

# “Formation of Lithuanian manufacturing industry clustering economic preconditions”

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# FORMATION OF LITHUANIAN MANUFACTURING INDUSTRY CLUSTERING ECONOMIC PRECONDITIONS

## Abstract

The main Lithuanian manufacturing industry clustering preconditions are related to productivity, innovation, and export development. In this research paper, it was found that the strength of cooperative relationships among cluster members, more favorable opportunities to access, and use of infrastructure of business and professional human resources are the major factors to form the preconditions chosen for developing a research model. Four hypotheses have been formulated, which aim to confirm or deny the formation of clustering economic preconditions for productivity, innovation, and export development. Along with the exploratory study, the arisen hypotheses verified that improvement of infrastructure of business and professional human resources and easier access to it for companies have a positive impact on export development. Two other factors – the strength of cooperative relationships and the infrastructure of human resources – are not significant. Cooperation and partnership processes remain undeveloped, as high-quality and full-value formation of the economic preconditions for productivity, innovation, and export development is not ensured properly.

## Keywords

industrial clusters, economic preconditions,  
competitiveness, productivity, innovation, export

## JEL Classification

D24, O12, O14

## INTRODUCTION

Major changes in the manufacturing industry are taking place in the contemporary global economy, which is extremely dynamic, economic development is uneven, and competitive struggle is intensifying. Therefore, the use of competitive advantage factors is becoming a key priority for successful competition. In this context, industrial companies are embarking on networking, one of the relevant forms of which is clustering. Most researchers emphasize the benefits of a cluster and its relationship with the preconditions for business efficiency, productivity, and innovation; policies to promote clustering are increasingly being developed in the countries' strategies for economic development and increasing competitiveness.

In today's dynamic economy, basic factors of growth and macroeconomic stability are no longer sufficient for countries seeking to remain competitive. Businesses are faced with the need to look for alternative forms of cooperation that would ensure the coherence between operational efficiency and innovation. One of such forms is clustering, which is rapidly expanding in the last decade – the tendency of interconnected companies, specialized suppliers, service providers, and associated institutions to geographically concentrate, cooperate, and, at the same time, compete. A cluster, as a form of organization of economic activity, helps organizations to overcome the challenges posed

by the modern business environment since a synergy effect is created when striving to achieve the overall economic growth of the whole group. Collaboration, competition, and close cooperation provide cluster entities not only with access to professional human resources and to certain elements of infrastructure of business but also create preconditions for increasing productivity (which is one of the main sources of competitiveness), innovation, and internationalization.

The formation of main preconditions for clustering is becoming a major challenge for business companies, organizations with different kinds of activities, and governments. In many developed countries, clustering is considered as an economic phenomenon promoting economic growth and development, attracting innovation and investment in the scientific research and experimental development (hereinafter referred to as R&D), and promoting the introduction of new technologies. By bringing businesses, public and educational institutions together, clusters provide access to specialized resources, and the emerging specialization provides its members, and, at the same time, individual regions, industries, and national economy, with a competitive advantage. Although in the scientific literature, considerable attention has been paid to the activity of clustering, the economic problems of the formation of clustering preconditions in the manufacturing industry have not been sufficiently investigated. The economic preconditions for cluster-oriented processes in the Lithuanian manufacturing industry have not been evaluated either.

## Aims

The study aims to evaluate the formation of economic preconditions for clustering in the Lithuanian manufacturing industry.

The objectives of the study are:

- 1) to identify the general characteristics of Lithuanian manufacturing clusters;
- 2) to evaluate the relationship between the strength of cooperative relationships among cluster members and more favorable opportunities to access, and use of infrastructure of business and professional human resources;
- 3) to identify the impact of the strength of cooperative relationships among cluster members and opportunities to use infrastructure of business and professional human resources on preconditions for productivity, innovation, and export development.

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## 1. LITERATURE REVIEW

The issues of clustering have been investigated and analyzed in the scientific literature already since the nineteenth century. When evaluating the beginning of the historical development of the concept of a cluster, it is worth noting that the ideas on the concentration of related economic activities and specialized industry, as well as the synergy effect resulting from the division of labor, are analyzed in Marshall's "Principles of Economics" (1890). In this book, those ideas are evaluated based on the agglomeration theory. Porter, in his book "The Competitive Advantage

of Nations", published in 1990, was among the first to present the concept of a cluster. There he substantiated the need for clusters and highlighted the potential of industrial clusters. Later, many researchers in their studies have relied on Porter's (1990) basic concept of a cluster. When developing the concept of a cluster, Rosenfeld (1995, 1997) emphasized the importance of synergies between companies' activities due to their close cooperation and close location in the region. The author has highlighted the lack of precision in the concept of a cluster in Porter's research, precisely because of the importance of the geographical location of enterprises and the problems that

may arise from too close cooperation and competition. Different authors emphasize different aspects of the concept of cluster: Padmore and Gibson (1997), Roelandt and den Hertog (1998) emphasize value chains, Feser (1998) pays attention to competitiveness, Simmie and Sennett (1999) note the importance of innovation created by industrial clusters. In the works of the researchers of the twenty-first century, clustering is associated with “knowledge economy”, technological “know-how”, and innovation. The application of this concept in various fields of economic activity is presented by Roelandt, Gilsing, and Sinderen (2000), Hill and Brennan (2000), Bekar and Lipsey (2001), Rosenfeld (2002), Martin and Sunley (2003), Ketels (2003), Andersson, Seger, and Sörvik (2004), Kamarulzaman and Mariati (2008), Sölvell (2009), Sopoligová and Pavelková (2017), and many others. In Lithuania, the studies on the themes of clustering processes are only fragmentary, there is a lack of continuity in the research, and clustering processes are usually evaluated in the context of other economic phenomena. Lithuanian authors include Jucevičius (2008), Malakauskaitė and Navickas (2008, 2010, 2011), Mačys (2005), Viederytė (2014), and Juščius (2012) who analyze clustering processes in the maritime sector, and other authors.

In the works of many authors, the study of the concept of clusters is almost inseparable from the competitiveness of enterprises and individual sectors of industry or region (Karaev, Koh, and Szamosi, 2007; Ștefan, Olteanu, & Constantin, 2019; Biukšāne, 2019). According to Porter (2000), successfully functioning clusters affect the competitiveness of a region in at least three ways: (1) increase the productivity of cluster members and, thereby, the productivity of the related industry; (2) create favorable conditions for the adaptation of cluster companies to innovation, thus, ensuring an increase in their efficiency; (3) promote the emergence of new businesses supporting innovation, thereby expanding cluster boundaries. In the present article, one distinguished the economic preconditions for clustering to increase productivity, innovation, and export development of companies. When motivating the choice of these particular preconditions, it is important to analyze the reasons and tendencies of their formation in the context of clustering.

The formation of preconditions for productivity, as a key factor of competitiveness, is determined by the development of company clustering. Close cooperation and partnership activities provide the organizations with more favorable opportunities to access and use specialized innovation, information, technology, public services, professional human resources, additional value chain services and products, which ensures the productivity and overall economic growth in the cluster (Mačys, 2005). According to Porter (2000), Jucevičius (2008), Malakauskaitė and Navickas (2010), the productivity of cluster organizations is determined by the following factors:

- *Profitability.* Specialization of companies allows minimizing operating costs. Activities in the cluster also lead to the development of innovation, which also ensures the growth in profit margins.
- *Combined supply possibilities.* The negotiating activity of a group of companies is clearly superior compared to an individual company. Higher volumes of supply provide better conditions for transaction completion, pricing, payment deadlines, as well as decreasing transportation and storage costs. According to Viederytė (2014), by creating a concentrated outlet market for suppliers, cluster companies gain a certain competitive advantage in terms of costs and quality of service provision. The geographical proximity is further exploiting the conditions of combined supply and transportation.
- *Skilled labor force.* Increased demand for particularly qualified professionals in the region is shaping certain labor market trends, which individual companies would not be able to do.
- *Easier and cheaper access to specialized information.* Often specialized information requires considerable financial resources that cannot be allocated by individual companies. The demand for such type of information, which is formed by a larger number of companies involved in a cluster, leads to establishing a separate information business company or creates the preconditions for the emergence of such a business within the cluster itself; of course, if it has such competence.

- *Competitiveness in both domestic and international markets.* Cluster members are bound not only by cooperative but also by competitive relationships, which means that companies have to compete not only internally but also against external competitors. Competitive advantage is very important in this case, and it is acquired for the latter reasons that determine not only the characteristics of the product being manufactured. This enables the companies to become competitive, to generate other competitive factors related to marketing, culture, or other specific elements.
- *Increased opportunities to operate in international markets.* The growth of the cluster market leads to an interest in new opportunities to realize business products. More realistic development opportunities are ensured by the fact that the majority of cluster companies are interested in this aspect, even those companies that supply goods and services to the companies in the cluster. Sharing information on new and potential markets facilitates the situation, and if a cluster has a particular company specialized in international trade, the situation is even more favorable.
- *Synergy of activities.* Cluster companies have added value through their activities, as they use common information and physical elements, and thereby save their resources.

According to Viederytė and Juščius (2012), a larger number of productive and efficient companies and organizations operating in the region determine the productivity of the whole group or even the macrosystem (industry, region, state). The authors argue that intense flows of knowledge exchange in the cluster due to internal and external competition are intensively exploited and stimulate innovative activity, as well as a rapid competitive advantage and economic growth of a cluster, which is operating in a partner mode.

The formation of preconditions for innovation is determined by favorable conditions in the cluster, including specialization, dissemination of technical knowledge and experience, opportunities for cluster members to learn from each other while looking for common solutions to prob-

lems. Geographic proximity allows for faster detection and application of spill-over innovations (Lietuvos pramonės klasterių plėtros programinė studija, 2003). According to Sölvell (2009), the relationship between the regional dimension, geographical proximity, and innovation of companies has been proven by a series of studies published over the past decade (Crescenzi, Rodriguez-Pose, & Storper, 2007; Chandrashekar, Subrahmanya, Joshi, & Priyadarshi, 2019). The innovation indicators in the European regions with no clusters are significantly lower than in the regions with clustering structures. In innovation processes, cluster members create a particularly strong synergetic effect, which is achieved for the same reasons that ensure the formation of preconditions for productivity: availability of specialized information on foreign markets, suppliers, consumers, and other aspects important to business entities; specialization of activities allowing to achieve a higher quality of production; competition within and outside the cluster encouraging the growing need to be innovative. According to Viederytė (2014), cluster members have more favorable opportunities to experiment with lower prices and the possibility not to take major commitments until they are convinced that innovative projects will be successful. Generally, innovation generated in a cluster involves the creation of new products or the improvement of the already existing ones.

The formation of preconditions for export development is inherent in organizations of the industry cluster. In the Guidelines of Lithuanian Export Development for 2014–2020 (2014), company clustering and cooperation are considered to be among the priority areas for promoting export. Clustering processes ensure the elimination of the main obstacles limiting the competitiveness of enterprises and facilitate access to foreign markets. Cooperation between companies facilitates the improvement of the efficiency of the supply of goods and provision of services, thereby contributing to increasing competitiveness. Moreover, cooperation between companies, when limited resources for marketing in foreign markets are concentrated, increases the potential for their international expansion. A particularly promising form of export development is participation of organizations in the international networks – in the activities of value chains. This creates an opportunity to gain

competitive advantage (it may be a patented product, equipment or technology, intangibles, as well as management techniques and competencies of the employees of a company).

## 2. RESEARCH METHOD AND HYPOTHESES DEVELOPMENT

Clustering in Lithuania is at a relatively early stage compared to other emerging and developed countries. In Lithuania, clustering processes were most active in 2010–2015, when organizations had access to financial instruments (Lietuvos klasterizacijos studija, 2017).

The work systematizes features of formatting preconditions specific to manufacturing industry clustering. These features are combined into constructive formulae of preconditions. The list made of preconditions is divided into 3 equal parts in accordance with the impact of preconditions on the increase of productivity, innovation, and export development.

The main used methods are: systemic and comparative analysis and synthesis of scientific literature, strategic documents and legislation; statistical analysis of secondary data and empirical research – exploratory companies' survey, as well as correlation analysis of data and multiplier linear regression modeling.

On April 1 – May 3, 2019, exploratory research was conducted by surveying 40 business companies that belong to clusters. The structure of research model with a focus to main hypotheses is visualized in Figure 1 and explained further.

The functioning of a cluster as a combination of interorganizational business entity depends primarily on the nature and strength of cooperative relationships among its members. The advantages of human resources for cluster companies have been studied by Connell and Voola (2013). The relationship between the cooperation among cluster members and professional human resources has been analyzed by Hsu, Lai, and Lin (2014). The latter authors (Hsu, Lai, & Lin, 2013) have also carried out an empirical study, the results of which

have confirmed the relation between the cooperative relationships of industrial clusters, the availability of strategic resources, and the changes in performance indicators of a company. Based on these studies, the first hypothesis has been raised:

*H1: The strength of cooperative relationships among cluster members is directly positively related to more favorable opportunities to access, and use of infrastructure of business and professional human resources.*

Stojčić, Anić, and Aralica (2019) have investigated industrial clusters and have proven that company clustering has an impact on the increase in company productivity, sales, and export volumes. The results of the empirical study carried out by Giuliani (2013) have shown that the nature of cooperation among industrial cluster members is relevant for the productivity of companies, as well as for the quality of their final production. Hsu, Lai, and Lin's (2014) empirical research demonstrated that close cooperation and professional human resources existing in industrial clusters have an impact on companies' results: increase in the indicators of turnover, profit and profitability; reduction of operating costs; development of the levels of technological infrastructure; and the growth in innovation and competitiveness. Based on these findings, the second hypothesis has been formed:

*H2: The strength of cooperative relationships among cluster members and more favorable opportunities to access, and use of infrastructure of business and professional human resources are directly positively related to the formation of preconditions for productivity.*

The third hypothesis is formed according to the empirical studies carried out by Langa, Miquel, and Morales (2015), Bell (2005), Grashof, Hesse, and Fornahl (2019), which aim to evaluate the impact of companies' belonging to a cluster on their innovativeness:

*H3: The strength of cooperative relationships among cluster members and more favorable opportunities to access, and use of infrastructure of business and professional human resources are directly positively related to the formation of preconditions for innovation.*

Hill and Brennan (2000), Stojčić, Anić, and Aralica (2019) in their studies have identified those industrial clusters that provide the region with the greatest competitive advantage. The authors mention an increase in export volumes as one of the factors of competitiveness provided by the cluster. The evaluation of the relationship between company clustering and the growth in export volumes is also motivated by the fact that the activity of the majority of Lithuanian manufacturing enterprises is based on export to foreign countries. Therefore, it is significantly related to the competitiveness of the country. The fourth hypothesis of the present study is formulated as follows:

*H4: The strength of cooperative relationships among cluster members and more favorable opportunities to access, and use of infrastructure of business and professional human resources are directly positively related to the formation of preconditions for export development.*

The relationship between the strength of cooperative relationships among cluster members, opportunities to access, and use of infrastructure of business and human resources, company's performance, productivity, innovation, and export development factors are assessed. To evaluate the first hypothesis, the correlation analysis is used, and to test the second, third, and fourth hypotheses, multiple linear regression is employed by applying the ENTER method. During data analysis, mean variables have been derived, which, when processing the data, are denoted by appropriate abbreviations: cooperative relationships – *CR*, infrastructure of business – *BI*, human resources – *HR*, company's performance indicators – *PI*, productivity factors – *PF*, innovation factors – *IF*, export development factors – *EF*. Variable *CR* describes the nature of cooperative relationships among companies that belong to the same value chain and that are concerned with developing the final product. It also describes the nature of cooperative relationships among companies outside the value chain, among foreign organizations, public authorities, financial institutions, non-profit organizations. Variable *BI* reveals the intensity of companies' opportunities to access and use of infrastructure of business (logistics, raw materials, marketing tools, production distribution and supply channels, infor-

mation on resources, technologies, markets, and specialized services for businesses). Organizations' opportunities to access and use of professional human resources (skilled labor force, professionals in science and technology, management and marketing) are characterized by a variable denoted as *HR*. With the derived mean variable *PI*, one aimed at defining the indicators of companies' economic performance (turnover, profitability, costs, labor productivity). Variable *PF* measures the change in productivity of organizations due to their participation in a cluster (specialization, economies of scale, synergy effect, capture of market share, participation in training and seminars at lower costs). Variable *IF* defines the factors of innovation (easier and faster-found resources for innovation, new technologies, lower risks, development of new products, introduction of new production technologies, dissemination of good practices, funding for scientific research and experimental development). Variable *EF* has been used to evaluate the changes in export development factors – how participation in a cluster provides with easier and cheaper access to information on foreign markets; better quality of production at lower costs; easier discovery and development of relationships with customers, suppliers, and customers in foreign markets; better opportunities to participate in international exhibitions.

### 3. RESULTS AND DISCUSSION

When analyzing the structure of the Lithuanian manufacturing industry and the trends of its development, the competence of employees, traditions, and other circumstances, it should be noted that many of its sub-sectors are still oriented towards low value-added production, close cooperation and partnerships are avoided there, and competitiveness is based on relatively cheap labor and resources. On the other hand, in some sectors (chemicals, electronics, metals, machinery, and equipment), there can be observed significant enterprise integration processes through developing value-cost chains and growing investment in R&D and innovation. Although clustering of companies is clearly more intensive in the service sector, some of the clusters operating in the manufacturing industry are focused on creating high added value, international competitiveness and develop-

ment, and, therefore, are no less significant to the national economy. This gives a competitive advantage not only to cluster members but also to the national economy.

In the course of the research, business companies from 20 different clusters have been surveyed. Out of 40 respondents who completed the survey, 9 belonged to the metals, machinery and equipment manufacturing industries, 7 belonged to the electronics industries and 7 – to wood and furniture industries, 6 belonged to the food and beverage industries and 6 – to chemical industries. 5 respondents indicated to belong to other sectors of the economy. These have been companies in the sectors of information technology, services, and construction. This means that the activities of these clusters include not only the manufacturing industry but also other sectors of the economy. It can be argued that in the manufacturing industry, there are the processes of integrating companies into value chains.

In terms of the size of the companies surveyed, it can be noted that the majority of all respondents have consisted of small and medium-sized companies: 15 small companies (10-49 employees), 12 medium-sized companies (50-249 employees), and 10 very small companies (1-9 employees). The number of very large companies is not big – only 3 out of 40 respondents have indicated that they represent companies with 250-499 employees or companies with 500 or more employees. It can be concluded that the clusters currently operating in the manufacturing industry consist mainly of medium, small, and very small companies. It is worth noting that such a structure of a cluster creates favorable conditions for small businesses to gain maximum benefits from all the advantages provided by a cluster. Otherwise, the dominance of large companies would be disadvantageous and even harmful to the small ones, especially in the early stage of cluster formation, which currently includes most of the clusters of the manufacturing industry.

Summarizing the duration of the activities of all companies involved in the survey, it has turned out that the vast majority, i.e., 30 percent, have been operating between 11 and 20 years, 27.5 percent – between 21 and 30 years. A significant part

(17.5 percent each) is comprised of companies operating between 2 and 5 years and between 6 and 10 years. The proportion of economic entities with long experience of activity and companies that have been in business for more than 30 years has comprised 7.5 percent of the survey respondents. The vast majority of respondents, i.e., 21, have indicated that the company they represent has been in the cluster for 1 to 3 years. 14 business companies have been developing activities in the cluster for a longer period – between 4 and 9 years. A very small part – 4 companies – has duration of activity in the cluster of less than a year. Although one of the companies involved in the study has been operating in the cluster for more than 10 years, business activity in partnership of the majority of the companies in the cluster takes not a long time; thus, it can be argued that clustering in the Lithuanian manufacturing industry is still at an early stage. On the other hand, the nature of cooperation among cluster members is currently not limited to only a few aspects. In Figure 1, the distribution of the respondents according to the nature of cooperation in the cluster is presented. When systematizing the data, the individual criteria for partner activities are coded as follows: B1 – “You have signed cooperation agreements”; B2 – “You are cooperating in the value chain to develop the final product”; B3 – “You cooperate in different initiatives”; B4 – “You cooperate in the processes of the scientific research and experimental development”; B5 – “You are carrying out joint projects of the European Union”; B6 – “You cooperate episodically, you have almost no common activities”; B7 – “There is no relationship of cooperation”. When indicating the criteria on the nature of their cooperation with other members in the cluster, respondents have been given the opportunity to mark several options of responses. Only 1 out of 40 respondents indicated that the company they represent does not maintain cooperative relationships with other clusters. The majority of respondents, i.e., 30, have indicated that they cooperate in various initiatives (joint training, joint marketing, joint product development, etc.). 28 out of 40 respondents have mentioned that the company they represent is cooperating in the value chain to develop the final product, and that their company is carrying out joint EU projects. Some members of the manufacturing industry cluster (22 companies out of 40) carry out activi-

ties based on cooperation agreements. 23 respondents have indicated that they are involved in the processes of scientific research and experimental development. This multidimensional cooperation among the majority of cluster companies suggests that clustering processes in the Lithuanian manufacturing industry occur naturally and are based on close cooperation and partnerships, not only with the aspiration of gathering support from the EU structural funds.

To evaluate the factors of the strength of cooperative relationships among cluster members, more favorable opportunities to access, and use of certain infrastructure of business and professional human resources in various fields, as well as the relationship between the change in performance, productivity, innovation, and export development of cluster companies, the Pearson correlation coefficients have been employed (Table 1).

The hypothesis *H1* has been tested to determine whether cooperative relationships are directly related to more favorable opportunities to access and use of infrastructure of business and professional human resources. The results obtained have shown that the assessments of the cooperation relationships have positive, of moderate strength, and statistically significant correlation relations with infrastructure of business indicator ( $r = 0.663$ ,  $p < 0.05$ ). It can be argued that the strength of cooperative relationships among cluster members is directly positively related to more favorable opportunities to access and use of certain infrastructure of business. This means that the closer various cluster organizations (including business companies, government, science, education and research institutions, financial, non-profit organizations, etc.) work together, the easier it is for all the members to access and use of infrastructure of business (such as transportation infrastructure, marketing tools, better quality and

cheaper raw materials, information on local and foreign markets, technologies and resources, specialized services, etc.).

Besides, cooperative relationship assessments have been found to be associated with positive, weak, but statistically significant (with the level of statistical significance at 0.1) correlation relations with the indicator of infrastructure of human resources ( $r = 0.382$ ,  $p < 0.1$ ). It can be argued that cooperation among cluster members is directly positively related to more favorable opportunities to access and use of infrastructure of professional human resources (e.g., skilled labor force, highly qualified professionals in science and technology, and management and marketing). This means that the closer the cluster members cooperate, the more favorable are the opportunities to access and use of infrastructure of business and professional human resources.

Based on these results, the study hypothesis *H1* can be accepted because it has been found out that the closer is the cooperation, the more favorable are the opportunities and use of infrastructure of business and human resources.

The second, third, and fourth hypotheses due to their formulation structure are tested by constructing multiple regression models that help to analyze how the strength of cooperative relationships, infrastructure of business, and human resources affect productivity, innovation, and export development.

To test the hypothesis *H2*, it has been sought to determine whether the strength of cooperative relationships among cluster members and more favorable opportunities to access and use of infrastructure of business and professional human resources are directly positively related to the formation of preconditions for productivity.

**Table 1.** Correlations between the derivative variables

|                           |                 | Infrastructure of business | Human resources | Company's performance indicators | Productivity factors | Innovation | Export development |
|---------------------------|-----------------|----------------------------|-----------------|----------------------------------|----------------------|------------|--------------------|
| Cooperative relationships | <i>r</i>        | .663**                     | .382*           | .590**                           | .560**               | .495**     | .444**             |
|                           | <i>p</i> -value | .000                       | .015            | .000                             | .000                 | .001       | .006               |

Note: \*\* correlation is statistically significant, with the level of statistical significance at 0.05, \* correlation is statistically significant, with the level of statistical significance at 0.1.

**Table 2.** The impact of cooperative relationships and the infrastructure of business and human resources on company's performance and productivity factors

| Variables                                      | The composed equation ( <i>p</i> -values in brackets)                                 | The coefficient of determination |
|------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------|
| Company's performance indicators ( <i>PI</i> ) | $PI = -0.581 + 0.603(0.017) \cdot CR + 0.418(0.008) \cdot HR + 0.071(0.712) \cdot BI$ | 0.489                            |
| Productivity ( <i>PF</i> )                     | $PF = 0.125 + 0.050(0.759) \cdot CR + 0.275(0.011) \cdot HR + 0.606(0.000) \cdot BI$  | 0.689                            |

The results of the correlation analysis have shown that the assessments of the strength of the cooperative relationships are related with positive, moderate and statistically significant correlation relations with the change in the indicators of company's performance and productivity factors ( $r = 0.59, p < 0.05$  and  $r = 0.56, p < 0.05$ , respectively) (Table 1).

Cooperative relationships among cluster members are directly positively related to the changes in the indicators of company's performance and more favorable assessment of productivity factors. This means that the closer is the cooperation, the more business turnover is growing, profitability indicators are growing, operating costs are declining, and the level of labor productivity is rising. The strength of cooperative relationships also leads to a higher degree of specialization among companies in the cluster (by "transferring" secondary activities to other members in the cluster, there emerge favorable opportunities to best express one's competence in the field of activity). It enables economies to reach the economies of scale through an increased number of orders, and to occupy a larger part of the local market, to experience the advantages of the effects of the synergy of activities, and to participate in various training and seminars at lower costs.

The test of the hypothesis *H2* has been performed by constructing two multiple regression models. They help to assess the impact of cooperative relationships and the infrastructure of business and human resources on company's performance indicators and productivity factors characterizing the overall productivity of cluster companies. The obtained results have shown that all the factors, except the indicator of the infrastructure of business ( $b = 0.071, p = 0.712 > 0.05$ ), have a positive and statistically significant effect on the changes of the indicators of company's performance. This means that the strength of coopera-

tive relationships and more favorable opportunities for cluster members to attract and retain professional human resources simultaneously result in higher turnover, profitability, productivity levels, and lower operating costs. The coefficient of determination of the regression model is equal to 0.489; therefore, the developed model explains, on average, 48.9 percent of the dispersion of the productivity indicator depending on the indicators related to it (Table 2).

A regression of productivity factors is developed. It assesses the impact of cooperative relations, the infrastructure of business and human resources on productivity factors. The obtained results have revealed that all factors, except the indicator of the strength of cooperative relationships ( $b = 0.05, p = 0.759 > 0.05$ ), have a positive and statistically significant effect on productivity factors. This means that the level of productivity of cluster members, which is determined by the specialization of companies, synergy effect, economies of scale, and other factors, depends more on favorable opportunities among cluster members to access and use of infrastructure of business and human resources. The coefficient of determination of the regression model is equal to 0.689; therefore, the developed model explains, on average, 68.9 percent of the dispersion of the indicator of productivity factors depending on the indicators related to it.

Based on the results of the two regressions, it can be stated that the hypothesis *H2* is only partially validated, as it has been found out that the opportunities of cluster companies to access and use of infrastructure of business are positively not related to the change in the indicators of company performance, which determine the formation of preconditions for productivity, and the strength of cooperative relations is not directly related to productivity factors.

Testing the hypothesis *H3*, a multiple regression model of the innovation factor has been composed. It assesses the impact of cooperation relations, the infrastructure of business and professional human resources on the formation of preconditions for innovation. The infrastructure of business ( $b = 0.343$ ,  $p = 0.002 < 0.05$ ) and human resources ( $b = 0.469$ ,  $p = 0.001 < 0.05$ ) has a direct and statistically significant impact on the innovation factors of cluster members. Meanwhile, the indicator of cooperation relationships has no statistically significant impact on innovation, because  $b = 0.007$ ,  $p = 0.968 > 0.05$  (Table 3). More favorable opportunities to access and use of infrastructure of business and professional human resources have a direct positive impact on the preconditions for innovation: easier and faster found financial resources for innovation and investment in new technologies and R&D, and lower risk when implementing innovation (it is distributed to all cluster members); the development of new products and the introduction of production technologies is encouraged; there is an opportunity to share “good practices”. However, the strength of cooperative relationships does not have a significant impact on the formation of innovation; thus, the research hypothesis *H3* is partially confirmed.

The coefficient of determination of the regression model is equal to 0.638; therefore, the developed model explains, on average, 63.8 percent of the dispersion of the indicator of innovation depending on the change of other indicators.

Before testing the fourth hypothesis of the study, which is related to the assessment of export development, it is important to mention the data obtained during the research survey, which represents the export-related activities of the cluster companies. 35 out of 40 respondents of the survey have indicated that their company exports its products to other countries. This accounts

for 87.5 percent of all the surveyed; therefore, it once again proves that the strategies of the vast majority of Lithuanian manufacturing subsector companies are export-oriented, which ensures the competitiveness of the state in relation to other countries. In this respect, participation in cluster activities enables companies, especially small and medium-sized ones, to ensure quantitative and qualitative export development. Respondents have been asked how participation in cluster activities affects their export volumes. Responses have been given on a five-point scale ranging from “there is no effect” to “effect is very strong”. Respondents have rated the impact of participation in a cluster on export development on average by 2.57 points out of 5. This means that the impact of clustering on the growth of export volumes of manufacturing industries is currently moderate and does not have a significant impact. The vast majority of respondents, i.e., 14 out of 40, have indicated that belonging to a cluster has a very weak effect on export development of their represented company; 5 respondents have stated that there is no effect at all, but 8 out of 40 have rated this effect as relatively strong. The relatively weak effect of clustering on export development has been assessed by 10 respondents.

In the following stage of the study, a multiple regression model has been composed. It has helped to assess the level of export development and to show the impact of cooperative relationships and the infrastructure of business and human resources on export development factors. Based on the results of the model, the research hypothesis *H4* has been tested.

The obtained results have shown that only infrastructure of business has a positive and statistically significant effect on export development ( $b = 0.595$ ,  $p = 0.005 < 0.05$ ). The effect of other two indicators – cooperative relationships ( $b = 0.028$ ,  $p = 0.907 > 0.05$ ) and the infra-

**Table 3.** The impact of cooperative relationships, infrastructure of business and human resources on innovation

| Variables                | The composed equation ( $p$ -values in brackets)                                     | The coefficient of determination |
|--------------------------|--------------------------------------------------------------------------------------|----------------------------------|
| Innovation ( <i>IF</i> ) | $IF = 0.732 - 0.007(0.968) \cdot CR + 0.343(0.002) \cdot HR + 0.469(0.001) \cdot BI$ | 0.638                            |

**Table 4.** The impact of cooperative relationships, infrastructure of business and human resources on export development

| Variables                        | The composed equation ( <i>p</i> -values in brackets)                                | The coefficient of determination |
|----------------------------------|--------------------------------------------------------------------------------------|----------------------------------|
| Export development ( <i>EF</i> ) | $EF = 0.425 + 0.028(0.907) \cdot CR + 0.171(0.261) \cdot HR + 0.595(0.005) \cdot BI$ | 0.439                            |

structure of human resources ( $b = 0.171$ ,  $p = 0.261 > 0.05$ ) – is not statistically significant because  $p > 0.05$  (Table 4). This means that export development is positively affected only by the improved opportunities to access and use of infrastructure of business and human resources. Based on this finding, the hypothesis  $H4$  is only partially validated, as the improvement of infrastructure of business and human resources and easier access for companies have a positive impact on the factors of their export development (e.g., easier and cheaper access to information on foreign markets; there are more favorable opportunities to produce higher quality products with-

out increasing operating costs; there are more favorable opportunities to find new partners in foreign markets and to develop cooperation with them and to participate in international exhibitions and similar events at lower costs, etc.), but other two factors – the strength of cooperation relationships and the infrastructure of human resources – are irrelevant.

The coefficient of determination of the regression model is equal to 0.439; therefore, the composed model explains, on average, 43.9 percent of the dispersion of the indicator of export development depending on the change of other indicators.

## CONCLUSION

Summarizing the results of the analysis of the research data, it can be stated that the cooperation and partnership processes of the majority of clustering companies are intensively developing and occur in various respects (integration through the value-cost chain, joint initiatives and training, cooperation agreements, etc.), thereby determining more favorable opportunities to access and use the elements of infrastructure of business and professional human resources. However, these processes remain undeveloped, as high-quality and full-value formation of the economic preconditions for productivity, innovation, and export development is not ensured. This is proved by partial validation of the second, third, and fourth hypotheses.

It has been found out that the opportunities for cluster companies to access and use of infrastructure of business and professional human resources are not positively related to the changes in the indicators of company's performance, which determine the formation of preconditions for productivity; and the strength of cooperative relationships is not directly related to the factors of productivity. Improvement of infrastructure of business and professional human resources and easier access to it for companies have a positive impact on export development; however, two other factors – the strength of cooperative relationships and the infrastructure of human resources – are not very important in this case.

Although several clustering initiatives are currently identified in the Lithuanian manufacturing sector, clustering is still at an early stage. There are also many barriers to the formation and development of clustering processes. Clusters operating in the Lithuanian manufacturing industry are faced with a lack of infrastructure of professional human resources, lack of cooperation and trust among them as well as inactive specialized institutions in the sector. Insufficient application of measures to promote clustering processes when shaping the economic policy of the state can also be distinguished. These and other assessed the problems leading to insufficient and inadequate formation of economic clustering preconditions for productivity, innovation, and export development.

## AUTHOR CONTRIBUTIONS

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