



Bočková, N. (2015). Research, Development and Innovations in Czech Manufacture of Electronic Products. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 10(4), pp. 163-180, DOI: <http://dx.doi.org/10.12775/EQUIL.2015.041>

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Research, Development and Innovations in Czech Manufacture of Electronic Products**

JEL Classification: *E61; H29; D 92*

Keywords: *small & medium-size enterprises; R&D tax deductible; R&D investment; electronic industry*

Abstract: *The paper deals with the topic of research and development investments and its use in small and medium-sized enterprises SME's operating in the electronic industry. The aim of the article is to find out the impact of innovation activities on enterprises, especially the influence of the sources of funding for the research activity. The Czech Republic is the geographic segment to be explored. A chapter on theoretical issues is followed by a description of the current situation in the Czech Republic and abroad, and access to legal support for research and development in the business sector. Primary data collected from a survey are analysed in the analytical part. The statistical data processing was done using Statistica 12 software. Some SME's of chosen group of manufacturing industry focus on research and development performed by their own means, and they searched for the possibility of financing the research from various sources.*

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Date of submission: April 13, 2015; date of acceptance: September 8, 2015

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** The research is financed by Internal Grant Agency of the Brno University of Technology. Name of the Project: Economic Determinants of Competitiveness of Enterprises in Central and Eastern Europe. Project Registration No. FP-S-15-2825.

Introduction

The third millennium, the change of regimes in the countries of Eastern and Central Europe, the expansion of the European Union has brought the enlargement of globalization and the pressure on sustainable development and growth of competitiveness of enterprises of all sizes (Balcerzak (ed.) 2009; Balcerzak, 2009a, pp. 279-290). Companies can no longer operate only regionally, but if they want to succeed in the global market, they must be flexible when responding not only to the demands of consumers and customers, but all stakeholders, to the legislative changes and to the changes in the business environment. The turbulence that occurred to the EU when accepting new member states caused, thanks to the process of economic integration, the reduction of the technology gap between new and old members of the EU. This emphasized the dynamics of the export of the member countries. The link between technological innovation and the growth of the international competitiveness of both new and existing EU member states has been empirically confirmed (Antimiani & Costantini, 2013, p. 355-389). One of the ways to succeed in the global market is therefore a systematic research, development and innovation of products and services provided, all in accordance with the protection of the environment (Borghesi, 2015, p. 669-683; Balcerzak, 2008, pp. 139-154). Innovation is not only the modern trend, but this is a basis for sustainable growth of enterprises, regardless of size. Product, process, marketing and organisational innovations must respond to the development and trends in the demographic area (Bierwisch *et al.*, 2014, p. 343-357).

The forces that drive innovations at the company level, and innovations that will succeed in improving the performance of the enterprise, are essential to establish the strategic objectives. Recently, there was a connection of the practical interest of the business community and the professional public as for the creativity and types of innovations in enterprises, in particular the impacts of the types of innovation activities on the performance of the business. The question of how to successfully make use of the innovation in enterprises is very important in the time when innovation strategy is nearly the question of survival. This solution is not surprising, because innovation could be described as a differentiation from the others, which will lead to an increase of the performance level and to a gain of a competitive advantage. Evaluation of the types of innovation in organizations should help managers to develop production processes and productivity (Gelard & Emamisaleh, 2014, p. 222-228).

The impact to differences in the structural characteristics of the selected member countries of the EU was described in a study conducted in the private sector of manufacturing enterprises (Mate-Sanchez-Val & Harris, 2014, p. 451-463). The business innovations were described using the two-step Heckman model. The European Community Innovation Surveys (CIS4) revealed that Spanish enterprises were at a different stage and they were behind the UK enterprises. According to (European Commission, 2012) the Czech Republic is in the same category as Spain, namely the weak innovators (moderate innovators), while the UK belongs to the innovators – followers. Similar recommendations to the ones given to Spanish enterprises – to try to reach the technological level of innovators followers – should be recommended for the Czech enterprises. Therefore, it is recommended to make use of public or regional support for the increasing market share of the enterprise.

Research activities and the following implementation of innovation belongs among the expensive budget items with no guarantee that the investment would have a real rate of return in the future for the enterprise and the owner (Balcerzak & Rogalska, 2008, pp. 71-87). Investment in research, development and innovations (hereinafter referred to R&D&I) should be a reasonable expenditure, a presumption for the continuous evaluation of innovative projects and processes. Ongoing evaluation of innovative projects should accompany the enterprises when deciding whether a project is beneficial for the company, and whether it is appropriate to continue the innovation. Several authors define the terminology and concepts dealing with R&D&I used in the literature. The concepts of innovation, innovation ability, development and applied research must be defined for the purposes of this contribution. Joseph Schumpeter mentions the importance of innovations for the competitiveness of the enterprise. He worked out the way of inherence in the productive process of capital, called it creative destruction, and its effect is called innovation. The positions and importance of the business were introduced in 1911. The entrepreneur is, according to him, the only one who is innovating and developing unproven technologies (Jirásek, 2002).

The main international source for the collection, analyse and use of information and data on the development and innovation is the Oslo manual. It summarizes the definitions and the legislations of the different EU countries. In the Czech Republic, the research is defined by the law 130/2002 Sb. as a systematic creative work of expanding knowledge, including knowledge of man or of society using methods enabling the confirmation, completion or overturn of the previous results as basic and applied research. Development is then defined as a creative use of research

knowledge to produce new or improved materials, products, equipment and services, including the acquisition and verification of prototypes. Results of R&D are, in many cases, innovations. The Oslo manual defines innovations in four types:

- Product innovation – means the introduction of new or significantly improved goods or services with respect to their characteristics or intended use. This includes significant improvements in technical specifications, components and materials, software, user friendliness or other function parameters.
- Process innovation – means the introduction of new or significantly improved production or supply methods. This includes significant changes in techniques, equipment and/or software.
- Marketing innovation – means the introduction of a new marketing method involving significant changes in product design or packaging, product placement, promotion of the product or of pricing. The distinguishing feature of a marketing innovation compared with other changes in the marketing tools of the enterprise is the introduction of marketing methods, which were not previously used.
- Organization innovation – means the introduction of a new organisational method in business practices, the organization of the workplace or external relations. Organisation innovation in business practice includes the implementation of new methods for the organization of the standard practices and procedures for the implementation of the work (OECD - Eurostat, 2005).

This article examines the R&D&I in the field of electronic industry in the Czech Republic. The branch of electronic industry is one of the most important and significant part of the manufacturing industry and occupies the leading position in the Czech economy. It concentrates many groups and the total trade, capital and production consistency make electronic companies strong enterprises. These companies had to respond to globalization and the entry of foreign investors.

It is possible to maintain continuity in business and achieve success only by developing innovative capabilities (Dul & Ceylan, 2014, pp. 1254-1267).

Having the ability to ensure competitiveness and sustainable growth is not possible at present without innovation capacity of enterprises (Ebersberger & Herstad, 2013, pp. 626-630; Costa & Carvalho, 2013, pp. 355-389; Balcerzak, 2009, pp. 713-742). SME's have due to the quick flow of information in the vertical direction and due to simpler administrative systems an advantage in pace of response to market demands and trends. Innovation can be interpreted as the ability to transform innovation inputs into

outputs; it means the ability to transform innovation capacity and efforts to implement its results on the market (Zizlavský, 2013, pp. 234-250). SME's have a more difficult position when financing R&D. Especially for this market segment, the measures were taken in the form of direct support for R&D and R&D Tax Deductible in 2005.

Method of the Research

Before starting the research itself, a selection of respondents was made. The enterprises operating in NACE 26 and taking part in 2013 and 2014 at AMPER exposition were chosen to be analysed.

Enterprises in this group of the manufacturing industry were chosen according to the participation in specific research "Effective economic management of the enterprise with regard to the development of global markets" and "Microeconomic and macroeconomic principles and their effect on the behaviour of firms", and according to the participation in the research on the financing of innovative activities through indirect support R&D. The intention was to contact enterprises based in the Czech Republic only. The Table 1 shows the number of respondents by size.

Table 1. Numbers of enterprises surveyed according to the industry group

Industry chapter	Size of enterprise according to the number of employees			
	0 – 9	10 – 49	50 – 249	250 –
26.1	4	11	6	1
26.2	6	4	2	3
26.3	2	7	1	0
26.4	0	0	3	0
26.5	5	15	7	2
26.6	0	0	1	0
26.7	0	1	3	0
26.8	0	1	0	0
Total	17	39	23	6

Source: own resources.

In the research process two hypotheses based on the findings issues were established:

H₁: An increasing market share is the impetus for introducing innovations in enterprises.

H₂: Manufacturing enterprises make use of deductible item as the most frequent source of R&D funding

Respecting the identified objectives for basic research – to investigate the current state of the evaluation of innovative activities and sources of financing in the electronic industry enterprises in the Czech Republic were used scientific methods of work – secondary data analysis method. This method was used to obtain new knowledge about the quality and relevance. The source of secondary data was the literature, especially foreign literature – books, magazines, articles from scientific and professional conferences, published in the databases (Scopus, Science Direct, Web of Science, EBSCO). Questionnaires were used to obtain the primary data. The data obtained from the survey were enriched during structured interviews with owners or enterprise managements. Logical methods were used for processing primary and secondary data. Analysis was used to study the records of interviews. Synthesis was the method used for data classification and processing of research results, induction was used for the generalization of all results gained in the survey. Statistical methods were used for analysing primary data. The results are published in tables in this article. Statistical Software Statistics 12 was used for verifying and validation of stated hypotheses

The investigation itself could be carried out under condition that the questionnaire would be simple, accurate and relatively short for a respondent. These conditions were an important criterion for the preparation of the questionnaire. The questionnaire was composed of four types of responses. There were questions with one or more optional answers. Questions aimed at measuring the innovations were pre-defined answers proposing the evaluation scale. Some questions were without predefined answers, free to be answered. In case of an enterprise which does not implement any activity, the answer was redirected to the next block of questions.

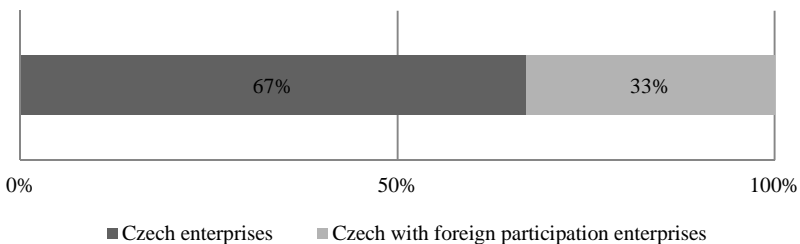
Research Results

The questionnaire was divided in four sections:

- characteristics of the enterprise
- innovation activity
- sources of R&D financing
- evaluation of innovations for the enterprise

The questionnaires were distributed to companies, which I knew by name, so it was possible to add their economic data from the database or Amadeus Commercial register. The definition of micro and SME's used in the EU comes from Annex no. 1 of Commission Regulation (EC) No. 800/2008 of 6. 8. 2008, in accordance with Articles 87 and 88 of the EC Treaty declaring certain categories of aid are compatible with the common market (General Regulation of Block Exemptions; Evropská společenství, 2006). Question N.1 and 2 were focused on the number of employees and the size of the turnover in 2013, possibly 2012. For simplification, the size of the company is based only on the number of employees. Micro and small enterprises prevail among the contacted companies, which are 63.9 %. That's mostly because the research was focused on companies based in the Czech Republic. The number of micro and small innovative companies was higher in a study conducted among manufacturing enterprises (Zizlavsky, 2013, p. 234-251). Two-thirds of surveyed companies are owned by Czech owners, one third is a foreign-owned enterprise. These are mainly medium-sized enterprises. The ratio of enterprises is shown in the Figure 1.

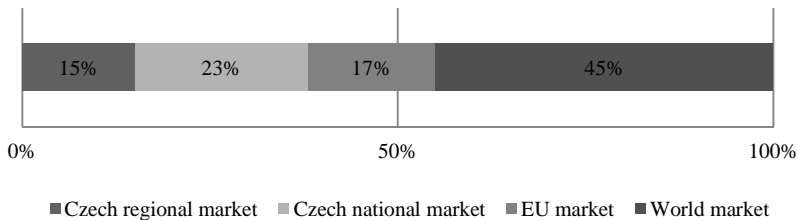
Figure 1. The ownership structure of companies



Source: own research.

The surveyed enterprises answered the question about their regional influence. In terms of competitiveness, the presence on the global market is advantageous for the company. The deficit of customers can be compensated by the expansion of activities in another market. Territorial partition of companies is shown in Figure 2. The companies focus on the world market (45 %). Enterprises that not only exported to the EU countries, but especially the Russian and American markets were represented in this category. Enterprises operating in the regional market were represented by 15 % and the companies operating on the Czech national market were represented by 23 %.

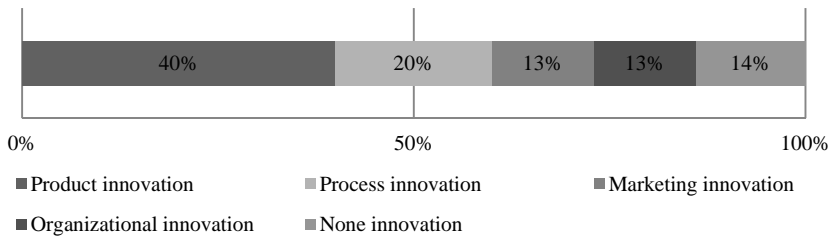
Figure 2. Orientation to markets



Source: own research.

Further on, the respondents answered the question: what types of innovations were carried out in the company in 2011-2013. The information was used in the following questions relating to the evaluation of innovative means and funding R&D. The choice from 5 predefined answers corresponded to the classification according to the Oslo Manual (OECD, 2005). The most frequent type of innovations was the product innovation, however, marketing and organization innovations were performed by the same percentage of companies. Only 14 % of companies made no innovation. For more information see Figure 3.

Figure 3. Effected innovations (%)



Source: own research.

In the period following the economic recession and increasing pressure of globalization, it is expected that SME’s are forced by the external conditions and the threat of competition to invest in innovations. On the other hand, the larger medium enterprises and large enterprises can increase operational efficiency and reduce costs by economies by quantity. The importance that the respondents see in various types of innovations is shown in Table 2.

Table 2. Importance of individual types of innovations for enterprises

Type of innovation	Evaluation 1 - 5 (%)					Average	Modus	Standard deviation	Σ 1+2 (%)
	1	2	3	4	5				
Product innovation	53	27	13	0	7	1.8000	1	1.2540	80
Process innovation	23	52	9	0	17	2.3636	2	1.3093	74
Organizational innovation	25	9	41	16	9	2.7500	3	1.2502	34
Marketing innovation	23	23	23	8	23	2.8514	Multiple	1.4650	46

Source: own research.

The results of weighted averages accentuate the importance of individual types of innovation for the business, product innovation are important for companies, but the innovation of new products may accompany the innovation process and marketing. The importance of innovations was evaluated on the scale: 1 – Very important, 2 – Important, 3 – Neutral, 4 – Not important, 5 – Completely unimportant. The table shows the percentage of positive responses, i.e. the sum of responses 1 and 2. According to this summation of the respondents answer, the importance of innovation for the

company is in the following order: product innovation, process, marketing and organizational innovation. Compared with the research carried out throughout the manufacturing industry in the Czech Republic in the years 2010–2011 (Zizlavský, 2013, p. 234-251). the difference is in ranking between marketing and organizational innovation. A higher percentage of enterprises in the electronic industry appreciate product innovation. Organizational innovations are, according the percentage of answers, less important for companies operating in electronic industry than for companies in manufacturing industry.

Another part of the questionnaire was to answer questions about the impetus for the introduction of innovations and to evaluate their significance for the company. Answers of respondents according to the level of importance in percentage and their statistical processing are shown in Table 3.

Similarly, the development of new forms of work organization, or possibly organization of supplier relationships is considered “not very important” for enterprises. 44 % of respondents considered it “very important” or “important”.

Extend the range of products and increase the quality of use of a product or provided services were the most significant impulses for the surveyed enterprises. R&D Council of the Czech Republic found that the Czech production had relatively high expenditures of production, which is compared to the EU average of 28 countries 2.5 times higher to a production unit of GDP (R&D Council, 2014, p.3) and it is very alarming that to reduce energy and material costs of production is the least significant impetus for the introduction of innovations in the electronic industry.

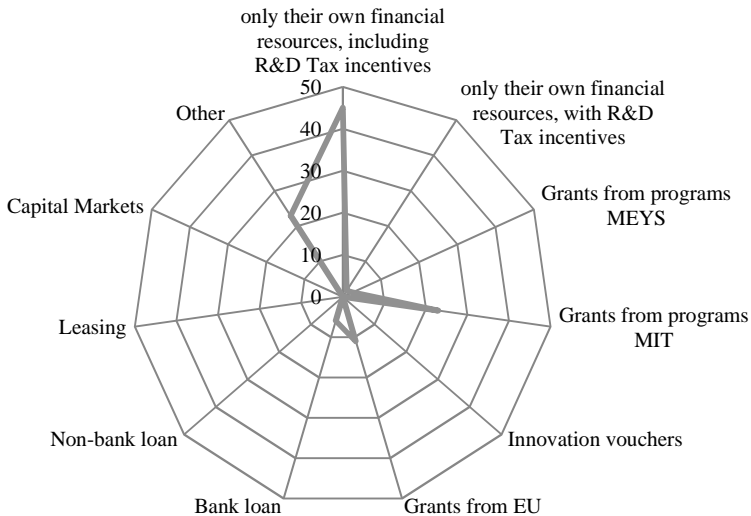
The respondents provided information on the sources of funding for innovation activities in the next part of the questionnaire. SME's in the manufacturing industry often mentioned insufficient resources to cover R&D expenditures. (Nowakowska-Grunt, 2014, pp. 789 - 795); (Kearney, 2014, pp. 552 - 567) SMEs in the Czech electronic industry use mainly their own resources. The result of the survey is presented in the Figure 4.

Table 3. Importance of innovations for the enterprise

	Evaluation 1 – 5 (%)					Average	Modus	Standard deviation	Σ 1+2 (%)
	1	2	3	4	5				
Extending the assortment	69	23	8	0	0	1.3900	1	0.6339	92
Reducing material intensity of production	30	14	30	22	0	2.4583	Multiple	1.1600	44
The development of new technologies	31	45	8	8	8	2.1700	2	1.1896	76
The introduction of new work organization	31	15	46	8	0	2.3100	3	1.0020	46
Increase the utility qualities of the products or service	50	34	16	0	0	1.6600	1	0.7415	84
Increase the market share	46	23	23	8	0	1.9300	1	1.0076	69

Source: own research.

Figure 4. The sources of funding of research activities of SMEs in the electronic industry



Source: own research.

The most common way of financing development activities of SMEs in the electronic industry are own resources. The enterprises use financing to their own detriment without the use of tax incentives. Tax incentives in the Czech Republic were legitimized in 2005. Companies, as a legal entity, could make use of the tax allowances for research and development in the reporting period according to § 34 para. 4-8 of the Act no. 586/1992 Coll., on income taxes, and deductions among individuals according to § 34 para. 4 of the Act no. 586/1992 Coll. Among the respondents there were only two companies that took advantage of tax incentives for reimbursement of a part of eligible R&D costs. The company representatives said that the deductible item for R&D was the form less demanding as for administration as well as less time-consuming form of support from public funds than direct assistance in the form of grants. Tax incentives were used repeatedly. A quarter of companies used direct support for R&D programs of the Ministry of Industry and Trade (MIT). Only 13 % of companies reported that in 2011–2013 they used funding support from the EU for research. None of the companies had any experience with the use of innovation vouchers. This tool of innovation support was introduced in 2009 in the Czech Republic by the South Moravian Innovation Centre (hereinafter referred to as

JIC). It is a way of collaboration between Brno research institutions and enterprises in the region. Vouchers are designed especially for SME's, which enable the company to fully concentrate on business, while the selected researcher will supply the knowledge necessary for innovation. The aim of the cooperation is to create high added value and increase the competitiveness of companies in the region. According to the authors of this idea, the innovation vouchers help to eliminate mutual distrust between the academic and business backgrounds. (Jihomoravské inovační centrum) A total of 300 innovation vouchers for over 32 – million CZK were issued during the calls from 2009 to 2014. This principle of innovation support was also adopted by other regions, eg. Zlin, Liberec etc. SME's of electronic industry do not benefit from leasing, non-bank loans and financing through capital markets for funding innovation activities.

The enterprises of the manufacturing industry felt that the most important factor limiting their innovation activities was a lack of funds and too high costs and risks of innovation in the years 2009–2011 (Žižlavský, 2013, p. 242). The companies reported in other responses the reasons for not using innovation vouchers, indirect support, subsidy programmes and bank loans to finance their research activities. More than half of the companies stated that they did not trust the system of allocation of funds for innovation vouchers and indirect support. At the same time, however, two thirds of respondents stated that management did not know about the possibility to finance R&D expenditures through innovation vouchers and deductions when they were asked questions about this kind of financing.

The last part of the questionnaire contained questions about the ways of evaluation of innovation processes. The most important indicator for the evaluation of innovation activities for SMEs of electronic industry was *revenues*, which 27 % of companies considered “very important”. The evaluation of innovative activities through the Balance Scorecard, indicators of profitability and market potential was behind the revenues.

Conclusions

The survey was based on the interest of companies in practical experience in the use of methods of funding research activities a importance of innovations and innovation metrics for the enterprises in the Czech electronic industry. Basing on experience with the use of direct aid and tax incentives in advanced European economies (Bozeman & Link, 1985, pp. 370-382; Bozio *et al.*, 2013, p. 1-28; Baghana & Mohnen, 2009, pp. 91-107; Cappelen *et al.*, 2012, pp. 334-345), and evaluation of the legislation in the

Czech economy (Elschner *et al.*, 2011, pp. 233-256), it might be assumed that the Czech production enterprises would invest in accordance with the International Strategy of competitiveness in the Czech Republic in research and development and constantly innovate. The survey revealed that the reality was different. Enterprises involved in the primary research are in 2/3 owned by Czech capital, and more than half of them are operating only on the regional and European markets.

Real numbers of innovations, measurement of innovation activities in connection with the competitiveness of countries are measured by international indicators such as Innovation Scoreboard, GCI etc. Countries whose indicators are lower look for a way to increase innovations and enhance the innovation process. One of the means is to identify barriers. Identification of innovation barriers was effected in the Spanish manufacturing industry with 294 enterprises (Madrid-Guijarro *et al.*, 2009, pp. 465-488). The biggest barrier is the high costs of the innovation process. This barrier affects small-sized enterprises to a greater extent than large enterprises. A less significant barrier to innovation is the discrepancy between employees and owners. Innovative activities of companies depend on the company's position in the region, the size of enterprise and public support for innovation in the private sector. The identification of barriers was conducted from the perspective of managerial perceptions. *Internal barriers*: lack of financial resources, low-skilled human resources, weak financial position of the enterprise, the high cost of innovations and investment risk of innovations. *External barriers*: turbulence environment, lack of external partners for cooperation, lack of information, lack of public support. Similar results were reported by other authors (Cordeiro & Vieira, 2012, pp. 97-104; Holmenlund, 2014; Georghiou *et al.*, 2014, pp. 1-12). In Finland, one of the most innovative and developed countries, the barriers of innovations are described in the smallest detail, including recommendations on how to overcome those barriers (Sandberg & Aarikka-Stenroos, 2014, pp. 1293-1305). Global European survey was performed in two stages and their results are presented by (Hölzl & Janger, 2013, pp. 1450-1468). They point to differences in barriers to the fast growing innovative enterprises and other enterprises in connection with the influence of public administration.

Identification of innovation barriers in countries with a similar historical development, such as the Czech Republic, is based on a comparison of innovation barriers in different industrial branches (Balcerowicz *et al.*, 2010, pp. 1-44). I did not find any detailed information in available resources about identification of innovation barriers in Hungary and Slovakia.

There are more authors in the local literature who deal with the issue of identification of innovation barriers, especially (Nečadová & Scholleová, 2011; Nečadová & Breňová, 2012). They mention especially these kinds of innovation barriers:

- high expenditures,
- lack of specialists,
- extremely long period of return on investment,

High expenditures and a long period of return on investment are the barriers of innovation activities that can be partially overcome by using direct and indirect support for research and development. The Czech business sector has one of the best legislative support for tax incentives, i.e. the possibility to deduct incurred expenditures of research and development in the amount of 200 %. This possibility can be applied if the enterprise is not profitable. Deductible item can be applied in three following tax years. There is existing legislative support for enterprises, therefore, SMEs finance the innovations mainly from their own sources and without the use of indirect support as the survey revealed. Deductible item was used only by two enterprises from all surveyed ones. Most enterprisees – 45 financed the research from their own resources. According to the survey the enterprises do not trust the subsidy programmes offered by MIT, MEYS and EU. However, 27 companies made use of the direct R&D support sometimes in the past. The hypothesis about the use of R&D Tax deductible has not been confirmed.

SME's in the electronic industry in the Czech Republic implemented all four types of innovations in 2010–2013, mostly product innovations. Product innovations are performed by 40% of enterprises. 80% of enterprises consider product innovation as “very significant” and “significant”, process innovations seem to be “significant” for 52% of respondents. Marketing innovations are more important than process innovation. 14% of enterprises do not innovate at all. Owners and management of enterprises consider the impact of innovation on the position of enterprises as beneficial, and enterprises behave responsibly when measuring the impact of innovations. The respondents rated as “very important” and “significant” the extending of assortment, the increase of the utility qualities of a product or a service. The development of new technologies has also a significant impact on enterprises. H1 hypothesis was confirmed. Increasing market share for enterprises one of the impulses for the the implementation of innovations. Measurement of results of innovations using financial and non-financial indicators was not the main aim of this paper, but could be the subject of further survey in individual groups of manufacturing industry.

In conclusion, it is necessary to add that funding of R&D&I in SMEs of certain groups of the manufacturing industry is influenced by the position of SMEs in comparison with the big players in the market – access to information, sources of financing, own research departments, ensuring their own research by skilled human resources. Yet, SMEs innovate, overcome the barriers in defined some pieces of research, and increase the competitiveness of SMEs in the electronic industry, thus contributing to increased competitiveness of regions according to their competence, and increase the chances of the Czech economy to progress to the category of *Innovation followers* or *Innovation leaders*. The use of these types of aid is not frequent, as the foregoing research reveals. It is important to note that Czech SMEs should make better use of available resources of funding research and development in cooperation with research institutions, which can significantly reduce their own costs for R&D.

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