp. 119 – 135. Available at: <https://doi.org/10.1002/smj.4250140910>.

MATSON, J. V. (1981): Innovate or Die! A Personal Perspective on the Art of Innovation' by Jack V. Matson. [Paperback.]

MANK, D. A. – NYSTROM, H. E. (2001): Decreasing Returns to Shareholders from R&D Spending in the Computer Industry. Engineering Management Journal, *13*, No. 3, pp. 3 – 8. Available at: <https://doi.org/10.1080/10429247.2001.11415120>.

MIT (2016): Financial Analyses of Corporate Sector, Focusing of the Competitiveness of the Sectors Monitored in 2015. Appendix 001. Prague: Ministry of Industry and Trade. [Retrieved May 9, 2018.] Available at: <http://download.mpo.cz>.

MIT (2018): Financial Analyses of the Business Sphere for 2017. Prague: Ministry of Industry and Trade. [Retrieved May 9, 2018.] Available at: <http://download.mpo.cz>.

NIVOIX, S. – NGUYEN, P. (2012): Characteristics of R&D Expenditures in Japan's Pharmaceutical Industry. Asia Pacific Business Review, *18*, No. 2, pp. 225 – 240. Available at: <https://doi.org/10.1080/13602381.2010.540120>.

PANTAGAKIS, E. et al. (2012): R&D Investments and Firm Performance: An Empirical Investigation of the High Technology Sector (Software and Hardware) in the EU. Available at: <https://doi.org/10.2139/ssrn.2178919>.

PITRA, Z. – MOHELSKÁ, H. (2015): Management Knowledge Transfer: From the First Idea to a Commercially Successful Innovation. 1st. ed. Prague: Professional Publishing.

PwC (2014): Creating Value Beyond the Deal. [Cit. 2016-07-27.] [Retrieved November 9, 2018.] Available at: <http://www.pwc.com/gx/en.html>.

RAO, S. et al. (2001): The Importance of Innovation for Productivity. International Productivity Monitor, *2*, No. 11, pp. 11 – 18.

REID, J. (2012): Productivity: A Key to Canadian Innovation and Prosperity. Ivey Business Journal, No. September/October 2021. Available at: <https://iveybusinessjournal.com/publication/productivity-a-key-to-canadian-innovation-and-prosperity/>.

SCHUMPETER, J. (1960): Teoria wzrostu gospodarczego. Warszawa: PWN.
SCHWARTZ, M. et al. (2012): What Drives Innovation Output from Subsidized R&D Cooperation? Project-level Evidence from Germany. Technovation, *32*, No. 6, pp. 358 – 369. Available at: <https://doi.org/10.1016/j.technovation. 2012.03.004>.
SHARMA, Ch. (2012): R&D and Firm Performance: Evidence from the Indian Pharmaceutical Industry. Journal of the Asia Pacific Economy, *17*, No. 2, pp. 332 – 342. Available at: <https://doi.org/10.1142/S1363919616500109>.
TUBBS, M. (2007): The Relationship between R&D and Company Performance. Research-Technology Management, *50*, No. 6, pp. 23 – 30. Available at: <https://doi.org/10.1080/08956308. 2007.11657470>.
VEBER, J. (2004): Nové prístupy management. II. část. Ekonomika a management podniku, *2*, No. 2, pp. 6 – 19.
VIVERO, R. (2002): The Impact of Process Innovations on Firm S Productivity Growth: The Case of Spain. Applied Economics, *34*, No. 8, pp. 1007 – 1016. Available at: <https://doi.org/10.1080/00036840010019684>.
YABUUCHI, N. et al. (2014): Research Development on Sodium-Ion Batteries. Chemical Reviews, *114*, No. 23, pp. 11636 – 11682. Available at: <https://doi.org/10.1021/cr500192f>.