EKONOMICKÁ UNIVERZITA V BRATISLAVE
PODNIKOVOHOSPODÁRSKA FAKULTA
SO SÍDLOM V KOŠICIACH
Evidence number: 107007/D/2017/1398731179

ENTERPRISES' INNOVATION ACTIVITY IN CONTEXT OF FOREIGN DIRECT INVESTMENT

The dissertation thesis

2017 **Ing. Zuzana Kubíková**

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The study programme:	Economics and Business Management
The field of study:	3.3.16 Economics and Business Management
The study department:	Department of Management
The supervisor:	doc. JUDr. Ing. Aneta Bobenič Hintošová, PhD.

Košice 2017 **Ing. Zuzana Kubíková**

Zadanie záverečnej práce (vo vytlačenej verzii nahradiť stranou z AIS-u).

Honourable statement

I honestly declare that I have written the final thesis on my own and I have referred all the literature used.

The date: ……………………………………..

Ing. Zuzana Kubíková

Acknowledgement

I would like to thank to my supervisor doc. JUDr. Ing. Aneta Bobenič Hintošová, PhD. for her guidance, support and advices during my whole PhD. study, as well as for the supervision of my dissertation thesis.

ABSTRAKT

KUBÍKOVÁ, Zuzana: *Inovačná aktivita podnikov v kontexte priamych zahraničných investícií*. – Ekonomická univerzita v Bratislave. Podnikovohospodárska fakulta; Katedra manažmentu. – Školiteľ: doc. JUDr. Ing. Aneta Bobenič Hintošová, PhD. – Košice: PHF, 2017, 139 s.

Cieľom záverečnej práce je identifikácia existencie a sily vzťahu medzi inovačnou aktivitou podnikov a tokmi priamych zahraničných investícií v podmienkach Slovenskej republiky. V dizertačnej práci analyzujeme tri súbory dát o výrobných podnikoch pôsobiacich na Slovensku s využitím metódy najmenších štvorcov v prípade, že je táto metóda vhodná na použitie. Zistili sme negatívny vplyv prílevu PZI na výdavky na výskum a vývoj, ktoré predstavujú ukazovateľ inovačného vstupu, zatiaľ čo inovačný výstup nebol štatisticky významne ovplyvnený prílevom PZI na základe dizertačnej makroekonomickej analýzy. Na druhej strane odlev PZI mal pozitívny vplyv na výdavky na výskum a vývoj a v prípade inovačného výstupu sme dokázali jeho nelineárnu závislosť na tomto determinante. Navyše v dizertačnej analýze na podnikovej úrovni sme dokázali, že zahraničné vlastníctvo negatívne vplýva na inovačný výstup podnikov.

Kľúčové slová:
inovačná aktivita, priame zahraničné investície, toky PZI, alokácia

ABSTRACT

KUBÍKOVÁ, Zuzana: *Enterprises' innovation activity in context of foreign direct investment*. – University of Economics in Bratislava. Faculty of Business Economics; Department of Management. – Supervisor: doc. JUDr. Ing. Aneta Bobenič Hintošová, PhD. – Košice: PHF, 2017, 139 p.

The aim of the dissertation thesis is to identify the existence and the magnitude of the relationship between the innovation activity and the foreign direct investment flows in the Slovak Republic. In our thesis we analysed three datasets of the manufacturing enterprises operating in the Slovak Republic, with use of the OLS, when this estimation method was proved to be appropriate. We found negative effect of the FDI inflows on the R&D expenditures, measuring the innovation input variable, while the innovation output was not statistically significantly influenced by FDI inflow on the macroeconomic level. On the other hand, the FDI outflow was found to positively influencing the R&D expenditures, as well as the innovation output, where we also found non-linear relationship between the two variables. Furthermore, the foreign ownership was proved to be negatively influencing the innovation output of the enterprises on the microeconomic level.

Key words:

innovation activity, foreign direct investments, FDI flows, allocation

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The introduction

The innovation activity of enterprises can be defined in various ways. J. A. Schumpeter, who is considered as one of the first authors defining the term innovation, defined the innovation as something new, what is beneficial for the enterprise and helps it to achieve competitive advantage on the market. The literature distinguishes technological innovations, where we include product and process innovation, and non-technological innovations, which contain marketing and organisational innovations. OECD considers the research and development activities as the innovation activity, as well. Hence, the enterprises with innovation activity are generally those, who introduced some of these mentioned innovations, or conduct research and development.

In our thesis we provide the definitions of the innovation activity emerging from existing literature, and introduce various measurements of this variable. We analyse the innovation activity of the enterprises on macroeconomic, industrial and microeconomic level. There is a large number of determinants, which can influence the innovation activity. Firstly, we summarise the empirical researches on this issue in our theoretical section of the thesis. Then, we examine the possible determinants of the innovation activity on three levels, namely: in conditions of the Slovak economy, the manufacturing industrial sector, and the selected sample of large manufacturing enterprises.

The large number of authors introduce the foreign direct investments as one of the possible determinant of the innovation activity of the enterprises. We devote a part of our literature review to these empirical researches in domestic and foreign literature. Consequently, we conduct our own research in the Slovak enterprises, where our main interest is devoted to the relationship between the innovation activity and the foreign direct investments. The aim of our thesis is to identify the existence and the magnitude of this relationship in conditions of the Slovak Republic.

The purpose of this dissertation thesis is to contribute to the literature about the effect of the foreign direct investment flows on the innovation activity of the enterprises. The motivation for conducting our research is to expand the empirical findings in condition of the Slovak Republic, where, based on our knowledge, only a limited number of similar researches exists. The Slovak Republic belongs to the Central and Eastern European countries, which recently overcame the transition process, and can be included into the group of developed countries. The limited existing literature in condition of this country focused mostly on the macroeconomic research, and in some cases suffered from the non-availability of the data. We enrich the existing literature with the research of the latest available data not only on the macroeconomic, but also on the industrial and microeconomic level. In addition, we briefly analyse the relationship between the innovation activity and the performance of the enterprises. We expect a positive effect of the innovation activity on the enterprise's performance, because we suppose that the reason for the enterprises to involve in the innovation activities could be their expectation of the performance improvement.

The dissertation thesis is organised as follows. The first chapter is devoted to description of the current state of the issue in domestic and foreign literature. In the second chapter we define the objectives of the thesis. In the third chapter we characterise the object of our research, describe the methods of the data processing, then we introduce the sources of the thesis, and describe the used variables and methods. The fourth chapter is devoted to the presentation of own results. In the last chapter we discuss our results, and we compare them to the existing literature. The conclusion is devoted to the summarisation of our results and evaluation of the objectives fulfilment.

1 The state of the issue in the domestic and foreign researches

In this chapter, first the foreign direct investments are defined. They are categorized according to their characteristics and forms. Then the theories, which attempt to explain the reasons of enterprises for investing in a host country, are briefly summarized. Afterwards, the definitions and measures of innovation activity in existing literature are described, and the effects of innovation on performance of enterprises are briefly discussed.

The main interest we devoted to the innovation activity of enterprises in context of foreign direct investment. The possible relations and effects of foreign investment on innovation activity of enterprises are discussed. Besides the foreign direct investments, other possible determinants of innovation activity are introduced.

1.1 The foreign direct investments

According to Balance of Payment Manual from International Monetary Fund (1993, p. 86), foreign direct investments (hereafter also "FDI") represent obtaining a lasting interest in an enterprise operating out of investor's economy, while the investor's intention is to gain a significant vote on the management of the enterprise.

Gunter (2007, p. 105) defines foreign direct investments as investment made to acquire a lasting management interest (usually at least 10% of voting rights) in an enterprise, which is in a country other than of the investor's residence.

Baláž et al. (2010, p. 116) defines foreign direct investments as the investments to an enterprise based on long-term relationship, which reflect a lasting interest of resident subject of one country in control of enterprise in another country.

Bobenič Hintošová (2010, p. 47) considers as foreign direct investments those, which provide investors with long-term participation in the management and control of the enterprise abroad through property rights at the level of at least 10% of the equity share or voting rights.

Gopinath (2008, p. 101) states that foreign direct investments are effectively controlled from abroad, and may take the form of a new enterprise or acquisition of a controlling interest in an existing enterprise. They represent high level of commitment of the investor in the country, and they are usually for the long term.

Foreign direct investments can be made in three forms (Baláž et al., 2010, p. 117):

- in the form of initial contribution, called *equity capital*, which includes property, shares, and other equity contributions;
- in the form of *other capital*, which consists of funds, debt securities, and supplier credits between direct investors and affiliates;
- and in the form of *reinvested earning*, which is the profit share of the investor, which has not been paid in the form of dividends or revenue share, but reinvested into the enterprises' facilities, equipment, activities, etc.

A country of investor's residency is called parent, or home country, and a country, where the investments flow is host, or partner country. Regarding the FDI, the change of investment over time represents inflow and outflow, while the cumulative sum of inflow is inward stock, and the cumulative sum of outflow is outward stock, what represents the total volume of the FDI at a specific time (Baláž et al., 2010, p. 118 and 124).

According to the type of activities of a parent company and its affiliates, Baláž et al. (2010, p. 118-119) distinguishes the following:

- horizontal FDI - when the affiliates perform in the host country the same activities as the parent company in its own country;
- vertical FDI - when the affiliates and the parent company specialize in a certain activity of the production process on a different stage of product's completion;
- and conglomerate FDI - when the affiliate's activities are unrelated to the activities of the parent company.

According to Dunning (1995), based on the enterprise's investment motivation, the FDI can be:

- market-seeking – when an enterprise uses horizontal strategy to access a host country market,
- resource-seeking – when an enterprise aims to access raw materials, labour force, and physical infrastructure resources in a host country,
- efficiency-seeking – when an enterprise use vertical strategy to take advantage of lower labour costs, especially in developing host countries,
- and strategic assets-seeking - when an enterprise aims to access research and development, innovation, and advanced technology.

Stiglitz (2007) states that the FDI are widely praised for bringing not only capital, but also access to foreign markets, technology, and human capital. Epstein (2011) tells about possible positive and negative effects of the FDI on a host country. The possible positive effects are the following:

- the FDI is a stable source of finance,
- it creates more employment opportunities,
- it leads to increases in the demand for labour, thereby raising wages,
- it brings technologies and increase productivity,
- thanks to better technologies and higher productivity, enterprises can pay workers more.

The possible negative effects of the FDI on host country are the following:

- asymmetry in location of the FDI,
- the FDI is concentrated in hands of a relatively small number of enterprises,
- tax competition of host countries,
- policy competition of host countries in questions of attracting investment.

Additionally, except from stated effects, Bobenič Hintošová (2010, p. 50-51) considers growth of employer's qualification, improvement of image of affiliates and products, access to foreign distribution channels, and improvement of institutional system in host country as positive effects of the FDI. To negative effects author adds depreciation of the local currency, decrease in production, which requires manual labour, weakening the competitiveness of local enterprises, and repatriation of profits to the parent country.

1.2 The theories of FDI

The theories of the FDI have evolve through time, and there are many different approaches, attempting to explain the reasons for investing in different countries (Culahovic, 2008, p. 4). The first theoretical attempt to explain the FDI is found within *the neo-classical theory of international trade*. Mundell (1957, p. 321) included the factor movement in the previous classical framework, where factors of production (land, labour, capital) were internationally immobile. He described some of the effects of relaxing this classical assumption, allowing not only commodity movements, but also factor mobility. Specifically, he showed that an increase in trade barriers stimulates factor movements and an increase in restrictions to factor movements stimulates trade. As the first, he attempted to explain the FDI by means of factor endowments and cost of factors.

Additionally, the neo-classical economic theory concludes that under perfect factor mobility, capital would flow from relatively rich countries to relatively poor countries. The Heckscher-Ohlin's model argues that a country will export the commodity that intensively uses its relatively abundant production factor (Sánchez-Martín, 2014, p. 280). However, this approach was not useful in discussing the activities of multinational enterprises (MNEs), as an unavoidable FDI phenomenon, because of the presumptions that manufacturing factors are fixed and immobile, transport costs negligible, technology pre-set and geographically constant, and economy of scale non-existent.

These presumptions that limited general acceptance of neo-classical theories, gave rise to the emergence of *the new theories of trade*, which combine ownership and location advantages with technology and country-specific factors (Culahovic, 2008, p. 4-6). There has been considerable progress in terms of theory regarding MNEs and FDI location behaviour (Gamboa, 2013, p. 997).

Dunning (1980, p. 9) proposed *the eclectic theory of international production*. The eclectic theory describes that the propensity of an enterprise to engage in international production, which is financed by the FDI, rests on three main determinants:

- The extent, to which an enterprise possesses, or can acquire assets, which its competitors do not possess. This may arise from the enterprises' privileged ownership of a set of income-generating assets, or from its ability to coordinate these assets with other assets across national boundaries in a way that benefits them relative to their competitors, or potential competitors (Dunning, 2001, p. 176). It is called ownership advantage (O).
- The extent, to which it is profitable for an enterprise to exploit these assets in connection with the local resources of foreign countries, rather than those of the home country (Dunning, 1980, p. 9). It is called location advantage (L).
- The extent, to which an enterprise prefer to internalise the markets for the generation and/or the use of these assets; and by doing so to add value to them (Dunning, 2001, p. 176). It is called internationalization advantage (I).

With use of his eclectic theory (so-called *OLI theory*), Dunning attempted to answer the question why, how and where the FDI will take place (Culahovic, 2008, p. 6). The more an enterprise possesses the ownership advantages, the greater is the tendency to internalize them. Furthermore, the larger is the attractions of a foreign rather than a home country, the greater is the likelihood that an enterprise will engage in international production. To sum up, a national enterprise supplying its own market has various options for growth: it can diversify horizontally into new product lines, or vertically into new activities, including the production of knowledge; it can acquire existing enterprises; or it can exploit foreign markets, when the enterprise becomes an international enterprise. However, to be able to produce alongside with local firms in foreign markets, the enterprise must possess additional ownership advantages sufficient to outweigh the costs of servicing an unfamiliar or distant environment (Dunning, 1980, p. 9).

Ownership, Location and Internalization (OLI) advantages encouraged enterprises to undertake foreign investment. However, OLI theory was not built on a formal setting. Helpman (1984) and Markusen (1984) incorporated Dunning's ideas into *the general equilibrium theory of trade*.

In the general equilibrium theory of international trade, Helpman (1984, p. 470) stated that MNEs play an essential role in conducting the foreign trade. He defined MNEs as economic entities, which possess firm-specific assets, engage in monopolistic competition, and play an active role in foreign trade. General equilibrium theory identified and analysed the circumstances, in which enterprises find it profitable to become multinational. It has following important feature: there exist inputs that can serve product lines without being located in their plants (Helpman, 1984, p. 452).

This theory was extended to horizontally as well as vertically integrated MNEs, which generated more realistic pattern of resource allocation. Particularly, the integrated MNEs may have production facilities in both home, and host countries, and vertical integration brings intrafirm trade in general purpose inputs and intermediate inputs. This theory explained cross-country penetration of MNEs as well, as a result of trade barriers, such as transport cost or tariffs. The establishment of new plant for the same products requires additional fixed cost, but saves the costs connected with trade barriers, and does not require new general purpose inputs. Thus, for high barriers, cross-country penetration is expected (Helpman, 1984, p. 470).

Markusen (1984, p. 223-224) explained the allocative and distributive effects of MNEs with use of the general equilibrium theory, which should meet following pre-conditions:

- It provides rationale for FDI versus portfolio investments.
- It does not rely on international factor movements, factor price differences, or international trade barriers.
- It explains the reason for superior monopoly production to collusion among independent producers.
- It explains, why MNEs may diversify geographically, and conduct different activities in otherwise identical countries.
- It allows positive economic profits, as the gain from trade.

The general equilibrium theory of trade led to *the knowledge-capital theory* (Markusen, 1998). The ownership advantage from Dunning´s OLI theory belongs to knowledge, while the location advantage includes size of the market and costs of trade for multinational enterprises. Markusen (1997, p. 2-3) considered the relationship between trade and investment liberalization with focus on host countries. In his knowledge-capital model, there are two goods, two countries, two factors - unskilled and skilled labour, and six possible configuration of plants and headquarters locations, which describes how the knowledge is allocated in MNEs.

Markusen (1997) combined horizontal and vertical motives for the FDI and concluded that similarities in market size, factor endowments and transportation costs were determinants of the horizontal FDI, while differences in factor endowments were determinants of the vertical FDI. The horizontal MNEs produce similar goods and services in different countries with main motivation to access markets, when trade costs are high. The vertical FDI refer to a fragmentation of the production process into stages of production that are each produced in different locations, and are motivated by the differences in factor prices, especially in labour costs (Gamboa, 2013, p. 997).

The location theory deals with factors that influence the location of production, as well as with determining economic and market effects of the location (Culahovic, 2008, p. 5). Concerning firm location decisions, *the new economic geography theory* by Ethier (1986) incorporate location theories into a formal model. His implications are different from those of Markusen and Helpman, who took internationalization of enterprise for granted. Ethier (1986, p. 831) argued that a critical question for understanding the FDI was the nature of internationalization, and the essential aspect of it is the exchange of information. The presence of MNEs is related to factor endowment and dispersion, which attract or discourage enterprise from locating in host country.

On one hand, MNEs attempt to locate in host country, near to other firms, especially if they are its suppliers or customers, to take advantage of positive externalities as technological spillovers. On the other hand, increases in wages and land prices, reduce the attractiveness of a host country. New economic geography theory shows, how liberalization reforms influence the FDI location decisions. It highlights the importance of factor prices and market size as major determinants of location decisions (Gamboa 2013, p. 997).

Although macro theories can help in characterizing an internationalization process, they cannot provide a background for an enterprises' geographic, organizational, sectoral or transnational activities (Culahovic, 2008, p. 4-5). Hymer (1976) first observed that the problems connected to production internationalization should not be treated within the international capital theory, but rather the behaviour of MNEs, as carriers of production internationalization, and the FDI flows, as their major tool, should be analysed. In his analysis of the expansion of MNEs, Hymer (1976) employed *the theory of industrial organization*, within which he separated the concept of portfolio investment from the FDI, and introduced the argument that particular enterprises have advantage in some activities, which the others do not have. With this theory he developed previous work by Kindleberger (1969), who explained specific advantages of foreign enterprises in production and market factors, economy of scale and government-imposed restrictions.

Another FDI theory is Vernon's (1966) *theory of product life cycle*, according to which production starts in developed countries, and when a product is fully standardized, the production moves to developing countries with lower production costs. International trade is then related to international investment, which also partly explains the development of MNEs (Culahovic, 2008, p. 5).

Sánchez-Martín (2014 p. 281–282) mentioned the emergence of a recent *risk diversification theory* that complements previous theories, and argues that the vertical FDI are more common, and enterprises often open different production facilities and export platforms, or even use outsourcing to diversify risks, including country-specific, political and economic risks.

Additionally, a growing body of literature emphasizes the quality of institutions to be important for deciding about FDI. Rodrik (2004) claims in *the new institutional economics theory* that attracting the FDI into a host country is often presented as a "beauty contest" or even a "race to the bottom", and poor quality of institutions and corruption increase the cost of doing business, and may lead to poor infrastructures. Then, in the absence of property rights protection, an enterprise may prefer the FDI rather than contracts with local suppliers (Resmini, 2007, p. 212).

Alongside with Dunning´s OLI theory, there is *the gravitational theory* (Tinbergen, 1962; Poyhonen, 1963), as one of the main theories that explain, why enterprises use the FDI to operate in a host country rather than export or licensing tools. The gravitational theory specifies trade flows between countries as a function of their GDP and the distance between them (Bergstrand, 1985; Bergstrand, 1989). However, this theory has not strong theoretical foundation (Blonigen, 2005, p. 393). Application of this theory to the FDI is implicit: if the countries are far from each other, then it is more convenient for enterprise to produce in a host country than to export, since the greater the distance the higher the transportation costs (Gorbunova, 2012, p. 132).

Last but not least, one of the important group dealing with the FDI and its relationship with economic growth is *the developing theories*, which are based on the fact that the economic structure influence the FDI, which consequently impact on the economic structure and development. To the developing theories belong the Kojim's hypothesis from 1978 about Japanese FDI (Kojima, 2010), and Dunning's theory about the economic development path of countries and the FDI.

Kojima (2010) studied the FDI in Japanese enterprises, and stated that the Japanese enterprises differ from the American ones, because they creates the goods flow instead of replacing them. Japanese FDI use the comparative advantages of countries better, and they initially support transfer of industries demanding the labour capital, or sensitive on environment. The Kojim's hypothesis from 1978 was further developed by Ozawa (1992), who examined the relations between the economic development level and the accumulation of physical and human capital, and he identified three development levels:

1. level – FDI inflow is dedicated to find beneficial production factors, while FDI outflow is not important;
2. level – FDI inflow focuses on growing home markets, and FDI outflow is motivated with cheap labour;
3. level – both FDI inflow and outflow are motivated with market and technological factors.

Dunning's theory about the economic development path of countries and the FDI distinguishes five basic development levels (Baláž, 2010):

1. level – a country does not invest abroad, due to its low development. It cannot use its specific advantages. Domestic enterprises participate in the foreign markets only with exporting activities. The FDI from developed countries starts to flow into the developing country, because they attempt to use the specific advantages of the country.
2. level – the FDI inflow increases. Foreign enterprises replace their import to the host country with the production there, due to growing purchasing power of the host country residents. The host country invest abroad rarely, the domestic enterprises do not possess the advantages needed to invest abroad.
3. level – the FDI outflow starts to rise, because the domestic enterprises gained the specific advantages, thanks to presence of the foreign investors on the domestic market. The wages start to grow and the country, hence, it loses the advantage of cheap labour. However, new advantages appear – high demand, technological development, modern infrastructure, etc. The FDI outflow is lower than the FDI inflow, but they start to converge.
4. level – the FDI outflow becomes important in the country.
5. level – decisions about the FDI flows are not based on the advantages of countries, but based on dynamic factors. Inflow and outflow converge. This level is typical for the most developed countries.

1.3 The innovation activity

Innovation can be defined from various perspectives. An early and one of the most popular definition of innovation comes from Joseph Alois Schumpeter (2003), who defined innovation already in 1911 as something that changes the market in a beneficial way, and an enterprise, which innovates, can be a new market leader, and can achieve competitive advantage over its competitor with high probability. He considered as the innovation one or more activities from the following (Schumpeter, 2011):

- Introducing new or enhanced products,
- Introducing new method of production,
- Entering new markets,
- Using new raw materials, energies and semi-finished goods,

- Creating new organisation of production.

In the Slovak Republic, the innovation is defined in the Act no. 172/2005 Coll. on the organisation of state support of research of development and on amendment to Act no. 575/2001 Coll. on the organisation of government activities and the organisation of the central state administration, as amended, which defines the innovation as follows (The Act no. 172/2005 Coll., Art. I., § 2, par. 5):

- New or enhanced product or service, which can be used on the market, and is based on the results of research and development or entrepreneurial activity,
- New or enhanced production process or distribution method, including significant changes of technology, equipment, or software,
- New way of organisation in enterprise, its plants, or external relationships,
- Transfer of scientific and technological findings into a practise,
- Purchase of production, technical, and business know-how, acquisition and rent of licences,
- Introduction of modern methods in the pre-production stages and organisation of work,
- Improvement of control and testing methods in the production process and services,
- Improvement of quality and safety of work,
- Decrease of negative influence on the environment,
- More effective usage of natural sources and energy.

OECD (2005, p. 46) defines innovation as implementation of new or significantly enhanced product, service, and process, a new marketing or organisational method in entrepreneurial practise, workplace or external relations. OECD (2005, p. 47) distinguish product, process, marketing, and organisational innovations.

As the **innovation activity** we consider all scientific, technological, organisational, financial, and commercial activities leading to the implementation of innovation. While some of these activities are innovative on their own, others may not be new activities, however, are inevitable for the innovation implementation. The innovation activities include research and development, which are not directly attributable to the specific innovation, as well (OECD, 2005, p. 47).

The innovation activities include, according to Statistical Office of the Slovak Republic (2010, p. 2), product innovations, process innovations, ongoing or abandoned innovation activities for product and process innovations, organisational innovations, and marketing innovations. In general, the product and process innovations create the group of technological innovations, while the marketing and organisational innovations creates the group of non-technological innovations.

Statistical Office of the Slovak Republic (2010, p. 2) and OECD (2005, p. 48) define **product innovation** as a new or significantly improved product (good, service) with respect to its fundamental characteristics, technical specifications, incorporated software, or other immaterial components, intended uses or user friendliness, or other functional characteristics. The product innovations are based on new knowledge, technologies, or their new combinations and usage. New products differ significantly in their characteristics or usage forms from previous products of the enterprise. In case of services, the innovation includes improvements in the way of service provision in terms of e.g. speed or efficiency, the new functions or characteristics of services, or the entirely new services. OECD (2005, p. 48) states that a part of the development and implementation of product innovation is a design, which we define later in our thesis. However, changes in the design itself are not considered as the product innovation, unless they involve a significant usage or functional change.

Process innovation includes new and significantly improved production technologies or methods of supplying services and delivering products, including significant changes of specific techniques, software or equipment for optimization of quality, efficiency or flexibility of production and distribution, or for reduction of environmental or safety risks (Statistical Office of the Slovak Republic, 2010, p. 2; OECD, 2005, p. 49). These innovations lead to decrease of production unit or delivery costs, to enhancement of quality, or to production of new or improved product, and cover support activities, such as purchasing, accounting, computing, and maintenance.

Organisational innovation means the implementation of new or significant changes in firm structure or management methods that are intended to improve use of knowledge in an enterprise, the quality of goods and services, or the efficiency of work flows. Organisational innovations involve the implementation of a significant change in business practices, workplace organisation or external relations, intended to improve the enterprise's innovative capacity or performance characteristics (Statistical Office of the Slovak Republic, 2010, p. 2; OECD, 2005, p. 51). These innovations are aimed to performance improvement of an enterprise by administrative, supplies, or transaction cost reduction, by improvement of labour productivity, or by obtaining of special knowledge.

Marketing innovation is defined as the implementation of new or significantly improved designs or sales methods to increase the appeal of your goods and services or to enter new markets. The marketing innovations cover significant changes in how enterprise offers new goods and services (Statistical Office of the Slovak Republic, 2010, p. 3; OECD, 2005, p. 49). The marketing innovations include significant changes in product design (form and appearance, packaging), in product placement (new sales channels, such as a franchising, direct selling, retailing, licensing, and new presentation concepts), in product promotion (new media or techniques, branding), and in pricing (new pricing strategies, varying the price according to demand). However, the price differences for various customer segments, seasonal, regular and routine changes in marketing instruments are not considered as the marketing innovations (OECD, 2005, p.51).

Enterprises that have made any kind of innovation activity during observed period are called **enterprises with innovation activity**. That are enterprises, who introduced new or significantly improved products or process, had ongoing or abandoned innovation activities for product and process innovations, implemented new organisational method or marketing concept or strategy (Statistical Office of the Slovak Republic, 2010, p. 3).

According to OECD (2005, p. 90), the innovation activity includes capital purchases, research and development (R&D), and other expenditures on innovations, which involves investments that can yield in possible future returns reaching often beyond the initially intended innovation activity (the application is allowed in many other tasks).

Research and development (R&D) involves creative work performed on a systematic basis, in order to increase the knowledge of man, culture, and society, and usage of this knowledge to create new applications (OECD, 2002).

According to OECD (2005, p. 114), it is important for all the enterprises, which would like to gain from their innovation activities, to protect their innovations. The enterprise, unable to protect its innovations from imitations by competitors, is less likely to involve in innovation activities. There are several possibilities of methods of the innovation protection – formal legal methods are patents, utility models, registration of designs, trademarks, copyrights, confidentiality agreements and trade secrecy, and informal methods – secrecy that is not covered by legal agreements, complexity of product design, and lead time advantage over competitors.

According to the Industrial Property Office of the Slovak Republic (2009) a **patent** is a protective document granted by the state to the patent proprietor, giving him an exclusive right to exploit the invention during the fixed period, which is 20 years, to exclude others from making, using, offering for sale, or selling the invention throughout that country, or importing the invention into that country. By publishing the patent the proprietor gives the public valuable technical information. The prerequisite of the duration of the patent protection is the payment of maintenance fees. According to the patent law, the patents are given on inventions, which are new, include inventive activity, and are industrially usable, after formal-juridical and factual investigation (The Act no. 435/2001 Coll., § 5, par. 1).

The Industrial Property Office of the Slovak Republic (2009) defines a **utility model** as a form of a protection of new technical solutions, which are results of an inventive activity from any technical field. The validity of a utility model is 4 years from the date of filing a utility model application, and can be extended on the request of a utility model owner two times, always for another 3 years. The Act no. 517/2007 Coll. on utility models and on amendments and supplements to certain laws (as amended by Act No. 495/2008 Coll.) regulates the legal relationship in connection with creation of legal protection, and application of technical solution, which is an object of the utility model. The technical solution can be protected with the utility model, when it is new, it results from inventive activity, and it is industrially usable.

A **design** means the appearance of a whole or a part of a product, resulting from the features of the lines, contours, colours, shape, texture, or materials of a product itself, or its ornamentation. Design protects the outward appearance of a product. The scope of protection is determined by the image of the design as it is entered into the Register. Registered design owner has an exclusive right to exploit registered design, to prevent third parties from exploitation of registered design without his consent, to provide his consent with exploitation of registered design, to assign registered design to another person, or to establish a line to registered design. Registered design is valid 5 years, and can be extended repeatedly four times for another five years up to total term of protection 25 years (The Industrial Property Office of the Slovak Republic, 2009). The Act no. 444/2002 Coll. on designs investigates the applications for design registration from the formal-juridical and factual point of view, and as the underlying condition for design registration it considers the novelty and unique character of design.

A **trademark** consist of any sign, which can be represented graphically, particularly words, including personal names, designs, letters, numerals, the shape of goods or of their packaging, that distinguish goods and services from those manufactured or sold by others, and to indicate the source of the goods. A trademark proprietor has an exclusive right to use a trademark in relation to his goods or services, for which the trademark is registered, and is entitled to use the sign ® with the trademark for a term of protection 10 years, which can be extended for additional 10 years once (The Industrial Property Office of the Slovak Republic, 2009). The Act no. 506/2009 Coll. on trademarks states the conditions for the trademark registrations, as well as the exclusions, such as mark or labels with states´ names, specification of a kind of a product or a service, generally-known geographical signs, or delusional signs.

However, the well-functioning enterprise without any formal protection of its innovations may consider this protection unnecessary, because it may slow the technology and knowledge flow and lead to higher prices for products (OECD, 2005, p. 114).

1.3.1 The measures of innovation activity

Innovations can be measured on a macroeconomic (regional, national), and on a microeconomic (firm) level. On a firm level, the literature uses R&D, effectiveness of production processes, customer satisfaction, innovation and technology transfer, employees' motivation, etc. as a measurement of innovation. On a macroeconomic level, the literature deals with competitive advantages of regions or countries, and there are commonly used measurements in a form of prescribed variables (Sabadka, 2009).

Firstly, we start with the macroeconomic level measurements. Innovation can be measured on this level with several commonly used variables. The European Commission publish from 2007 the Innovation Union Scoreboard, where countries of the EU are evaluated and compared in regards with their innovation performance. The European Commission (2015) uses for this purpose a number of variables divided into three groups: *enablers, firm activities,* and *outputs*. **Enablers** consist of variables, which help to implement innovation in firms or in economy in general. They include *human resources*, measured by:

- new doctorate graduates per 1000 population aged 25-34,
- percentage of population having completed tertiary education,
- and percentage of youth with upper secondary level education;

then open, excellent and attractive research systems, measured by:

- international scientific co-publications per million population,

- non-EU doctorate students as a percentage of all doctorate students,
- scientific publications among top 10% most cited;

and finally, *finance and support*, measured by:

- R&D expenditure in the public sector as a percentage of GDP,
- and venture capital investment as a percentage of GDP.

Firm activities describe innovation actions in firms, and includes *firm investments*, which are measured by:

- R&D expenditure in the business sector as a percentage of GDP – this variable captures the creation of new knowledge within firms, especially important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics), where most new knowledge is created in or near R&D laboratories.
- Non-R&D innovation expenditures as a percentage of total turnover – these innovation expenditures, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.

Then firm activities include *linkages and entrepreneurship,* measured by variables:

- Sum of small and medium enterprises with in-house innovation activities – this variable measures the degree, to which SMEs have innovated in-house. The variable is limited to SMEs, because almost all large firms innovate.
- Sum of SMEs with innovation co-operation activities, i.e. those firms that had any co-operation agreements on innovation activities with other enterprises or institutions – this variable measures the flow of knowledge between public research institutions and firms, and between firms and other firms.
- Number of public-private co-authored research publications per million population - this variable captures active collaboration activities between business sector researchers and public sector researchers.

And finally, firm activities include *intellectual assets,* measured by:

- Number of patent applications- describes firm's capacity to develop new products.

- Number of patent applications in environment-related technologies and health-these patents will be necessary to meet the societal needs of an ageing European society and sustainable growth.
- Number of new trademarks applications - trademark identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising.
- Number of new designs applications.

Outputs tells about successfully finished innovation process in firms and economy, and consist of two categories: innovators, and economic effects. Innovators are represented by variables:

- Number of SMEs, who introduced a new product or a new process to one of their markets.
- Number of SMEs, who introduced a new marketing innovation or organisational innovation to one of their markets.
- Employment in fast-growing enterprises in innovative sectors as a percentage of total employment.

Economic effects are measured by:

- Employment in knowledge-intensive activities as a percentage of total employment.
- Exports of medium and high-technology products as a share of total product exports.
- Knowledge-intensive services exports as percentage of total services exports.
- Sum of total turnover of new or significantly improved products, either new to the firm or new to the market.
- License and patent revenues from abroad.

The Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO, an agency of the United Nations) (2015) co-publish from 2007 the Global Innovation Index Report. This report consists of a ranking of innovation capabilities of the countries, and is a leading reference on innovation. The most recent Global Innovation Index relies on two sub-indices, the *Innovation Input Sub-Index* and the *Innovation Output Sub-Index*.

The Innovation Input Sub-Index consists of five pillars: *institutions, human capital and research, infrastructure, market sophistication,* and *business sophistication*. Institutions refer to political, regulatory, and business environment. Human capital and research deals with education and R&D. Infrastructure include information and communication technologies, general infrastructure, and ecological sustainability. Market sophistication is described by credit, investment, trade, and competition. Business sophistication covers knowledge absorption, innovation linkages, and knowledge workers (Cornell University, INSEAD, and WIPO, 2015).

The Innovation Output Sub-Index includes two pillars: *knowledge and technology outputs,* consisting of knowledge creation, impact and diffusion; and *creative outputs,* covering intangible assets, creative goods and services, and online creativity (Cornell University, INSEAD, and WIPO, 2015).

However, the Innovation Union Scoreboard and the Global Innovation Index focus on evaluation of innovation in EU and other countries in general. Hence, all these variables intend to describe innovation performance of whole economy, not on a firm level.

On the other hand, many authors study innovation activities of enterprises, hence, on the microeconomic (firm) level. **R&D expenditures** were earlier considered as a substitute for measuring enterprise's innovation activity. However, not all R&D investment leads to successful innovation, thus R&D expenditures cannot be used as direct measure of innovation output (Zemplinerová, 2012). Mishra (2007) suggests two kinds of innovation measures, which distinguish between *input-based measures*, and *output-based measures*. **Innovation input** can be measured by *expenditures on R&D*, or *the number of research staff*, and some authors use a logarithm of sum of innovation expenditures as well (Zemplinerová, 2012; Mishra, 2007). **Innovation output** can be measured by *the number of patents, trademarks,* and *industrial designs* (Mishra, 2007; Ghazal, 2015), or as a logarithm of the share of sales of new products and services in the total revenue of the enterprise (Zemplinerová, 2012).

In addition, Brzozowski (2008) measures enterprises' innovation activity by **R&D and innovation intensity**. He defines *the R&D intensity* as the ratio of R&D expenditures to industry sales, where the expenditure consists of both current expenditure, and capital expenditure on fixed assets connected with R&D activity, but excluding the depreciation of these assets. *The innovation intensity* is defined as the ratio of expenditure on innovations to sales. Expenditure on innovation includes expenditure on R&D activity, acquisition of disembodied technology, fixed assets required for the introduction of innovations, preparations for the implementation of innovations, and marketing for technologically new and improved products.

1.3.2 The effects of innovation activity on the performance of enterprises

The aim of innovation activities is the transfer of their results into successful products, which are commercially usable. The innovation activity is reasonable to perform only if its outputs would have positive impact on the effectiveness improvement and performance enhancement in an enterprise, and would bring required future benefits to its customers (Chromjaková, 2009).

For measurement of effects of the innovation activity Pitra (2006) distinguishes three groups of financial measurements:

1. Group represent the measurements, which evaluate the contribution of innovations to competitiveness enhancement of an enterprise. To the most used measurements in this group belong productivity, return on sales, liquidity, and indebtedness.
2. Group of measurements evaluates the innovation effect on economic results of an enterprise. To this group belong the profitability variables, such as return on investments, return on equity, and return on capital.
3. Group of measurements is used to evaluation of financial effects of innovation activities, and is represented, for instance, with operational capital turnover, profitability, or overall productivity.

OECD (2005, p. 109-112) describes several effects of innovations in the enterprises. First is the impact on turnover. The enterprise is able to assess the proportion of turnover due to innovations on the overall turnover of the enterprise. Second is the impact on cost and employment. The costs are mostly influenced by the process innovations, which lead to changes in the costs of material, energy or labour. Third is the impact on productivity. Process or organisational innovations can lead to efficiency improvement in the enterprise.

1.4 The innovation activity in context of FDI

A decision of foreign investor to invest in a host country in context of its innovation activities may be related to three motives (Granstrand, 1993):

- knowledge-seeking, where foreign investor aims to exploit a certain host country´s research capacities or technologies, in order to expand its existing knowledge assets;
- market-seeking, where foreign investor aims to access a host country´s market, in order to sell its innovations, i.e. to exploit their existing knowledge assets.
- efficiency-seeking, where foreign investor is primarily interested in reducing costs of innovation activities by performing activities in a host country with a lower cost of innovation inputs, particularly human capital.

These motives can be combined, as well. International innovation activities are a specific type of foreign direct investment. Thus, the theory of FDI and its determinants is relevant for the study of a decision of foreign investor to internationalise its innovation activities (Schmiele, 2012).

Moreover, some authors introduce innovation as a potential determinant of FDI. For example, Pradhan (2012) studied innovation, measured as a percentage of research and development (R&D) expenditure, as a determinant of the FDI flows. Similarly, Sun (2002) measured innovation by R&D expenditures and the number of patents, and states that higher level of innovation should promote the FDI flows. Pfister (2005) concluded that strengthened intellectual property protection in emerging countries is often expected to attract FDI to these economies, although stronger patent protection in countries with a high GDP or with a low R&D intensity seemed to reduce the attractiveness to FDI.

The main purpose of this dissertation thesis is to study the relationship between innovation activity and FDI. Generally, existing literature shows no consensus about the sign of the correlation between innovation activity in terms of R&D in a host country and FDI inflows (Beladi, 2008). A negative correlation is usually explained with fact that the foreign investors avoid investing in a host country, if domestic firms are expected to be a significant technological challenge. A positive correlation is explained in terms of technology sourcing, where the foreign investment is partially motivated by the technological spillover expected to emerge from the R&D undertaken by domestic firms in the host country.

The effect of FDI on innovation and R&D has been largely studied in literature. Bertrand (2009) identifies two main effects of FDI on R&D – efficiency gains, and anti-competitive effect. On one hand, FDI can generate scale and scope economies in R&D, enhancing R&D efficiency. Investments push firms to develop their innovative capabilities, and raise the budget on R&D. Fixed costs are spread over more R&D output, which increases the incentive to invest in R&D. The firms can use economies of scope by spreading fixed costs over different types of R&D output. They can employ the same research facilities for different technologies.

On the other hand, the reduction in competition in the technology or product markets, which is caused by mergers and acquisitions of a domestic firm by a foreign investor, may deter domestic firms from innovating. Foreign investors are able to decide, in which country they want to locate their R&D, and by relocation of innovation activities into parent country they can save duplicated inputs in terms of personnel or equipment.

A number of studies confirm the positive effect of FDI inflows (often proxied by foreign ownership of a firm) on innovation or R&D. The literature often mentions so called innovation, technological or R&D spillover effect. Cheung (2004) mentioned several important channels, through which inward FDI can positively influence innovation activity of domestic firms in the host country:

- Firms in a host country can learn about the products and technologies brought in by foreign investors, e.g. with help of reverse engineering.
- Spillover can take place through labour turnovers, whereby firms in a host country obtain the technological know-how of foreign investor by "stealing" their skilled workers.
- Inward FDI has a demonstration effect on R&D activities in a host country. By their presence in a host country market, foreign products/technologies can inspire and stimulate domestic innovators to develop new processes and products.
- Spillover can take place vertically from foreign firms to their suppliers or customers in a host country by means of technological know-how transfer, staff training, etc.

According to Zulkhibri (2015), studies on FDI in industrialized countries generally find positive effect of FDI on innovation in the host economy. Based on his results in developing countries, FDI is the main contributing factor to innovation outputs, measured by number of patent, and trademark. FDI can increase the knowledge stocks and can act as an international transmission mechanism for knowledge. His results implicitly suggest that providing a ground to attract more FDI can lead to much better innovation performance.

Cheung (2004) found evidence of positive spillover effect of FDI on the number of domestic patent application in China, as a measure of innovation output. The effect was strongest on minor innovations, such as designs.

Girma (2008) examined state-owned, as well as collectively owned, and private-owned enterprises in China. His econometric analysis showed that enterprises with foreign capital participation and those with good access to domestic bank loans innovate more than others do. Sector-level inward FDI has two effects - it transfers technology and may increase domestic credit opportunities. It is an important channel, through which FDI affects the innovation of domestic private and collectively owned enterprises. Bertrand (2009) stated in his study of French manufacturing innovative firms that acquisition of firms by foreign investor strongly increased the level of R&D budget, and positively and significantly influenced R&D expenditures. He concluded that foreign investments could be beneficial to host country firms, as well as innovation system of a host country.

In a study of determinants of R&D investments, Lee (2012) showed that foreign ownership positively affects R&D investment, and author stated that these two affect each other, as well. The interacting effects of foreign ownership and R&D investment means that R&D investment can simultaneously be an outcome of foreign ownership, as well as a cause of the foreign ownership. This implies that foreign investors encourage R&D investment and, at the same time, are attracted to firms with high R&D investment.

Čaplánová (2012) also identified positive effect of foreign firms on innovation activity of domestic firms (spillover effect). However, she found non-linear spillover effect, where increase of foreign firms' share in particular region of a host country initially leads to decrease, and consequently to intensification of innovation activity of domestic firms. She suggested a dual effect of foreign firms on innovation activity – on one hand, spillover effect, and adverse effect, due to rising competition, on the other. The adverse effect dominates at the beginning, and then the positive effect prevails.

Similarly, Girma (2009) found evidence that state-owned enterprises in China with some share of foreign capital are more likely to engage in product innovation, but this relationship between foreign capital participation and innovation is concave. The foreign capital participation increases innovation up to a critical value, after which the marginal effect of changes in foreign capital on innovation activity starts to decline. Author advocated this by fact that while some foreign capital may bring knowledge transfer, which initially increases innovation activity, further increase in foreign ownership share (over 61%) may lead to innovation activity relocation to the parent country of foreign investor.

While above-mentioned authors found positive effect of FDI inflow, or foreign ownership on innovation and R&D activities, other studies do not confirmed these findings. For example, Dachs (2009) analysed data from Austrian firms, and found that the impact of foreign ownership on innovation input and outcome is not significant. After controlling for other variables that influence innovative behaviour, he found that the impact of foreign ownership on innovation is neutral. Although membership in a multinational enterprise group significantly helps to overcome different obstacles in the innovation process, this advantage does not transfer into a higher innovative input or output. Differences between foreign-owned and domestically owned enterprises in Austria can therefore rather be explained by enterprise characteristics such as size, sectoral affiliation, export intensity etc. than by the ownership status.

Similarly, Qu (2013) found positive, but insignificant influence of inward FDI on innovation performance in China. Moreover, he claimed that different sources of FDI have different spillover effects. FDI originated from Asian developed economies and local innovation correlate significantly and positively, while FDI originated from European economies and USA negatively affect a host country innovation.

In Korea, Lee (2011) found that, whether a firm is domestic or foreign, it seems not to increase R&D expenditure significantly. He stated that FDI did not have an effect on R&D expenditure intensity, and technical support from foreign firms made little contribution to firms' R&D activities. These results showed that there should be efforts and strategies to encourage foreigners to undertake more positive R&D activities.

Furthermore, there has been some arguments about the negative influence of FDI inflow on innovation/R&D activities. In early studies, Love (1999) and Bishop (1999) suggested that foreign ownership has a negative association with innovation. Veugelers (1990) found that foreign capital negatively affects local R&D expenses in Belgium. Fan (2007) verified that R&D expenses of firm decreased, when extended foreign capital entered in a host country.

Stiebale (2011) found highly significant and negative effect of foreign acquisition on R&D expenditures, as a measure of innovation input, in small and medium sized German firms, advocating it by relocation of R&D facilities from a host country to a parent country of a foreign investor. Alternative interpretation is that foreign investor rationalized the processes, and thus reduced R&D activities in target firms. In case of innovation output, author found no significant impact of foreign acquisition on innovation sales or product and process innovation.

Zemplinerova (2012) in her study of Czech firms founds that foreign ownership decreases probability of a host country firm´s decision to innovate, probably due to direct transfer of knowledge and technology from the parent country, as R&D in multinational companies is often centralized in headquarters. This result is in line with analysis of Srholec (2005), who found that foreign affiliates tend to engage less in internal R&D compared with domestic owned firms. In addition, Zemplinerova (2010) showed that there exists negative relation between foreign ownership of the firm and numbers of R&D employees - foreign firms have less R&D employees in comparison to domestic firms.

In addition to FDI inflow, there is very limited number of studies about FDI outflow. Boermans (2013) in his study of firm-level data from 10 transition economies examined the impact of internationalization on innovation, and stated that internationalization and innovation go hand in hand. First, he found that export increases R&D expenditures and raises the probability of acquiring international patents by a firm. Second, outward FDI increases the number of domestic and international patents. Third, international outsourcing is a key driver of the launch of new products and services. Hence, he concluded that exporting, FDI outflow, and international outsourcing show large and positive impacts on various innovation outcomes. Furthermore, he found a bi-causal linkage between innovation output and FDI. Outward FDI not only causes more domestic and international patenting, but such patents further increase the likelihood to invest abroad. As explanation, he stated that domestic firms wait for (international) protection of intellectual property before they engage in outward FDI, while there are also important feedbacks loops from international activities that spur the development of more (international) patents.

To sum up the results of above-mentioned studies, the authors found positive impact of the FDI on the innovation activity mostly in Asian countries, such as China, or Korea. On the other hand, negative impact was found in European countries. However, most of the presented researches in Europe were conducted in well-developed countries, such as Belgium, Germany, or the United Kingdom. It can be discussed, whether the impact of the FDI on the innovation activity depends on the development level of a country, or on the region, where the country belongs. However, it can be argued that the region itself has a specific level of its development. Hence, the regional specification is in connection with the development of the countries.

In this dissertation thesis, we consider the level of development as region-specific. However, we can distinguish several sub-regions inside the Europe. The Slovak Republic belongs to the Central and East European region, as well as to the countries, which recently overcome a transition process. Hence, in our research we can expect the results in line with the European researches, which found negative impact of the FDI on the innovation activity. Yet considering the recent transition process, we may find the results showing the transition from developing to developed country.

1.5 The other determinants of innovation activity

Besides FDI, discussed in previous sections as a possible determinant of innovation activity of both an enterprise, and a host country, a number of other possible determinants are commonly discussed in the literature.

Cumming (2000) divides determinants of R&D into four groups: (1) legal protection, (2) market factors, (3) strategic alliances, and (4) firm characteristics. One of the most widely recognized determinant of R&D is the expectation of patent protection. The greater is a firm's belief that it will obtain a patent protection of the results of its R&D expenditures, the more willing will be the firm to spend on R&D. The author found positive, significant influence of patent protection on R&D.

As the market factors the author considers competition, market demand pull, and consumer controversies. Competition in the market is well regarded as an important determinant of R&D. The greater are the concern of a firm with current or potential competitors, the greater are the R&D expenditures to gain a competitive advantage. Irrespective of competitive factors, R&D may be caused by market "demand pull" for a product to perform a particular function, or an idea for an innovative product, which has no established market, referred to as "product push". A firm's attitude towards the development of a successful product, whether by means of market demand pull or product push, however, may be influenced by current or potential controversies surrounding its R&D activities, which may reduce or even eliminate the potential market, and therefore R&D expenditures are less profitable.

Strategic alliances, as the third factor, reduce risk, facilitate knowledge transfer, and generally, increase R&D activity among firms. Firms may be interested in R&D activities, in order to reduce dependence on suppliers by producing internally.

The fourth factor is the firm characteristics. The author distinguishes several firm-specific factors, such as type of technology used by a firm, financing constrains of a firm, stage of a firm development, and a size of a firm. Many other authors discuss in their studies similar R&D determinants. In the following section, these determinants of R&D activities are briefly reviewed.

According to Mishra (2007), many studies focusing on the R&D activities of firms consider two broad factors: the firm size and the market structure. He mentioned also third factor - corporate characteristics, such as diversification and financial capabilities.

First determinant of R&D largely discussed in the literature is *the firm size*. Zemplinerová (2012) mentions two traditional theories on relationship between size of the firm and the ability to generate innovation:

- Schumpeterian theory, which claims that monopoly profiting from the dominant position, creates enough financial resources to innovate, leading to more efficient production and better performance, and thus large firms are the main source of innovation. Schumpeter (2003) considered R&D to be an engine of economic growth and development. He realised the role of innovation in improving technology and in contributing towards increased efficiency and productivity.
- On the other hand, studies by Fellner (1951), Arrow (1962), Williamson (1965), Bozeman (1983), and Mukhopadhyay (1985) have rejected Schumpeter's hypothesis. Arrow (1962) concludes that a firm in a competitive industry has a greater incentive to invest in research and development in comparison with a monopolist.

A large number of literature test Schumpeter's hypothesis, which generally asserts a positive link between firm size and R&D activity, and focus on analysing the impact of firm size on the innovative activity taken by firms (Lee, 2011; Mishra, 2007; Stiebale, 2011). The early studies by Horowitz (1962), Hamberg (1964), Comanor (1967), Scherer (1980), Pavitt (1987), and Nelson (2000) found a positive linear relationship between firm size and the R&D activities. Love (1999) argued that large firms are in a better position to carry out the R&D necessary for innovation. These firms have stronger cash flows to fund R&D activity and their large sales volume implies that the fixed costs of R&D activity can be spread over a large sales base. In addition, they have access to a wider range of knowledge and human capital skills (Rogers, 2004). Lee (2011) found that sales amount – a proxy variable for firm size – is positive and statistically significant determinant of R&D expenditure. However, the coefficient of a square of sales is negative and statistically significant, which means that with the increase in sales amount, the probability of R&D expenditure increased, even though it decreased marginally.

On the other hand, the studies by Scherer (2007), Bound (2007), and Mahlich, (2006) found evidence of negative impact, or an inverted-U shaped relationship between R&D and the firm size (Aghion, 2004; Zemplinerova, 2010). The argument in favour of small firms is their higher flexibility in shifting employees to R&D-related projects, and less complex management structures in implementing new projects (Acs, 1987; Bhattacharya, 2004). Mishra (2007) argues that with growth of the firm size, the efficiency in R&D is reduced by the loss of managerial control, and the incentives of individual scientists and engineers is limited.

In addition to linear relationship between innovation or R&D and firm size, Doi (1994) took into account a quadratic term to check the nonlinearity of the relationship between firm size and innovation. Bound (2007) also found nonlinearity in relationship between firm size, measured by sales, and R&D, implying that both very large, and very small firms are more R&D intensive than average-sized firms. Similarly, Mishra (2007) found the coefficients of sales and sales square terms as highly significant determinant of R&D activity, and the value of the coefficient on 'sales squared' is found negative. Thus, a positive relationship between the probability of a firm engaging in R&D and its size is found. However, this relationship is non-linear, as is indicated by the coefficient of the sales square term. This implies that the positive relationship between R&D and firm size holds only up to a certain threshold, and starts decreasing after that point, although the magnitude of the size square term is small.

One of the reasons of ambiguous results of the literature on relation between the firm size and innovation is the existence of industry-specific characteristics. Some of the early studies, such as Acs (1987) and Dorfman (1987), indicate that the innovation of firms may depend on *industry conditions* and *market structure*. They argue that not firm size directly affects R&D activity, but that size is correlated to some firm-specific effects, such as internal cash flow, degree of product diversification, and export orientation, which affect the R&D initiative. The second argument by Schumpeter was that firms require some kind of incentive, in terms of market power, in order to invest in R&D (Mishra, 2007).

Lee (2011) introduces as measures for the market structure: concentration ratios, market share ratios, and measures of barriers to entry. These measures are proxies for the firm ability to benefit from the R&D activity in a competitive situation (Rogers, 2004). In many studies, a positive relationship between R&D activity and market concentration ratio has been demonstrated. A common finding is that R&D intensity and innovative performance first increase, and then decrease with a rise in the concentration ratio. Bhattacharya (2004) found that the market concentration ratio significantly increases subsequent innovation only in the case of firms in high-tech industries. Pavitt (1984) showed that sectoral characteristics affected firm innovation activities. For example, the innovative firms in electronics and chemicals were relatively big, while the innovative firms in mechanical and instrument engineering were relatively small. Among the variables capturing the market structure, Mishra (2007) showed that the effect of the market concentration is insignificant, but positive, and the effect of the market share is significant and positive, indicating that a firm with a larger market share has a higher probability of engaging in R&D activity. Some early studies such as Scherer (1967), Scott (1984), and Levin (1985) found evidence of a non-linear, "inverted U-shaped" relationship between R&D intensity and market concentration.

In addition, firms and industries vary according to how they are able to *network*. Some researchers have emphasized the role of knowledge networks linking universities, research institutes, domestic companies and foreign companies in promoting R&D activity. Link (1990) suggested that large firms benefit more from the R&D activities of their industrial counterparts, while small firms benefit from the spillover of research undertaken in university laboratories. Audretsch (1994) stated that in comparison to large and medium-sized firms, small firms rely less on R&D expenditure and more on university research. Almeida (1997) found that small American semiconductor firms are more closely linked to regional knowledge networks than large firms are. Macpherson (1997) also found support for external linkages increasing innovation in American scientific instrument companies. Moreover, some studies investigated the influence of other firms' R&D activities in the same industry on the target firm's R&D activities (Yang, 2003). If R&D activities in one firm expand, R&D activities in other firm could contract, because they have a comparative disadvantage in relation to a leading firm in the innovation. On the other hand, R&D activities of one firm can stimulate the R&D activities of other firms. The influence of the network effect and R&D activities of one firm in the same industry on R&D activities of other firm can improve firm's absorptive capacity, which means its overall ability to be aware of, identify, and take advantage of new technology. Absorptive capacity is considered a reason for companies to invest in R&D instead of simply buying the results (e.g. patents).

The next determinant of innovation, which we focus on, are *public subsidies* to R&D. Governments often provide significant subsidies to private R&D to promote innovation activities of firms, and thus the growth of the economy (Lee, 2011; Zemplinerová, 2012). However, empirical evidence on the efficiency of subsidies to private R&D is mixed. Some earlier studies found positive link between R&D and subsidies. Lerner (1999) demonstrated that a grant from the US Small Business Innovation Research Program encouraged firms with R&D expenditure and innovation activities. Gans (2000) and Hall (2002) showed that because the benefit of R&D is so uncertain, support from the government could decrease a firm's R&D investment risks, hence inducing more investment. Lee (2011) found that support from the government encourage a firm to increase R&D expenditure. However, some studies report significant crowding out effect. According to the result of Wallsten (2000), the US Small Business Innovation Research Program grants crowded out firm-financed R&D expenditure. Busom (2000) showed that about 30% of the firms supported by the government reduced R&D expenditure in Spain. Almus (2003) analysed the causal effects of public R&D policy schemes on the innovation activities of firms in Germany, and found that compared to firms without public financial means, firms provided with public finance increase their innovation activities by relatively very low percentage points close to zero. Cerulli (2008) verify a policy failure of public support on private R&D effort by finding some cases of total crowding-out for Italian data.

Furthermore, the studies showed that the number of years of the firm operation in a market (*firm age*) is a potential determinant of R&D. According to Hansen (1992), the age of the firm has a positive relation to R&D activities. Cumming (2000) showed that firms in their early stages of development spend a large proportion of their total expenditures on R&D. Mishra (2007) found that the age of the firm had a significant positive impact on R&D initiative. Girma (2009) found that older firms are more likely to engage in product innovation than their younger counterparts are. On the other hand, Stiebale (2011) showed in his research of German firms, that younger firms are more innovative. However, a study of Chinese firms by Jefferson (2006) showed no statistically significant effect of age on innovation.

Some early studies (Jaffe, 1989; Brouwer, 1996) revealed that the *firm location* had an indirect effect on the R&D activities of a firm. Brouwer (1996) indicated that more agglomerated regions seemed to be better places for innovation than rural areas.

Additionally, Lee (2012) devoted his study to examining the financial determinants of expenditures on R&D in Korea. He studied financial performance measures, such as return on sales, cash flow, debt, equity, and net income. His results suggest that R&D investments is not influenced by cash flow in old firms, but is positively influenced in young firms, furthermore, he showed the significant and positive effect of debt finance on R&D investment, and a U-shaped relationship between R&D investment and equity financing. Some other studies showed the positive effect of equity on R&D investment (Carpenter, 2002; Brown, 2009), and the negative effect of debt on R&D investment (Hall, 1990, 1992). Other studies show that debt financing encourages R&D investment (e.g. Bond, 2003). Cumming (2000) found that firms with greater debt-equity ratios are more financially constrained, and therefore spend relatively less on R&D.

2 The objective of the dissertation thesis

The topic of a dissertation thesis is "*Enterprises' innovation activity in context of foreign direct investments*", which combines knowledge from international management, international trade, and innovation management. As we described in the previous section, the researches of the relationship between the innovation activity and the FDI flows showed ambiguous results. While one group of authors found positive impact of FDI flows on the innovation activity, the other group stated that this impact is negative. There are some studies that show not statistically significant impact of the FDI flows on the innovation activity, as well. This would mean that the FDI flows may not be the determinants of the innovation activity at all.

Most of the presented researches are conducted in the Asian countries, generally considered as the developing countries, or in the well-developed European countries. In the conditions of the Central and Eastern European countries, there is a limited number of researches mostly conducted in the Czech Republic. However, there is a lack of the researches performed in condition of the Slovak Republic, based on our knowledge.

Thus, the main objective of the thesis is to **identify the existence and the magnitude of the relationship between enterprises' innovation activity and the foreign direct investment in the Slovak Republic**.

The fulfilment of the main objective is supported by following sub-objectives:

Sub-objective 1: Defining the FDI flows and the innovation activity, and selecting the right measurement variables for these terms.

Sub-objective 2: Suggesting, characterizing and selecting possible determinants of innovation activity.

Sub-objective 3: Evaluating the effects of the selected determinants on the innovation activity distinguishing a macroeconomic, an industrial, and a microeconomic level, with emphasis on a determinant FDI flows.

Sub-objective 4: Examining the relationship between the enterprises' innovation activity and the performance of the selected enterprises with innovation activity.

The first sub-objective is devoted to a definition of the FDI flows and the enterprises' innovation activity, according to literature review in the chapter *1 The state of the issue in the domestic and foreign researches*. Subsequently, the brief review of the measurements of the innovation activity is introduced. The appropriate measurements of the FDI flows and the innovation activity in our research are selected based on the construction of the variables for measurement, as well as the availability of data needed for their calculation.

The second sub-objective is devoted to a selection of the most appropriate determinants of the enterprises' innovation activity, which are suggested for a further analysis based on the previous empirical studies. The emphasis is on the determinant of our main interest - the FDI flow. We measure the selected determinants in the same way as the authors did in the existing literature, in order to ensure the comparability of the results. The variables used for measurement of the determinants are listed in chapter 3 *The working methodology and the research methods.*

The third sub-objective deals with measuring the relationship between the selected determinants and the enterprises' innovation activity, based on a methods described in the chapter *3 The working methodology and the research methods*. The effects of the determinants are estimated with use of a regression analysis, where OLS, or other estimation methods are employed, based on the character of the data and the conducted tests of the method appropriateness. After definition and selection of a proper measurement of the determinants, we analyse and quantify their effect on the innovation activity on the national level (the macroeconomic analysis), on the industrial level (the industrial level analysis), and on the firm level (the microeconomic analysis). Based on the results, we determine how important are the selected determinants, with emphasis on the FDI flows, in context of innovation activity of the enterprise.

The fourth sub-objective examines the relationship between innovation activity and selected performance measures in an enterprise. The results show, how the enterprises' innovation activity influences their performance. In this analysis, we attempt to test the hypothesis that the innovation activity leads to higher performance of the enterprise. We expect that the enterprises with innovation activity are better performing than the ones with no innovation, as well as that the performance of the enterprises increase after they introduce the innovation.

3 The working methodology and the research methods

In the dissertation thesis possible determinants of the innovation activity of enterprises, especially the FDI flows, are discussed. In this chapter, an object of our research is characterized, then the resources of the data, and the methods are described, as well as definition of used variables is provided.

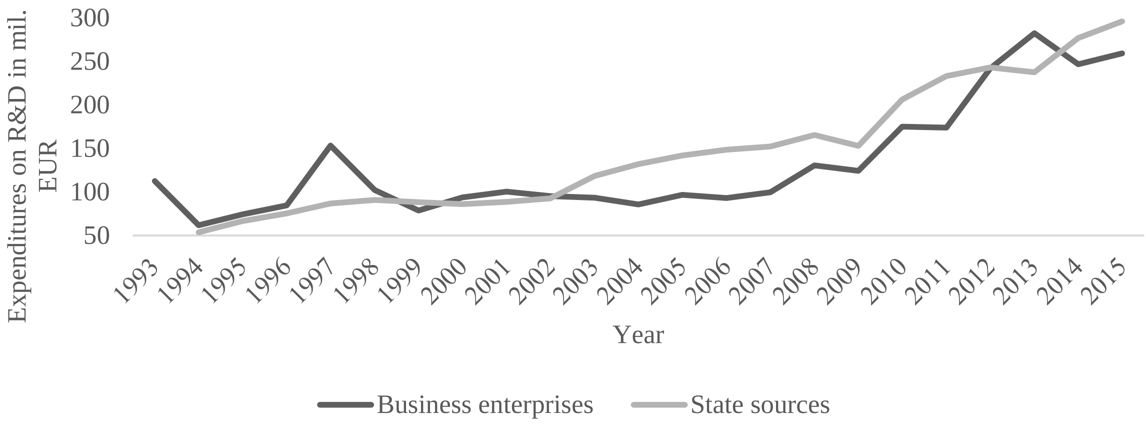
3.1 The characteristic of the research object and the datasets structures

The object of the dissertation thesis is the innovation activity in the context of the FDI flows from macroeconomic, industrial, and microeconomic point of view. Similarly, Girma (2008) divided his research of determinants of innovation activity in Chinese enterprises into a firm level analysis, industrial level analysis, and the economic level analysis.

From **the macroeconomic point of view**, we used the dataset of annual data from 1993 till 2015 about innovation, FDI flows, and other selected variables in the Slovak Republic. The dataset combines the data from the Eurostat and the Statistical Office of the Slovak Republic, where 6.8% of the data are missing due to non-availability. The variables are measured in millions of EUR in case of the expenditures, the FDI flows, and the other financial variables; then in absolute number of persons in case of personnel; and finally, in the percentage in case of rates.

The innovation activity is on a national level described with expenditures on R&D activities, the number of R&D employees, and the number of patent and trademark applications. The European Commission (2015) suggests similar variables in the Innovation Union Scoreboard (mentioned in the section *1.2.1 The measures of innovation activity*) as the measurements of firm activities, describing innovation actions in enterprises on a macroeconomic level.

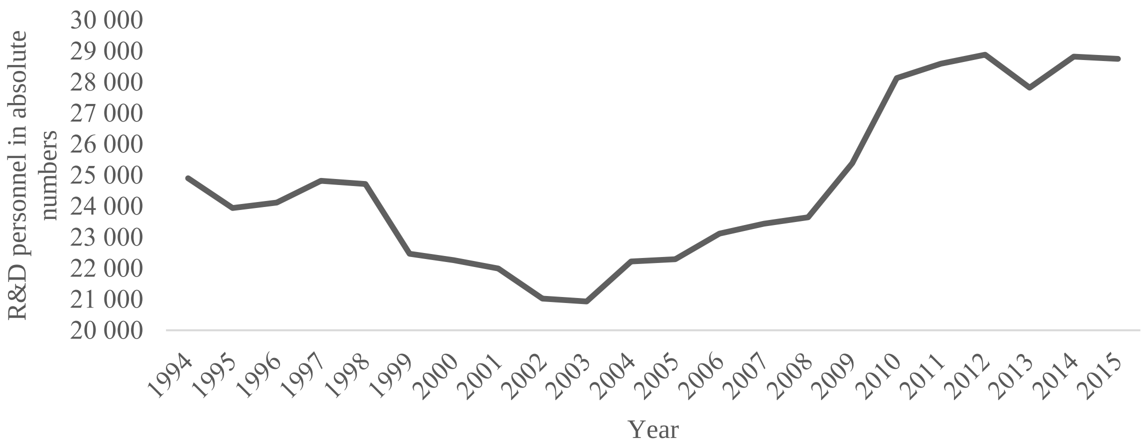
In the Slovak Republic, the business enterprises spend on average 133 million of EUR on research and development expenditures during the observed period, while from the state sources the expenditures on R&D are on average in sum of 147 million of EUR. The evolution of these two variables during the observed period is presented in the Graph 1. The R&D expenditures from the state sources are increasing constantly during the whole observed period, with one downfall in the year 2009, which can be explained with the economic crisis in this period. On the other hand, the expenditures on R&D from business enterprises fluctuate, and we can observe downfalls in the years 1994, 1999, and 2014, but also peaks in the years 1993, 1997, 2008, and 2013. The fluctuation is caused by the changing market conditions, the economic and politic situations in the country, and various other reasons.



Graph 1 The expenditures on R&D by source

Source: own processing of the data based on the Statistical Office of the Slovak Republic, 2017a

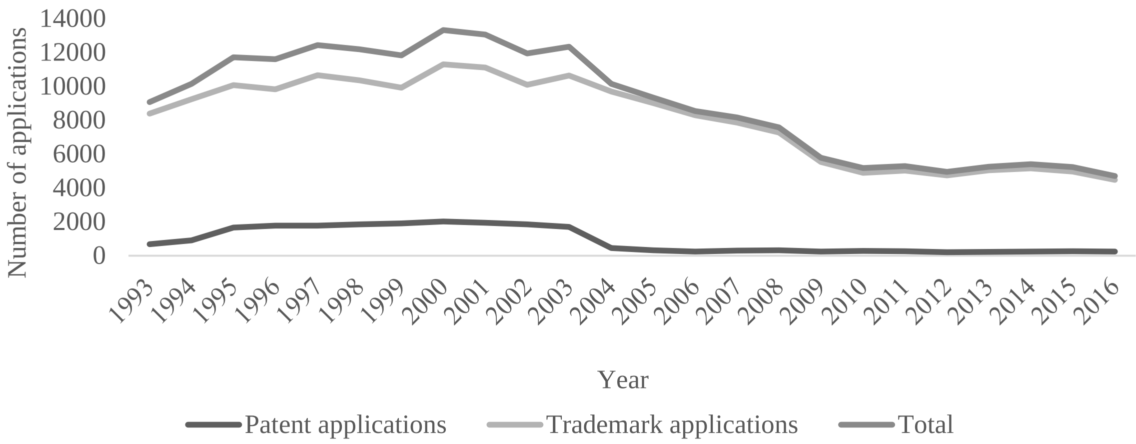
The number of R&D employees is on average 25 thousands persons per year in the whole economy during the observed period, and the Graph 2 presents the evolution of this variable. We observe that the number of R&D employees is higher in the years 1994 and 1997, then it starts to decrease till the year 2003, and afterwards it slowly increases, and after the year 2008 the increase is steeper, and stabilises in the period from 2011 till 2015, with one downfall in the year 2013.



Graph 2 The R&D personnel

Source: own processing of the data based on the Statistical Office of the Slovak Republic, 2017b

During the observed period, on average 897 patent applications and on average 8 063 trademark applications were filed with a national or regional Intellectual Property office from the Slovak Republic. The evolution of the applications number is presented in the Graph 3. In the graph, we can observe a fluctuation in the period from 1995 to 2003, and then a decreasing tendency of the patent and trademarks applications until 2016.



Graph 3 The innovation output

Source: own processing of the data from the Industrial Property Office of the Slovak Republic, 2017

On the industrial level, we used the panel dataset of the manufacturing industry in the Slovak Republic, which includes the sectors from code 10 to code 32 based on NACE Rev. 2 classification in the period from 2008 to 2015. We targeted our research on the manufacturing industry, since many previous studies were devoted to manufacturing sectors, and we attempted to sustain the comparability of the results. In addition, in the observed period, the share of the manufacturing industry on the GDP of the Slovak Republic was on average about 19%, and about 24% of the workers in the Slovak economy were employed in this industry (Statistical Office of the Slovak Republic, 2017), hence the manufacturing industry represents important part of the economy. The dataset of the manufacturing industry contains the data about innovation activity, FDI flows, sales, production, profitability, etc., which are combined from the databases of the Statistical Office of the Slovak Republic and the National Bank of Slovakia. The financial variables are measured in thousands of EUR, while the number of R&D employees and the number of innovation enterprises in the particular industrial sector are in absolute numbers.

The innovation activity is on the industrial level described with input-based measures, as discussed in the section *1.2.1 The measures of innovation activity* – the expenditures on R&D and the number of R&D employees, as suggested by Mishra (2007). And the innovation output is on the industrial level measured with number of enterprises, which introduced a process, products, marketing, or organisational innovation. This measurement express the successfully finished innovation process in the enterprises, and is similarly used in the Innovation Union Scoreboard by European Commission (2015).

Table 1 The average innovation input and output variables in the industrial sector

The manufacture of (with NACE code):	**The R&D expenditures (in th. EUR)**	**The number of enterprises with the innovation activity**	**The share of innovation enterprises on the total number**
10 – 12 Food, beverages and tobacco products	249	194	10%
13 Textile	170	25	3%
14 Wearing apparel	95	35	1%
15 Leather	260	17	4%
16 Wood	47	45	0.5%
17 Paper	744	30	13%
18 Printing and media reproduction	300	23	2%
20 Chemicals	x	44	18%
21 Pharmaceuticals	1 190	8	31%
22 Rubber	627	110	9%
23 Other non-metal mineral products	266	66	3%
24 Metal products	948	26	10%
25 Metal constructions	149	180	1%
26 PC, electronics, optics	1 008	33	5%
27 Electronics	843	80	7%
28 Machines and equipment	712	103	8%
29 Motor vehicles	3 608	74	34%
30 Other vehicles	1 391	8	13%
31 Furniture	216	78	7%
32 Other	x	75	2%

Note: x denotes the non-availability of the data.

Source: own processing of the data the Statistical Office of the Slovak Republic, 2017

The overall description of the average innovation activity on the industrial level is shown in the Table 1, where the average values for each industrial sector during the observed period from 2008 to 2015 are presented. The highest average expenditures on R&D in the sum of 3 608 thousand EUR are in the motor vehicles manufacturing sector, followed by the other vehicles manufacture (1 391 thousand EUR), the manufacture of the pharmaceuticals (1 190 thousand EUR), and the manufacture of computers, electronics and optical products (1 008 thousand EUR). The lowest average expenditures on R&D in the sum of 47 thousand

EUR are in the sector of wood and wooden products manufacture, where on average only 0.5% of the enterprises introduced in the observed period the innovation. The highest average share of enterprises with innovation activity is again in the motor vehicles manufacturing sector (34%), followed by the manufacture of pharmaceuticals (31%), the manufacture of chemicals (18%), the other vehicles manufacture (13%), and the manufacture of paper and paper products (13%).

From **the microeconomic point of view**, we used the dataset of 278 large manufacturing enterprises with at least 250 employees as at 31.12.2015, obtained from the Statistical Office of the Slovak Republic, which we combined with the financial data from Finstat databases, and the data from the Industrial Property Office of the Slovak Republic and the European Patent Office. The dataset consists of all large enterprises with a legal form of the joint stock company, or limited liability company, which operated in the industrial sector (NACE Rev. 2 classification codes 10 - 32), and were registered in the Business Register of the Slovak Republic at the end of the year 2015. The dataset contains the data about the location, age, profitability, productivity, industrial sector, innovation activity and the ownership of the enterprises. 32% of the enterprises represents the innovation enterprises, and have at least one patent, trademark, design, or utility model registered with the Industrial Property Office of the Slovak Republic, or the European Patent Office. The ownership structure of the dataset is the following:

- 23% of the enterprises are domestic-owned,
- 12% of the enterprises are partially domestic- and partially foreign-owned,
- and 65% of the enterprises are foreign-owned.

The innovation activity is on the firm level measured with the number of patents, trademarks, designs, and utility models. The same measurement on the firm level used Mishra, (2007) and Ghazal (2015) in their researches, as stated in the section *1.2.1 The measures of innovation activity*.

3.2 The methods of obtaining the data and their sources

The FDI flows are largely discussed topic in present literature, and we use both domestic and foreign resources to compile the literature review in the dissertation thesis. The large number of monographs, journals, and articles from various authors is found in the Slovak Economic Library, as well as in the EBSCO Research Databases. The emphasis is given on the actuality and the relevance of the used resources.

The data about the FDI flows are obtained from the portal of the National Bank of Slovakia (NBS), the Statistical Office of the Slovak Republic (SOSR), Finstat, and the European Commission (EC). We focus on the most recent data available, however, for more detailed analysis the archived data are used as well.

Similarly, the primary data about the possible determinants of the innovation activity are obtained from various databases, mainly Statistics, Slovstat, STATdat, DATAcube, and Eurostat. There can be found the variables, such as inflation rates, labour characteristics and average wages, technology, etc.

The data about the enterprises' innovation activity are obtained from a combination of the data found in the database of the Industrial Property Office of the Slovak Republic, the European Patent Office, the Sario agency, the SOSR, Finstat, and the Business Register of the Slovak Republic. On a macroeconomic level, besides the data from the SOSR, the data from the Global Innovation Index Reports and from the Innovation Union Scoreboards are used.

3.3 The methods and the variables used

To fulfil the objectives of the dissertation thesis, the statistical methods are used to examine the impacts of selected determinants, especially the FDI flows, on innovation activity of enterprises. We divided the analysis into three parts – macroeconomic analysis, analysis on an industrial level, and microeconomic analysis. For each analysis the different datasets, variables, and research methods are used.

First of all, **the macroeconomic analysis** is performed. We analysed the impact of selected independent variables on the dependent variables – research and development expenditures (representing innovation input variable), and innovation output. The following models are created to study the impacts of selected determinants on innovation activity input and output variables:

$$BERD = f(FDIin, FDIout, GERD,\ IR) \qquad (1)$$

$$IO = f(FDIin, FDIout, BERD,\ RDE, IR, LP) \qquad (2)$$

In the model (1), the research and development expenditures spent by business enterprises (*BERD*) are regressed on the FDI inflow and FDI outflow, the inflation rate (*IR*), and the gross expenditures on research and development from state sources (*GERD*). This model studies the innovation in terms of innovation input variable. In order to study the possibility of non-linear relationship between the dependent variable and the FDI flows, we used squared values of the FDI inflow and outflow variables as well.

In the model (2), the innovation output (*IO*) is regressed on the FDI inflow and FDI outflow, the unemployment rate (*UR*), the labour productivity (*LP*), and the expenditures on R&D activities spent by business enterprises (*BERD*). This model is used to study the innovation in terms of innovation output. Again, in order to study the possibility of non-linear relationship between the dependent variable and the FDI flows, we used squared values of the FDI inflow and outflow variables.

Cheung (2004) studied similar determinants of innovation – FDI flows, R&D employees, and expenditures on R&D. Pfister (2005) studied also the determinant inflation rate. Zemplinerová (2012) in her analysis of innovation output added the determinant labour productivity. Čaplánová (2012) used in her research also the squared variables of FDIs.

Then, **the analysis on the industrial level** is performed. We start with simple t-test for comparison of means between the enterprises with some innovation activity and the enterprises without innovation activity for two variables – *sales* and *number of employees*, which can describe the size of an average enterprise in the industry. The hypothesis tested is that the enterprises with some innovation activity are bigger than those without innovation activity.

In addition, we study the effect of selected independent variables, mainly innovation activity, on the size variable in the following regression model:

$$Size = f(IA, Exp, Industrial\ sector) \qquad (3)$$

In the model (3), the *Size* represents the volume of sales, or the number of employees in particular industrial sector regressed on the innovation activity (*IA*), represented by dummy variable, which takes value 1, when the enterprise has some innovation activity, or value 0 otherwise; the expenditures on innovation in particular industrial sector (*Exp*); and the dummy variable for industrial sector codes from 10 to 32 based on NACE Rev. 2 classification, which represents the manufacture industrial sector. While the variable the expenditures on innovation represents the innovation input, the innovation activity represents the innovation output in the particular industrial sector. We expect the positive impact of the innovation input and output on the size variables. Similarly, Zemplinerová (2010) used the model in her research, where the size of an enterprise is regressed on the innovation variables.

As the main part of the industrial level analysis, we examined the impact of selected independent variables on the four dependent variables – the research and development expenditures, the research and development personnel (input variables), and the number the enterprises in the particular industrial sector with some innovation activity, and the share of these enterprises on the total number of enterprises in the particular industry (output variables).

The following models are created to study the impacts of selected determinants on the innovation input and output variables:

$$RDE = f(FDIin, FDIout, Sales, Industrial\ sector) \quad (4)$$

$$BERD = f(FDIin, FDIout, Sales, Industrial\ sector) \quad (5)$$

$$No.of\ IA = f(FDIin, FDIout, Sales, ROS, RDE, BERD) \quad (6)$$

$$Share\ of\ IA = f(FDIin, FDIout, Sales, ROS, RDE, BERD) \quad (7)$$

In the model (4), the research and development personnel (*RDE*) is regressed on the FDI inflow and FDI outflow; the volume of sales (*Sales*); and the industrial sector dummy, representing the codes from 10 to 31 based on NACE Rev. 2 classification. For example, Zemplinerová (2010) studied in her research the dependent variable R&D employees regressed on the independent variables the FDIs, the volume of sales, and she analysed the industrial sector in terms of its concentration, as well.

In the model (5), research and development expenditures spent by business enterprises (*BERD*) are regressed on the same independent variables, as used in the previous model. For example, Stiebale (2011) analysed the variables industrial dummies, the sales per employee, and variable describing the FDIs, as the possible determinants of the R&D activity engagement. These two models (4) and (5) analyse the innovation input variables on the industrial level, while the next two models (6) and (7) focus on the innovation output variables.

In the model (6), the number of enterprises with the innovation activity in a particular industrial sector (*No. of IA*) is regressed on the FDI inflow and FDI outflow, the volume of sales (*Sales*), the return on sales (*ROS*), the R&D personnel (*RDE*), and the expenditures on R&D activities spent by business enterprises (*BERD*). We use the innovation input variables in this model, in order to examine the possible influence of the innovation input on the innovation output variables. Similarly in the model (7), the share of enterprises with the innovation activity on the total number of enterprises in a particular industrial sector (*Share of IA*) is regressed on the FDI inflow and FDI outflow, the volume of sales (*Sales*), the return on sales (*ROS*), the R&D personnel (*RDE*), and the expenditures on R&D activities spent by business enterprises (*BERD*). Moreover, we regress this dependent variable on the industrial sector dummy variables, representing the codes from 10 to 33 based on NACE Rev. 2 classification, in order to study the potential impact of particular sectors on the share of enterprises with the innovation activity on the total number of enterprises.

While e.g. Cheung (2004), Čaplanová (2012), Sivalogathasan (2014), or Qu (2013) focused on the FDI inflows in their researches, e.g. Boermans (2013) analysed the FDI outflow as a possible determinant of innovation activity. The influence of the innovation input variables R&D employees and R&D expenditures on the innovation activity was considered by e.g. Cheung (2004), Zemplinerová (2012), and Sivalogathasan (2014). Bertrand (2009) took financial variables (e.g. sales, return on sales) into account, when analysing the drivers of innovation-active companies.

Last but not least, we performed **the microeconomic analysis on a firm level**. As the dependent variable, we use the innovation activity, measured with the number of innovation outputs of a particular enterprise. The main independent variable, which we examine, is the FDI inflow, represented by foreign or international ownership of an enterprise (at least 10% of a shares owned by a foreign investor). We analyse the model of a following general form:

$$IO = f(FDIin, Own, Age, Size, Sales, ROS, Debt, LP, MS, Industrial\ sector, D) \quad (8)$$

In a model (8), the number of innovation outputs (*IO*), which summarize the number of patents, trademarks, designs and utility models, and denote the innovation activity of an enterprise, is regressed on either the dummy variable, which takes the value 1, when a foreign investor owns at least 10% of an enterprise' shares, and the value 0 otherwise (*FDIin*); or the factorial variable with three levels, which represent hundred percent domestic, partially domestic and partially foreign, or wholly foreign ownership of an enterprise (*Own*). The other regressors are the age of an enterprise (*Age*); the size of an enterprise, measured with number of employees (*Size*), or with the volume of sales (*Sales*); the return on sales (*ROS*); the debt ratio (*Debt*); the labour productivity (*LP*); the market share (*MS*); the industrial sector dummies, representing the codes from 10 to 33 based on NACE Rev. 2 classification (Industrial sector); and the district, where an enterprise belongs, which denotes the location (*D*).

Similarly, Stiebale (2011) used, besides the variable denoting foreign ownership of an enterprise, the variables age, market share, size, labour productivity, and the industrial and locational dummies as the firm characteristics in his research of the impact of FDI on innovation in enterprises. Bertrand (2009) used also variables describing the financial state of an enterprise – return on sales, debt, and productivity, when studying the effect of foreignness on the innovation activity. Also Zemplinerová (2012) used in her research the foreign ownership, firm size, and labour productivity, when analysing determinants of innovation of enterprises. Some authors also used the squared value of size in their research (Dachs, 2009; Zemplinerová, 2010).

Moreover, we conduct the simple enterprises' performance analysis with use of the t-test for comparison of two means, where we compare the performance of the enterprises with innovation outputs with the enterprises without innovation output, as well as we compare the performance of the same group of enterprises before and after the innovation output.

3.3.1 The innovation variables

The innovation variables used in the above-mentioned general models are the following:

BERD – this variable represents the total intramural gross expenditures on the research and development, which are spent by business enterprises. They include total expenditures on R&D activities within the enterprise - capital and current expenditures, and external expenditures, which serve as a support to the internal R&D are included (e.g. purchase of equipment for R&D). The capital expenditures are spent on acquisition of tangible and intangible assets (land and buildings, instruments and equipment), while the current expenditures include operating and financial costs related to R&D activities (labour costs and other current costs). On the macroeconomic level, this variable is measured in million EUR, and expresses the amount of invested capital into R&D activities from all enterprises in the economy. On the industrial level, this variable is measured in thousand EUR, and represents the average expenditures on R&D activities spent by one enterprise in a particular industrial sector. The same variable was used in the research by Brzozowski (2008), Lee (2011) and Lee (2012). Cheung (2004), Zulkhibri (2015) and Zemplinerová (2012) also consider the R&D expenditures as innovation input variable.

GERD – this variable represents gross expenditures on research and development from state sources measured in millions of EUR. On the macroeconomic level, it expresses the whole sum spent on R&D by the government sector in the country. Piekut (2013) examined in her research of selected countries the R&D expenditures from government sources, as well.

Exp – represents the expenditures on innovations, which are spent in particular industrial sector, based on NACE Rev. 2 classification of economic activities, divided by number of enterprises, which perform innovation activities. On the industrial level, this variable expresses the average amount of capital in thousands of EUR spent on innovations by an enterprise, which has performed the process, product, marketing, or organisational innovation, and belongs to particular industrial sector. For example, Zemplinerová (2012) used in her research the expenditures on innovation as the measure of innovation investments.

RDE – the R&D personnel are persons directly engaged in R&D, as well as employees performing direct services to R&D. R&D personnel includes the researchers, who decide about the creation and social utilization of scientific knowledge; the technicians, who contribute to research projects by performing scientific and technological tasks under the control of researchers; and the supporting staff, who are qualified craftsmen, secretaries and other employees participating on R&D projects, as well as other managers and administrative staff dealing with personal and financial issues directly attributable research projects. On the macroeconomic level, this variable shows the number of R&D employees in the whole country, while on the industrial level, this variables expresses the average number of R&D employees in one enterprise operating in particular industrial sector. Zemplinerová (2010, 2012) considers this variable as important, because about half of R&D expenditures are created by the salaries of R&D employees, and uses the same variable as the innovation activity measure. Also Cheung (2004) considers the number of personnel for science and technical development as the input variable. Similarly, Sivalogathasan (2014) regressed the number of patents on the number of research and development personnel.

IO – on the macroeconomic level, the innovation output variable summarizes the number of patent applications filed with a patent office, and the trademark applications for registering with an intellectual property office. This number shows all the applications filed within the Slovak Republic, and express the overall innovation output of the country in the observed period. On the microeconomic level, the number of innovation outputs in the enterprise express the exact number of patents, trademarks, designs, or utility models, which the enterprise has registered with the intellectual property office from its establishment till the year 2015. It expresses the successfully ended innovation process in the particular enterprise. The patent, trademarks and industrial design were used as proxy for innovation output in study by Zulkhibri (2015). Cheung (2004) used the number of patents as a measurement of R&D output.

No. of IA – on the industrial level, this variable **-** the number of enterprises with the innovation activity, expresses the overall innovation output in a particular industrial sector. This variable belongs to innovation output variables, because it describes the successfully finished innovation process, which ended with product, process, marketing, or organisational innovation in a particular enterprise operating in a particular industrial sector. **Share of IA** – similarly, as in case of the previous variable, the share of innovation enterprises on the total enterprises in a particular industrial sector expresses the innovation output of this sector. This variable helps us to compare the industrial sectors, and identify the sectors with the highest percentage of successfully innovating enterprises. Similarly, Piekut (2013) stated that one of the variables, which describes a development level of a country is the number and the share of innovative business enterprises on the overall number of businesses.

3.3.2 The FDI flows variables

The variables describing the FDI flows in the above-mentioned general models are the following:

FDIin – on the macroeconomic level, this variable denotes the foreign direct investment inflow into the Slovak Republic in million EUR. On the industrial level, it represents the foreign direct investment inflow into a particular industrial sector, measured in thousand EUR. And finally, on the microeconomic level, this variable is a dummy, which takes the value 1, if an enterprise has at least 10% of its shares, votes, or ownership interests owned by a foreign investor, and the value 0, if the ownership of the enterprise is purely domestic. Hence, this variable represents the FDI inflow into the particular enterprise. For example, Lee (2012) used the variable foreign ownership, measured as percentage of foreign shares on the total shares, as the determinant of R&D expenditures. Zemplinerová (2012) used the dummy variable, distinguishing the foreign and domestic ownership in her research. Zulkhibri (2015) used the FDI as the determinant of innovation output.

FDIout – this variable represents, on the macroeconomic level, the foreign direct investment outflow from the whole country, measured in million EUR, while on the industrial level, it represents the foreign direct investment outflow from a particular industrial sector, measured in thousand EUR. Similarly, Boermans (2013) or Zhang (2014), used the outward FDI in their research of innovation.

Own – on the microeconomic level, this variable represents the type of ownership of a particular enterprise. It is a factorial variable with three levels, which distinguishes, whether the enterprise has purely domestic ownership, wholly foreign ownership, or mixed ownership, where the share of foreign ownership is from 10% up to 90%. For example, Girma (2009), and Zhang (2014) distinguished in the research the levels of the foreign ownership in an enterprise.

3.3.3 The other variables

The other variables used in the general models are the following:

On the macroeconomic level, **IR** – denotes the inflation rate. Inflation is measured by the consumer price index, and reflects the annual percentage change in the cost of the average consumer, who acquires a basket of goods and services. Similarly, Pfister (2005) used consumer price index as a determinant of innovation output. This variable can describe the economic stability of a country. The economic stability is reflected by the inverse ratio of inflation rate. The inverse ratio is used because of the inverse correlation between inflation and economic stability. Hence, the economic stability is supposed to decline, when there is a rising inflation.

On the macroeconomic level, the variable **LP** denotes the labour productivity, which is measured as the gross value added in million EUR per employee in the whole country. It reflects the average value added, which is produced by one employee in the economy. On the microeconomic level, this variable represents the value added in thousand EUR per employee in a particular enterprise. It describes the performance of the enterprise, because it reflects the sum, which stays in the enterprise per one employee, after deducting the costs. This variable is used as a determinant of innovation output, as well as the measure of performance of the enterprise, in research by Zemplinerová (2012), or Jefferson (2006).

On the microeconomic level, the variable **Sales** is used in the models, as well. This variable represents the volume of sales in an enterprise, measured in thousand EUR, which can be a measurement for a firm size, as used in the research by Bound (2007), Lee (2011), Lee (2012), Zemplinerová (2010), as well as a measurement for a firm performance, as used in the research by Jefferson (2006). Another measurement of a size, used in the analysis on the microeconomic level, is a number of the employees, which is denoted by variable **Size** in the model. This measurement of a firm size is used for example by Zemplinerová (2012), and Schmiele (2012). Mishra (2007) or Dachs (2009) included the squared value of the firm size in his research, in order to capture the presence of possible non-linear relationship between the firm size and R&D.

Then the variable **ROS**, denoting the return on sales, is used. This variable belongs to performance measures as well, and describes the amount of profit created by one unit of sales in the enterprise. The positive values are expected in the enterprises, and the higher the ratio is, the better performance the enterprise has. The same measure of the profitability is used by Bertrand (2009). On the other hand, the variable **Debt**, which represents the debt ratio of the enterprise, describes the indebtedness of the enterprise. Hence, the lower the debt ratio is, the better performance the enterprise has, because it borrows less capital from creditors. The debt ratio is calculated as borrowed sources to assets of the enterprise. Similarly, Bertrand (2009), Cumming (2000), and Lee (2012) used the variable debt in their researches.

On the microeconomic level, the variables **Age**, **D** (denoting the district), and **Industrial sector** represent the general characteristics of an enterprise. The age represents the number of years from the establishing the enterprise until the year 2015, which is the reference year in our research. The district describes the location of the enterprise within the country, and we distinguish eight districts – Bratislava, Trnava, Trenčín, Nitra, Žilina, Banská Bystrica, Prešov, and Košice. Similarly, Lee (2011) used age and geographical location as a determinant of expenditures on R&D. Lee (2012) proxied the maturity stage of an enterprise with variable age. Schmiele (2012) and Girma (2011) used the variables age, location and industry as the main characteristics of an enterprise. Cheung (2004) used the location variable as the determinant of the patent applications. And, for example, Brzozowski (2008) and Bound (2007) analysed the R&D activities in various industrial sectors, while Čaplánová (2012) and Girma (2008) analysed the innovation outputs in various industrial sectors.

Last but not least, the variable **MS** – denoting the market share of an enterprise is used in the model on the microeconomic level. This variable represents the share of the enterprise's sales on the sales in the market, and is similarly used in research by Bertrand (2009), Girma (2011), and Mishra (2007).

3.4 The methods of data processing

In this section, we describe the methods of data processing used in our research. Besides the logical methods, such as analysis, synthesis, comparison, deduction, generalisation, we use the statistical methods. We apply different method in each analysis due to different characteristics of the datasets used on each level. As mentioned above, on the macroeconomic level we use the dataset of annual data, on the industrial level we use the panel dataset, and on the microeconomic level we use the dataset of cross-sectional data from one period. In each model we tested the appropriateness of the estimation method with several tests: F-test of goodness-of fit, Breusch – Pagan test for heteroscedasticity, Shapiro – Wilk test for normality of residuals, Durbin – Watson statistics for autocorrelation.

Before we regress the data, we used the correlation matrix[1] with Pearson and Spearman rank correlation coefficients to study the correlations between our independent variables. The high coefficient of correlation between the independent variables could lead to multicollinearity, what could increase the standard deviation of our estimators and reduce the precision of the coefficients. The variance inflation factor (VIF) help us to evaluate the risk of multicollinearity. Pfister (2005) claimed that the more the VIF moves away from 1, the higher the risk of multicollinearity is. He continues that the threshold is sometimes put at 100, but usually the VIF higher than 10 denotes an important risk of multicollinearity. Hence, we use the threshold value 10 in our research.

In some models, we standardise the values of the model variables, because the variables measured at different scales do not contribute equally to the analysis. The standardised values we obtain by subtracting the mean from an individual value and then dividing the difference by the standard deviation. This data transformation is called z-score scaling, and help us to deal with various scales of the variables used in the models. However, it changes the interpretation of the estimation results. The interpretation would be that one standard deviation s_x change in independent variable x produces a standard deviation s_y change of size β in dependent variable y.

On the macroeconomic level, we operate with the time-series data. The general model used for the data analysis is as follows:

$$Y_t = \beta_0 + \sum_{k=1}^{K} X_{tk}\beta_k + \varepsilon_t , t = 1, 2, \dots, T \quad \text{(Eq. 1)}$$

Where β_0 is a constant, X_{tk} represents the k^{th} explanatory variable of the t^{th} year, ε_t is the error term. K is number of explanatory variables excluding the constant, T is time period.

Initially, we perform the ordinary least squares (OLS) estimation to obtain the coefficients of the analysed model. However, if the p-value of the Durbin – Watson statistics leads to rejection of the null hypothesis (no autocorrelation in errors), we use the Cochrane- - Orcutt regression. Wooldridge (2013) described the Durbin – Watson statistics as appropriate for the serial correlation detection in a model, and recommended the Cochrane- – Orcutt regression as one of the possible solutions for this problem in times-series data.

On the industrial level, the following general model is used to analyse the panel dataset:

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} X_{itk}\beta_{ik} + \varepsilon_{it} , t = 1, 2, \dots, T, i = 1, 2, \dots, N \quad \text{(Eq. 2)}$$

[1] Due to limited scope of the dissertation thesis, we report the correlation matrixes in the Appendix 1.

Where β_0 is a constant, X_{itk} represents the k^{th} explanatory variable of the t^{th} year in the industry i, ε_{it} is the error term. K is number of explanatory variables excluding the constant, N represents the number of cross-sectional individuals, T is time period.

We estimated the coefficients of the models with use of a pooled OLS method, or the panel data estimations – fixed-effect or random-effect estimation methods. The same methods use, for example, Cheung (2004), Brzozowski (2008), Mahlich (2006), Sivalogathasan (2014), or Qu (2013) in their researches. The panel data estimation assumes that the constant in Eq. 2 varies across the industrial sectors and thus can be written as β_{0i}. The fixed-effect estimation assumes that the constant terms β_{0i} are fixed parameters, while the random-effect estimation assumes that β_{0i} is random, and can be written as $\beta_{0i} = \beta_0 + u_i$ where u_i are independently identically distributed random variables with zero mean and constant variance. This error term u_i can be viewed as industry-specific components, which can represent the environment of each industrial sector.

Several test are performed to select the appropriate model estimation method, as similarly undertaken e.g. in the research by Brzozowski (2008), Qu (2013) or Sivalogathasan (2014). We used the F-test for testing, whether there exist panel effects in the model. If the null hypothesis is rejected, the fixed-effect method is better than pooled OLS method for the coefficient estimation. The Breusch – Pagan Lagrange multiplier test (LM-test) is used for testing of significant difference across units. If the null hypothesis is rejected, the random-effect method is better than pooled OLS method for the coefficient estimation. Finally, the Hausman test is used for choosing between the random- and fixed-effect methods. When the null hypothesis of errors not correlated with regressors is rejected, the fixed-effect is better estimation method.

On the microeconomic level, we use the following general model for the cross-sectional data analysis:

$$Y_i = \beta_0 + \sum_{k=1}^{K} X_{ik}\beta_k + \varepsilon_i\,,\, i = 1, 2, \ldots, N \quad \text{(Eq. 3)}$$

Where β_0 is a constant, X_{ik} represents the k^{th} explanatory variable in an enterprise i, ε_i is the error term. K is number of explanatory variables excluding the constant, N represents the number of enterprises.

We estimate the coefficients of the models with use of the OLS method. Similarly, for example, Lee (2011) used the OLS method in his research of cross-sectional data in Korean study of the determinants of R&D expenditures. We perform the necessary tests for goodness-of-fit, for normality of residuals, for presence of heteroscedasticity, for multicollinearity, and for correlation in errors.

Moreover, we examine the performance of the enterprises. We use the variables sales and the number of employees, as the measure of the enterprise´s size, and we compare the group of the innovation enterprises with the group of enterprises without any innovation introduced in the industrial level analysis. We use the matching technique to select the group of the non-innovation enterprises. For each enterprise with innovation activity we find the most similar enterprise with no innovation activity based on the following characteristics: industrial sector, ownership of an enterprise, and the number of employees. The matching technique is used similarly in research by Dachs (2009), who used the ownership, membership of a group and size as the matching criteria. The ownership of an enterprise is important criterion, because it accounts for the fact that foreign-ownership may improve the performance of the enterprise. Hence, we compare in our analysis the foreign-owned innovation enterprises with foreign-owned non-innovation enterprises, and the domestic-owned innovation and non-innovation enterprises together. We distinguish in our research the mixed ownership, as well.

In the firm level analysis, we compared the group of innovation enterprises with the group of enterprises without innovation output in terms of their profitability and productivity. We calculate the so called *premia*. The premia is the difference between the performance of an enterprise before and after it introduced the innovation. The term *premia* was used by Bernard (1999) for the difference between exporters and non-exporters in the same state and industry.

Then, we analyse the performance premia of the group of the innovation enterprises before and after they register their innovation output. The variables used for the performance measure are in line with the variables suggested by Pitra (2006). The statistical method used for the comparison of the two groups is the Welch t-test for comparison of means. Similarly, Dachs (2009) used in his research t-test for testing the equality of means, when comparing the group of foreign- and domestic-owned enterprises in terms of their innovation.

4 The results of the research

In this chapter we present the results of our research. We divided our empirical research in three parts – macroeconomic analysis, analysis on the industrial level, and analysis on a firm level. We start with macroeconomic analysis, where we report the effects of the selected determinants on the innovation input and the innovation output variables. Then we continue with the analysis on the industrial level, where are studied the effects of the selected determinants on the innovation input variables, and the number and the share of innovation enterprises in a particular industrial sector. The last part is devoted to the microeconomic analysis. We analyse the selected possible determinants of the innovation activity of an enterprise. In addition, we study the performance of the selected enterprises, both with and without the innovation activity, as well as the difference in performance before and after the innovation activity is performed in the enterprise.

4.1 The macroeconomic analysis

In the macroeconomic analysis, we examine the innovation input variable – the research and development expenditures, and the innovation output variable – the number of patent and trademark applications. These variables are measured on the level of the whole country.

4.1.1 The innovation input variable

Firstly, we analysed the dependent variable expenditures on research and development and its determinants. The first model regress the research and development expenditures spent by business enterprises (BERD) on the FDI inflow (FDIin), the FDI outflow (FDIout), the inflation (IR) and the gross expenditures on research and development from state sources (GERD). In the second model we study the non-linear relationship between BERD and the FDI inflow and outflow.

Table 2 OLS regression – dependent variable BERD

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.027		0.09	0.29	0.77	-
FDIin	- 0.213	**	0.10	-2.37	0.03	1.05
FDIout	0.330	***	0.10	3.33	0.00	1.28
IR	- 0.159		0.14	-1.13	0.28	2.39
GERD	0.940	***	0.16	6.03	0.00	2.12

R-squared	0.85		Adjusted R-squared	0.81
Durbin-Watson statistics	1.90	H0: no autocorrelation in errors	p-value	0.19
F (4, 15)	21.22	H0: coefficients equal to zero	p-value	0.00
Breusch-Pagan BP	3.58	H0: heteroscedasticity not present	p-value	0.47
Chi-square	1.83	H0: error is normally distributed	p-value	0.40

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The Durbin-Watson statistics equalling to 2 indicates no autocorrelation of the residuals, while value less than 1 indicates positive serial correlation, and more than 2 indicates negative correlation.

Source: own processing of the data.

The results of the OLS regression with dependent variable BERD are presented in table 2. Since there are various scales and units of measures in the independent variables, we subtracted the means from values, and then divided by their standard deviation. It changes the interpretation of the results, but has solved our problem with various scales. Based on the results, both the FDI inflow, and the FDI outflow, as well as the variable GERD are statistically significant determinants of the research and development expenditures spent by business enterprises. The inflation rate seems not statistically influencing the dependent variable. The model explains 85% of the dependent variable variance, and the errors of the model are normally distributed. There is not suspicion of the heteroscedasticity or autocorrelation problem.

We can interpret the results as follows: the increase on the FDI inflow of 1 229 million EUR (one standard deviation change) causes the decrease of expenditures on R&D by enterprises of 13.6 million EUR (0.213 times one standard deviation of BERD, which equals to 64 million EUR); the increase of the FDI outflow of 281 million EUR causes the increase of the expenditures on R&D by enterprises of 21 million EUR; and the increase of gross expenditures on R&D from state sources of 71 million EUR causes the increase of the expenditures spent by enterprises of 60 million EUR[2].

It is very interesting result that the FDI inflow to the country causes the decrease of the expenditures on R&D spent by enterprises. It can be explained by the fact that the multinational companies, which invest to the Slovak Republic in form of the direct investments, may not perform R&D activities in the country, and rather centralize these

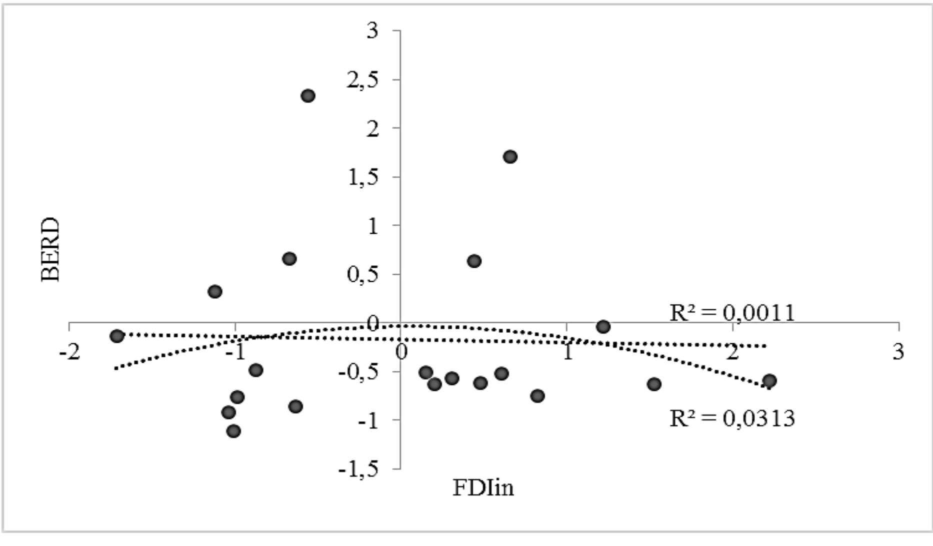
[2] For simplification, we do not state “other determinants held constant” in the interpretations of the coefficients. We suppose this statement to be true in all our interpretations presented in the whole dissertation thesis.

activities in their headquarters in the parent countries. Hence, the more multinational companies invest to the Slovak Republic, the less R&D activities are performed there by these companies.

On the other hand, the enterprises, which invest abroad, and represents the FDI outflow from a country, seem increasing their R&D activities. It may be explained by fact that these enterprises need to compete on foreign markets, and thus have to offer innovative products and services, what require R&D activities to invent that kind of products and services.

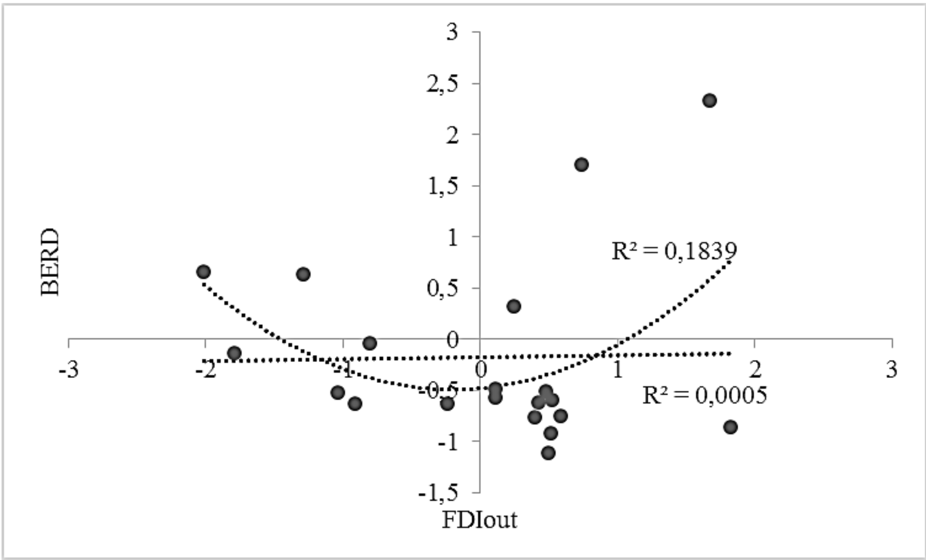
In case of increasing expenditures on R&D activities spent by business enterprises, when the R&D activities by state sources increase, we can conclude that there is a positive link between the two variables. It means that enterprises are encouraged to spend more on R&D activities, when the state (the government) spends more on those activities. The explanation may be the more inventive environment created by the government in form of more university researches, higher grand to research projects, etc., which can involve the cooperation between the enterprises and the government or universities.

In our analysis, we address the question of non-linear impact of the FDI on the innovation input variable. In the following graphs 4 and 5, we present the relation between the dependent variable BERD and the FDI inflow and the FDI outflow, respectively. The displayed R^2 are the coefficients of determination for two trend lines – linear and quadratic. In both cases, we can observe that the coefficient is higher in case of the quadratic trend line, suggesting the non-linearity of the relationship between the variables.



Graph 4 The relation between FDI inflow and BERD

Source: own processing of the data



Graph 5 The relation between FDI outflow and BERD

Source: own processing of the data

The possible non-linear relationship between the dependent variable and the FDI inflow and outflow is studied more detailed in the model in table 3.

Table 3 OLS regression with squared FDI flows – dependent variable BERD

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.060		0.15	0.41	0.69	-
FDIin	-0.332	**	0.11	-2.88	0.01	1.80
FDIout	0.329	***	0.10	3.37	0.00	1.30
Squared FDIin	0.131		0.10	1.30	0.22	1.88
Squared FDIout	-0.124		0.10	-1.31	0.21	1.94
IR	-0.060		0.16	-0.37	0.72	3.29
GERD	1.181	***	0.22	5.49	0.00	4.22
R-squared	0.87				Adjusted R-squared	0.82
Durbin-Watson	1.85	H0: no autocorrelation in errors			p-value	0.16
F (6, 13)	15.16	H0: coefficients equal to zero			p-value	0.00
Breusch-Pagan BP	2.06	H0: heteroscedasticity not present			p-value	0.91
Chi-square	0.52	H0: error is normally distributed			p-value	0.77

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The Durbin-Watson statistics equalling to 2 indicates no autocorrelation of the residuals, while value less than 1 indicates positive serial correlation, and more than 2 indicates negative correlation.

Source: own processing of the data

The results of this model are very similar to those in previous one, and these model explains 87% of the BERD variance. We do not suspect any heteroscedasticity problem, autocorrelation in errors, and the errors are normally-distributed. Again, there is statistically significant impact of variables the FDI inflow, the FDI outflow, and GERD.

The increase of one standard deviation of the FDI inflow of 1 229 million EUR causes the decrease of BERD of 21 million EUR. The increase of one standard deviation of the FDI outflow of 281 million EUR causes the increase of BERD of 21 million EUR. And the increase of GERD of 71 million EUR causes the increase of BERD of 75 million EUR. The squared FDI variables, representing the non-linear impact on the variable BERD, are not statistically significant. Hence, we are not able to confirm the non-linearity of their relationships.

4.1.2 The innovation output variable

Secondly, we study the impact of the selected independent variables on the variable output (IO), which represents the sum of the patent and trademark applications, as the measurement of the innovation output. The results of the model, where the independent variables are the FDI inflow and outflow, the inflation rate, the labour productivity, and the expenditures on R&D activities spent by business enterprises (BERD), as well as the number of R&D employees (RDE), as the measurements of the innovation input, are presented in table 4.

The model explains 98% of the variance of innovation output variable. The test results do not lead to rejection of null hypothesis of no autocorrelation in errors, normality of errors, and homoscedasticity. Based on the results of standardized variables, the labour productivity, the inflation rate, RDE and BERD, and the FDI outflow are statistically significant determinants of the innovation output.

Table 4 OLS regression – dependent variable IO

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.040		0.03	1.23	0.24	-
FDIin	0.052		0.04	1.26	0.23	1.71
FDIout	-0.175	***	0.05	-3.20	0.01	3.15
BERD	0.477	***	0.11	4.52	0.00	8.54
RDE	-0.400	***	0.08	-4.95	0.00	5.74
IR	0.193	***	0.06	3.28	0.01	2.58
LP	-0.890	***	0.08	-10.88	0.00	6.28

R-squared	0.98	Adjusted R-squared		0.98
Durbin-Watson	2.06	H0: no autocorrelation in errors	p-value	0.27
F (6, 12)	128.86	H0: coefficients equal to zero	p-value	0.00
Breusch-Pagan BP	2.93	H0: heteroscedasticity not present	p-value	0.82
Chi-square	1.74	H0: error is normally distributed	p-value	0.42

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The Durbin-Watson statistics equalling to 2 indicates no autocorrelation of the residuals, while value less than 1 indicates positive serial correlation, and more than 2 indicates negative correlation.

Source: own processing of the data

In case of the FDI outflow, 281 million EUR increase of inflow causes the decrease of the innovation output of 592 applications. This result is opposite to the positive impact of the variable on the innovation input variable, as showed in section 4.1.1. While the R&D activity can be performed in the home country, the results of this activity in form of intellectual property protection seem to be registered in the foreign host countries, because enterprises need to protect their innovation outputs in the country, where they use them. Hence, the more the enterprises invest abroad, the less they register their outputs in the home country, and the outflow of the innovation outputs may be observed.

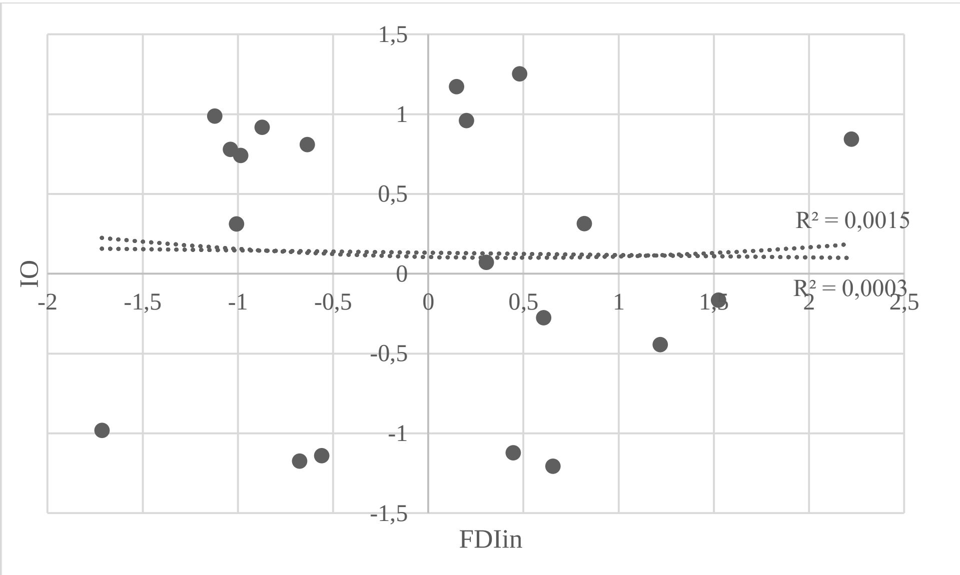
The innovation input variable BERD, changed by one standard deviation in sum of 64 million EUR, causes the increase of the innovation output number of 1 613 applications. Thus, the more is invested into R&D in the country, the more innovation outputs there are. This relationship seems logical, since the purpose of the R&D activities is to invent something new, which can consequently be registered for intellectual property protection.

On the other hand, the increase of the number of R&D employees by 2 630 persons causes the decrease of the innovation output of 1 352 applications. We may explain it with the high costs of the intellectual property protection. The rising number of the R&D employees is connected with the increased labour costs, what may lead to lower sum of financial sources left for the protection of the innovation outputs.

In case of the inflation rate, the increase of this variable by approximately 4% leads to increase of the number of innovation output of 653 applications. With the increasing inflation, the prices generally rise in the country, and this variable indicates economic instability of the country. It is possible that the enterprises expect the prices to grow in the future, and hence, they may think that their costs for innovation output registration would increase, and that is why they may prefer to register the outputs in the current period. Thus the impact of the inflation on the innovation output is positive.

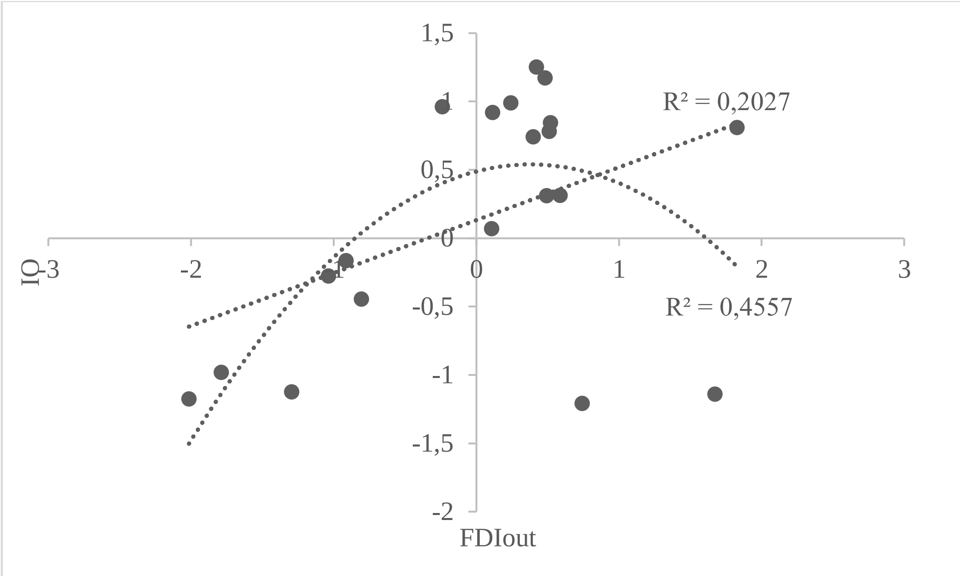
In case of the negative impact of the labour productivity on the innovation output, the increase of 811 thousands EUR per employee causes the decrease of the innovation output of 3 009 applications. Thus, when the value added per employee rises in an enterprise, this enterprise is less willing to apply for patent or trademark. It may be due to decreased need of this enterprise to compete on the market with innovations, when it can achieve higher profits due to its rising productivity.

Moreover, we study the possible non-linear relationship between the FDI flows and the innovation output variable. First, in the graphs 6 and 7 we present the relation between the dependent variable and the FDI inflow, or FDI outflow, respectively. The coefficient of determination R^2 is very low in case of the FDI inflow, however, slightly higher for quadratic trend line. And similarly, in case of the FDI outflow the quadratic trend line has more than two times higher coefficient of determination R^2 than the linear trend line.



Graph 6 The relation between FDI inflow and innovation output

Source: own processing of the data



Graph 7 The relation between FDI outflow and innovation output

Source: own processing of the data

The suggested non-linearity is further studied in the model in table 5. Due to high collinearity, we omit the variable BERD from the model.

Table 5 Cochrane-Orcutt regression with squared FDI flows– dependent variable IO

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.214	*	0.10	2.08	0.06	-
FDIin	-0.005		0.06	-0.08	0.94	2.78
Squared FDIin	-0.035		0.04	-0.90	0.39	1.83
FDIout	-0.018		0.06	-0.33	0.75	1.41
Squared FDIout	-0.082	*	0.04	-1.87	0.09	2.26
RDE	-0.158		0.11	-1.44	0.18	3.46
IR	0.084		0.08	1.05	0.31	3.24
LP	-0.693	***	0.14	-4.94	0.00	6.90
R-squared	0.98				Adjusted R-squared	0.96
Durbin-Watson	1.56	H0: no autocorrelation in errors			p-value	NA
F (7, 10)	17.04	H0: coefficients equal to zero			p-value	0.00
Chi-square	0.06	H0: error is normally distributed			p-value	0.97

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The Durbin-Watson statistics equalling to 2 indicates no autocorrelation of the residuals, while value less than 1 indicates positive serial correlation, and more than 2 indicates negative correlation, the p-value for the Durbin-Watson statistic is not available.

Source: own processing of the data

The model can explain the variability of the dependent variable on the level of 98%. The Durbin-Watson statistics showed the possible autocorrelation in errors, hence we used Cochrane-Orcutt regression method. The goodness-of-fit and normality tests show no suspicions of problems in the model. Except for the constant, the statistically significant coefficients have the squared value of the FDI outflow and the labour productivity. We interpret the negative impact of the labour productivity on the innovation output in the previous model results that is why we skip this interpretation, and focus only on the squared FDI outflow variable.

The negative coefficient of the squared value of FDI outflow means that the relationship between this variable and the dependent variable can be described with the inverted U-shaped curve, as we proposed in the graph 7. The number of innovation output increases with increase of the FDI outflow up to a certain level, and then starts to decrease again. It can be related to the Dunning's FDI development path of the country. Firstly, the country is not interested in the FDI outflow due to no specific advantages and low development in the home country. Then, the FDI outflow slowly rises, but the investments are focused mostly on the cheap sources, and the enterprises start to relocate their production plants to the host countries, but the innovation activity remains in the home country, and can slowly increase. On a particular level of the FDI development path, the FDI outflow from the country increases more due to a specific advantage of the enterprises, such as their technological development represented by innovation output. When the FDI outflow exceeds a certain level, the enterprises may relocate also the innovation activities to the host countries due to exploitation of advantages of other countries, hence, the innovation output in the home country may decrease.

4.2 The industrial level analysis

On the level of the industry, we conducted the analysis of the innovation activity variables in the manufacturing industry (NACE Rev. 2 code 10 – 32). Similarly as in the previous section, we examined the innovation input variables - the expenditures on R&D, as well as the number of R&D employees, and the innovation output variable - the number and share of enterprises with some innovation activity in particular industrial sector. Before we present the empirical results of the conducted regression analysis, we introduce a simple comparison of the group of innovation enterprises (the enterprises with the innovation activity, as defined in the previous sections of our thesis) with the group of enterprises with no innovation activity at all. The comparison evaluates only two variables – the volume of sales, and the number of employees, both representing the measurement of a firm size.

We used the Welch two sample t-test for the comparison of means between a sample of enterprises with some innovation activity (IE) and a sample of enterprises with no innovation activity (NE). In the following table 6 we show the results of the comparison of means of the variable *Sales*. This variable represents the average volume of annual sales achieved by enterprise (IE or NE) in a particular industrial sector.

Table 6 Welch t-test – dependent variable Sales

Welch t-test statistic	6.58 *** (0.00)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = 24 246.06	Upper = 56 157.40
Means of samples:	Sales in IE = 47 335.81	Sales in NE = 7 134.08

Note: the value in the parenthesis is the p-value of the Welch t-test, and based on the p-value, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

The mean of annual sales in the average enterprise with some innovation activity is 47 336 thousands EUR, and the mean of annual sales in the average enterprise with no innovation activity is 7 134 thousands EUR. The 99% confidence interval of the difference in mean is between 24 246 and 56157 thousands EUR. Based on the Welch t-statistic, the true difference in means is not equal to zero. Hence, the enterprises with some innovation activity achieve greater volume of annual sales than those with no innovation activity.

One explanation may be that the innovation activity helps the enterprises win on the market. The innovation activity includes product, process, marketing, and organisational innovations. Innovative products or services, as well as marketing innovations attract more customer. Organizational innovation save the costs, and thus the enterprises attract the customers with lower prices for products and services, which creates a higher demand, and consequently, generates greater volume of sales. On the other hand, the enterprises with no innovation activity gain lower sales.

In addition, we used a regression to study the impact of the selected variables on the volume of sales in enterprises. We are interested, whether the innovation activity itself, the industrial sector, and the expenditures on innovations, as the innovation input variable, influence the volume of sales in particular sectors[3]. Since we deal with the panel data set, firstly, we present the testing of suitable panel estimation method in table 7.

Table 7 Panel diagnostic – dependent variable Sales

	Testing statistic	*Null hypothesis*	*Recommendation*
F-test	29.08 *** (0.000)	No panel effects	FE is better than OLS
LM-test	214.84 *** (0.000)	No significant difference across units	RE is better than OLS
Hausman test	49.45 *** (0.000)	Errors not correlated with the regressors	FE is better than RE

Note: the values in the parenthesis are the p-values, and based on the p-values, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

Based on the panel diagnostic, the pooled model is rejected in both the F-test and the Breusch-Pagan LM test. The Hausman test´s result is in favour of the fixed-effect alternative. Since we are interested in coefficient estimations of the time-invariant variables - the industrial sector and the dummy variable innovation activity, which takes the value 1, if an enterprise performed any innovation activity (product, process, marketing, or organisational innovation), or the value 0 otherwise; we use the least squares dummy variable (LSDV) model. The results of the LSDV regressions are presented in table 8.

Table 8 LSDV regression – dependent variable Sales

(in thousands EUR)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
Exp	7.83		7.85	1.00	0.32
No. of IA	- 6 658.15		4 160.09	-1.60	0.11
IA	21 647.15	***	6 063.26	3.57	0.00
Industrial sector 13	- 3 515.98		4 731.01	-0.74	0.46
Industrial sector 14	- 4 357.60		4 713.27	-0.92	0.36
Industrial sector 15	- 754.65		4 864.80	-0.16	0.88
Industrial sector 16	- 6 852.78		5 728.91	-1.20	0.23
Industrial sector 17	13 247.46		8 738.84	1.51	0.13
Industrial sector 18	- 3 873.63		4 792.99	-0.81	0.42
Industrial sector 19, 20	49 962.22	***	11 997.92	4.16	0.00
Industrial sector 22	788.04		4 381.12	0.18	0.86
Industrial sector 23	- 706.13		5 045.42	-0.14	0.89
Industrial sector 24	78 282.78	***	19 151.98	4.09	0.00

[3] Due to missing observations for some industrial sectors in some years, we omit NACE Rev. 2 sector codes 21, 26, and 27, in order to create balanced panel data set.

(in thousands EUR)	Coefficient		Std. error	t-ratio	p-value
Industrial sector 25	- 3 225.16		4 611.26	-0.70	0.48
Industrial sector 28	979.21		4 400.12	0.22	0.82
Industrial sector 29	93 844.87	***	27 600.75	3.40	0.00
Industrial sector 30	8 867.00	**	4 159.11	2.13	0.03
Industrial sector 31, 32	- 2 842.99		4 495.87	-0.63	0.53
R-squared	0.70		Adjusted R-squared		0.68
F (18, 238)	31.17	H0: coefficients equal to zero		p-value	0.00
Breusch-Pagan LM	706.65	H0: heteroscedasticity not present		p-value	0.00
Shapiro-Wilk W	0.76	H0: error is normally distributed		p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. Since the tests reveals possible heteroscedasticity and non-normality of residuals of a model, the Arellano estimator (suitable in case of heteroscedasticity and serial/cross-sectional correlation) is used for computation of coefficients. The industrial sectors 10-12 – manufacture of food products, beverages, and tobacco products (included in one dummy variable) are dropped from the regression in order to avoid perfect multicollinearity, and represent the reference sector.

Source: own processing of the data

Based on the results of LSDV regression, the industrial sectors 19 and 20 – manufacture of coke, chemicals, refined petroleum products, and chemical products, 24 – manufacture of metals, 29 – manufacture of vehicles, and 30 – manufacture of other transport equipment, and the innovation activity dummy have statistically significant and positive impact on the volume of sales. The model can explain 70% of the sales variability.

The positive impact of the innovation activity dummy we interpret as the sales increase of almost 22 mil. EUR in the industrial sector, when all the enterprises in that sector have some innovation activity. This result confirm the previous result from Welch test, that the innovation activity truly makes significant difference in the sales volume.

The coefficients of the industrial sectors represent the deviation of the sector specific intercepts from the baseline intercept (reference sector). For example, the vehicle manufacturers gain almost 94 mil. EUR higher sales than the food, beverage and tobacco product manufacturers. Interestingly, some sectors are beneficial for the volume of sales, while some are not. However, not all sectors are statistically significant determinants of sales.

Another measure of the firm size is number of employees. Again, we are interested in the difference between the size of innovation enterprises and enterprises with no innovation activity. The table 9 shows the results of the comparison of means of the variable

Employees, which represents the number of employees in all enterprises (IE or NE) employed in a particular industrial sector.

Table 9 Welch t-test – dependent variable Employees

Welch t-test statistic	7.89 *** (0.00)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = 139.62	Upper = 277.63
Means of samples:	Employees in IE = 301	Employees in NE = 92

Note: the value in the parenthesis is the p-value of the Welch t-test, and based on the p-value, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

The average number of employees in the enterprises with some innovation activity is 301, while the average number of employees in the enterprises with no innovation activity is 92. The 99% confidence interval of the difference in mean is between 140 and 278 employees. Based on the Welch t-statistic, the true difference in means is not equal to zero. The enterprises with some innovation activity employ more workers than those with no innovation activity, and since the number of employees describes the size of an enterprise as well, we can conclude that the enterprises with some innovation activity are bigger than those without innovation activity. There may be several explanations. First, the enterprises, which invest to innovations, need more employees to work on the innovation activities, and thus employ more labour force. Second, the enterprises with innovation activities prosper on the market, and thus grow in their size. Third, the bigger enterprises may have more resources (both financial and human) for innovation activities, which would suggest that not only the innovation influence the size, but the size influence the innovation, as well (we address this question later in our thesis).

In order to examine the relationship between the innovation activity, the expenditures on innovation, as well as the industrial sector, and the number of employees, we performed the regression. The tests conducted to select the appropriate estimation method for the regression model are presented in the following table 10.

Table 10 Panel diagnostic - dependent variable Employees

	Testing statistic	*Null hypothesis*	*Recommendation*
F-test	13.00 *** (0.000)	No panel effects	FE is better than OLS
LM-test	122.37 *** (0.000)	No significant difference across units	RE is better than OLS
Hausman test	14.51 (0.63)	Errors not correlated with the regressors	RE is better than FE

Note: the values in the parenthesis are the p-values, and based on the p-values, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

The most suitable for the model estimation is the random-effect method, based on the Hausman test. The results of the model are presented in table 11.

Table 11 Random-effect regression - dependent variable Employees

(in thousands EUR)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
Constant	4.53		45.84	0.10	0.92
Exp.	0.02		0.02	1.35	0.18
IA	180.82	***	36.88	4.90	0.00
Industrial sector 13	49.06		51.90	0.95	0.35
Industrial sector 14	106.13	**	44.80	2.37	0.02
Industrial sector 15	89.25		59.66	1.50	0.14
Industrial sector 16	-37.32		67.75	-0.55	0.58
Industrial sector 17	53.20		55.24	0.96	0.34
Industrial sector 18	-26.46		65.62	-0.40	0.69
Industrial sector 19, 20	94.18	**	46.22	2.04	0.04
Industrial sector 22	5.81		59.72	0.10	0.92
Industrial sector 23	34.21		46.59	0.73	0.46
Industrial sector 24	545.59	*	275.35	1.98	0.05
Industrial sector 25	-14.01		63.53	-0.22	0.83
Industrial sector 28	71.82	*	42.38	1.69	0.09
Industrial sector 29	241.80	***	80.58	3.00	0.00
Industrial sector 30	207.16	***	69.07	3.00	0.00
Industrial sector 31, 32	2.07		58.24	0.04	0.97
R-squared	0.24			Adjusted R-squared	0.18
F (17, 238)	4.32	H0: coefficients equal to zero		p-value	0.00
Breusch-Pagan LM	899.21	H0: heteroscedasticity not present		p-value	0.00
Shapiro-Wilk W	0.72	H0: error is normally distributed		p-value	0.00
Durbin-Watson DW	1.22	H0: no correlation in idiosyncratic errors		p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. Since the tests reveals possible heteroscedasticity and serial correlation in errors of a model, the Arellano estimator (suitable in case of heteroscedasticity and serial/cross-sectional correlation) is used for computation of coefficients. The reported R-squared is not correct.

Source: own processing of the data

Similarly, as in case of the variable *Sales*, the innovation activity is positive statistically significant determinant of the average number of employees per enterprise in particular group (IE or NE) in the industrial sectors. Hence, we confirm the results of the

Welch test, that there is a statistically significant difference between the group of innovation enterprises and non-innovation enterprises due to their innovation activities. In the group of innovation enterprises is on average 181 more employees than in the other group. The explanations are stated in the description of the Welch tests results. However, since the expenditures spent on innovations is not a statistically significant determinant of the number of employees, the second explanation (that an enterprise, which invest to innovation activities, needs more employees to perform these activities) do not hold. Whether the enterprise do, or do not spend the money on innovation, seems not influencing the employees' number.

The constant in this model represents the average enterprise with no innovation activity, and zero expenditures on innovation, which operates in sector of food, beverage or tobacco products manufacturing (reference enterprise). The manufacturers of wearing apparel have on average 106 more employees, the manufacturers of coke, chemicals, petroleum and chemical products have on average 94 more employees, the manufacturers of metal on average 546 more employees, the manufacturers of vehicles on average 242, and the manufacturers of other transport equipment on average 207 more employees than reference enterprise.

These two simple comparisons, supported with the regression analysis, provide an evidence that innovation activity is beneficial for the enterprises in terms of their size. It is also possible that bigger enterprises (in terms of both the number of employees and the volume of sales) in general invest in innovations more than smaller ones. Thus, we further examine this issue about enterprises' innovation activity influenced with the size of the enterprise.

4.2.1 The innovation input variables on the industrial level

On the industrial level, we examined the relationship between the two previously-mentioned innovation input variables and the selected independent variables, especially the FDI inflow and outflow. First, we regress the innovation input – research and development personnel (RDE), on the FDI inflow, the FDI outflow, and the volume of sales, which is a measure of the size. Table 12 presents the necessary tests results needed for the selection of the appropriate method of estimation. Since the unit of measure of the R&D personnel is small number and the units of measure of FDI and sales are in thousands of EUR, we standardised the variables of the model by subtracting their means and dividing by their standard deviations.

Table 12 Panel diagnostic – dependent variable RDE

	Testing statistic	*Null hypothesis*	*Recommendation*
Breusch-Pagan	6.08 (0.108)	No heteroscedasticity	No need of HC
F-test	9.38 *** (0.000)	No panel effects	FE is better than OLS
LM-test	13.75 *** (0.000)	No significant difference across units	RE is better than OLS
Hausman test	13.95 *** (0.003)	Errors not correlated with the regressors	FE is better than RE

Note: the values in the parenthesis are the p-values, and based on the p-values, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

Breusch-Pagan test for heteroscedasticity shows no result suggesting this problem in the model, hence we do not use any heteroscedasticity corrected estimation method. Based on the F-test, the model is not poolable, suggesting the use of the fixed-effect variant. Breusch-Pagan LM test result leads to rejection of hypothesis of no panel effects, and favours the random-effect rather than pooled OLS method. Based on the Hausman test, the fixed-effect is better in comparison with the fixed-effect variant.

Table 13 Fixed-effect regression - dependent variable RDE

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	
Sales	0.104		0.12	0.90	0.37	
FDIin	- 0.007		0.02	- 0.33	0.74	
FDIout	0.118	***	0.04	2.86	0.01	
R-squared	0.12				Adjusted R-squared	- 0.17
F (3, 46)	2.09	H0: coefficients equal to zero			p-value	0.11
Shapiro-Wilk W	0.72	H0: error is normally distributed			p-value	0.00
Durbin-Watson DW	1.81	H0: no serial correlation in idiosyncratic errors			p-value	0.27
Pesaran CD test	2.10	H0: no cross-sectional dependence			p-value	0.04
Wooldridge's test	11.23	H0: no serial correlation in FE			p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. The (adjusted) R-squared and F statistic are reported, but incorrect due to suppression of constant of model. The correct R-squared is 0.25.

Source: own processing of the data

The Shapiro-Wilk test for normality of residuals lead to rejection of normality, meaning that we should interpret the statistical significance of the variables with caution (the significance may be on a lower level as reported). The Durbin-Watson tests show no suspicion of serial correlation in errors, however, the Wooldridge's test leads to rejection of null hypothesis, and we suspect serial correlation in model. The Pesaran test shows possible cross-sectional dependence in the model. We accounted for these two problems and estimated the model with use of a nonparametric robust estimators[4] - we present only the robust results in the table.

Only the FDI outflow shows to be statistically significant with positive, but small impact on the dependent variable. The interpretation of the coefficient is that ten standard deviation od FDI outflow increase (72 410 thousands EUR) leads to increase of 1.18 times standard deviation of the R&D personnel (0.847 person), thus increase of R&D personnel of about 1 person. The positive relationship can be explained by fact, that the enterprises, which invest abroad, employ more R&D workers in order to perform R&D activities in a home country aiming to increase their chances on foreign markets due to developed innovations.

Furthermore, we attempt to examine the impact of the industry on the R&D personnel. In the table 14 we present the results of the pooled OLS with use of nonparametric robust estimation, and the results of the least squares dummy variable with use of White's heteroscedasticity-corrected estimator.

Table 14 Pooled OLS and LSDV - dependent variable RDE

(Pooled OLS)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	-0.617	***	0.06	-11.04	0.00	-
Sales	0.104		0.12	0.90	0.37	3.81
FDIin	-0.007		0.02	-0.33	0.74	1.12
FDIout	0.118	***	0.04	2.86	0.01	1.19
Industrial sector 14	-0.011		0.02	-0.61	0.54	1.13
Industrial sector 20	0.544	***	0.08	7.07	0.00	
Industrial sector 22	0.169	**	0.07	2.42	0.02	
Industrial sector 23	-0.009		0.05	-0.18	0.86	
Industrial sector 24	0.324	*	0.18	1.80	0.08	
Industrial sector 25	0.011		0.03	0.34	0.74	
Industrial sector 26	0.188		0.12	1.60	0.12	
Industrial sector 27	0.479	***	0.08	5.72	0.00	
Industrial sector 28	0.528	***	0.09	6.14	0.00	
Industrial sector 29	0.761		0.87	0.87	0.39	
Industrial sector 30	2.270	***	0.03	69.99	0.00	
Industrial sector 31	0.134	***	0.03	4.63	0.00	

[4] We used the nonparametric robust covariance matrix estimators suggested by Driscoll (1998) for panel models with cross-sectional and serial correlation.

R-squared	0.78				Adjusted R-squared	0.71
F (15, 46)	10.93	H0: coefficients equal to zero			p-value	0.00
Breusch-Pagan BP	196.04	H0: heteroscedasticity not present			p-value	0.00
Shapiro-Wilk W	0.72	H0: error is normally distributed			p-value	0.00
Durbin-Watson DW	1.81	H0: no serial correlation in idiosyncratic errors			p-value	0.02
Pesaran CD test	2.10	H0: no cross-sectional dependence			p-value	0.04
(LSDV)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Sales	0.104		0.23	0.44	0.66	3.86
FDIin	-0.007		0.03	-0.24	0.81	1.12
FDIout	0.118	**	0.05	2.15	0.04	1.19
Industrial sector 10	-0.617	***	0.08	-8.08	0.00	1.12
Industrial sector 14	-0.628	***	0.10	-6.34	0.00	
Industrial sector 20	-0.073		0.12	-0.63	0.53	
Industrial sector 22	-0.447	***	0.09	-5.17	0.00	
Industrial sector 23	-0.626	***	0.11	-5.95	0.00	
Industrial sector 24	-0.292	**	0.13	-2.19	0.03	
Industrial sector 25	-0.606	***	0.11	-5.61	0.00	
Industrial sector 26	-0.429	***	0.09	-4.71	0.00	
Industrial sector 27	-0.138		0.12	-1.11	0.27	
Industrial sector 28	-0.088		0.12	-0.73	0.47	
Industrial sector 29	0.144		1.05	0.14	0.89	
Industrial sector 30	1.654	***	0.06	29.23	0.00	
Industrial sector 31	-0.483	***	0.08	-6.36	0.00	
R-squared	0.81				Adjusted R-squared	0.74
F (16, 46)	12.09	H0: coefficients equal to zero			p-value	0.00
Breusch-Pagan BP	196.04	H0: heteroscedasticity not present			p-value	0.00
Shapiro-Wilk W	0.72	H0: error is normally distributed			p-value	0.00
Durbin-Watson DW	1.81	H0: autocorrelation of errors			p-value	0.02

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem.

Source: own processing of the data

In the pooled OLS, the constant represents the average enterprise operating in the sector of manufacture of food, beverages, or tobacco products, which is the same as presented in LSDV model by variable Industrial sector 10. Due to heteroscedasticity problem and serial correlation in errors, we estimate the coefficient with use of White's estimator to control for these problems. These two estimations help us study the impact of the industrial sectors on the R&D personnel. The LSDV model by its definition supposes an initial level of R&D personnel in an average enterprise operating in each particular sector, and in this case, LSDV improved F-test and R-squared of a model.

The coefficients estimates for the volume of sales, the FDI inflow, and the FDI outflow remain the same as in the previous model in table 13 without the industrial sector included. However, including the industrial sectors clearly increased the R-squared (78% for the pooled OLS, and 81% for the LSDV) in table 14. Based on the White's estimator in LSDV model, some industrial sectors are statistically significant determinants of R&D personnel, and are both negative and positive. The model shows that the average manufacturers of transport equipment have initially almost two persons more in R&D than the average enterprise in the industry, while for instance, the average manufacturer of food, beverages, or tobacco products, the average manufacturer of wearing apparel, the average manufacturer of non-metallic mineral products or metal products have initially almost 1 person less in R&D than the average enterprise in the industry. Initially lower number of R&D personnel compared to the average industrial enterprise have the average manufacturers of rubber and plastic, basic metal, computer, electronic and optic products, and furniture, as well.

The reason for such results is the character of manufactured products. In rising competition pressure in the industry with transport equipment, the enterprise is pushed to perform some R&D activities. However, in the industry sector manufacturing some kind of products for further production (materials), the enterprises have a constant demand for their products regardless of their R&D activities. In case of food, beverages and tobacco products, as well as wearing apparel, the innovation activities are generally not so common, as in other industrial sectors. Interestingly, results show that in case of computer, electric and optic products manufacture, there is also initially less R&D persons than in an average industrial enterprise, although one could expect the opposite, based on the character of production.

Second model, which we study on the industrial level, has the variable expenditures on R&D activities spent by business enterprises (BERD) as the dependent variable regressed on the FDI inflow and outflow, the volume of sales as the measure of the firm size, and the industrial sector dummies. We estimate this model with use of pooled OLS, fixed-effect, and random-effect method, and based on the tests presented below in table 15, we selected the random-effect as the most suitable one. Moreover, the random-effect method allows for generalisation of the results.

Table 15 Panel diagnostic - dependent variable BERD

	Testing statistic	*Null hypothesis*	*Recommendation*
Breusch-Pagan	169.53 *** (0.000)	No heteroscedasticity	Need of HC estimator
LM-test	7.49 *** (0.006)	No significant difference across units	RE is better than OLS
Durbin-Watson	2.07 (0.120)	No serial correlation in errors	No need of correction
Pesaran test	0.21 (0.836)	No cross-sectional dependence	No need of correction
Shapiro-Wilk	0.89 *** (0.000)	Normality of residuals	Cautious interpretation

Note: the values in the parenthesis are the p-values, and based on the p-values, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

Based on the results of the estimation reported in table 16, the volume of the sales, the FDI outflow and some industrial sectors are statistically significant determinants of the variable BERD. The model can explain the variance of the dependent variable on the level of 69%. Based on F-tests, the coefficients seem different from zero, thus the model is fine. However, the Breusch-Pagan test and the Shapiro-Wilk test in table 15 reveal that there is a heteroscedasticity problem and the errors are not normally distributed. For this reason, we used the White's heteroscedasticity corrected estimation of the coefficients. The Durbin-Watson and Pesaran test do not reveal the serial correlation problem, or cross-sectional dependence in the model. Based on the Lagrange multiplier test, the random-effect method is better for estimation of the model's coefficients.

Table 16 Random-effect regression - dependent variable BERD

(in thousands of EUR)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	298.57	***	72.93	4.09	0.00	-
Sales	-0.04	***	0.01	-2.62	0.01	3.31
FDIin	0.001		0.00	1.53	0.13	1.12
FDIout	0.02	*	0.01	1.89	0.06	1.13
Industrial sector 14	-157.41	*	89.83	-1.75	0.09	1.10
Industrial sector 17	830.05	***	233.85	3.55	0.00	
Industrial sector 18	-39.10		170.03	-0.23	0.82	
Industrial sector 22	415.88	***	146.18	2.85	0.01	
Industrial sector 23	-33.15		139.05	-0.24	0.81	
Industrial sector 24	1 404.90	***	491.98	2.86	0.01	
Industrial sector 25	-206.17	**	96.67	-2.13	0.04	
Industrial sector 26	1 168.20	**	541.12	2.16	0.04	

(in thousands of EUR)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Industrial sector 27	549.53	***	146.00	3.76	0.00	
Industrial sector 28	133.92		178.11	0.75	0.46	
Industrial sector 29	5 635.30	***	1 376.30	4.09	0.00	
Industrial sector 30	1 952.00	***	191.97	10.17	0.00	
Industrial sector 31	55.67	***	95.56	0.58	0.56	
R-squared	0.69				Adjusted R-squared	0.59
F (16, 55)	7.49	H0: coefficients equal to zero			p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The coefficients are estimated with heteroscedasticity corrected White's estimator.

Source: own processing of the data

The increase of sales of one thousand EUR causes the small decrease of the average expenditures on R&D by 40 EUR, based on the estimation results. The explanation may be that the enterprises with the highest sale volume, which are the market leaders, do not consider as necessary to invest into the R&D activities, in order to win on the market. They sustain their leading position on the market with marketing activities, favourable prices, and other possibilities, different from R&D activities.

The FDI outflow increase of one thousand EUR causes the increase of the average expenditures on R&D of 20 EUR. This is due to fact that the enterprises, which are investing abroad, need to develop new products, processes or another types of innovation, in order to be able to compete on the foreign markets. The other explanation may be that the enterprises investing abroad gain new knowledge in the foreign countries, which they attempt to implement in their businesses afterwards.

Furthermore, some industrial sectors seem beneficial for expenditures on R&D activities, while some seem to deter these expenditures. For instance, the highest expenditures on R&D activities make the enterprises operating in the manufacture of vehicles, then the manufacturers of transport equipment, the manufacturers of computer, electronic, and optical products, and the manufacturers of basic metals. The less than the general average in the industry are investing into the R&D activities the enterprises in sector manufacturing fabricated metal products, and wearing apparel. These differences can be again explained by the character of manufactured products. The country is oriented in the automotive industry, hence the increased level of R&D expenditures in the motor vehicles sector is expectable – the car manufacturers perform R&D activities in the country of the production (Slovakia). The side-lined productions (transport equipment, metal products) are motivated to increase their R&D activities as well, in order to improved products for the demanding car manufacturers. In case of computer, electronic and optic products, the higher level of R&D expenditure is motivated by the general fast development of this industrial sector. Since in the previous model is shown that the number of R&D personnel is initially under industrial average, it means that the R&D activities are in this sector oriented in new technology, rather than in knowledge and human capital. Again, the wearing apparel sector is not motivated to perform R&D, and the enterprises compete on the market rather with lower prices, achieved thanks to cheap labour force in the country.

4.2.2 The innovation output variables on the industrial level

In this section, we examine the innovation output variables on the industrial level. The dependent variable, measured by number of enterprises with some innovation activity, represents the innovation output of particular industrial sector. This variable is regressed on the FDI inflow and outflow, the volume of sales, as the measure of size, the return on sales, as the measure of profitability, and the innovation input variables. First, the panel diagnostic tests are performed and their results reported in table 17. We used standardisation of the variables, since the scales and units are different among all the variables.

Table 17 Panel diagnostic – dependent variable No. of IA

	Testing statistic	*Null hypothesis*	*Recommendation*
Breusch-Pagan	10.17 (0.12)	No heteroscedasticity	No need of correction
F-test	8.66 *** (0.00)	No panel effects	FE is better than OLS
LM-test	32.30 *** (0.00)	No significant difference across units	RE is better than OLS
Hausman test	8.29 (0.22)	Errors not correlated with the regressors	RE is better than FE
Durbin-Watson	1.75 (0.13)	No serial correlation in errors	No need of correction
Pesaran test	2.56 *** (0.01)	No cross-sectional dependence	Need of correction
Shapiro-Wilk	0.83 *** (0.00)	Normality of residuals	Cautious interpretation

Note: the values in the parenthesis are the p-values, and based on the p-values, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

The errors of the model do not have normal distribution, but there is no heteroscedasticity, or serial correlation problem in the model. The Pesaran test reveals the problem with cross-sectional dependence in the models. Hence, we estimated the coefficient with cross-sectional dependence-corrected estimator, results of which are in the next table. The Lagrange multiplier Breusch-Pagan test of panel effects shows that the random-effect estimation is better than pooled OLS, and the F-test leads to rejection of the pooled OLS method in favour of fixed-effect as well. Based on the Hausman test, we selected the random-effect variant. The results of the model estimated with use of random-effect method corrected for cross-sectional dependence are presented in the table 18.

Table 18 Random-effect regression - dependent variable No. of IA

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.311		0.30	1.04	0.30	-
Sales	0.044		0.13	0.34	0.73	1.22
ROS	-0.193		0.13	-1.47	0.15	1.20
BERD	-0.092		0.10	-0.89	0.38	1.23
RDE	-0.241	***	0.07	-3.69	0.00	1.23
FDIin	-0.044		0.05	-0.94	0.35	1.22
FDIout	0.051	**	0.02		0.01	1.17
R-squared	0.06				Adjusted R-squared	-0.05
F (6, 50)	0.52	H0: coefficients equal to zero			p-value	0.79

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem. The reported (adjusted) R-squared and F-statistic are incorrect. The correct R-squared is 0.32.

Source: own processing of the data

Based on the results, the statistically significant impact on the innovation activity have only the R&D personnel and the FDI outflow, the first with negative, and the latter with positive effect. The interpretation of scaled variables is that one standard deviation increase (0.847) of R&D personnel causes decrease of 0.241 times standard deviation of innovation activity in the sector. Hence, the increase of about eight R&D employees causes the decrease of average number of enterprises with some innovation activity in the industrial sector of 142 enterprises. And the increase of the FDI outflow of one standard deviation (153 456 thousands EUR) leads to increase of the number of innovation enterprises of three enterprises, which means that, when the enterprises invest abroad, the innovation activity slightly increase in their home country. It can be explained by either (1) the effort of the enterprises to be able to compete on the (usually) more developed foreign markets with innovative products or processes, or (2) the motivation and new knowledge of these enterprises obtained abroad, which they try to implement in their parent company.

Examining the number of the innovation enterprises in the sector can be confusing, when there is not the comparison to the total number of enterprises in the sector. For this reason, we construct the same model, where the main dependent variable is the share of the innovation enterprises on the total number of enterprises in the industrial sector. The results, as well as the tests for selecting the appropriate estimation method are in table 19.

We decided to use pooled OLS with Arellano estimator, which gives us heteroscedasticity- and serial correlation-corrected results. The model can explain 50% of the dependent variable's variance, and based on the F-test, it is poolable, and based on the Breusch-Pagan LM test, the pooled OLS is more suitable than random-effect method. We estimated the model also with cross-sectional dependence-corrected estimator, and, after comparison of those results with the presented results, we decided not to report them, since they are very similar (the same for coefficients, similar for standard errors, t-ratios, and p-values, and same for statistical significance).

Table 19 Pooled OLS - dependent variable Share of IA

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	-0.016		0.12	-0.13	0.89	-
Sales	0.624	***	0.11		0.00	1.78
ROS	-0.038		0.05	-0.71	0.48	1.34
BERD	-0.152		0.26	-0.58	0.56	2.09
RDE	0.092		0.29	0.31	0.75	1.58
FDIin	-0.203	***	0.07	-2.80	0.01	1.15
FDIout	-0.045		0.12	-0.38	0.71	1.14
R-squared	0.50			Adjusted R-squared		0.43
F (6, 50)	8.17	H0: coefficients equal to zero			p-value	0.00
Breusch-Pagan BP	20.71	H0: no heteroscedasticity			p-value	0.00
F-test	1.60	H0: no panel effects			p-value	0.14
LM-test	1.11	H0: no significant difference across units			p-value	0.29
Hausman test	11.42	H0: errors not correlated with regressors			p-value	0.08
Durbin-Watson	1.57	H0: no serial correlation in errors			p-value	0.03
Pesaran test	6.77	H0: no cross-sectional dependence			p-value	0.00
Shapiro-Wilk	0.93	H0: normality of residuals			p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem.

Source: own processing of the data

Based on the reported results, the sales have statistically significant and positive effect, while the FDI inflow has statistically significant and negative effect on the share of innovation enterprises on the total enterprises in the industrial sector. The increase of the average sales volume in the industrial sector of 17 389 thousands EUR (one standard deviation) causes the increase of the share of innovation enterprises by approximately 7% of the total number (one standard deviation of the dependent variable equals to 12.1%). The increase of the FDI inflow of 153 456 thousands EUR leads to the decrease of these percentage by 2.5%.

We can explain the positive effect of the sales volume in the industrial sector by fact that higher sales lead to higher profits in the sector. With the higher profit an enterprise may have enough resources for funding the innovation activities. On the other hand, the negative effect of the FDI inflow may be caused by relocation of the innovation activities into the parent company, or other host country, which is a common practice of the multinational companies, which represents the FDI inflow to the industrial sector.

In addition, we examine the effect of the industrial sector on the share of innovation enterprises on total number. Based on the pooled OLS regression with use of the heteroscedasticity and serial correlation corrected estimation method more than half of the industrial sectors have statistically significant impact on the innovation enterprises share (results presented in table 20).

Table 20 Pooled OLS – dependent variable share of IA regressed on the industrial sector

(in percentage)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
Industrial sector 10 - 12	0.13	***	0.03	3.78	0.00
Industrial sector 13	-0.07	*	0.04	-1.78	0.08
Industrial sector 14	-0.10	***	0.04	-2.55	0.01
Industrial sector 15	-0.08	**	0.03	-2.44	0.02
Industrial sector 16	-0.10	***	0.04	-2.59	0.01
Industrial sector 17	0.02		0.05	0.43	0.67
Industrial sector 18	-0.09	**	0.04	-2.38	0.02
Industrial sector 19 - 20	0.08	**	0.04	2.24	0.03
Industrial sector 21	0.19	***	0.05	3.99	0.00
Industrial sector 22	-0.01		0.05	-0.26	0.79
Industrial sector 23	-0.04		0.05	-0.69	0.49
Industrial sector 24	0.02		0.06	0.33	0.74
Industrial sector 25	-0.09	**	0.04	-2.06	0.04
Industrial sector 26	-0.04		0.05	-0.83	0.41
Industrial sector 27	-0.03		0.04	-0.57	0.57
Industrial sector 28	-0.02		0.04	-0.56	0.58
Industrial sector 29	0.24	***	0.07	3.62	0.00
Industrial sector 30	0.02		0.05	0.40	0.69

(in percentage)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
Industrial sector 31	-0.03		0.05	-0.68	0.50
Industrial sector 32 - 33	-0.10	***	0.03	-3.05	0.00
R-squared	0.54			Adjusted R-squared	0.45
F-statistics (19, 103)	6.30			with p-value	0.00
Breusch-Pagan BP	39.90			with p-value	0.00
Shapiro-Wilk W	0.87			with p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values.

Source: own processing of the data

The effect of the industrial sectors is both positive, and negative, depending on the character of the sector. For example, the sector of manufacture of motor vehicles (code 29) has on average 24% higher share than the sector of food, beverage, and tobacco products manufacture (code 10, 11, 12), while the sector of wearing apparel manufacture (code 14), manufacture of wood products (code 16), and other manufacture (code 32) and repair sector (code 33) has on average by 10% lower share of the innovation enterprises on the total number of enterprises compared to the sector of food, beverage, and tobacco products manufacture.

4.3 The microeconomic level analysis

On a firm level, we analyse the possible determinants of the dependent variable enterprise's innovation activity. The independent variable of our main interest is the ownership of the enterprise, describing the FDI inflows to the enterprise. In the first model, we regress the innovation activity, measured as the number of patents, trademarks, utility models, and designs, registered in the Industrial property office of the Slovak Republic, or the European patent office, on the dummy variable the FDI inflow, which has a value 1, when an enterprise has at least 10% of shares owned by foreign investor, and value 0 otherwise. The results are presented in following table 21.

Table 21 White's HC OLS – Innovation activity regressed on FDI

(in absolute numbers)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
Constant	9.73	***	2.88	3.38	0.00
FDI	-5.24	*	3.11	-1.69	0.09
R-squared	0.01			Adjusted R-squared	0.01
F (1, 276)	3.83			with p-value	0.05
Breusch-Pagan BP	10.45			with p-value	0.00
Shapiro-Wilk W	0.37			with p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values.

Source: own processing of the data

This model can explain only 1% of the variance of the dependent variable, and one of the estimated coefficients may equal to zero, based on the F-test. Due to heteroscedasticity problem, we used heteroscedasticity corrected (HC) variant for estimating the coefficients – the White's estimator, which is the only one reported in the table. Based on the results, when an enterprise is domestically-owned the number of innovation activity outputs is on average almost 10, while after a foreign investor invests into an enterprise, the innovation activity decreased on average of 5 outputs. The explanation may be that the domestic enterprises attempt to compete on the domestic market with innovations. Then a foreign investor enters an enterprise and, for example, starts with costs saving processes, or brings a well-known product brand, and consequently, the enterprise can compete on the market with price policy, marketing, etc. instead of innovations, and the R&D activities and innovations are relocated in the parent company in a foreign country.

In addition, we study the innovation activity regressed on the factorial variable ownership, which has the code 1 for the international ownership, the code 2 for the foreign ownership, and the code 3 for domestic ownership. The results of the model estimation with use of the OLS method are presented in table 22.

Table 22 White's HC OLS – Innovation activity regressed on ownership

(in absolute numbers)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*
International ownership	8.59	***	2.99	2.87	0.00
Foreign ownership	- 4.82		3.25	-1.48	0.14
Domestic ownership	1.14		4.16	0.27	0.78
R-squared	0.02			Adjusted R-squared	0.01
F (2, 275)	2.83			with p-value	0.06
Breusch-Pagan BP	10.87			with p-value	0.00
Shapiro-Wilk W	0.38			with p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values.

Source: own processing of the data

Based on the results of the model, the international and the domestic ownership have a positive impact, while the foreign ownership has a negative impact on the innovation activity of an enterprise. It means that only when the ownership of an enterprise is at least partially domestic, the enterprise produce some innovation outputs. The results suggest that the cooperation between the domestic entrepreneurs with the foreign investor can be the most beneficial in terms of the enterprise ownership. The domestic owner brings the knowledge about the local market, while the foreign investor provides new technologies and knowledge. The domestic owner is also interested in producing innovation outputs in his country. The purely foreign-owned enterprises seem relocating the innovation activities outside the host country. However, only the international ownership is statistically significant determinant of the dependent variable, and the model can explain only 2% of the innovation activity's variance. Moreover, some of the coefficients is possibly zero, based on the F-test, and the residuals of the model do not have normal distribution, and there is a heteroscedasticity problem in the model, which we accounted for in the White's estimation of the model's coefficients (presented in the table).

Besides the main independent variables (FDI and type of ownership), we examine the impact of age, size, profitability (ROS), debt, labour productivity (LP), market share, industrial sector, and location on the enterprise's innovation activity. We used the OLS method for estimation of the coefficients. After testing for heteroscedasticity, we revealed the heteroscedasticity problem in the model, hence, we estimate the coefficients with heteroscedasticity corrected White's estimator. The results of the model are presented in table 23. Due to various units of measure and scales, we standardised all the variables.

Table 23 White's HC OLS – other determinants of innovation activity

(standardised variables)	*Coefficient*	*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.05	0.18	0.29	0.78	-
Age	-0.06	0.14	-0.41	0.68	1.05
Size	0.34	0.47	0.72	0.47	6.32
Squared Size	-0.02	0.24	-0.06	0.95	5.99
ROS	0.50	0.74	0.68	0.50	1.19
Debt	-0.03	0.07	-0.47	0.64	1.26
Labour productivity	0.37	0.40	0.93	0.36	1.71
Market share	-0.24	0.31	-0.77	0.44	4.97
R-squared	0.17			Adjusted R-squared	0.10
F (7, 83)	2.45	H0: coefficients equal to zero		p-value	0.02
Breusch-Pagan BP	209.19	H0: no heteroscedasticity		p-value	0.00
Durbin-Watson	1.80	H0: no autocorrelation in errors		p-value	0.16
Shapiro-Wilk	0.71	H0: normality of residuals		p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. VIF represents variance inflation factor, where values above 10.00 may indicate a collinearity problem.

Source: own processing of the data

Based on the results presented in table 23, the model can explain 17% of the dependent variable variance. The constant represents an average enterprise with all the independent variables on an average level, since we used variables centred on their means. Although none of the independent variables are statistically significant determinant of the innovation activity, we can explain the results at least from economical point of view.

The increase of the age of 6 years (one std. deviation) causes the decrease of the enterprise's innovation activity of about one output (0.06 times std. deviation of innovation activity, which equals to 18.79). It means that younger enterprises register their innovations more than older enterprises. The older ones have know-how, tradition, stable base of customers, developed relationships with suppliers and other enterprises, etc., and all these factors support their strong position on the market. Hence they are not motivated (or pushed) to innovate. Unlike the younger ones, which need to come up with new ideas, products, services, etc., in order to compete on the market.

The results shows inverted U-shaped relationship between innovation activity and the size of an enterprise, measured as the number of employees. The innovation activity is increasing up to a certain point, and then starts to decrease. It means that an enterprise is initially interested in innovation, and with growing size it innovate more. But after it reaches the size of more than 11 thousand employees, it do not see the innovation as necessary to sustain its position on the market, and decreases its innovation activity.

In case of the return on sales as the measurement of profitability, the increase of the profitability by 81% (one std. deviation) leads to increase of innovation activity of about nine outputs. This can be explained with fact that with higher profitability the financial strength of an enterprise grows as well, and it has more sources for innovation activities funding.

The negative impact of debt means that the increase of debt ratio by 28% leads to the decrease of innovation activity of 0.6 output. Hence an enterprise is less willing to innovate, when its indebtedness rises. The innovation activity requires a certain amount of capital, and the enterprise is not able to borrow more from its creditors, when it already owes them money.

In case of labour productivity, the increase of value added of 28 thousand EUR per employee (one std. deviation of labour productivity) leads to the increase of the innovation activity of almost seven innovation outputs. It may be due to productive labour developing more innovations, or due to higher motivation of these employees to innovate.

The market share increased by 3% (ten std. deviations) causes the decrease of the innovation activity of 45 innovation outputs. It suggests that enterprises with stronger positions on the market (with higher market shares) do not innovate as much as enterprises with lower market shares. Again, it can be explained with fact that the leaders on the market have another ways of sustaining their winning positions instead of the innovation activities, while the market followers try to innovate in order to succeed on the market.

In the next table 24 we show the results of the determinant industrial sector.

Table 24 White's HC OLS – Industrial sector as determinant of innovation activity

(in absolute numbers)	*Coefficient*		*Std. error*	*t-value*	*p-value*
Industrial sector 10	23.95	***	9.71	2.47	0.01
Industrial sector 11	20.25		25.24	0.80	0.42
Industrial sector 13	-23.95	***	9.71	-2.47	0.01
Industrial sector 14	-21.86	**	9.78	-2.24	0.03
Industrial sector 15	-22.75	**	9.78	-2.33	0.02
Industrial sector 16	-23.95	***	9.71	-2.47	0.01
Industrial sector 17	-19.09	*	10.51	-1.82	0.07
Industrial sector 18	-23.28	**	9.72	-2.40	0.02
Industrial sector 19	55.05	***	9.90	5.56	0.00

(in absolute numbers)	Coefficient		Std. error	t-value	p-value
Industrial sector 20	-7.28		14.92	-0.49	0.63
Industrial sector 21	-4.95		16.97	-0.29	0.77
Industrial sector 22	-19.52	*	10.66	-1.83	0.07
Industrial sector 23	-15.68		10.84	-1.45	0.15
Industrial sector 24	-19.85	**	10.15	-1.96	0.05
Industrial sector 25	-22.89	**	9.73	-2.35	0.02
Industrial sector 26	-22.03	**	9.88	-2.23	0.03
Industrial sector 27	-19.88	**	10.05	-1.98	0.05
Industrial sector 28	-21.39	**	9.76	-2.19	0.03
Industrial sector 29	-23.75	**	9.71	-2.45	0.02
Industrial sector 30	-5.45		15.45	-0.35	0.72
Industrial sector 31	-22.12	**	9.88	-2.24	0.03
Industrial sector 32	-23.55	**	9.72	-2.42	0.02
Industrial sector 33	-21.33	**	9.88	-2.16	0.03
R-squared	0.25			Adjusted R-squared	0.19
F-statistics (22, 255)	3.87			with p-value	0.00
Breusch-Pagan BP	473.42			with p-value	0.00
Durbin-Watson DW	1.96			with p-value	0.34
Shapiro-Wilk W	0.41			with p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values.

Source: own processing of the data

Similarly as in our analysis on the industrial level, the results of the model with independent variable industrial sector lead to conclusion that some industrial sector have statistically significant impact (either positive or negative) on the innovation activity. The highest positive impact has the manufacture of coke and petroleum products (sector code 19), where the enterprises have on average 55 more innovation outputs, while the lowest negative impact have the textiles manufacture, the manufacture of wood and wooden products, printing and reproduction of recorded media sector, the manufacture of motor vehicles, and the other manufacture (sector codes 13, 16, 18 and 29, 32), where the enterprises operating in these sectors have on average of 24 less innovation outputs than an average enterprise in food manufacturing sector (sector code 10) – in fact on average they have not innovation outputs at all.

This is very interesting results in case of manufacturers of motor vehicles, since we found high expenditures on R&D activities and the relatively high share of enterprises with some innovation activity in this sector in the industrial level analysis. It means that even though these enterprises perform research and development, and develop new products, processes, marketing or organisational innovations, they do not register for intellectual property protection for their innovations. The benefits from legal protection of their innovation are probably overweighed with the high price of this protection and fast changing nature of the sector inventions.

On average one or two innovation outputs have the manufacturers of wearing apparel (code 14), leather and related products (code 15), fabricated metal products (code 25), computer and electronics (code 26), machinery and equipment (code 28), furniture (code 31), and repair and installation (code 33). The wearing apparel and leather product manufacturers probably register for protection of their designs, while the other named may register, for example, for patent or utility model for their unique invention, which is special for the enterprise.

Four or five innovation outputs have on average manufacturers of paper and paper products (code 17), rubber and plastic products (code 22), basic metals (code 24), and electrical equipment (code 27). The intellectual property protection in these cases may represent patents or utility models of production techniques or technologies, design of some products, etc.

In table 25, the results of model examining the relationship between the location of the enterprise and its innovation activity are reported.

Table 25 White's HC OLS – Location as determinant of innovation activity

	Coefficient		*Std. error*	*t-ratio*	*p-value*
BA	6.00	**	2.72	2.21	0.03
TN	-0.20		3.68	-0.06	0.96
TT	-3.25		3.13	-1.04	0.30
NI	-0.34		3.60	-0.10	0.92
BB	2.15		5.61	0.38	0.70
ZA	-2.10		3.92	-0.54	0.59
PO	4.04		6.46	0.62	0.53
KE	-1.96		3.30	-0.59	0.55
R-squared	0.01			Adjusted R-squared	-0.01
F-statistics (7, 270)	0.46			with p-value	0.87
Breusch-Pagan BP	69.12			with p-value	0.00
Durbin-Watson DW	1.84			with p-value	0.08
Shapiro-Wilk W	0.41			with p-value	0.00

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values.

Source: own processing of the data

The results in the table 25 show that only the Bratislava region has statistically significant impact on the innovation output of enterprises, and the impact of other regions are both positive and negative. In the west part of Slovakia, only Bratislava (BA) region has positive impact, while Trnava (TT), Trenčín (TN) and Nitra (NI) region influence the innovation output negatively. In the middle Slovakia Banská Bystica (BB) region has positive, and Žilina (ZA) region negative impact. And in the east part of Slovakia Prešov (PO) region has positive, while Košice (KE) region negative impact on the innovation activity of the enterprises. However, the model is unreliable from statistical point of view, and has a very low coefficient of determination.

For better further analysis, we model the combinations of the determinants of the innovation activity as well. Based on the Pearson's and Spearman's correlation coefficients (table 26), high correlation is expected between the variables: *ROE* and *ROA, ROS* and *ROA, Size* and *Market share*. Hence, we do not use these combination in the following models.

Table 26 Pearson's and Spearman's correlation matrix

	IO	**Age**	**Sales**	**LP**	**ROA**	**ROE**	**ROS**	**MS**	**Debt**
IO	**1**	0.07	0.09	0.33***	-0.03	-0.01	-0.03	0.10	-0.05
		(0.24)	(0.16)	(0.00)	(0.65)	(0.93)	(0.57)	(0.12)	(0.44)
Age	0.31***	**1**	0.04	-0.08	-0.12**	-0.06	-0.08	0.01	-0.21***
	(0,00)		(0.52)	(0.45)	(0.05)	(0.37)	(0.20)	(0.91)	(0.00)
Sales	0,04	0,03	**1**	0.28***	-0.04	-0.01	-0.05	0.71***	-0.08
	(0,48)	(0,67)		(0.00)	(0.55)	(0.43)	(0.43)	(0.00)	(0.19)
LP	-0,01	-0,06	0,55***	**1**	-0.06	0.08	0.04	0.48***	-0.20**
	(0,91)	(0,54)	(0,00)		(0.54)	(0.42)	(0.67)	(0.00)	(0.05)
ROA	-0,05	0,06	-0,09	0,26**	**1**	0.68***	0.82***	-0.03	0.03
	(0,41)	(0,33)	(0,12)	(0,01)		(0.00)	(0.00)	(0.67)	(0.58)
ROE	-0,09	-0,01	-0,06	0,31***	0,83***	**1**	0.48***	-0.004	-0.04
	(0,13)	(0,92)	(0,30)	(0,00)	(0,00)		(0.00)	(0.95)	(0.53)
ROS	-0,03	0,07	-0,13**	0,26**	0,97***	0,81***	**1**	-0.03	-0.01
	(0,61)	(0,26)	(0,04)	(0,01)	(0,00)	(0,00)		(0.56)	(0.81)
MS	0,04	0,03	0,99***	0,55***	-0,09	-0,06	-0,13**	**1**	-0.05
	(0,48)	(0,67)	(0,00)	(0,00)	(0,12)	(0,30)	(0,04)		(0.36)
Debt	-0,10*	-0,25***	-0,02	-0,11	-0,06	0,09	-0,09	-0,02	**1**
	(0,09)	(0,00)	(0,77)	(0,29)	(0,30)	(0,11)	(0,15)	(0,77)	

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values, which are in the parentheses. The Spearman's rank correlation coefficients are below the diagonal, while the Pearson's correlation coefficients are above the diagonal.

Source: own processing of the data

Based on the results in the following table 27, there is a statistically significant and negative impact of the FDI on the innovation activity of an enterprise. When an enterprise has at least 10% of the shares owned by foreign investor, this enterprise has less innovation outputs than an average-sized domestic-owned enterprise. This can be explained by relocation of innovations to the parent company in the foreign country. The volume of sales as a measure of firm size seems not influencing the innovation activity on a statistically significant level.

Table 27 White's heteroscedasticity-corrected OLS

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	0.24		0.16	1.50	0.13	-
Sales	0.11		0.14	0.80	0.43	1.01
FDIin	- 0.31	*	0.17	- 1.85	0.07	1.01
R-squared	0.03			Adjusted R-squared		0.02
F (2, 275)	3.62	H0: coefficients equal to zero			p-value	0.03
Breusch-Pagan BP	41.56	H0: heteroscedasticity not present			p-value	0.00
Shapiro-Wilk W	0.40	H0: error is normally distributed			p-value	0.00
Durbin-Watson DW	1.82	H0: no autocorrelation in errors			p-value	0.06

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. Since the Breusch-Pagan test shows presence of heteroscedasticity, we used the heteroscedasticity-corrected White´s estimator for coefficients estimation, and only these are presented in the table.

Source: own processing of the data

The statistically significant impact on the innovation activity of the enterprises have, besides the FDI, the industrial sectors, as shown in table 28. The constant represents an average-sized domestic-owned enterprise with average labour productivity, which operates in sector of food manufacture. As in previous model, the foreign shares on the enterprise's ownership causes the decrease of the innovation activity. Most of the industrial sectors seem having negative and statistically significant effect, which is already explained in sections above. However, the variable *labour productivity* and *sales* has not statistically significant effect on the dependent variable.

Table 28 White's HC OLS – Sales, FDI, LP, and industrial sector as determinants of IA

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	1.83	***	0.36	5.11	0.00	-
Sales	-0.09		0.08	-1.06	0.29	1.24
FDIin	-0.40	*	0.22	-1.78	0.08	1.26
LP	0.45		0.31	1.46	0.15	1.33
Industrial sector 11	1.37	***	0.36	3.84	0.00	1.02
Industrial sector 14	-1.10	***	0.17	-6.42	0.00	
Industrial sector 15	-1.51	***	0.19	-8.00	0.00	
Industrial sector 16	-1.64	***	0.12	-13.23	0.00	
Industrial sector 17	-2.31	***	0.62	-3.72	0.00	
Industrial sector 18	-1.81	***	0.22	-8.08	0.00	
Industrial sector 20	-0.53		0.63	-0.84	0.41	
Industrial sector 22	-1.25	***	0.25	-4.92	0.00	
Industrial sector 23	-1.71	***	0.28	-5.99	0.00	
Industrial sector 24	-1.76	***	0.24	-7.20	0.00	
Industrial sector 25	-1.76	***	0.24	-7.48	0.00	
Industrial sector 26	-1.60	***	0.09	-16.96	0.00	
Industrial sector 27	-1.43	***	0.20	-7.20	0.00	
Industrial sector 28	-1.71	***	0.20	-8.38	0.00	
Industrial sector 29	-1.73	***	0.19	-9.16	0.00	
Industrial sector 30	-0.62	**	0.31	-1.97	0.05	
Industrial sector 31	-1.57	***	0.28	-5.67	0.00	
Industrial sector 32	-1.87	***	0.26	-7.22	0.00	
Industrial sector 33	-2.75	***	0.79	-3.49	0.00	
R-squared	0.45				Adjusted R-squared	0.28
F (22, 73)	2.66	H0: coefficients equal to zero			p-value	0.00
Breusch-Pagan BP	534.99	H0: heteroscedasticity not present			p-value	0.00
Shapiro-Wilk W	0.66	H0: error is normally distributed			p-value	0.00
Durbin-Watson DW	2.09	H0: no autocorrelation in errors			p-value	0.61

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. Since the Breusch-Pagan test shows presence of heteroscedasticity, we used the heteroscedasticity-corrected White´s estimator for coefficients estimation, and only these are presented in the table.

Source: own processing of the data

We modify the previous model to study the particular form of the ownership – domestic, international, or foreign. Based on the results in table 29, domestic ownership, and the industrial sectors have the statistically significant impact on the innovation activity. The constant represents an average-sized, average-productive, internationally owned enterprise operating in the sector of food products manufacture (the reference enterprise). The average domestic-owned enterprise seems having on average even more innovation outputs than the reference enterprise, and this positive effect is statistically significant. The individual effects of industrial sectors are discussed and explained in previous section.

Table 29 White's HC OLS – Sales, own, LP, and industrial sector as determinants of IA

(standardised variables)	*Coefficient*		*Std. error*	*t-ratio*	*p-value*	*VIF*
Constant	1.27	***	0.21	6.15	0.00	-
Sales	-0.09		0.08	-1.11	0.27	1.24
Foreign ownership	0.36		0.34	1.06	0.29	1.16
Domestic ownership	0.71	*	0.43	1.67	0.10	
LP	0.47		0.31	1.54	0.13	1.34
Industrial sector 11	1.16	**	0.49	2.36	0.02	1.02
Industrial sector 14	-1.28	***	0.23	-5.45	0.00	
Industrial sector 15	-1.60	***	0.28	-5.63	0.00	
Industrial sector 16	-1.83	***	0.29	-6.26	0.00	
Industrial sector 17	-2.41	***	0.66	-3.68	0.00	
Industrial sector 18	-1.95	***	0.32	-6.10	0.00	
Industrial sector 20	-0.71		0.68	-1.04	0.30	
Industrial sector 22	-1.37	***	0.27	-5.11	0.00	
Industrial sector 23	-1.89	***	0.41	-4.55	0.00	
Industrial sector 24	-1.88	***	0.35	-5.32	0.00	
Industrial sector 25	-1.90	***	0.34	-5.62	0.00	
Industrial sector 26	-1.77	***	0.25	-6.99	0.00	
Industrial sector 27	-1.58	***	0.31	-5.04	0.00	
Industrial sector 28	-1.89	***	0.34	-5.53	0.00	
Industrial sector 29	-1.89	***	0.33	-5.81	0.00	
Industrial sector 30	-0.76	*	0.41	-1.86	0.07	
Industrial sector 31	-1.70	***	0.36	-4.77	0.00	
Industrial sector 32	-2.01	***	0.35	-5.69	0.00	
Industrial sector 33	-2.93	**	0.87	-3.37	0.00	

R-squared	0.46	Adjusted R-squared		0.28
F (23, 72)	2.64	H0: coefficients equal to zero	p-value	0.00
Breusch-Pagan BP	475.53	H0: heteroscedasticity not present	p-value	0.00
Shapiro-Wilk W	0.71	H0: error is normally distributed	p-value	0.00
Durbin-Watson DW	2.06	H0: no autocorrelation in errors	p-value	0.58

Note: The asterisks denote the statistical significance of coefficients on a level of 10% (*), 5% (**), and 1% (***), based on p-values. Since the Breusch-Pagan test shows presence of heteroscedasticity, we used the heteroscedasticity-corrected White´s estimator for coefficients estimation, and only these are presented in the table.

Source: own processing of the data

So far, we proved that the foreign direct investments have negative effect on the innovation activity, while the domestic ownership caused increase of the innovation activity in enterprises. In addition, international ownership of an enterprise is an important determinant of the innovation activity, suggesting that the mixed ownership may be the most beneficial in terms of enterprises' innovation activity. We also discussed other determinants of the dependent variable.

4.4 The enterprises' performance analysis

In this section, we would like to analyse the performance of the innovation enterprises. As stated in the theoretical part of our dissertational thesis, the performance of an enterprise can be measured from various points of view. We used the profitability and the productivity as the variables describing the performance of enterprises.

Firstly, we examine, whether there is a statistically significant difference between enterprises with innovations and enterprises with no innovation outputs at all. We used the simple matching technique, and to each enterprise with innovation output we assign an enterprise with no innovation output from the same industrial sector, with the same type of ownership, and the approximately same number of employees. Hence, we obtain the group of enterprises with innovation output and the group of enterprises with no innovation output, where both groups contains very similar sample enterprises in terms of their firm characteristics.

The table 30 presents the comparison of performance variables' means of these two groups of enterprises with use of a Welch t-tests.

Table 30 Welch t-tests - ROS, ROE, ROA, LP

ROS		
Welch t-test statistic	- 1.51 (0.14)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -0.63	Upper = 0.09
Means of samples:	ROS in IE = 0.03	ROS in NE = 0.30
ROE		
Welch t-test statistic	- 2.14 ** (0.03)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -2.15	Upper = -0.08
Means of samples:	ROE in IE = - 0.22	ROE in NE = 0.90
ROA		
Welch t-test statistic	- 1.50 (0.14)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -1.00	Upper = 0.14
Means of samples:	ROA in IE = 0.04	ROA in NE = 0.47
Labour productivity		
Welch t-test statistic	0.03 (0.98)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -13.30	Upper = 13.68
Means of samples:	LP in IE = 37.72	LP in NE = 37.53

Note: the value in the parenthesis is the p-value of the Welch t-test, and based on the p-value, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

Based on the results, only in case of the return on equity there is a statistically significant difference between average values of this variable between the group of innovation enterprises (IE) and enterprises with no innovation outputs (NE). It means that these two groups differs from each other in terms of how high profit an enterprise can create on one EUR of its equity. The innovation enterprises have on average the loss of 22 cents on one euro of equity, while the other enterprises have on average 90 cents of profit on one euro of equity.

In case of the return on sales, the average return is on a level of 3% in the innovation enterprises, while the average return is 30% in the enterprises with no innovation outputs, but these difference are not truly statistically significant. Hence, the innovation output, measured as the number of registered intellectual property protections, is not significant determinant of the profit amount created on one EUR of sales. The same holds for the return on assets, where the innovation enterprises can create on average four cent of profit on one euro of assets, while the other group creates on average 47 cents of profit on one euro of assets. Similarly, the difference is neither statistically significant in case of labour productivity, where the both group of enterprises have on average almost 38 EUR value added per employee.

However, this analysis compared two groups of enterprises. In the next analysis, we compare the performance of the same sample of enterprises before and after they register for the intellectual property protection (patent, trademark, utility model, design), in order to study a performance change.

We expect the performance measures to be better after the innovation was registered, because we suppose that the motivation behind the innovation activity of an enterprise is to improve its performance. The performance improvement due to innovation activity we call innovation premia.

Table 31 Welch t-tests – Sales, Assets, Equity, Profit, ROS, ROA, ROE

Sales		
Welch t-test statistic	0.106 (0.917)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -1 170 003	Upper = 1 297 406
Means of samples:	Sales before I = 449 552.40	Sales after I = 513 254.20
Sales innovation premia	63 701.80	
Assets		
Welch t-test statistic	0.100 (0.921)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -382 121.60	Upper = 421 667.80
Means of samples:	Assets before I = 176 433.10	Assets after I =196 206.20
Assets innovation premia	19 773.10	
Equity		
Welch t-test statistic	0.075 (0.941)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -221 553.20	Upper = 238 349.00
Means of samples:	Equity before I = 96 092.82	Equity after I = 104 490.67
Equity innovation premia	8 397.85	
Profit		
Welch t-test statistic	0.190 (0.851)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -31 932.28	Upper = 38 464.45
Means of samples:	Profit before I = 13 249.29	Profit after I = 16 515.38
Profit innovation premia	3 266.09	
ROS		
Welch t-test statistic	-0.981 (0.342)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -3.37	Upper = 1.24
Means of samples:	ROS before I = 1.13	ROS after I = 0.07
ROS innovation premia	-1.06	

ROE		
Welch t-test statistic	0.409 (0.686)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -0.11	Upper = 0.16
Means of samples:	ROE before I = 0.15	ROE after I = 0.18
ROE innovation premia	0.03	
ROA		
Welch t-test statistic	0.179 (0.859)	H0: difference in means equals to 0
99 percent confidence interval:	Lower = -0.08	Upper = 0.09
Means of samples:	ROA before I = 0.077	ROA after I = 0.084
ROA innovation premia	0.007	

Note: the value in the parenthesis is the p-value of the Welch t-test, and based on the p-value, the asterisks denote the statistical significance on a level of 10% (*), 5% (**), or 1% (***).

Source: own processing of the data

In table 31 we present the results of the Welch t-test comparing the means of particular performance variable in the sample of enterprise before and after the innovation output is registered. All the results show that there is not statistically significant difference between the performance before and after the innovation registration. In case of the return on sales, we find even a decrease of the performance, since the innovation premia of ROS has negative value.

Hence, these results suggest that the motivation of an enterprise for innovation output registration is different from the performance improvement. The enterprises probably register their innovation outputs, in order to protect their unique or new inventions and ideas from “stealing” by the competition, which grants them the competitive advantage on the market. However, they do not expect the directly attributable performance improvement due to innovation protection, but rather they expect costs savings (in case of new technologies and processes), new customers (in case of new products or marketing innovations), increase of effectiveness (in case of organisational innovations), etc. In this performance analysis we are not able to confirm our previous hypothesis that the innovation activity increases the performance of an enterprise.

5 The discussion

In this section, we compare the results of our research with the empirical results of other authors reviewed in the section *1 The state of the issue in the domestic and foreign research*. The main focus of this dissertation thesis is on the relationship between innovation activity and the FDI flows. We analysed the innovation input, as well as innovation output variables in context of the FDI inflow and outflow on all three levels – macroeconomic, industrial, and microeconomic.

For better clarity of all statistically significant results of the research, we present them in table 32 with the results summary.

Table 32 The summary of results

Variable	**BERD**	**RDE**	**IO**	**No. of IA**	**Share of IA**
FDIin	-		-		-
FDIout	+	+	-	+	
BERD			+		
RDE			-	-	
GERD	+				
IR			+		
LP			-		
Sales					+

Note: The sign + denotes statistically significant positive effect, while the sign – denotes statistically significant negative impact.

Source: own processing of the data

5.1 The effect of FDI on the innovation activity

The first dependent variable, which we used in our research, was the expenditures on R&D spent by business enterprises. We found negative effect of the FDI inflow on the R&D expenditures on the macroeconomic level. Similarly, Girma (2008) stated that multinationals generally perform their innovation activity in the headquarters, hence the inflow of foreign capital into an enterprise may reduce innovation activity.

On the industrial level, the effect of the FDI inflow on the expenditures on R&D was positive, but very small and not statistically significant. Similarly, a number of authors found in their researches positive, or neutral, and not statistically significant impact of the FDI inflow (Dachs, 2009; Qu, 2013).

On the other hand, the FDI outflow had positive and statistically significant effect on the expenditures on R&D spent by business enterprises on the macroeconomic level. In addition, the FDI outflow had statistically significant, positive, but relatively small impact on the expenditures on R&D in the industrial level analysis. We can explain these findings with several facts. The enterprises, which are investing abroad, (1) have the opportunity to learn from foreign enterprises, and then invest to R&D activities in their home country, (2) perceive the advanced competition on the foreign market, and invest to R&D activities in an effort to cope with it, (3) have a need to develop new products, or marketing methods, in order to be able to compete on the foreign market, and therefore, invest to R&D activities. According to our knowledge, there are no studies analysing the relationship between the FDI outflow and the expenditures on the R&D activities in the recent literature, hence we cannot compare our results with other countries.

However, there was a research on the FDI outflow and the innovation output variables. On the macroeconomic level, we found negative, statistically significant effect of the FDI outflow on the number of innovation outputs (patent and trademark applications), and their relationship may be described with the inverted U-shaped curve. On the industrial level, the FDI outflow showed again negative, but not significant impact on the share of the innovation enterprises on the total number of enterprises. We can explain this negative effects with possible outflow of the innovation outputs together with the capital outflow in form of FDI.

On the contrary, the impact on the number of enterprises with innovation activity in a particular industrial sector was positive, and statistically significant. Zhang (2014) found in his research in China a significant effect of FDI outflow on innovation, and stated that the enterprises in the most developed regions tend to involve in higher value-added production, which relies on foreign knowledge and technology. Hence, when an enterprise establish a subsidiary abroad, this enterprise has better geographic proximity to the initial innovators abroad, and consequently it gains from technology diffusion in its home country. Boermans (2013) mentioned in his study of transition economies, that the FDI outflow positively affects the patent applications, and that there may be some learning opportunities from the activities abroad, which help to develop more patents. However, we were not able to fully confirm these suggestions in our research. We can only claim that with rising FDI outflow from a particular industrial sector, the number of the enterprises with innovation activity increases. One explanation may be the knowledge of the enterprises from abroad activities, as suggested by Boermans (2013).

The second dependent variable, which we used in our research as measurement for the innovation input, was the number of R&D personnel. In our research, we found the negative, but statistically not significant effect of the FDI inflow on the number of R&D personnel. This finding is partially in line with finding of Zemplinerová (2010), who showed that negative relation between foreign ownership of the enterprises in the Czech Republic and the number of R&D employees. She claimed that foreign enterprises have less R&D employees in comparison to domestic ones. In case of the FDI outflow, the effect of this variable on the R&D personnel on the industrial level was positive and highly statistically significant determinant. This means that the enterprises investing abroad, employ more R&D workers in the home country. This positive influence can be due to learning of the enterprises from the entrepreneurs on the foreign markets, where they invest, and subsequently, implementing the knowledge in the home country, for example, in form of reverse engineering (decomposing the products, in order to recognise the essential parts and functions of it), which is performed by R&D personnel. Cheung (2004) mentioned reverse engineering as one of the channels, through which foreign enterprises can influence the innovation activity.

The third dependent variable in our research was the innovation output. We found a positive, but not statistically significant effect of the FDI inflow on the innovation output on the macroeconomic level. Similarly, Dachs (2009) found not significant impact of foreign ownership on the innovation outcome, as well as Qu (2013) showed positive but not statistically significant impact of FDI inflow on innovations.

However, in our research on the firm level, the foreign ownership, as the measurement of the FDI inflow to an enterprise, had negative and statistically significant effect on the number of the innovation output, while the domestic ownership increased the number of innovation output in the enterprise. Zulkhibri (2015) found that FDI shows a negative and statistically significant effect on the number of industrial design applications. He stated that the negative effect of the FDI suggests that FDI does not associate with more industrial design innovation. One explanation, which he gives, is that the domestic-owned firms are the ones, who apply for industrial designs, in contrast with the foreign-owned firms. In such cases, it is expected that FDI do not show any significant impact on industrial designs. When we distinguished domestic-, foreign-, and internationally-owned enterprises, our research showed that wholly foreign ownership reduced the number of innovation output (but the results was not statistically significant), while domestic and international ownership increased this number, and the effect of international ownership was statistically significant.

Hence, our results are very similar to those by Zulkhibri (2015). The difference is that we studied not only industrial designs, but the patents, trademarks, and utility models, as well. In addition, according to Zemplinerová (2012) the foreign ownership of enterprises in conditions of the Czech Republic decreased the innovations in enterprises due to direct transfer of knowledge and technology from the parent country, since the R&D activities are in the multinational companies centralized in headquarters. This is in line with our findings.

In our research on the industrial level, we found negative effect of the FDI inflow on the number of the enterprises with the innovation activity and their share on the total number of the enterprises. This finding can be again explained by relocation of the innovation activities to the parent countries of the foreign investors, as stated by Zemplinerová (2012).

5.2 The other determinants of the innovation activity

In addition to the FDI inflow and outflow, we analysed in our dissertation thesis other determinants of the innovation activity input and output variables. Firstly, we should address the question that the innovation output itself can be influenced by the innovation input variables, as shown in research by Stiebale (2011).

On the macroeconomic level, we studied the effect of the R&D expenditures on the innovation output. We found the positive, statistically significant effect of the R&D expenditures on the number of patent and trademark applications. These results are in line with results of Bound (2007), who showed in his research of the manufacturing U.S. sector that the R&D expenditures has positive impact on the number of patents. He stated that the patents are a good indicator of the innovation output of the R&D departments in enterprises.

We also found negative, and statistically significant effect of the R&D personnel, as the other innovation input variable, on the innovation output on the macroeconomic level, as well as on the number of the innovation enterprises on the industrial level. We may explain these findings with high costs of the innovation outputs protection – the enterprise investing into R&D personnel, which generally can be expensive, may not have enough financial resources for registering the patents or trademarks for protecting their innovation outputs.

On the industrial level, we found negative, but not statistically significant effect of the R&D expenditures on the number of the innovation enterprises in a particular industrial sector, as well as on their share on the total number of enterprises in the sector. Our findings contradict the results of the research by Piekut (2013), who showed positive correlation between the number of innovative firms and R&D expenditures. In her research, a large number of selected countries of the world were analysed, and she showed that the Slovak

Republic belongs to the group with relatively disadvantageous situation in respect of R&D and the innovative activity of business enterprises. She also pointed out the diverse situations among the countries. We can explain the negative effect of the R&D expenditures on the number and share of innovation enterprises on the total enterprises with fact that the both variables were measured in the same period (it was similarly done e.g. by Stiebale, 2011). Hence, when an enterprise spends a large amount of capital on the R&D, in order to develop a new product, process, or non-technological innovation, this enterprise does not belong to category of the enterprises with innovation activity. After the activities of R&D end, and the enterprise introduces some kind of innovation, the number of innovation enterprises and their share on the total enterprises in the industrial sector increases, while at the same time the R&D expenditures decrease due to successfully finished R&D activities. Thus, the relationship between these two variables is negative.

Moreover, we found positive, and statistically significant impact of the R&D expenditures from state sources on the R&D expenditures spent by enterprises. We can explain this positive relationship with a cooperation of the enterprises with the government, as well as a support from government for the enterprises. Zulkhibri (2015) distinguished the stages of R&D activities by government, and stated that the firs stage is the government and university basic research, then the second and third stages of R&D are the applied and development research, in which government cooperate with the business enterprises. The author also argued that in developing countries a big part of R&D expenditures are conducted by the government, and hence a significant relationship between businesses and the governmental R&D activities can be observed. Similarly in our country, we can observe the positive influence of the government on the R&D expenditures of the enterprises.

Additionally, we analysed other possible determinants of the innovation activity of the enterprises in our research. Now we discuss our results with the existing empirical researches by other authors.

We found positive, but not significant effect of the variable sales on the R&D personnel, while the effect of this variable on the R&D expenditures was negative, and statistically significant in our industrial level analysis. This finding contradicts the results by Lee (2012), who found that sales accelerates the investments into the R&D activities in Korea. However, Korea (and Asian countries in general) is perceived as more advanced and inventive in industrial research and development. The market conditions in the Slovak Republic are different. We can explain our finding with the certainty of the large enterprises of their market position. The large enterprises with high volume of sales may perceive no need for research or development in comparison to small enterprises, which need to attract customers with a new products or processes.

Although, we found that the high volume of sales, as the measurement of a firm size, in the particular industrial sector positively influenced the number of innovation enterprises, and significantly positively influenced the share of these enterprises on the total number of enterprises in the sector. Furthermore, in our research on the firm level, we found positive and non-linear relationship between the innovation output and the firm size, measured as the number of the employees, but the results were not statistically significant. Similarly, in the research by Zemplinerová (2012) in Czech enterprises, she showed that the probability that an enterprise decides to innovate is increasing with its size, and that the bigger enterprises invest higher amounts of money to innovation. These results she explained by advantages of large enterprises, as compared to the small ones, in financing R&D activities, possibility to diversify risks, as well as scale economies in R&D. In her other research, Zemplinerová (2010) suggested that the relationship between the firm size and the R&D of enterprises can be non-linear, which corresponds with our results. We confirmed also the results of a study by Scherer (2007), who found that number of patents in an enterprise increases with the firm size up to a certain point, and then the number either decreases or the relationship does not exist anymore. Our results are in line also with the results by Mishra (2007), who studied the R&D activities in Indian firms. He reported the coefficients of size and size squared term as highly significant, and the effect of the squared term was negative. Thus he showed a non-linear relationship, which implies that the positive relationship between the R&D and the firm size holds only up to a certain threshold, and starts decreasing afterwards.

Then on the microeconomic level, we found negative, but not statistically significant impact of age on the innovation activity of an enterprise. This finding is in contrast with finding by Mishra (2007), who found that the firm age had a significant positive impact on R&D activities. He considered the variable age as a proxy for accumulated learning in an enterprise, and stated that an older enterprise has more experienced scientists and better equipped laboratories compared to a new enterprise. However, our results suggest the opposite, and we can argue that the newly-established enterprises can employ specialists, as well as young scientists with new ideas, and they can benefit from the cooperation of these two groups of employees in context of new innovations. While the older enterprises use the long established processes and practise, which may hamper the innovation ideas in the enterprise.

In case of the variable the return on sales, in our firm level analysis we found not significant, but positive effect of this variable on the number of innovation outputs of the enterprise. In our previously published research, we found the opposite effect of this variable on the R&D expenditures (Kubíková, 2015). The negative effect of return on sales on the expenditures on R&D means that enterprises with high financial performance are not interested in investing into R&D activities, because they consider their position on the market to be strong, and rather allocate their investments into maintaining this market position, than into research and development activities. However, in case of the innovation output, even the well-performing enterprises consider it important to introduce innovations, and they also have more financial sources to do so. On the other hand, our industry level analysis did not prove the significance of the variable ROS on the number, or share of the innovation enterprises on the total number of enterprises.

Next financial variable, which we analysed as the potential determinant of the innovation activity, was the debt ratio. We found negative, but not statistically significant impact of the debt ratio on the enterprise´s innovation activity. This finding is in line with the results of the research by Cumming (2000) in Canadian enterprises, who stated that the enterprises with greater debt-equity ratios are more financially constrained, and therefore spend relatively less on R&D activities. The same holds for the innovation activity, as we have shown in our research. The enterprises, which have the greater debt coverage of their assets, perform less innovation activity. Due to bigger indebtedness, they are not able to borrow more money, which they need for patent, trademark, design, or utility model registration.

In case of variable market share on the firm level, we found negative, but not statistically significant effect of this variable on the innovation activity of an enterprise. On the contrary, Mishra (2007) showed significant and positive effect of the market share, indicating that an enterprise with a larger market share more likely engages in R&D activity. The difference between our research and the research by Mishra (2007) is that he analysed the impact of market share on the R&D activities, while we analysed the innovation activities. Hence, it can be true that larger enterprises, which are the market leaders, have more sources for R&D activities (as found by Mishra (2007)), and at the same time, the enterprises with smaller market shares introduce more innovations, in order to gain better position on the market, as we found in our research.

In our research, we found that the industrial sector in general is the statistically significant determinant on both the innovation input and innovation output variables. Our results are in line with the findings by e.g. Brzozowski (2008), Bound (2007), Čaplánová (2012), Girma (2008), or Schmiele (2012). The significance and the sign of the effect on the innovation activity of the enterprises depends on the particular industrial sector. Our findings are similar to the results by Bound (2007), who found that the industrial sector of motor vehicles, computers, electrical equipment, petroleum and chemicals have the highest number of patents per firm. We found that the highest number of innovation output in firm had the petroleum and coke products manufacture. In the analysis on the industrial level, we showed that the highest share of the innovation enterprises is in the motor vehicle manufacture, in which operates the enterprises spending the most on the R&D activities, followed by the manufacture of transport equipment, and the manufacture of computer, electronic, and optical products. As one of the explanations, Bound (2007) mentioned that the enterprises operating in these sectors are bigger in comparison with the enterprises in other sectors, hence they may have more financial sources on innovation activities. On the other hand, Brzozowski (2008) showed in his research of Polish enterprises that enterprises operating in wearing apparel spent nothing on R&D activities. Similarly, in our research we found that the sector of wearing apparel manufacture spend the least on the R&D in comparison with other sectors. We can explain these differences in the industrial sectors with the various characteristics of the manufactured products, and different competitive environment on the market of these products.

5.3 The enterprises' performance results

On the industrial level, we performed the t-tests for comparison of means between the group of the enterprises with the innovation activity and the group of the enterprises without any innovation activity, and we examined two variables – the volume of sales of the enterprises, and the number of employees. Our research showed that the enterprises with innovation activity truly employ more workers and gain greater volume of sales, and the difference between these enterprises and those with no innovation activity was statistically significant. Our findings are in line with the results by Zemplinerová (2012), who studied the Czech enterprises. She claimed that innovating enterprises are significantly bigger in terms of employment.

On the firm level, we performed the similar t-tests for comparison of means of the variables describing the performance of the enterprise, namely the return on sales, the return on equity, the return on assets, and the labour productivity. These variables were suggested by Pitra (2006) for measuring the effects of the innovation activity on the enterprises' performance. Our results showed that only in case of the return on equity there was a statistically significant difference in performance between the group of enterprises with the innovation activity, and the group of enterprises without the innovations.

Moreover, we compared the performance of the same enterprises before and after they register their innovation. We found that there was not statistically significant difference between the performance before and after the innovation registration. This finding is in line with the statement by Zemplinerová (2012), who stated that innovating firms are more productive on average both before and after introduction of innovation.

5.4 The limitations of the thesis and the recommendation for the future research

In this section, we elaborate the limitations of our research, which we are aware of, and we suggest the recommendations for further research.

First, our research is limited by availability of data. On the macroeconomic and industrial level we used the databases by Eurostat and the SOSR, as described in the section *3.1 The characteristic of the research object and the datasets structures.* In this databases, the data about innovation activity are measured in two years intervals, and are not available for all industrial sectors. On the microeconomic level, we used the data from Finstat, where the financial data are available from the year 2010.

In addition, we were not able to obtain the data about the individually spent expenditures on the R&D activity, or the innovation activity represented by product, process, marketing or organisational innovation. We measured the innovation activity on the microeconomic level only with the number of patent, trademarks, designs, or utility models registered within the Industrial Property Office, or the European Patent Office by an enterprise. One could argue that the innovation process of the enterprise can be finished and successfully introduced on the market even without the registration of the innovation output in form of an industrial property protection. However, these data may be obtained through the survey or individual interview with the firm management, which we were not able to undertake due to large sample size and time and financial constrain of our research.

Second, we aimed our research on the industrial enterprises. On the industrial level, we used the data about the manufacturing sector with codes 10 – 33 based on the NACE Rev. 2 classification of economic activities. On the microeconomic level, only the large enterprises with at least 250 employees from the manufacturing sector were examined. Our motivation to analyse the manufacturing sector is that this sector represents a significant part of the Slovak economy. However, it would be interesting to analyse the innovation activity in the other sectors, for example in the service providing sector, where we can find different results. This can be a suggestion for the future research.

Third, we observed the determinants and the innovation activity in the same time period. It is possible that the innovation activity is influenced by some determinants not directly, and the impact can be observed only after longer time. However, we suppose that the impact of selected determinants in our research shows immediately, and we did not use the time lagged variables. Similarly, Stiebale (2011) in his research states that the most researches on the innovation output consider that the determinants influence the output in quite a short time horizon, and therefore, they are conducted in the current year.

Moreover, we targeted our research on the simple variables describing the innovation activity – the expenditures on the R&D, the R&D personnel, and the number of patents, trademarks, utility models, and designs. The suggestion for the future research can be to analyse the composite variables, as well. For example, Brzozowski (2008) used the variables innovation intensity and the R&D intensity. We did not obtain the data needed for the construction of these variables, however, it would be interesting to calculate them and conduct another research with use of these variables.

Another recommendation for the future research is to distinguish between technological and non-technological innovation. The impact of the determinants might be different, when only the non-technological innovations would be considered. Also the innovation output, which we analysed in the microeconomic analysis, could be divided into patents, trademarks, designs, and utility models, and analysed separately. The motivation for division of these innovation output in a future research can be the fact that these forms require different volume of capital, for example patents are generally more expensive than utility models. For example, Zulkhibri (2015) examined in his research the trademarks, patents, and industrial designs separately.

In addition, our recommendation for the future research is to expand the FDI flows variable. The FDI can be in a form of mergers and acquisitions, joint ventures, or greenfield and brownfield investments. It would be interesting to analyse if the particular form of the FDI influence the innovation activity of the enterprises in the Slovak Republic. For example, Stiebale (2011) examined the impact of the mergers and acquisitions on innovation in German enterprises. Moreover, due to non-availability of the data, we did not analyse the impact of the FDI outflow on the innovation activity on the microeconomic level. We can expand our research with this analysis in the future.

5.5 The benefits of the dissertation thesis

In this chapter, we briefly summarize the benefits of this dissertation thesis. First, we proved the existence of the relationship between the foreign direct investment flows and the enterprises' innovation activity. We found that the FDI inflow influence the innovation activity negatively in case of both the innovation input, and the innovation output. The FDI outflow had positive impact on the innovation input, while the impact on the innovation output was negative.

Second, we analysed the FDI from both perspectives – the inflow and the outflow. Based on the studied literature, most of the authors devoted their research to the analysis of the FDI inflow and its effects on the innovation. However, there is only a limited number of researches about the FDI outflow and its effects on the innovation activity. In the dissertation thesis, we studied the FDI outflow as the possible determinant of the innovation activity. Thus, we enrich the existing literature with new findings.

Third, we distinguished among macroeconomic, industrial, and microeconomic level of the research. Many of the researches are performed only on one level, however, there is a lack of researches with a more complex point of view. We attempted to remove this scarcity, and take all levels into account in the research.

Fourth, we enrich the literature concerning the post-transition economies. In the Slovak Republic, as one of the countries, which has recently overcome the transition process, there was a very limited number of researches on the innovation and its determinants. The post-transition countries may differ from the well-developed and the developing countries, and they represent the intermediate level between these two development stages. Hence, the research of the post-transition countries can complete the knowledge about the innovation and its determinants.

The conclusion

In the dissertation thesis on the topic "*Enterprises' innovation activity in context of foreign direct investments*" we analysed the relationship between the innovation activity and the FDI flows on macroeconomic, industrial, and microeconomic level. The main objective of the thesis was to identify the existence and the magnitude of this relationship, and the fulfilment of the main objective was supported with four sub-objectives.

We fulfilled the first sub-objective by defining the terms FDI and the innovation activity in the theoretic part of this thesis, and by selecting several variables for measuring of these terms, as was described in the methodological part of our thesis. Then we introduced possible determinants of the innovation activity based on the existing literature, and we selected the ones for our research, as also described in the methodological part, which led to fulfilment of the second sub-objective.

The third sub-objective we fulfilled in the analytical part of our thesis. On the macroeconomic level we found negative impact of the FDI inflow on the R&D expenditures spent by enterprises, meaning that the foreign investors may relocate the R&D activities into their parent or other host countries. In case of the innovation output the FDI inflow positively, but not statistically significantly influenced the number of patent and trademark applications in a country.

On the microeconomic level, we found that the FDI inflow to an enterprise, represented by foreign ownership, reduced its number of the innovation output. However, it depends on the type of the firm ownership. We found that the mixed ownership positively influence the innovation output – the enterprise benefits from the presence of the foreign investor, because he brings new knowledge into the enterprise, while the wholly foreign ownership reduces the innovation output – the foreign investor relocates the R&D activities and drains all the innovation from the enterprise into his parent country, after he took over the ownership of the enterprise.

In case of the FDI outflow, we found on the macroeconomic level that it has positive impact on the R&D expenditures. Hence, the enterprises investing abroad perform R&D activities with intention to compete on the foreign markets with developed products or processes, and the increasing tendency suggests that the country may evolve, based on the FDI development path. On the industrial level, we confirmed the positive effect of the FDI outflow on the R&D expenditures.

On the other hand, the FDI outflow negatively impacts the innovation output, and the relationship can be described with inverted U-shaped curve. The number of innovation output increases with increase of the FDI outflow up to a certain level, and then starts to decrease again, which we also can explain with the FDI development path of the country. Initially, the FDI outflow rises slowly and the enterprises relocate mostly production to the host countries, but the innovation activity remains in the home country. At certain volume of the FDI outflow, the better-evolved enterprises may relocate also the innovation activities to the host countries, and consequently, the innovation output in the home country may decrease.

The fourth sub-objective we fulfilled in our enterprises' performance analysis. Based on the results, we were not able to confirm our hypothesis that the enterprises' innovation activity leads to increase of its performance. It means that the performance improvement is not the motivation behind the innovation activity of the enterprise, and it expect rather different benefits, such as cost savings, increased demand, effectiveness improvement, etc.

We compared our results with existing researchers from other author in the chapter *5 The discussion.* Our results are in line with findings of researches conducted in the Czech Republic, which also belongs to the group of the Eastern and Central European countries. However, these finding are similar also to the research conducted in China or the developing countries. We may suggest that it shows the similarity of our country with the developing countries in terms of the innovativeness, because the Slovak Republic overcame the transition process only recently.

Resumé

V dizertačnej práci na tému „*Inovačná aktivita podnikov v kontexte priamych zahraničných investícií*" sa venujeme skúmaniu vzťahu medzi inovačnou aktivitou podnikov a tokmi priamych zahraničných investícií (ďalej len PZI). Hlavným cieľom práce je identifikácia existencie a sily tohto vzťahu v podmienkach Slovenskej republiky. Naplnenie hlavného cieľa je podporené štyrmi čiastkovými cieľmi.

Prvým čiastkovým cieľom je definovať pojmy toky PZI a inovačná aktivita a zvoliť vhodné metódy na meranie týchto pojmov. Druhý čiastkový cieľ sa venuje návrhu, charakteristike a výberu možných determinantov podnikovej inovačnej aktivity. následne v treťom čiastkovom cieli sa venujeme určeniu vplyvu vybraných determinantov na inovačnú aktivitu na makroekonomickej, odvetvovej aj mikroekonomickej úrovni. Na mikroekonomickej úrovni ďalej skúmame aj vzťah medzi inovačnou aktivitou podniku a jeho výkonnosťou na vzorke vybraných podnikov, čo je obsahom štvrtého čiastkového cieľa.

Pojem inovácia zahŕňa podľa Schumpetera (2003) predstavenie nového alebo zlepšeného produktu alebo produkčnej metódy, vstup podniku na nové trhy, využívanie nových surovín, materiálov, energií, alebo vytvorenie novej organizácie produkcie. Na Slovensku je inovácia definovaná v zákone č. 172/2005 Z. z., ktorý pridáva k Schumpeterovej definícií aj transfer vedeckých a technických výtvorov do praxe, obstaranie know-how a licencií, predstavenie nových metód v predvýrobnej fáze, zlepšenie kontrolných a testovacích metód, zvýšenie kvality a bezpečnosti pri práci, zníženie negatívneho dopadu na životné prostredie a tiež účinnejšie využívanie prírodných zdrojov a energie (Zákon č. 172/2005 Z.z., Čl. I., § 2, ods. 5).

OECD (2005) považuje za inovačnú aktivitu všetky vedecké, technologické, organizačné, finančné a komerčné činnosti, ktoré vedú k implementácií inovácie. Niektoré tieto činnosti môžu byť inovačné samy o sebe, niektoré nemusia byť novátorské, ale sú nevyhnutné pre podporu implementácie inovácie. Inovačné aktivity zahŕňajú tiež výskum a vývoj, ktorý je priamo priraditeľný k inovácií.

Výskum a vývoj je definovaný ako kreatívna práca vykonávaná systematicky za účelom zvýšenia vedomostí človeka, kultúry a spoločnosti, a tiež využitie týchto vedomostí na kreatívne nové použitia OECD (2002).

Štatistický úrad SR (2010) definuje inovačnú aktivitu ako produktovú inováciu, inováciu procesu, tiež ich priebeh v podniku, ďalej aj organizačnú a marketingovú inováciu.

Produktovú a procesnú inováciu zaraďujeme medzi technologické inovácie, zatiaľ čo organizačnú a marketingovú medzi netechnologické inovácie. Podniky s inovačnou aktivitou sú podľa Štatistického úradu SR (2010) tie, ktoré spomínané inovácie vykonali alebo vykonávajú. Podľa OECD (2005) je dôležité pre podniky, aby vedeli chrániť svoje inovácie. Je niekoľko možností na ochranu inovácií: formálna právna ochrana prostredníctvom patentov, úžitkových vzorov, dizajnov, ochranných známok, autorských práv, dohodách o mlčanlivosti a obchodného tajomstva; a neformálna ochrana prostredníctvom ochrany tajomstva zmluvami a dohodami, formou komplexnosti dizajnu produktu, a tiež ochrana vďaka časovému náskoku pred konkurenciou.

Autori uvádzajú niekoľko možností na meranie inovačnej aktivity podnikov. Z makroekonomického hľadiska Európska komisia (2007) publikuje tabuľku hodnotenia inovácií v krajinách, kde prideľuje na základe komplexu ukazovateľov rating krajinám. Podobne Cornell University, INSEAD, a Svetová organizácia duševného vlastníctva (WIPO) (2015) spoločne publikujú globálny inovačný index krajín, kde vyhodnocuje inovačné vstupy a výstupy.

Na druhej strane z podnikového hľadiska sa za ukazovateľ inovačnej aktivity považujú napríklad výdavky na výskum a vývoj a počet zamestnancov výskumu a vývoja, ktoré predstavujú inovačné vstupy do podniku (Zemplinerová, 2012; Mishra, 2007). Inovačné výstupy sa dajú v podniku merať na základe počtu patentov, ochranných známok a dizajnov, alebo na základe podielu tržieb z inovácií na celkovom príjme podniku (Mishra, 2007; Ghazal, 2015). Brzozowski (2008) tiež uvádza intenzitu výskumu a vývoja a intenzitu inovácií ako ukazovatele inovačnej aktivity.

V dizertačnej práci meriame inovačnú aktivitu pomocou ukazovateľov, ktoré sú navrhnuté v súlade so spomínanými výskumami horeuvedených autorov. Na makroekonomickej a odvetvovej úrovni používame ukazovatele inovačných vstupov – výdavky na výskum a vývoj z podnikových zdrojov, výdavky na inovácie, počet osôb pracujúcich na výskume a vývoji. Ako ukazovatele inovačného výstupu využívame počet patentov a ochranných známok v krajine na makroekonomickej úrovni. Na odvetvovej úrovni využívame počet podnikov s inovačnou aktivitou, tak ako je definovaná podľa štatistického úradu SR, a tiež podiel týchto podnikov na celkovom počte podnikov v danom odvetvovom sektore. Na podnikovej úrovni meriame inovačný výstup prostredníctvom počtu patentov, ochranných známok, dizajnov a úžitkových vzorov daného podniku.

Pojem PZI je definovaný viacerými spôsobmi. Medzinárodný menový fond (1993) uvádza, že PZI predstavujú získanie trvalého podielu v podniku operujúceho mimo ekonomiku investora s cieľom získať hlasovacie práva vo vedení podniku. Gunter (2007) definuje PZI ako investície za účelom získania trvalého manažérskeho podielu v podniku, ktorý spravidla presahuje desať percent hlasovacích práv. Baláž (2010) dodáva, že PZI sú investície založené na dlhodobom vzťahu, ktoré odrážajú trvalý záujem investora o kontrolu podniku v inej krajine.

Sumarizáciu definícií pojmu PZI prináša napríklad Bobenič Hintošová (2010), ktorá považuje za PZI tie investície, ktoré zabezpečia investorovi dlhodobú účasť na riadení a kontrole podniku v zahraničí prostredníctvom podielov v minimálnej výške 10 percent hlasovacích práv, akcií, či majetkových podielov daného podniku.

Baláž (2010) uvádza tri formy PZI:

- prvotné zapojenie sa zahraničného investora do riadenia podniku, ktoré zahŕňa majetkový podiel, akcie a vlastnícke práva, sa nazýva majetkový kapitál;
- ďalšie fondy, dlhové zabezpečenie a dodávateľské pôžičky medzi investorom a zahraničnými afiliáciami sú vo forme ostatného kapitálu;
- a nakoniec môže investor reinvestovať svoj podiel na zisku do vybavenia, budov, alebo zariadenia podniku, čo spadá do formy PZI prostredníctvom reinvestovaného zisku.

Baláž (2010) ďalej rozlišuje tri typy PZI na základe vzťahu medzi materským podnikom a jeho afiliáciami: horizontálne, vertikálne a konglomerátne PZI. Na základe motivácie investora pri PZI môžeme hovoriť o investoroch vyhľadávajúcich nové trhy, zdroje, nákladové úspory, alebo investoroch, ktorí vyhľadávajú strategické výhody. (Birsan, 2009; Zheng, 2009). Tieto motivačné modely PZI rozpracoval medzi prvými autor Dunning.

Podľa Stiglitza (2007) sú PZI všeobecne pozitívne vnímané, pretože prinášajú do krajín nie len kapitál, ale aj prístup k zahraničným trhom, technológiám a ľudskému kapitálu. Epstein (2011) uvádza niekoľko pozitív PZI na hostiteľskú krajinu, napríklad, že PZI sú stabilným zdrojom financovania, vytvárajú zamestnanecké príležitosti, zvyšujú produktivitu, ale na druhej strane tento autor hovorí aj o negatívach, akými je asymetria pri alokácií PZI, daňová a politická konkurencia krajín a najmä koncentrácia kapitálu do relatívne malého počtu veľkých podnikov.

Vplyv PZI na inovačnú aktivitu podnikov bol skúmaný v mnohých výskumoch, pričom výsledky sa od seba odlišujú. Veľa štúdií uvádza pozitívny vplyv PZI na inovácie a výskum a vývoj (Cheung, 2004; Zulkhibri, 2015; Lee, 2012; Bertrand, 2009, Boermans,

2013) a tiež často uvádzajú tzv. spillover efekt (Čaplánová, 2012, Cheung, 2004). Spillover efekt sa prejavuje tým, že sa domáce podniky hostiteľskej krajiny učia od zahraničných investorov. Niektorý autori uvádzajú že vzťah medzi PZI a inovačnou aktivitou môže byť popísaný krivkou v tvare obráteného písmena U (Čaplánová, 2012; Girma, 2009). Na druhej strane mnohí autori našli negatívny vzťah medzi inováciami a PZI (Love, 1999, Bishop, 1999, Stiebale, 2011, Zemplinerová, 2012, Srholec, 2005).

PZI sú v dizertačnej práci merané na makroekonomickej a odvetvovej úrovni pomocou prílevu a odlevu PZI, čo je bežne používaný ukazovateľ vo výskumoch zaoberajúcich sa vzťahom inovácií a PZI (ako príklad môžeme uviesť autora Zulkhibriho, 2015). Na mikroekonomickej úrovni využívame na definíciu zahraničného vlastníctva podniku, ktoré predstavuje prílev PZI do daného podniku, binárnu premennú alebo kategorickú premennú. V prípade binárnej premennej hodnota 1 predstavuje zahraničné vlastníctvo podniku a hodnota nula domáceho vlastníka. Kategorická premenná má tri úrovne, kde je kódované domáce vlastníctvo, čisto zahraničné vlastníctvo a zmiešané vlastníctvo, kde na riadení podniku participuje domáci podnikateľ aj zahraničný investor. S binárnou premennou sa stretneme napríklad vo výskume Zemplinerovej (2012), zatiaľ čo kategorickú premennú používa napríklad Girma (2009) alebo Zhang (2014).

Štúdie tiež uvádzajú iné determinanty inovačnej aktivity podnikov. Často spomínaný determinant je veľkosť podniku, ktorého vplyv na inovačnú aktivitu môže byť pozitívny ako bolo dokázané napríklad v štúdiách Leeho (2011), Mishru (2007), alebo Stiebala (2011), avšak aj negatívny ako zhodnotili napríklad Scherer (2007), Bound (2007), či Mahlich (2006). V dizertačnej práci je tento determinant tiež zohľadnený a meraný je pomocou počtu zamestnancov v podniku alebo prostredníctvom objemu tržieb.

Ďalším je trhová štruktúra, ktorú ako pozitívny determinant uvádzajú napríklad Lee (2011), Mishra (2007), alebo Bhattacharya (2004). V dizertačnej práci tento determinant meriame pomocou trhového podielu jednotlivých podnikov, ako navrhuje napríklad Bertrand (2009), Girma (2011), a Mishra (2007).

Tiež vek podniku je dôležitým determinantom inovačnej aktivity podnikov (Cumming, 2000, Mishra, 2007; Girma, 2009; Stiebale, 2011, Jefferson, 2006). Ďalším možným determinantom, ktorý rovnako patrí do skupiny podnikových charakteristík, je umiestnenie podniku, ktorý skúmal napríklad Brouwer (1996) vo svojej skorej štúdií. My sme tiež zaradili tieto dva determinanty do nášho výskumu.

Nakoniec môžeme uviesť aj finančné determinanty, ktoré spomína vo svojom výskume napríklad Lee (2012). Patria sem napríklad rentabilita tržieb, peňažný tok, zadlženosť, čistý príjem a vlastné imanie podniku. My sme skúmali finančné determinanty rentabilita tržieb, produktivita a zadlženosť.

V práci sme na analýzu využili tri súbory dát, keďže sme skúmali problematiku na makroekonomickej, odvetvovej aj mikroekonomickej úrovni. Súbor dát pre makroekonomickú analýzu obsahoval ročné údaje o slovenskej ekonomike od roku 1993 do roku 2015, ktorý bol najnovším rokom s dostupnými údajmi. Súbor dát pre odvetvovú analýzu obsahoval panelové dáta o priemyselných sektoroch s kódmi od 10 do 32 na základe klasifikácie ekonomických činností podľa SK NACE Rev. 2 od roku 2008 do roku 2015. A súbor dát na podnikovú analýzu obsahoval údaje o vzorke 278 veľkých priemyselných podnikov, kde boli zahrnuté ich všeobecné charakteristiky, finančné údaje a inovačné údaje k 31.12.2015.

Analýzu sme vykonali pomocou skúmania niekoľkých vytvorených modelov s využitím nasledovných štatistických metód: metóda najmenších štvorcov v prípade, že model spĺňal všetky nevyhnutné podmienky pre použitie tejto metódy; ďalej regresia navrhnutá Cochranom a Orcuttom pre časové rady; a nakoniec pre panelové dáta metóda fixných alebo náhodných efektov.

V makroekonomickej analýze sme sa najprv venovali ukazovateľu inovačného vstupu. Hodnotili sme vplyv determinantov na výdavky na výskum a vývoj z podnikateľských zdrojov v rámci celej krajiny. Zo skúmaných determinantov – prílev a odlev PZI, inflácia a výdavky na výskum a vývoj zo strany štátu, boli štatisticky významné premenné prílev a odlev PZI a štátne výdavky na výskum a vývoj. Štátne výdavky na výskum a vývoj ovplyvňujú výdavky zo strany podnikateľského sektora pozitívne, čo môžeme pripísať vytvoreniu určitého inovatívneho prostredia a tiež podpore štátu podnikov v otázkach inovácie.

Pozitívny vplyv na výdavky na výskum a vývoj podnikateľského sektora má tiež odlev PZI. To môžeme pripísať snahe podnikov o konkurencieschopnosť na zahraničných trhoch pomocou inovatívnych riešení, kvôli ktorým vyvíjajú podniky na domácom trhu väčšiu výskumnú činnosť. Tiež môže byť tento pozitívny vplyv vysvetlený tým, že sa podniky na zahraničnom trhu učia a tieto svoje nové poznatky chcú pretaviť do svojho podnikania, preto sa zvyšujú ich výdavky na výskum a vývoj. V dizertačnej práci sme skúmali aj kvadratickú premennú odlevu PZI, avšak nebola štatisticky významným determinantom PZI.

Prílev PZI má na základe nášho výskumu negatívny vplyv na výdavky na výskum a vývoj z podnikateľských zdrojov, ktorý vysvetľujeme presunom činností výskumu a vývoja do domovských krajín zahraničných investorov, čo je bežná prax multinacionálnych korporácií. Výsledky dizertačnej práce sú v súlade s výsledkami výskumu Girmu (2008). Pri skúmaní kvadratickej premennej prílivu PZI sme nepotvrdili štatistickú významnosť tohto determinantu.

Na makroekonomickej úrovni sme skúmali tiež determinanty inovačného výstupu, ktorý bol meraný na základe počtu patentov a ochranných známok na Slovensku. Zo sledovaných determinantov boli štatisticky významné odlev PZI, výdavky na výskum a vývoj z podnikateľských zdrojov, počet pracovníkov výskumu a vývoja, inflačná miera a produktivita práce. V tomto prípade má odlev PZI negatívny vplyv na inovačný výstup. Zistili sme tiež, že regresný koeficient v modeli naznačuje, že vzťah medzi podnikovými výdavkami na výskum a vývoj a odlevom PZI môže byť popísaný krivkou v tvare prevráteného písmena U.

V odvetvovej analýze sme sa tiež zamerali na rovnaké inovačné vstupy. V analýze determinantov počtu pracovníkov vo výskume a vývoji sme zistili, že táto závislá premenná je ovplyvnená na základe štatistickej významnosti odlevom PZI a niektorými výrobnými sektormi, ako napríklad sektorom výroby dopravných prostriedkov. Odlev PZI na počet výskumných pracovníkov vplýva pozitívne.

Výdavky na výskum a vývoj, ako druhý ukazovateľ inovačných vstupov, boli štatisticky významne ovplyvnené tržbami v danom sektore, priemyselným sektorom a odlevom PZI. Vplyv tržieb je negatívny, čo môže byť dôsledkom toho, že podniky s vyšším objemom dosiahnutých tržieb nepociťujú potrebu investovať do výskumu a vývoja, aby na trhu dosiahli lepšiu konkurenčnú pozíciu. Pozitívny vplyv odlevu PZI sa dá vysvetliť rovnako ako v prípade makroekonomickej analýzy.

Ako ukazovateľ inovačnej aktivity z hľadiska inovačného výstupu sme v odvetvovej úrovni zvolili počet podnikov s inovačnou aktivitou a tiež ich podiel na celkovom počte podnikov v danom priemyselnom sektore. Medzi sledované determinanty sme zaradili aj ukazovatele inovačných vstupov, keďže Stiebale (2011) ich považuje za možné determinanty inovačných výstupov.

Štatisticky významne ovplyvnili počet podnikov s inovačnou aktivitou odlev PZI, ktorého vplyv bol pozitívny, a tiež počet zamestnancov výskumu a vývoja, ktorý negatívne vplýval na počet podnikov s inovačnou aktivitou v odvetví. Pozitívny vplyv odlevu PZI môže byť vysvetlený získaním nových poznatkov v zahraničí u podnikov investujúcich na zahraničných trhoch, v dôsledku čoho rastie počet podnikov na domácom trhu, ktoré inovujú. Z hľadiska podielu inovačných podnikov na celkovom počte podnikov v danom priemyselnom sektore, táto premenná bola štatisticky významne ovplyvnená pozitívne objemom tržieb a negatívne prílevom PZI. Negatívny vplyv prílevu PZI je v dôsledku odčerpania inovácií multinacionálnymi korporáciami do materskej krajiny. Tiež ukazovateľ priemyselného sektora bol štatisticky významným determinantom podielu inovačných podnikov.

Na podnikovej úrovni sme analyzovali inovačnú aktivitu pomocou inovačného výstupu, čiže pomocou počtu patentov, ochranných známok, dizajnov, a úžitkových vzorov, ktoré podnik zaregistroval na Úrade priemyselného vlastníctva SR alebo na Európskom patentovom úrade. Ako hlavný determinant, ktorý sme v analýze skúmali, boli PZI, ktoré v tomto prípade predstavovalo zahraničné vlastníctvo podniku.

V prípade použitia binárnej premennej na zachytenie zahraničného vlastníctva sme zistili, že zahraničné vlastníctvo negatívne ovplyvňuje inovačný výstup podniku. Tiež sa teda prejavuje relokácia inovácií do domovskej krajiny v prípade, že do podniku vstúpi zahraničný investor a získa vplyv na rozhodovanie o podniku. Naše zistenia sú v súlade s výskumom Zulkhiriho (2015), Zemplinerovej (2012), alebo Girmu (2008).

Skúmali sme tiež vplyv jednotlivých druhov vlastníctva na inovačný výstup. Rozlišovali sme domáce vlastníctvo, kde sto percent akcií alebo majetkových podielov vlastní domáci majiteľ, ďalej zahraničné vlastníctvo, kde je vlastníctvo podniku plne v rukách zahraničného investora, a nakoniec zmiešané vlastníctvo, kde je podiel vlastníctva zahraničného investora od desať do deväťdesiat percent.

V prípade rozlišovania druhov vlastníctva ako štatisticky významný determinant v dizertačnej analýze vyšlo len zmiešané vlastníctvo, ktoré malo pozitívny vplyv. Čisto zahraničné vlastníctvo negatívne vplývalo na počet inovačných výstupov, zatiaľ čo domáce vlastníctvo malo pozitívny vplyv. Tieto dva ukazovatele však neboli štatisticky významnými determinantmi. Tieto výsledky naznačujú, že pre podnik je najvýhodnejšia spolupráca domáceho podnikateľa so zahraničným investorom, kde domáci podnikateľ prináša do podniku poznatky o lokálnom trhu, zatiaľ čo zahraničný investor prináša nové technológie a poznatky.

Okrem vplyvu PZI boli skúmané tiež iné determinanty inovačnej aktivity podniku, ktoré boli navrhnuté na základe spomínaných výskumov ostatných autorov. V dizertačnej analýze však žiaden z nich nebol potvrdený, ako štatisticky významný. Napriek tomu môžeme analyzovať ich vplyv na inovačnú aktivitu z ekonomického hľadiska.

Prvým skúmaným determinantom bol vek podniku, ako jedna zo základných charakteristík podniku. Na rozdiel od výskumu Mishru (2007) v našom výskume sme hodnotili vplyv veku podniku na inovácie negatívne. Mladšie podniky registrujú viac inovačných výstupov ako staršie v prípade slovenských podnikov. Môže to byť spôsobené tým, že staršie podniky majú vytvorenú zákaznícku základňu a majú stabilné postavenie na trhu, a teda nepociťujú potrebu inovovať. Na druhej strane nové podniky sa musia presadiť na trhu s inovatívnymi nápadmi, teda prinášajú nové produkty a procesy, ktoré si následne chránia pomocou formálnej ochrany priemyselného vlastníctva.

Druhým determinantom je veľkosť podniku vyjadrená počtom jeho zamestnancov. Výsledky nášho výskumu ukázali, že vzťah medzi veľkosťou a inovačnou aktivitou podniku môže byť zobrazený krivkou v tvare prevráteného U. Tieto výsledky potvrdili tvrdenia Zemplinerovej (2010), že vzťah medzi inováciami a veľkosťou podniku môžu byť nelineárne. Tento vzťah môžeme vysvetliť tým, že podniky s rastúcou veľkosťou majú aj viac finančných prostriedkov, ktoré môžu investovať do inovačnej činnosti. Avšak po prekročení určitej veľkostnej hranice podniky strácajú záujem o inovačnú činnosť, pretože sa dokážu presadiť na trhu napríklad so zníženou cenou svojich produktov dosiahnutou vďaka úsporám z rozsahu.

Ako tretí determinant sme skúmali rentabilitu tržieb, ktorý pozitívne vplýval na inovačné výstupy. Tieto výsledky potvrdili náš predchádzajúci výskum, ktorý sme publikovali na konferencií. Pozitívny vplyv rentability tržieb, ako ukazovateľa ziskovosti podniku, sa dá vysvetliť väčším množstvom finančných prostriedkov na zakúpenie ochrany priemyselného vlastníctva.

Ďalším finančným determinantom, hodnoteným v našom výskume, bola zadlženosť podniku. Podľa očakávaní, rovnako ako aj napríklad autor Cumming (2000), sme zistili, že tento determinant negatívne vplýva na inovačné výstupy. Podnik je teda menej ochotný investovať do inovácií, keď je zadlžený. Tiež sa dostáva do horšej situácie pri snahe požičať si finančné prostriedky na splatenie ochrany inovácií.

Ako determinant inovačnej aktivity sme hodnotili aj produktivitu práce, ktorá tiež vyjadruje výkonnosť firmy ako predchádzajúce dva determinanty. V tomto prípade sme našli pozitívny vplyv tohto determinantu na inovačný výstup podniku. Môže to byť spôsobené tým, že pri vyššej efektívnosti práce vzniká priestor pre viac inovácií, respektíve pracovníci, ktorí sú produktívnejší, sú viac motivovaní k vytvoreniu inovačných riešení v podniku.

Tiež sme analyzovali aj trhový podiel ako možný determinant inovačného výstupu podniku. Vyšší trhový podiel na základe dizertačnej analýzy vedie k menšiemu množstvu inovačných výstupov. Opäť to môžeme vysvetliť tým, že trhoví lídri majú iné spôsoby udržania si svojej pozície na trhu (ako napríklad zmienená cenová konkurencia v dôsledku znižovania nákladov vďaka úsporám z rozsahu) ako pomocou inovácií. Na druhej strane malé podniky, sa snažia získať väčší trhový podiel pomocou predstavenia nových produktov, ktoré následne chránia napríklad dizajnom, a pod.

Ďalej sme sa venovali priemyselnému sektoru, ktorý štatisticky významne ovplyvňuje inovačné výstupy podniku. Štatistická významnosť a sila vplyvu závisí od konkrétneho priemyselného sektora. Naše výsledky sú v súlade s výsledkami autorov Brzozowski (2008), Bound (2007), Čaplánová (2012), Girma (2008), a Schmiele (2012). Najvyšší pozitívny vplyv na inovačné výstupy má sektor výroby koksu a ropných výrobkov, zatiaľ čo najnižší negatívny vplyv majú sektory výroby textilu, dreva a drevených výrobkov, tlače a reprodukčných médií a výroby motorových vozidiel.

Veľmi zaujímavý je hlavne výsledok v prípade výroby motorových vozidiel, keďže v prípade výdavkov na výskum a vývoj sme v analýze na odvetvovej úrovni zistili, že v tomto sektore sú výdavky jedny z najvyšších, rovnako ako podiel inovačných podnikov v tomto sektore bol relatívne vysoký oproti iným sektorom. Napriek tomu majú podniky v tomto sektore jeden z najnižších počtov registrovaných patentov, ochranných známok, dizajnov, či úžitkových vzorov. Znamená to, že podniky v tomto sektore investujú do výskumu a vývoja, pretože sú vystavené silnému konkurenčnému tlaku na trhu, preto sa snažia inovovať svoje výrobné postupy a prinášať inovatívne výrobky. Avšak dynamika zmien v tomto sektore odrádza podniky od registrácie svojich inovácií na Úrade priemyselného vlastníctva alebo Európskom patentovom úrade, keďže proces získania takejto ochrany by mohol presiahnuť životnosť a využiteľnosť inovácie.

Ako posledný determinant sme skúmali regionálne umiestnenie podniku. Na základe analýzy, inovačné výstupy podnikov sú štatisticky významne ovplyvnené iba umiestnením v bratislavskom kraji. Na západe Slovenska zo všetkých krajov práve podniky v bratislavskom kraji majú viac inovačných výstupov ako tie v nitrianskom, trenčianskom, alebo trnavskom kraji. Na strednom Slovensku banskobystrický kraj má pozitívny, zatiaľ čo žilinský kraj negatívny vplyv na inovačné výstupy. A nakoniec na východe Slovenska negatívne vplýva košický kraj, zatiaľ čo prešovský kraj má pozitívny vplyv. Tieto regionálne rozdiely môžu byť spôsobené konkurenčným prostredím jednotlivých krajov, alebo investičnými príležitosťami v daných krajoch.

Okrem analýzy determinantov inovačnej aktivity sme sa v dizertačnej práci venovali aj vzťahu medzi inovačnou aktivitou podnikov a ich výkonnosťou. Chromjaková (2009) hovorí, že inovačná aktivita má zmysel len vtedy, keď má podniku pozitívny prínos v otázke efektívnosti a výkonnosti. Pitra (2006) predstavil tri hlavné skupiny ukazovateľov pre meranie efektov inovačnej aktivity:

- ukazovatele, ktoré hodnotia prínos inovácií ku konkurencieschopnosti firmy, akými sú napríklad produktivita, rentabilita tržieb, likvidita a zadlženosť;
- ukazovatele, ktoré hodnotia efekt inovácií na ekonomických výsledkoch podniku, kde patrí napríklad rentabilita investícií, rentabilita vlastného imania a rentabilita kapitálu;
- ukazovatele, ktoré sa používajú na hodnotenie finančných vplyvov inovačnej aktivity, ako napríklad prevádzkový kapitál, obrat, ziskovosť, celková produktivity.

V dizertačnej práci sme na odvetvovej úrovni skúmali rozdiely medzi podnikmi s inovačnou aktivitou a podnikmi bez inovačnej aktivity z hľadiska ich veľkosti, ktorú sme vyjadrili počtom zamestnancov, ale aj objemom tržieb, ako ukazovateľom výkonnosti. Na porovnanie priemerov týchto ukazovateľov medzi menovanými skupinami podnikov sme použili Welchov t-test. Náš výskum ukázal, že podniky s inovačnou aktivitou skutočne zamestnávajú viac osôb a dosahujú väčší objem tržieb ako podniky bez inovačnej aktivity a rozdiel v týchto skupinách podnikov je štatisticky významný. Tiež napríklad Zemplinerová (2012) vo svojom výskume českých podnikov poukázala na to, že inovačné podniky sú väčšie ako tie bez inovácií.

Na podnikovej úrovni sme vykonali podobnú analýzu, kde sme porovnali skupinu vybraných podnikov, ktoré majú patent, ochrannú známku, dizajn, alebo úžitkový vzor registrovaný na Úrade priemyselného vlastníctva SR alebo Európskom patentovom úrade, so skupinou podnikov bez inovácií chránených formou priemyselnej ochrany. Pre výber skupiny podnikov bez inovačnej aktivity sme využili metódu priraďovania, podobne ako napríklad Dachs (2009), kde sme ku každému podniku s inovačnou aktivitou priradili jeden podnik bez inovačnej aktivity, ktorý pôsobí v rovnakom priemyselnom sektore, je približne rovnako veľký a má rovnaký typ vlastníctva. Skúmali sme ukazovatele: rentabilita tržieb, rentabilita vlastného imania, rentabilita aktív a produktivita práce. Jedine v prípade rentability vlastného imania sme dokázali, že existuje štatisticky významný rozdiel medzi inovačnými a neinovačnými podnikmi.

Ďalej sme skúmali tzv. inovačnú prémiu. Tento pojem sme použili na základe výskumu Bernarda (1999), ktorý využil pojem exportná prémia pri hodnotení rozdielu medzi výkonnosťou podnikov predtým a potom ako sa zúčastnili exportných aktivít. My sme skúmali výkonnosť vybranej skupiny podnikov predtým a potom, čo získali priemyselnú ochranu svojich inovácií. Zistili sme, že po získaní tejto ochrany sa výkonnosť podnikov štatisticky významne nezmenila ani v jednom zo skúmaných ukazovateľov, ktorými boli objem tržieb, majetok, vlastné imanie, zisk, rentabilita tržieb, rentabilita vlastného imania a rentabilita aktív. Podobne napríklad Zemplinerová (2012) hovorí, že podniky, ktoré inovujú sú produktívnejšie aj pred samotnou inováciou v podniku.

Záverom tejto analýzy je, že motivácia podnikov pre registráciu svojich inovačných výstupov nie je zvýšenie ich výkonnosti. Pravdepodobne sa podniky snažia o ochranu svojich inovácií, aby si zabezpečili svoje komparatívne výhody pred konkurenciou a predpokladajú skôr nepriame vplyvy na podnikovú ekonomiku, akými sú nákladové úspory, nový zákazníci, či nárast efektívnosti procesov.

Nakoniec sme v práci uviedli jej limitácie, ktorými je hlavne zlá dostupnosť dát, zameranie analýzy len na priemyselné podniky, sledovanie závislej premennej v rovnakom časovom období ako nezávislé premenné, a komplikovanosť konštrukcie ukazovateľa inovačnej aktivity v podnikoch.

Ako návrh pre ďalší výskum sme uviedli tiež možnosť rozšíriť analýzu o výskum rozlišujúci technologické a netechnologické inovácie; tiež rozlišovanie medzi jednotlivými druhmi priemyselnej ochrany, keďže sa medzi sebou odlišujú najme po finančnej stránke; ďalej PZI je možné deliť podľa ich formy na akvizície a fúzie, spoločné podniky a investície na zelenej, či hnedej lúke.

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Appendix 1

Table 33 Summary statistics – macroeconomic variables

Variable	Mean	St. Dev.	Minimum	Maximum	Skewness	Kurtosis
BERD	133	64	62	283	1.149	0.260
GERD	147	71	54	296	0.658	-0.656
RDE	24 648	2 630	20 928	28 880	0.444	-1.134
IO	9 085	3 381	184	13 316	-0.788	0.263
FDIin	1 452	1 229	-655	4 182	0.331	-0.456
FDIout	-150	281	-715	363	-0.325	-0.180
Labour prod.	0.017	0.008	0.006	0.029	0.230	-1.671
Inflation rate	5.583	3.655	-0.076	13.410	0.492	-0.496

Note: BERD, GERD, FDIin, FDIout are measured in millions EUR; RDE, IO are measured in absolute numbers; Labour productivity, Inflation rate are ratios.

Source: own processing of the data

Table 34 Pearson's and Spearman's correlation coefficients - macroeconomic variables

	GERD	***BERD***	***RDE***	***IO***	***LP***	***IR***	***FDIin***	***FDIout***
FDIout	-0.32	0.02	-0.23**	0.45**	-0.45*	0.47**	-0.03	**1.00**
	(0.169)	(0.925)	(0.017)	(0.046)	(0.053)	(0.037)	(0.892)	
FDIin	0.22**	-0.03	-0.34*	-0.02	0.15	-0.17	**1.00**	0.05
	(0.050)	(0.925)	(0.057)	(0.943)	(0.534)	(0.471)		(0.826)
IR	-0.76***	-0.65***	-0.50**	0.73***	-0.78***	**1.00**	0.15	0.41*
	(0.000)	(0.001)	(0.012)	(0.000)	(0.000)		(0.534)	(0.073)
LP	0.96***	0.77***	0.74***	-0.94***	**1.00**	-0.77***	0.36	-0.31
	(0.000)	(0.000)	(0.001)	(0.000)		(0.000)	(0.127)	(0.193)
IO	-0.92***	-0.77***	-0.81**	**1.00**	-0.84***	0.71***	-0.14	0.26
	(0.000)	(0.000)	(0.012)		(0.000)	(0.000)	(0.564)	(0.264)
RDE	0.79***	0.84	**1.00**	-0.75***	0.52**	-0.47**	-0.41*	-0.18
	(0.008)	(0.403)		(0.000)	(0.020)	(0.032)	(0.077)	(0.441)
BERD	0.89***	**1.00**	0.64***	-0.63***	0.75***	-0.74***	0.07	-0.28
	(0.000)		(0.002)	(0.002)	(0.000)	(0.000)	(0.767)	(0.229)
GERD	**1.00**	0.82***	0.55***	-0.83***	0.98***	-0.80***	0.42*	-0.32
		(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.069)	(0.173)

Note: the values in the parentheses are the p-values for the correlation coefficient, based on the p-values the asterisks denotes the statistical significance ate the level of 1% (***), 5% (**), 10% (*). The Pearson's correlation coefficients are above the diagonal, and the Spearman's rank correlation coefficients are below the diagonal.

Source: own processing of the data

Table 35 Summary statistics - industrial variables

Variable	Mean	St. Dev.	Minimum	Maximum	Skewness	Kurtosis
No. of IE	65	58.80	6.00	322.00	1.675	3.267
RDE	0.60	0.84	0.00	3.38	1.943	3.052
BERD	723	1 043	16	6 747	3.546	17.244
FDIin	17 015	152 775	-683 315	814 996	1.315	13.203
FDIout	1 599	7 197	-10 388	26 369	1.294	2.145
Sales	8 297	17 771	74	104 012	3.506	12.603
Employees	47	68	1	435	2.998	10.600
LP	23.662	9.866	7.720	58.276	0.853	0.658
ROS	0.928	0.045	0.780	0.985	-1.323	1.773

Note: BERD, FDIin, FDIout, Sales are measured in thousand EUR; RDE, Number of innovation enterprises, Employees are measured in absolute numbers; Labour productivity, ROS are ratios.

Source: own processing of the data

Table 36 Pearson's correlation coefficients - industrial variables

	ROS	***LP***	***Emp.***	***Sales***	***FDIout***	***FDIin***	***BERD***	***RDE***	***No. of IA***
No. of IA	-0.52*** (0.000)	-0.24* (0.061)	-0.22* (0.089)	-0.22* (0.084)	-0.15 (0.252)	-0.04 (0.771)	-0.36*** (0.006)	-0.41*** (0.001)	**1.00**
RDE	0.42*** (0.000)	0.04 (0.769)	0.44*** (0.000)	0.42*** (0.000)	0.30** (0.018)	0.04 (0.747)	0.52*** (0.000)	**1.00**	-0,56*** (0,000)
BERD	0.40*** (0.002)	0.28** (0.038)	0.55*** (0.000)	0.64*** (0.000)	0.20 (0.138)	0.27** (0.040)	**1.00**	0,65*** (0,000)	-0,15 (0,102)
FDIin	0.01 (0.919)	0.06 (0.641)	0.10 (0.458)	0.21 (0.107)	0.18 (0.161)	**1.00**	0,04 (0,668)	-0,09 (0,436)	0,28*** (0,004)
FDIout	0.19 (0.141)	0.17 (0.198)	0.13 (0.322)	0.13 (0.311)	**1.00**	0,15 (0,187)	0,10 (0,396)	0,21* (0,097)	-0,07 (0,520)
Sales	0.37*** (0.003)	0.24* (0.061)	0.95*** (0.000)	**1.00**	0,08 (0,494)	-0,03 (0,791)	0,69*** (0,000)	0,72*** (0,000)	-0,11 (0,217)
Emp.	0.40*** (0.001)	0.11 (0.402)	**1.00**	0,91*** (0,000)	0,02 (0,889)	-0,04 (0,645)	0,53*** (0,000)	0,80*** (0,000)	-0,16* (0,084)
LP	0.35*** (0.005)	**1.00**	0,12 (0,183)	0,41*** (0,000)	0,20* (0,073)	0,06 (0,521)	0,49*** (0,000)	0,09 (0,398)	-0,02 (0,855)
ROS	**1.00**	0,09 (0,280)	0,62*** (0,000)	0,54*** (0,000)	0,14 (0,216)	-0,12 (0,200)	0,37*** (0,000)	0,56*** (0,000)	-0,22** (0,015)

Note: the values in the parentheses are the p-values for the correlation coefficient, based on the p-values the asterisks denotes the statistical significance ate the level of 1% (***), 5% (**), 10% (*).The Pearson's correlation coefficients are above the diagonal, and the Spearman's rank correlation coefficients are below the diagonal.

Source: own processing of the data

Table 37 Summary statistics - microeconomic variables

Variable	Mean	St. Dev.	Minimum	Maximum	Skewness	Kurtosis
Age	17	6	2	27	-0.257	-0.912
Employees	973	1 243	201	9 480	4.077	23.140
Sales	179 919	620 911	2 575	7 227 454	8.064	76.581
No. of IO	6	19	0	151	5.111	30.205
ROS	0.132	0.808	-0.679	9.590	10.545	118.636
ROA	0.413	3.955	-1.630	64.083	15.161	243.614
ROE	0.441	21.370	-243.992	249.749	0.390	127.693
M. share	$9.76x10^{-4}$	$3.37\ x10^{-3}$	$1.4\ x10^{-5}$	$3.92\ x10^{-2}$	8.123	76.58
Debt	57.764	28.079	4.707	284.642	2.123	14.496
LP	36.188	28.318	7.292	157.506	2.394	7.002
Assets	101 137	273 466	570	2 348 932	6.335	44.891
Capital	50 599	163 197	-36 101	1 403 049	6.271	42.974
Profit	6 322	23 320	-31 251	210 138	6.234	44.636

Note: Sales, Assets, Capital, Profit are measured in thousand EUR; Number of innovation outputs, Age, Employees are measured in absolute numbers; Market share, Debt, Labour productivity, ROS, ROE, ROA are ratios.

Source: own processing of the data