

Investment, Innovation and Firm Performance: Empirical Evidence from Small Manufacturing Industries

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Abstract The research paper contains the analysis of the intensity of R&D investments and innovations from 2005 to 2012 in Lithuanian industrial sectors of different technological levels and evaluation of operational efficiency of the aforementioned sectors. The obtained results of the study showed that until 2010 the leaders of investments in the field of tangible assets were medium-low-tech enterprises, while from 2010, high-tech sector was significantly ahead of other Lithuanian industrial sectors by level of its investments. This sector was significantly getting ahead of other industrial sectors by innovative activity. The study found that high and medium-high-tech enterprises are superior in terms of productivity, volumes of export and indicators of return on assets, comparing to medium-low and low-tech enterprises. However, it should be noted that, although, medium-high-tech industries got behind high-tech industries by their innovative activities, their operational efficiency was higher than high-tech enterprises for almost the entire period of study. To extend the research and represent countries general macro-economical tendencies and technological development of the industry, 5 financial indicators (investment to tangible assets, proportion of tangible investments to sales revenue, additional value created, return on assets (ROA), export share in total revenue) were selected to perform cluster analysis between different technological level industries and country's GDP using Ward's method with squared Euclidean distance interval.

Keywords: *innovation, R&D investment, manufacturing companies, technological level, company's performance*

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1. Introduction

The investment of industrial enterprises is a prerequisite for the increase of their operational effectiveness; however, the investments in expansion of production capacities do not necessarily lead to the growth of their technological potential. The implementation of technological innovations is crucial in order to take advantage of market opportunities by developing new products, providing innovative services or innovatively implementing various processes of business. The companies are encouraged to perform it by permanent competitive rivalry; however, the lack of innovations and industrial application is one of the main reasons of slow growth of the European economy. In its strategic documents, the European Commission emphasizes the high importance of technological innovations to the development of industry and the ambitions of community to increase the competitiveness of industry and companies through the implementation and application of innovations in business. Although the Summary Innovation Index (hereinafter – SII) in Lithuania is gradually increasing for many years; however, the growth rates are very low. In 2012, the average SII of European Union countries has

exceeded the Summary Innovation Index in Lithuania 1.94 times, while the analogical indexes of countries (i.e. innovation leaders) were almost 3 times higher than Lithuanian. [1]. The innovative activity of Lithuanian industrial enterprises is inactive; therefore, investments performed by these companies do not ensure the long-term competitive advantages and technological domination in the markets. Many of the promotion programmes of innovative activity emphasizes that high-technology sector creates the highest added value, but the top priority should be given to the development of this sector. However, in the recent years, the added value created by high tech industries in Lithuania was only 3-4% of total added value created by Lithuanian industrial enterprises, while medium-high-tech industries create 15.6-21.3% of total added value created by industrial enterprises. Many researches, performed in the level of enterprises, emphasize that investment activity and innovations have an impact on the growth of enterprises, their productivity, as well as the growth of export, consumption of material, labour resources and the efficiency of asset management. A considerable part of researches, designed for the analysis of effect of innovations in the level of enterprises, covers researches of the costs, designed for R&D, as well as interaction between the innovations and growth of

enterprises. Researches [2,3,4,5,6] have found that innovations creates faster opportunities of growth for enterprises; therefore, innovations accelerate the growth of enterprises. In addition, [2] came to the conclusion that influence of innovations for the growth of enterprises is higher in traditional industry, rather than industry based on technologies. In the global market the most rapid development can be noticed for those countries with intensive R&D processes integrated industries, what allows innovation integration for value creation. R&D activities in Lithuania's industry are low, at the same time very small investment to revenue rate for these activities are not creating long term sustainable competitiveness in global market. In the majority of different support for innovation programs, added value created in high-tech industry is stressed. However, in Lithuania this sector creates only 3-4 % share of country's industry added value. The share for medium-high technology sector in country ranges from 15,6 to 21,3 %, what shows country's dependence on that sector. Though it also can be assumed as development potential to country's economic wealth grow. In the course of discussion, whether the medium-low and low-tech industries have the greatest impact for the created added value, the question is – which industrial sectors in Lithuania should be promoted in order to make the greater effect? Therefore, the purpose of this article is to examine the levels of intensity of investment and innovations in the Lithuanian industrial sectors having different technological levels, as well as to perform a comparative analysis of the efficiency of these sectors.

2. Review of Literature and Theoretical Framework

In the current years regional differences across the world are one of the most important topics in economics, politics ore development research areas. However these differences are influenced by different factors encompassing R&D investments, social and institutional conditions analysing regional innovation nature [7]. For every country aiming to promote innovation development, constant monitoring of this process needs to be integrated and fostered [8]. For this reason factors and indicators determined in this process allow to determine innovation development difficulties, causes and circumstances limiting innovation promoting decisions selection process. Studies performed in European countries [5,9,10,11,12] show that technological innovations lead to higher economic indicators of enterprises, such as: productivity, volume of sales, profit and corporate market value. One of the main indicators depicting state government and business efforts to create competitive advantage in science and technology integration area are R&D expenditures [13]. These expenditures, innovation potential, investment to tangible capital, market share and export have positive impact on labour force productivity in production and service industries [14]. The positive impact of R&D expenses on enterprise productivity was also confirmed by researches [15,16,17,18] studies performed in Asian countries. Also, R&D expenditures can influence growth of productivity stimulating new technologies adoption [19]. Kraft and Kraftova [20] argues, that for successful global competition, country should foster the focus on high-tech industries. This idea

is supported by [21], because economic growth can be winning only by high-tech sector, which is receptive to R&D activities. That is why in this sector intensive competition is more active. In the past years research interrelation between economic growth and competition, under innovation development processes, becomes more and more analysed [20]. Crespi and Zuniga [22] revealed that effective policy actions should be taken for eliminating barriers to innovation investments and creating advantageous environment to reduce the gaps between more developed and less innovative countries. In this field, company as a fundamental cell in ecosystem has a big impact on the country's or region's sustainable development [23]. However, some studies performed in South American countries [24,25] have shown that innovations have no significant impact on enterprise productivity.

If deeper analysis will be made, especially small and medium size enterprises (SME) play a crucial role for socio-economical development because they possesses almost 99 % of the total companies number in European Union. Rosenbusch et al. [26] state that especially for SMEs', lacking considerable financial resources for development in starting or maturity stages, innovative activities are creating additional value. Though innovations introduced in these companies are related with high business risks for payback that investments made can never be recovered and uncertainty about clients loyalty, pricing for new products or services, SMEs are allocating their resources for that additional value possibilities. These research results are especially important for small countries, such as Lithuania, Latvia, Estonia, Croatia and etc. At the same time the research findings also states that newly established, starting companies in this field are more flexible and reactive to seize and exploit innovation advantages on the market, when matured companies are influenced by already established and designed processes [26]. By analysing SMEs in Croatia, [27] found that market orientation is the most important factor, depending on company ownership structure, employees education, readiness to respond market dynamics by implementing innovative organizational models. It is also worth to notice, that positive innovation effects is the market orientation, which is constructed from customer orientation, competitor orientation and inter-functional coordination. Companies with a strong market orientation also have much better effects of innovation activities [27]. On the other perspective [28] research in USA service industry specifics implementing innovative processes, stresses positive effect of innovative services on enterprises growth, but not on productivity. This can be explained by growth influencing external linkages supported by innovative companies, adding effectiveness to these companies, despite how these innovations are evaluated. At the same time [29] noticed, that not only technological innovations, but also non-technological innovations, such as new process or organizational methods are also very important and contributing. However, non-technological innovation stimulates success with product and process innovation together with market novelties in sales procedures or cost reductions from innovative processes.

Different authors in their research [2-4,6,30] find that investment activities for innovation fostering has a positive effect on company growth, increase of labour

productivity, export potential, asset exploitation, effective use of tangible and labour force resources. [31] argues that companies implementing innovations have stimuli to expand its activity in foreign markets because investments in other markets can earn them a higher return. Researches [32,33,34] have shown that innovations are one of the company's competitive advantages in international markets and have a positive impact on the development of export. [19] aiming to answer the questions - „what is the effect of innovations on productivity? How is the introduction of innovations related to R&D? Does R&D only stimulate the creation of innovations, or does it also help the firm in absorbing new technology created by others? Do the answers differ for product versus process innovations?“ found that R&D expenditures related with new product introduction to market in innovative Italian companies are financed not from internal company's financial sources, but from external funding provided. Also, R&D expenditure effect to stimulate product innovations or introduction of new technologies to enhance productivity is comparatively low if compared with other OECD countries [19]. This gives the reason why it is so important to study the structural, institutional and policy reasons for R&D financing at micro level.

[6] also highlights R&D investments as one of the main drivers for enterprise growth. This attitude is also supports [35]. [6] found positive effect of R&D intensity and company sales, especially in high-tech industries. Though [36] noticed that during the stagnation phases when business solves the dilemma to invest or delay the investments, R&D expenditures should not be counted as luxury, moreover these expenditures should be utilized to occupy market position. However R&D expenditures in low-tech manufacturing sectors are not resulting a

required return, because of high investment costs. [35] supporting positive effect of R&D investments stresses highest positive effect from investment to large companies. However, the strongest interdependence can be found and estimated between industries, divided according technological (from high-tech to low-tech) development level in the manufacturing sector, what should be investigated in a longer time perspective to reveal countries competitive position.

3. Material and Methods

Data sample. For this research data sample encompass 8000 industrial companies in Lithuania. Research period is 2005 – 2012. Data is taken from Statistics Lithuania [37]. To reveal interdependencies between different sectors according technological development level OECD classification is used [38] (see Table 1).

Based on classification in Statistics Lithuania “Aircraft and Spacecraft” industry is not distinguished, for this reason in further research results only 2 subsectors are analysed: a) manufacture of basic pharmaceutical products and pharmaceutical preparations; b) manufacture of computer, electronic and optical products. Segmentation of different innovation levels can be also important, because low and medium technology sectors are less analysed, however with the potential to develop. At the same time the share of these sectors in industry forms a background for growth. These sectors are also gates for new technologies invasion, through capital investments (expressed as the intensity growth of tangible investments and intangible investments).

Table 1. Classification of manufacturing industries into categories based on technological development level or R&D intensities [38]

High-technology industries	Medium-high-technology industries
Aircraft and Spacecraft Pharmaceuticals Office, accounting and computing machinery Radio, TV and communications equipment Medical, precision and optical instruments	Electrical machinery and apparatus, n.e.c. Motor vehicles, trailers and semi-trailers Chemicals excluding pharmaceuticals Railroad equipment and transport equipment Machinery and equipment, n.e.c.
Medium-low-technology industries	Low-technology industries
Building and repairing of ships and boats Rubber and plastic products Coke, refined petroleum products and nuclear fuel Other non-metallic mineral products Basic metals and fabricated metal products	Manufacturing, n.e.c.; Recycling Wood, pulp, paper products, printing and publishing Food products, beverages and tobacco Textiles, Textile products, leather and footwear

The study consists of two parts: 1) In order to evaluate the activity of business investment and innovations in the different technological levels of industry provided in the study, the indicators defined in recent literature review were used. In this research following indicators are calculated: a part of income provided for R&D; the intensity of tangible investments (tangible investments per year / income from sales); the intensity of intangible investments (intangible investments per year / income from sales); a part of companies introducing innovations in the total number of enterprises; 2) In order to evaluate the operational efficiency of companies in the different technological levels of Lithuanian industry, the following indicators are calculated: the productivity of enterprises (added value / number of employees); a part of export in

the income from sales (income from export / income from sales); return on assets (net profit / assets).

Hierarchical cluster analysis using Ward's method applying squared Euclidean Distance as similarity measure for companies data and country's GDP analysis was performed. Ward's method distinction from other methods is the analysis of variance approach by evaluating to evaluate the distances between clusters, at the same time defining the same dynamics' variables. This was important to understand the relationship between 5 financial indicators (investment to tangible assets, proportion of tangible investments to sales revenue, additional value created, return on assets (ROA), export share in total revenue) of different technological level industries and country's GDP.

4. Results

4.1. The Evaluation of a Part of Income, Provided for R&D, Intensity of Investments and Innovative Activity in the SECTORS of Lithuanian Industry

The scientific discussions and various different results of the studies show that the results of innovation intensity of commercial activity, as well as their efficiency can be very different at different levels of technological intensity in the industrial sectors due to different levels of R&D expenditures and volumes of investments. Therefore, in 2010, the Government of the Republic of Lithuania [38], taking into account problems arising in the system of researches and innovations, has changed the priorities of country and decided to focus on high value-added production and services, which are related to 1) investments in high value-added services, 2) development of science and technology centres and 3) innovative

traditional industries. In order to achieve these goals and accelerate the development of industrial sectors open to research, as well as development of innovations in Lithuania, the appropriate directions of specialization and priority economic sectors, related to the future of Lithuania were distinguished. According to the listed objectives, Table 2 presents Lithuanian economies having the greatest economic advantage, as well as potential sectors, which investments and implementations of innovations allow to achieve high performance. However, it is important to take into account the fact that implementation of innovations is successful by assessing the benefits in the sectors using the development of innovations and traditional technologies. Only this way the overall innovation of the country will be improved by appropriately reducing social disparities and increasing population welfare. The fundamentals of country's economic competitiveness are strengthened by using targeted promotion of the development of innovations. The same way it is contributed to the implementation of EU innovation policy.

Table 2. Competitive and Promising Lithuanian Industries [39]

Competitive and Promising Lithuanian Industries		
Competitive edge of Lithuania	Potential of Lithuania	Promising industries of Lithuania
1. Manufacture of food products and beverages 2. Manufacture of wood and furniture products 3. Manufacture of textiles products 4. Manufacture of chemical products	1. Biotechnology (Pharmaceuticals manufacturing sector) 2. Manufacture of computer, electronic and optical products sector 3. Laser technologies sector 4. Information and communication technologies manufacturing sector	1. Clean technologies 2. Renewable energy resources 3. Medical equipment manufacturing, health services 4. Production ecological agriculture products and food products

Lithuanian innovation strategy 2010-2020 [39] emphasizes that artistic activity is one of the fundamental factors of R&D, on the other hand, Research and Development are key factors promoting economic development and competitiveness; therefore, any new methods and techniques created during the time of research are an integral part of innovative process, allowing companies to implement innovative systems and to improve the provision of existing services or production. Therefore, during the assessment of an income part, provided for R&D, it has been found that Lithuanian industrial enterprises allocate only the small part of their income for R&D, i.e. during 2008-2012, the income part of Lithuanian industrial enterprises allocated for R&D was only 0.19-0.34% (see Table 3). In this respect, high-tech industries, which expenses for Research and Development have been steadily increasing and their relation to the income amounted to 1.96-3%, significantly distinguished. It should be noticed, that among all industries (analysing R&D to revenue ratio) pharmaceuticals manufacturing sector can be distinguished. But it is also confirmed by this analysis, that lower technology intensive industry, lower R&D to revenue ratio.

Table 3. A part of income of Lithuanian industrial enterprises, provided for R&D shown in percent

Manufacturing industries	2008	2009	2010	2011	2012
High-technology	1,96	2,77	2,31	2,72	3,00
Medium-high-technology	0,30	0,30	0,25	0,24	0,47
Medium-low-technology	0,35	0,46	0,13	0,15	0,07
Low-technology	0,04	0,20	0,10	0,07	0,03
Lithuanian manufacturing	0,22	0,34	0,22	0,19	0,21

At the same time, it should be noticed, that state government support is also a critical factor to macro-economic analysis of growth through innovations. Different financial mechanisms, debt instruments, EU funds supports acquisition tangible and intangible assets for technological development. Assessing the intensity of investments to tangible assets, it was found that changes in turnover of Lithuanian industrial enterprises do not result in analogically changing investments (see Table 3). Although during 2005-2007 the investments of Lithuanian industrial enterprises to tangible assets increased, the trend of decrease of investment intensity is seen in the research, investigating the relation of these investments with sales revenue. Therefore, if in 2005 Lithuanian industrial enterprises have allocated 10.5% of sales revenue to investments, then in 2007 this figure amounted to 9.6%. Influence of financial crisis was also noticed in Lithuania industry during 2008-2010. The intensity of investment was annually decreasing and in 2010 it reached the lowest level because industrial enterprises allocated only 3.8% of their sales revenue to the investments of tangible assets. During the recovery after crisis period 2011-2012, the intensity of investments of industrial enterprises remained relatively low because only 4.2-4.7% of incomes were allocated to tangible investments. The intensity of investments of high-technology industries was significantly behind the national average of industrial enterprises in 2005-2007 because enterprises in this section have allocated only 4.6-5.8% of sales revenue to the investments of tangible assets. In 2008, this figure increased to 7.8%, but remained behind the analogical index of industrial enterprises having medium-low-technology. In 2009, many Lithuanian enterprises

significantly reduced their investments to tangible assets; however, the decrease of investments was particularly evident in high-technology industries, because they invested only 2.6% of their income. Nevertheless, in 2010, unlike the other sectors, the indicator of this growth is significant, amounting to 5.6%, which exceeds the intensity of investments to tangible assets in the other sectors. In 2011 EU financial support assimilation in Lithuania increased significantly. In this period high-tech industries have invested 8.5% of their income to tangible assets; therefore, such level of investments in other industrial sectors has significantly exceeded a part of income allocated to investments. Medium-high-tech

industries have invested up to 16.4% to tangible assets in 2005; however, the continuous and rapid decline of investment intensity has been noticed since 2006. During 2010-2012, the intensity of investments of enterprises having medium-high technology has significantly left behind other national industrial sectors because a part of income to tangible assets amounted to 2-2.8%. During pre-crisis and crisis period 2005-2009, medium-low-tech enterprises have distinguished by their investments to tangible assets allocating 8.3-12.6% of their income. Companies were widely replacing their obsolete equipment, thus according to this indicator, in 2010-2012, high-tech industries have outperformed medium-low-tech industries.

Table 4. A part of income of Lithuanian industrial enterprises, provided for tangible and intangible investments shown in percent

Manufacturing industries	2005	2006	2007	2008	2009	2010	2011	2012
	A part of income of industrial enterprises, provided for tangible investments, per cent							
High-technology	5,5	4,6	5,8	7,8	2,6	5,6	8,5	5,4
Medium-high-technology	16,4	8,4	7,7	4,7	4,5	2,4	2,0	2,8
Medium-low-technology	12,6	10,2	12,0	10,1	8,3	4,2	6,2	5,2
Low-technology	8,6	10,5	9,5	7,7	4,1	4,1	5,4	4,4
Lithuanian manufacturing average	10,5	9,8	9,6	7,5	4,9	3,8	4,7	4,2
A part of income of industrial enterprises, provided for intangible investments, per cent								
High-technology	0,2	0,5	0,7	0,7	1,2	0,4	0,3	0,4
Medium-high-technology	0,4	0,2	0,1	0,1	0,1	0,1	0,1	0,1
Medium-low-technology	0,2	0,1	0,2	0,1	0,2	0,2	0,1	0,1
Low-technology	0,2	0,2	0,1	0,4	0,2	0,3	0,2	0,1
Lithuanian manufacturing average	0,2	0,2	0,1	0,3	0,2	0,2	0,1	0,1

The calculated indicators of *intensity of investments to intangible assets* shows that Lithuanian industrial enterprises invest only a small part of their incomes to intangible assets, which in 2005-2012 ranged from 0.1 to 0.3% (see Table 4). During the research, high-tech enterprises distinguished by the highest level of intangible investments, which during 2005-2009 annually increased. Although, in 2009 the companies have significantly reduced the investments to this sector, their investments to intangible assets increased by 42%, as compared with 2008. These companies have invested 1.2% of sales

revenue when, during the same period, the corresponding ratio of national industrial enterprises was only 0.2%. However, since 2010, high-tech enterprises extremely reduced investments in intangible assets and in 2010-2012 the companies in this sector invested only 0.3-0.4% of sales revenues; therefore, they have been just a little ahead of other industrial sectors. Meanwhile, the levels of intangible assets of medium-high-tech enterprises in 2005-2006 exceeded the average of industrial enterprises and during 2007-2012 such enterprises invested 0.1% of their sales revenue to intangible assets.

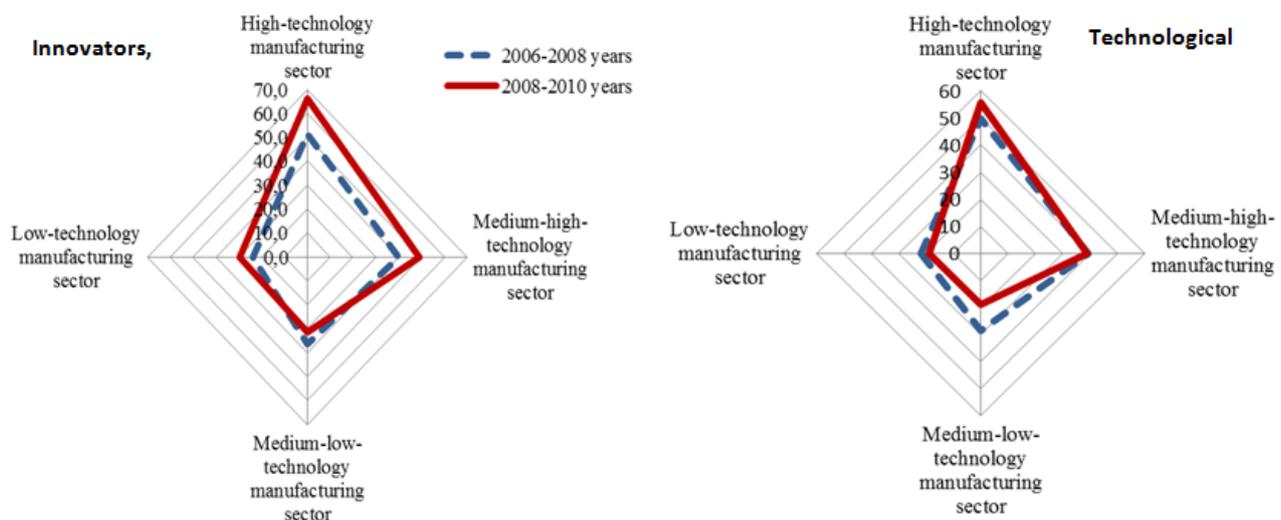


Figure 1. The percentage of innovators and technological innovators in Lithuanian industry

Business development is closely related with the needs to innovate for companies, and the majority of them are

realize that need through production re-composition, new product introductions or new technology adoptions.

During the assessment of innovators in Lithuanian industry and technological innovators, *the percentage of companies implemented innovations in the total number of companies and the percentage of companies implemented technological innovations in the total number of companies* have been calculated. The results show that a large part of investments of Lithuanian industrial enterprises are allocated for the increase of production capacity, but not the implementation of technological innovations (see Figure 1). During 2006-2008, innovations were implemented by only 30.2% of Lithuanian industrial enterprises, while during 2008-2010, a part of innovations implemented by industrial enterprises slightly increased and amounted to 32%. High-tech enterprises distinguish by significantly higher activity because during 2006-2008, companies-innovators represented 51.5% of the total number of enterprises and during 2008-2010, despite of crisis, the number of companies-innovators in this sector increased to 66.2%. The biggest number of companies implementing innovations are in industry sectors, related with ICT, energy supply, financial and insurance activities, utilities supply, manufacturing.

In the period of crisis, a part of technological innovators in high-tech industry of Lithuania did not decrease. In 2008-2010, 57% of high-tech industries implemented technological innovations and this part was 6 percentage points higher than in 2006-2008. However, a part of all other industrial sectors implementing technological innovations decreased during 2008-2010: technological innovations were implemented by less than fifth of medium-low-tech and low-tech industries. The majority of companies implementing technological innovations were investing to new equipment, implementing training activities for employees, performing R&D activities or buying R&D services.

In summary, decisions of the Government of the Republic of Lithuania in 2010, strengthening the country's economic competitiveness and promoting the growth of innovation have achieved its goal: from 2010, the high-tech sector significantly is ahead other Lithuanian

industrial sectors at the level of investment intensity and the highest level of intangible investments.

4.2. The Evaluation of Corporate Performance of Lithuanian Industrial Sectors Having Different Technological Levels

During the creation and implementation of innovations, the investments and funds are required in order to achieve actions necessary for the intended purpose. The investments in business have not only to pay off, but also to earn additional income. The implementation of continuous innovations is promoted by competition based market economy system, where the main indicators of such competitiveness are general and labour productivity. Therefore, after the calculation of *labour productivity indicators* in Lithuanian industries the growth of labour productivity has been found for the period of 2005-2007. In 2005, the added value created by one industrial employee amounted to 25.4 thousand LTL, while in 2007, the added value created by one employee amounted to 39 thousand LTL. Due to the financial crisis, labour productivity in 2009 decreased to 8.3%. During 2010-2011, the industrial enterprises sought to increase labour productivity; therefore, the added value created by one industrial employee has reached 47.3 thousand LTL that significantly exceed pre-crisis level. Due to the decreased labour productivity in medium-high-tech industries, the overall labour productivity of Lithuanian industries in 2012 has decreased to 44.1 thousand LTL.

During almost the entire period of research, medium-high-tech industries distinguished by the highest labour productivity, where labour productivity is 47 thousand LTL per employee (2005) increased to 116 thousand LTL per employee (2011). Such a high level of labour productivity is mostly determined by extremely high productivity of enterprises producing chemicals and chemical products. In 2005, the added value created by one employee in these enterprises was 96.6 thousand LTL, which 3.8 times exceeded the average of national industries.

Table 5. Labour productivity in Lithuanian industries (the added value is presented in thousand LTL per employee)

Manufacturing industries	2005	2006	2007	2008	2009	2010	2011	2012
High-technology	26,8	32,9	46,9	62,0	62,0	74,9	66,8	86,9
Medium-high-technology	47,0	54,3	72,8	79,3	52,2	104,6	116,1	73,0
Medium-low-technology	31,2	42,4	49,8	49,4	36,2	42,5	47,7	53,2
Low-technology	21,3	24,5	31,4	29,4	32,5	33,5	38,2	36,6
Lithuanian manufacturing average	25,4	30,6	39,0	38,9	35,6	42,1	47,3	44,1

In 2011, the labour productivity of enterprises producing chemicals and chemical products amounted to 255.9 thousand LTL per employee, which was 5.4 times higher than the average of national industries. During 2005-2007, high-tech industries distinguished by lower labour productivity than medium-low-tech industries. In 2005, the average added value created by an employee in high-tech industries was 26.8 thousand LTL, when the average of labour production in low-tech industries amounted to 31.2 thousand LTL. However, since 2008, the tendencies became completely different: In 2008, the labour productivity in high-tech industries exceeded the average labour productivity of low-tech industries by 25.5%, while in 2012 this gap amounted to 63.4%.

A large part of production produced by Lithuanian high-tech and medium-high-tech industries is exported. After the calculation of the indicator of the export share in sales revenue, it was found that, during the period of research, this part distinguished by the tendencies of growth (see Table 6).

In total turnover, the enterprises of this sector significantly differs from other national industries: During 2010-2012, the income from export of high and medium-high-tech industries accounted for 80.6-82.3% of sales revenues in all of these enterprises. In recent years, medium-low and low-tech industries export the increasing part of production; however, this part is significantly lower than high-tech industries.

Table 6. The export share of Lithuanian industries in sales revenue (income from export/sales revenue) shown in percent

Manufacturing industries	2005	2006	2007	2008	2009	2010	2011	2012
High-technology	69,1	74,1	72,3	73,6	76,5	82,3	80,6	80,8
Medium-high-technology	77,5	71,6	75,1	78,0	78,3	81,3	81,9	81,0
Medium-low-technology	37,8	37,9	37,9	40,8	50,1	50,9	50,5	53,0
Low-technology	48,6	47,5	46,9	44,6	46,4	50,8	51,5	51,9
Lithuanian manufacturing average	52,1	50,7	51,7	52,8	54,4	58,9	59,7	59,9

The performed analysis of *return on assets* in Lithuanian industrial sectors having different technological intensity showed that the higher intensity of investments does not necessarily lead to greater efficiency in asset management, especially when investments does not distinguish by technological innovation. Although, medium-low-tech industries have distinguished by the highest intensity of investment during 2005-2009, the

poor implementation of innovations led to lower return on assets than medium-high-tech industries. During 2005-2006, high-tech industries significantly left behind other national industries by the intensity of their investments, while their assets were managed ineffectively. However, during 2007-2012 the return on assets of high-tech industries exceeded the average of national industries (see [Table 7](#)).

Table 7. The return on assets of Lithuanian industries (net profit / assets) shown in percent

Manufacturing industries	2005	2006	2007	2008	2009	2010	2011	2012
High-technology	-6,6	-7,1	7,4	2,8	2,5	7,3	5,3	6,9
Medium-high-technology	7,8	7,2	8,8	5,9	-1,6	9,4	10,0	5,1
Medium-low-technology	3,6	6,1	6,0	2,8	-2,5	0,6	4,5	4,4
Low-technology	4,4	3,8	4,7	0,3	1,8	3,1	4,8	6,1
Lithuanian manufacturing average	4,0	4,7	6,0	2,2	0,0	4,0	5,9	5,5

Although, for the most of study period, medium-high-tech industries invested less income than other industries, but the higher extent of implemented innovations compared to medium-low-tech and low-tech industries led to greater efficiency of asset management, which is reflected by return on assets. Medium-high-tech industries faster recovered after crisis and during 2010-2011 their return on assets amounted to 9.4-10%; therefore, it can be said that the efficiency of activity in medium-high-tech

industries was greater than high-tech industries for almost the entire period of study. It shows that labour productivity, a part of export in income and return on assets of Lithuanian high-tech industries are largely determined by the intensity of investment, as well as innovations. For hierarchical cluster analysis using Ward's method, manufacturing industries' with subsectors were listed for analysis (see [Table 8](#)).

Table 8. The list of Lithuanian industries with subsectors for cluster analysis

No.	Sectors
1	High-tech manufacturing sector
2	C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
3	C26 Manufacture of computer, electronic and optical products
4	Medium high-tech manufacturing sector
5	C20 Manufacture of chemicals and chemical products
6	C27 Manufacture of electrical equipment
7	C28 Manufacture of machinery and equipment n.e.c.
8	C29 Manufacture of motor vehicles, trailers and semi-trailers
9	C30 Manufacture of other transport equipment
10	Medium low-tech manufacturing sector
11	C22 Manufacture of rubber and plastic products
12	C23 Manufacture of other non-metallic mineral products
13	C24 Manufacture of basic metals
14	C25 Manufacture of fabricated metal products, except machinery and equipment
15	C33 Repair and installation of machinery and equipment
16	Low-tech manufacturing sector
17	C10 Manufacture of food products
18	C11 Manufacture of beverages
19	C13 Manufacture of textiles
20	C14 Manufacture of wearing apparel
21	C15 Manufacture of leather and related products
22	C16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
23	C17 Manufacture of paper and paper products
24	C18 Printing and reproduction of recorded media
25	C31 Manufacture of furniture
26	C32 Other manufacturing
27	GDP at current prices

The cluster analysis also revealed the answers for theoretical and empirical discussions, that high-tech manufacturing sector development indicators in small

manufacturing industry as Lithuania are varying together with the main macroeconomic indicator GDP (see Figure 2).

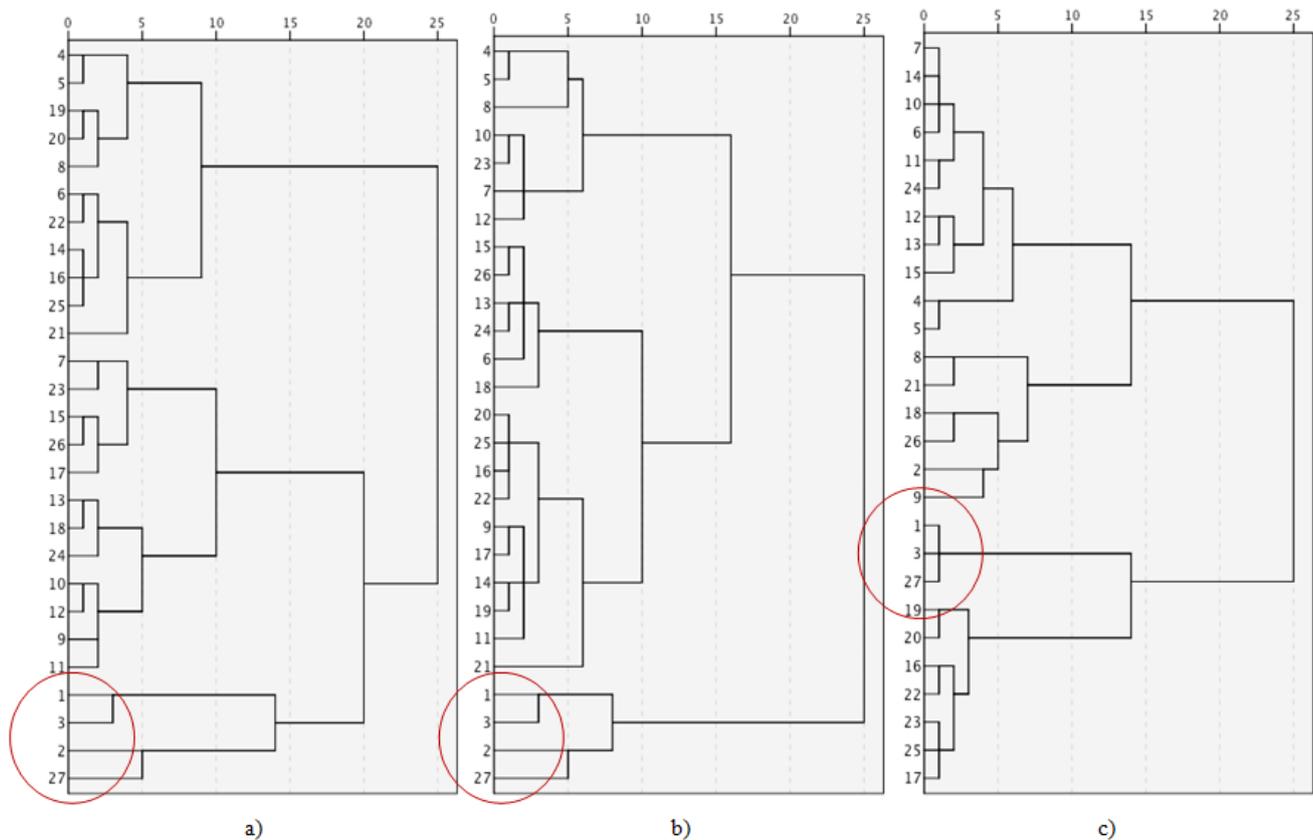


Figure 2. Dendrograms using Ward linkages for investment to tangible assets (a); proportion of tangible investments to sales revenue (b) and return on assets (ROA) (c)

However, it can be said that neither investments, nor innovation activity of enterprises give the immediate maximum effect; therefore, the differences of the indicators of performance efficiency in different industrial sectors will show up after a longer period of time, the more because high-tech industries operating in Lithuania began to develop more intensively in the recent years.

5. Discussion

In a recent years relation between global economic growth and competitiveness is significantly increasing. It forces to search for new qualitative and quantitative tools measuring technological innovation influence and impact for country's economy development. Innovations are also mentioned by academics and practitioners as one of the most effective economic recovery and growth instruments. Because of the intensive global competition each country analyse their potential advantages ensuring progress. Countries with industrial background (as Lithuania) are constrained to search for different improvement paths, based on more effective production industry developments.

Thus innovation adoption process includes high uncertainty about the risks and benefits, worldwide innovation research results are justifying innovation adoption activities in industry as the most important for added value creation.

Based on the results of research, it can be said that due to the different level of expenses provided for R&D,

results of investment volumes, innovation intensity of commercial activity, as well as their efficiency in the different levels of technological intensity of industrial sectors, the results are very different. These results are not fully supporting innovation process to be economically effective in all fields. However, the investment activity and innovations have a positive impact on the growth of companies, their labour productivity, and the growth of exports, as well as the efficiency of asset management.

Lithuanian industries invest only a small part of their income to the R&D activities. During 2008-2012, the income part of Lithuanian industrial enterprises allocated for R&D was only 0.19-0.34%. High-tech industries, which expenses for R&D have been steadily increasing and their relation to the income amounted to 1.96-3%, significantly distinguished. It is worth to notice serious tendency, that corporate/industry investments to innovations are very low. It shows not only uncertainty related risk valuation issues, but also reveals short-termism in business planning. These specifics are actual in a small changing economy countries, where the main turning point can arise from more intensive and effective cooperation between science & research institutions and business.

The obtained results of the study showed that until 2010 the leaders of investments in the field of tangible assets were medium-low-tech enterprises, while from 2010, high-tech sector was significantly ahead of other Lithuanian industrial sectors by level of its investments. Lithuanian industries invest only a small part of their

income to intangible assets, which during 2005-2012 ranged from 0.1 to 0.3%. Meanwhile, during a period of study, high-tech industries have distinguished by the highest level of investments to intangible assets. High-tech industries are significantly ahead of other Lithuanian industrial sectors by innovative activity.

The study confirms previous investigations' results stating that companies of high and medium-high-technologies are superior in terms of productivity, volumes of export, indicators of return on assets, comparing to the companies of medium-low and low-technologies. However, the case of Lithuania shows, that, although companies belonging to the industry of medium-high-technologies got behind the companies belonging to the industry of high-technology by their innovative activities, their operational efficiency was higher than high-technology companies for almost the entire period of study. On the one hand, it shows that labour productivity, a part of export in income and return on assets of Lithuanian high-tech industries are largely determined by the intensity of investment, as well as innovations. On the other hand, neither investments, nor innovation activity of enterprises give the immediate maximum effect; therefore, the differences of the indicators of performance efficiency in different industrial sectors will show up after a longer period of time, the more because high-tech industries operating in Lithuania began to develop more intensively in the recent years. Also, it should be mentioned that in the case of Lithuania, considerably high economic effect for innovation fostering can be obtained in a medium-high technology sector. This can result in a more rapid labour productivity increase, export share augmentation, and amplification of operations effectiveness.

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