EVALUATION OF THE IMPACT OF INNOVATIVE ACTIVITES ON PRODUCTIVITY – EXAMPLE FROM THE CZECH REPUBLIC

Krause J. *

Abstract: The article deals with impacts of innovative activities on productivity of businesses. The survey included 255 businesses participating in subvention programs focusing on support of innovative activities in companies. The study used the "two-sample t-test for means„ and "ANOVA" methods. The values of productivity indicators were higher in the year after the subvention was received. However, the increase was not statistically significant. At the same time, no difference was confirmed in the achieved values of productivity indicators depending on the amount of the subvention in any of the monitored years.

Key words: innovation, innovation strategies, economic performance

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Introduction

Innovations are seen as one of the basic elements in development of competitive advantage. Innovative activities of companies make it possible to create value for customers. Innovations may create new industries, new customer segments or new sources of competitive advantage. Innovations not only create competitive advantage but they can also eliminate competitive advantage of the other companies. Innovative strategies include new approaches to competition within one sector. Innovative strategies often serve as a basis of the best achievements in most industries (Grant, 2013). Innovation-based strategies are mentioned by all relevant authors dealing with business strategies. For example, Drucker (2006) calls the innovative strategy " the very first and the maximum", Miles and Snow (2003) refer to a prospector strategy and Kotler et al. (2011) used the term of a market leader strategy. Companies with better innovative competitive position are able to withstand the crisis more successfully (Shatrevich et al., 2012).

Innovations are supposed to help companies to higher prosperity. Innovation is considered as important conditions for competitiveness of companies (Scholleova and Necadova, 2012). This statement is supported by the very well-know blue ocean strategy. It is based on value innovation and creation of new industries (Kim and Maubrogne, 2004, 2005a, 2005b). The authors analyzed 108 businesses and came to the conclusion that 86% of their projects expanded the existing product lines. The projects accounted for 62% of their income and for 39% of their total profits. The remaining 14% of the projects which focused on innovations accounted for 38% of the income and 61% of the profits.

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The importance of innovations in a company strategy has been confirmed e.g. by Bartes (2010) who mentioned the "investigative strategy". The author believes that it is very difficult to stand the competition with a traditional strategy of direct confrontation.
The importance of innovations for development of industries was also studied by Porter (1998). Innovative activities are not important only for business entities but also for long-term success of public institutions (Straková, 2014).
Innovative companies can make advantage of their experience curve, good reputation on the market, economies of scale etc. However, innovative activities can be also risky. Companies may not be successful in their innovative efforts or they may enter unknown markets with unclear customer preferences. That is why the imitators, who have learned from experience of the innovators, are often more successful (Markides et al., 2005; Johnson et al., 2005; Drucker, 2006; Tabor, 2006). Fernandes et al. (2015) have reported that the risk of failure is higher for businesses with only one product. On the contrary, innovations are less risky for businesses with diversified sources or lower market risks. Cefis et al. (2006) believe that innovations have a positive effect on probability of survival of companies. The risk of failure is higher for small and young companies.
To make innovative activities efficient it is necessary to create such an environment in the company which allows efficient communication and in which the employees are familiar with the innovative strategy (Novak et al., 2013).
The aim of the article is to evaluate the impact of the innovative activates of the firms supported by subventions grant on the chosen indicator of productivity.

Material and Methods

The survey included companies which implemented innovations supported by the subvention programs focusing on energy savings, use of renewable and secondary energy sources. Some of the companies were excluded from the study due to lack of data. After removing extreme values from the data 255 businesses were included into the survey.
The study evaluated impact of innovations on the indicator of productivity. The productivity indicator was defined as follows:

$$productivity = \frac{monthly\ revenues}{\text{number of employees}} \quad (1)$$

The study monitored the change of the indicator in the year after the implementation and compared the productivity in the year in which the innovation was implemented with the productivity in the year before the innovation was implemented.
The comparison was executed using the two-sample t-test.
The study also investigated whether the amount of the provided subvention had any effect on values of the productivity indicator. The companies were divided into

three groups based on the amount of the received subventions. The evaluation used the "one-way ANOVA" method. ANOVA is used for the comparison of more than two groups (it is analogy of the two sample t test). The basic characteristic is F statistic. F statistic is generally calculated as (Hendl, 2012):

F statistic = variability between the groups/ variability the individuals within the same group

The first group of companies received subventions amounting to 1 – 370 000, - EUR, the second group 370 001, - – 1 480 000, -- EUR and the third one received subventions over 1 480 000, - EUR (Exchange rate is 1 EUR = 27.035 Czech crowns).
The structure of firms according to numbers of employees is:
– 29% with 0 – 50 employees,
– 52% with 50 – 249 employees,
– 19% with 250 and more employees.
The structure of the firms according to the NACE classification is:
– manufacturing – 82%,
– water supply – 2%,
– construction – 2%,
– wholesale and retail trade – 3%,
– information and communication – 3%,
– real estate activities – 1%,
– professional, scientific and technical activities – 7%,
– other sectors – 2%.
In the research were included companies implementing projects in the years 2010, 2011 and 2012. According to described research methodology described above, data from the financial statements from the years 2009 – 2013 were used.

Results

Result of two-sample test

The Table 1 shows the basic characteristics of productivity in the sample.

Table 1. Basic characteristics of productivity

Year	Y-1	Y0	Y+1
Average	5.37	5.40	5.43
Variance	3.22	3.17	3.05

Note: Y0 – value in the year of subvention use
Y-1 – value one year before subvention use
Y+1 – value one year after subvention use

In the monitored years the productivity values were slightly increasing. On the other hand, the variance values were slightly decreasing. The Table 2 contains results of "a two-sample t-test with paired samples".

Table 2. Results of the t-test

Year	t-statistic	t-critical*	P-value
Y_{-1}/ Y_0	0.2684	1.9694	0.7886
Y_{+1}/ Y_0	0.1678	1.9694	0.8669
Y_{+1}/ Y_{-1}	0.3636	1.9694	0.7164

Note: * the significance level $\alpha = 0.05$

None of the performed comparisons has shown a statistically significant difference in the achieved values of productivity at the selected significance level.

ANOVA Analysis

The Table 3 contains basic characteristics of productivity for the individual groups of companies.

Table 3. ANOVA analysis

Year	Group 1 0 – 370 000	Group 2 370 001- 1 480 000	Group 3 Over 1 480 000
Average (Y_{-1})	5.58	5.15	4.62
Standard deviation (Y_{-1})	3.32	3.16	2.53
Average (Y_0)	5.44	5.55	4.68
Standard deviation (Y_0)	3.25	3.28	1.83
Average (Y_{+1})	5.51	5.39	5.00
Standard deviation (Y_{+1})	3.36	2.63	2.02

In the year before the subvention and in the year after the subvention the productivity decreased with the growing amount of the subvention. In the year in which the subvention was used the highest productivity was demonstrated by the group which received the subvention of 370 001 – 1 480 000 EUR and it was followed by the group of companies with the lowest subventions and the lowest productivity was reported by the group of companies with the highest subventions.
The Table 4 contains results of the variance analysis. No difference has been found in the productivity in any of the monitored years for any of the groups of companies with different subventions.

Table 4. The results of ANOVA analysis

Year	F – statistic	P-value	F-critical*
Productivity (Y_{+1})	1.1319	0.3241	3.0316
Productivity (Y_0)	0.6756	0.5098	3.0316
Productivity (Y_{+1})	0.2782	0.7574	3.0316

Note: * the significance level $\alpha = 0.05$

Discussion

Results of the completed surveys have not confirmed a statistically significant increase of productivity of companies which invested into innovations. This conclusion is not consistent with earlier studies conducted by other authors.

For example, Crespi et al. (2012) in a study conducted in Latin America confirmed a positive effect of investments into knowledge and innovations on productivity in comparison with companies which failed to perform such activities. A positive effect of technology and non-technology innovations on productivity has been also confirmed by Alvarez et al. (2015). Cainelli et al. (2006) reported a mutual reciprocal positive effect between innovations and economic performance. The authors concluded that innovations are favorably affected by economic performance and innovations have positive effects on productivity. This means that innovations and productivity mutually increase each other. Chudnovsky et al. (2006) have confirmed that higher investments into research and development mean higher probability of launching of new products on the market and also higher productivity. They have also concluded that innovative activities are more frequent in big companies. The size of companies in connection with innovations was investigated e.g. by Blundell et al. (1999). The authors came to the conclusion that the impact of innovations on the market value of companies was higher in companies with higher market shares.

A study by Ulku et al. (2015) has confirmed that investments into research and development may have a positive impact on productivity growth. However, the achievement of higher productivity is affected by the threshold value of technological capabilities.

Productivity is generally formulated as the ratio of output to inputs. Therefore, productivity in the firms is influenced by many factors. Innovation is the only one of the possibilities to increase productivity. Factors affecting productivity can be divided into internal and external.

External factors are the various global trends, macroeconomic factors, the competitive position of the company, industry life cycle phase and so on.

Major global trends are changes in the importance of global superpowers, climate change, terrorism and global conflicts, the growing power of global corporations (Soucek, 2015). Macroeconomic factors have a significant impact on the enterprise and productivity are political factors (stability of the government, business support, the administrative burden associated with the business, ...), economic factors (labour cost, purchasing power of the population, taxes, interest rates, ...), social and demographic factors (trends in consumption, availability of labour, ...), technical and technological factors (technical education in the country, ...) (Johnson et al., 2008; Grant, 2013). The competitive position of the company is given by a number of individual factors, e.g. the bargaining power of customers and suppliers, exit barriers from the industry, the threat of entry of new competitors, etc. (Porter, 2004a, b).

Internal factors affecting productivity include in particular the quality of management, sources of business, the firm's ability to use the resources, flexibility of production systems, quality staff. Stamfestova (2015) as special factor considers for example customer capital.
Krauszová (2006) gives the following list of potential areas for increasing productivity. She considers as the main method automation, inventory reduction, production quality improvement, better arrangement of workplaces, employees motivation. Specific methods of increasing productivity are for example Kanban, TQM, Six Sigma, Lean Production, 5 S. The benefits of these methods are particularly in terms of reducing inventories, reducing the necessary areas of production space; reduce manufacturing time and the like. These methods are therefore focused mainly on increasing efficiency and benefits in the reduction of inputs. In this area, the principles of reengineering (Hammer, 1990) and Kaizen (Imai, 1986) are useable.
According to Dvorak (2006), it is very difficult and problematic to evaluate the effect of innovations with the regard of time aspect. There are problems with the calculation of costs and effects during the time period. To take account of this factor, the projects must clearly defined. Time unpredictability is particularly important by radical innovations. The financial and non-financial criterions can be used for evaluation. In the earlier phases, the non-financial criterions are recommended.

Conclusion

The performed study failed to statistically confirm a positive effect of investments and support to innovations on the productivity indicator at the selected level of significance. This conclusion is not consistent with most studies conducted by other authors. Some other studies, however, indicate that the positive impact on productivity is conditional on other factors. Further research in the Czech Republic should focus on identification of factors which influence successful introduction of innovations.

Limitation and Future of Research

The effect of the innovations can be measurable during a longer period than one year after the realisation of innovation. During the impact evaluation and article elaboration, it was not possible to evaluate impact during longer period because the data from financial statements in the year 2014 were not available. In future, it will be appropriate to evaluate impact in period of two and three years.
Effect of innovation can impact also other factors. For example Haryanto et al. (2015) distinguish four types of innovations: process innovation, product innovation, marketing innovation and organization innovation. According to their research, not all types of solved innovations have the positive effect on the performance of companies. Also Conto et al. (2013) observe that innovations

requires not only the adoption of new technologies but also other factors. Further research should be realised as questionnaire survey in concrete companies. This survey should concentrate on these potentially important factors.

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OCENA WPŁYWU DZIAŁAŃ INNOWACYJNYCH NA PRODUKTYWNOŚĆ – PRZYKŁAD Z REPUBLIKI CZESKIEJ

Streszczenie: Artykuł dotyczy wpływu działań innowacyjnych na produktywność przedsiębiorstw. Badaniem objęto 255 firm uczestniczących w programach dotacji skupiających się na wsparciu działań innowacyjnych w przedsiębiorstwach. W badaniu wykorzystano "dwu próbkowy test-t dla środków" i metody "ANOVA". Wartości wskaźników wydajności były wyższe w porównaniu do roku, w którym dotacja została otrzymana, jednakże wzrost ten nie był statystycznie znaczący. W tym samym czasie nie potwierdzono różnic w otrzymanych wartościach wskaźników wydajności w zależności od ilości subwencji w każdym z monitorowanych lat.
Słowa kluczowe: innowacja, strategie innowacji, wydajność ekonomiczna

評價科技創新活動工作效率的影響的 – 例如，從捷克共和國

摘要：本文對企業生產力的創新活動影響的交易。這項調查包括255商家資助計劃重點支持的企業創新活動的參與。研究中使用的“雙樣本t檢驗裝置”和“ANOVA”的方法。收到的補助金後，在今年的生產率指標的值較高。然而，增加無統計學意義。同時，沒有差別，確認在根據補助金中的任何監控年的量生產率的指標達到的值。

關鍵詞：創新，創新戰略，經濟表現