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Export Approach to Country's Competitiveness: Evidence from Lithuania

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Social sciences,
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ABBREVIATIONS AND DEFINITIONS

ECI – Economic Complexity Index
GCI – Global Competitiveness Index (the old version, before 2018)
GCI 4.0 – Global Competitiveness Index (the new version, starting from 2018)
FTA – Free Trade Agreements
IMD – IMD Competitiveness Rankings
IMF – International Monetary Fund
OLS – ordinary least squares estimation
PPML – Poisson pseudo-maximum likelihood estimation
RCI – the EU Regional Competitiveness Index
UN – United Nations
WCC – World Competitiveness Center
WEF – World Economic Forum
WTO – World Trade Organisation

Intensive trade margin examines the value of trade.

Extensive trade margin examines either the number of markets served or the number of products traded.

Direct effects (factors) – the factors which condition expanding the country's export network directly from the country of origin.

Examples of the direct effects are: the distance between the country of origin and country *c*, the number of emigrants from the country of origin to country *c*, the ability to communicate between the country of origin and country *c*.

Network effects (factors) / Indirect effects (factors) / Friends-of-friends effects (factors) – the factors which condition expanding the country's export network from the current export partners of the country of origin, i.e. via friends-of-friends search procedure.

Examples of the network effects are: the sum of distance between the current export partners of the country of origin and country *c*, the average number of emigrants from the current export partners of the country of origin to country *c*, the average ability to communicate between the current export partners of the country of origin and country *c*.

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INTRODUCTION

Relevance of the topic

The concept of a country's competitiveness is so extensive and unspecified that economists, after decades of discussions about what it is and how it is to be estimated, just let it be. At first it was associated with exports (e.g. Balassa, 1965), later with productivity (e.g. Krugman, 1994), then with the living standards of the country's residents (e.g. Fagerberg, 1988; Tyson, 1992; Annoni & Dijkstra, 2019), and with the overall growth and development of a country (e.g. Porter et al., 2001; Aghion & Howitt, 2006; Barry et al., 2003; Schwab, 2015; IMD, 2022). Perhaps the only two facts about a country's competitiveness that everybody agrees on are that a competitive country is an economically successful country, and that there is no single and generally accepted method to evaluate it.

By understanding competitiveness as economic success, economists turned to evaluating how economically successful individual countries actually are. They have developed a number of theories, models and methods to estimate the economic success of specific countries, or at least their success in some of the aspects of their economic structures. Schwab (2019), IMD (2022) and Annoni & Dijkstra (2019) applied different methodologies to calculate the competitiveness indexes of specific countries. Other economists try to evaluate a country's economic success in the fields of the green economy, technologies, human capital as well as some other fields. There are economists (e.g. Hidalgo et al., 2007; Hidalgo & Hausmann, 2009) who come back to the initial estimations of the economic success of countries and try to reveal their economic perspectives from the exports data.

Due to having so many different measures of a country's competitiveness, a question arises if these measures really show what they are meant to show, what the differences between them are, and whether they are comparable to each other. Therefore, in this thesis, we shall briefly examine a few of the most famous measures of a country's competitiveness, and then we shall look at the origins of the concept of a country's competitiveness and associate it with the country's success in competing in the world market via exports.

Taking exports as a proxy for the economic success of a country (or the country's competitiveness) has been justified by the findings of Lall et al. (2006), Rodrik (2006), Hidalgo et al. (2007), Hidalgo & Hausmann (2009) and other influential papers. According to them, knowing what kind of goods a country manufactures and exports allows to reveal what kind of resources and capabilities a country possesses, and, hence, what its perspectives for growth and development are. Therefore, in order to reveal Lithuania's

competitiveness, we shall examine Lithuania's export structure in terms of the export markets, the products exported, the factors that played a role for the development of Lithuania's export network and, finally, the strength and resilience of Lithuania's export network in the face of such a global crisis as the one caused by Covid-19 pandemic.

Economies usually do not experience smooth and undisturbed growth. One of the greatest shocks in the recent years was Covid-19 pandemic which affected not only a significant part of the population, but also the competitiveness of countries: both their internal economies and their export structures (Arriola et al., 2021; Hayakawa & Mukunoki, 2021; Espitia et al., 2022; Vidya & Prabheesh, 2020; Zainuddin et al., 2021; Zainuddin et al., 2022). Therefore, this thesis examines Lithuania's product exports and how the exports shifted in terms of products and regarding the export markets during the first year of the pandemic. Such analysis could reveal how Lithuania's export structure changed during the pandemic and how these changes influenced the country's competitiveness.

Today, Lithuania is a highly developed, high income country, belonging to the EU and the OECD and exporting a number of products all over the world. However, when Lithuania declared its independence in 1990 and started to develop its trade network, it was merely a small, lagging-behind country somewhere in the outskirts of the 'modern' Europe with shabby links to any other non-Soviet bloc countries. This thesis goes back in time and reveals which factors were important for the creation of Lithuania's export network and how their influence has been changing throughout the years. When examining the formation of Lithuania's export network, we follow the general literature on gravity modelling (Anderson & Van Wincoop, 2003; Shepherd, 2012; Correia, 2017; Mundlak, 1978) and the economics of networks (Jackson, 2010), as well as specific literature on trade networks (Chaney, 2014; Morales et al., 2019; Berthou & Ehrhart, 2017; Helpman et al., 2008; Zhang, 2020; Jun et al., 2020; Wang & Zhao, 2013; Chen & Sun, 2021; Basile et al., 2018; Baldwin & Di Nino, 2006). Analysis of the factors which played an important role in the process of Lithuania's trade network formation provides a deep insight to the factors that have shaped the current competitiveness of Lithuania and which are crucial for its further development.

Research problem

There are many different measures of a country's competitiveness. However, their relevance, reliability, how they define the country's competitiveness, and what they really say about the country's economic success is not

straightforward. Hence, in order to enhance Lithuania's economic success, we need a better and more profound understanding of its economic structure, abilities to compete in the world market and to ensure sustainable economic growth.

Therefore, by following the recent developments of Rodrik (2006), Hidalgo et al. (2007), Hidalgo & Hausmann (2009), Schetter (2020) and Balland et al. (2022), in this thesis, we choose exports as a proxy for a country's competitiveness. Based on that, we examine Lithuania's export structure: its development and resilience to the recent global economic shock caused by Covid-19 pandemic. Deeper knowledge on what kind of products Lithuania exports, what were the most important factors for the development of Lithuania's trade network, and how Lithuania's export structure changed during the first year of the pandemic would give us a better insight in this aspect of Lithuania's economy and help to determine the country's competitiveness.

Goal and objectives

The **goal** of the analysis is to identify the main determinants of the competitiveness of a country and to examine Lithuania's export competitiveness.

To achieve this goal, the following **research objectives** have been identified:

1. To review the concept and measures of a country's competitiveness and to highlight its most important aspects.
2. To critically evaluate the main composite measures of a country's competitiveness.
3. To determine the influence of Covid-19 pandemic to Lithuania's export structure in terms of the product groups and destination countries.
4. To evaluate if the importance of any of the export-determining factors have changed since the onset of the pandemic.
5. To determine which factors were the most important for the development of the extensive margin of Lithuania's export network and how their influence has changed throughout the years.

Research methods

A wide range of methods of economic analysis are applied in this research. The first part of the thesis relies on systematic analysis of literature, descriptive analysis, statistical and graphical analysis methods. The empirical Sections apply gravity modelling and network analysis methods. The main method used in this part of the thesis is panel data econometrics. Econometric

analysis was conducted by applying the ordinary least squares, linear probability, Logit, Probit and Poisson pseudo-maximum likelihood regressions. The graphical representations and quantitative analyses were conducted with the help of statistical software *Stata MP*.

Scientific novelty and contribution

The research presented in the thesis contributes to the literature on a country's competitiveness, empirical gravity modelling, international trade networks and the effects of the pandemic. It fills the gap in the current literature on the following issues:

1. The current research on a country's competitiveness is dispersed. There are many different institutions which try to define and estimate a country's competitiveness. However, their definitions of competitiveness focus on different aspects of a country's economy. Their estimation methodologies also differ. This research tries to fill the gap in the existing literature by comparing the main measures of competitiveness, and to contribute to the debate on the relevance of the measures of a country's competitiveness to its definitions.
2. Gravity models typically use export data aggregated by countries. To the best of our knowledge, such aggregated export data has been used by all the papers applying gravity model to examine Lithuania's international trade so far (e.g. Stavytskyy et al., 2019; Startienė et al., 2019; Čipkutė, 2017). Shepotylo (2010) used product-level export data for gravity modelling; however, this paper included Lithuania only as part of a region. Therefore, the novelty of the research in Sections 2 and 3 is the inclusion of the third dimension (i.e. product) to the gravity modelling of Lithuania's export. This allows us to thoroughly examine Lithuania's export structure: not only by the export partner, but also by the product group.
3. There is still lack of research on how Covid-19 pandemic affected trade in terms of the trade partners, and on the possible changes in the importance of various export determining factors during the pandemic. The research in Section 2 fills the gap in the current literature by empirically analysing the possible heterogeneity of export in terms of both products and destination markets. As far as we are aware, this is the first research to analyse the changes of the importance of different determinants of export during the first year of the pandemic.
4. The research in Section 3 contributes to the literature on trade networks by examining a large number of network effects (distance, common culture, economic development, common spoken languages, contiguity,

participation in free trade agreements, and the stock of migrants) on the extensive margin of foreign trade. To the best of our knowledge, this is the first research to include so many network effects in the gravity model.

5. The novelty of the research in Section 3 is that it focuses on the new entrance to the international trade market and analyses the very origins of a country's export network formation, while the existing papers are based mainly on the mature markets. To the best of our knowledge, this is the first research to attempt examining the process of the formation of a country's export network almost from the very beginning of its development.
6. The research in Sections 2 and 3 provides a novel approach to the analysis of Lithuania's international trade. To the best of our knowledge, it is the first in-depth and 3-dimensional (country, time, product) analysis of Lithuania's export which focuses not on the changes of Lithuania's export structure, but mainly on the factors determining Lithuania's export structure. It is the first research which revealed the factors that influenced the formation of Lithuania's trade network, as well as the changes of these factors after the shock of the pandemic.

Practical significance

The analysis of the effects of the pandemic on Lithuania's export structure gives insight into the influence of various export determinants. We are better informed which Lithuania's export sectors and destination markets are more or less vulnerable to external shocks. Being aware of these issues could help public institutions make better informed decisions as to which economic sectors are to be promoted, and what investments in these sectors are to be encouraged.

The knowledge on how Lithuania's export network developed and which factors were the most important during its formation process allows the policy makers of Lithuania and other countries to clarify the most significant aspects of the country's export competitiveness. This information could help less developed countries which are only entering the international trade market to form their economic and social policies accordingly.

The conducted research could also be useful for the researchers examining a country's competitiveness, international trade and networks in trade. The literature review on gravity modelling could also be used as a brief and concise introduction to the method and its applications.

Defended statements

1. Global Competitiveness Index (GCI) is not able to predict the future GDP growth rates of specific countries; hence, it does not correspond to the definition of the GCI as of Schwab (2016) and Schwab (2019). However, in the group of the high income countries, GCI does reveal their ability to avoid sharp fluctuations in their GDP growth rates and to maintain sustainable economic growth.
2. Lithuania's export was resilient to the shock of Covid-19 pandemic. There were no important negative changes in Lithuania's export competitiveness during the first year of the pandemic.
3. The influence of distance or any other factor determining the value of Lithuania's export has not changed due to the pandemic.
4. The most important factors conditioning the development of Lithuania's export network were the number of the current export markets of Lithuania, the previous exporting to the given destination, the closer distance, the ability to communicate, and the stock of emigrants in the destination country.
5. During the first years of Lithuania's opening to the foreign trade, the cultural and historic factors (i.e. common spoken languages and Soviet bloc membership) were the most important. Meanwhile, in the later years, economic effects (e.g. GDP of the destination country) started to dominate.
6. Indirect effects (e.g. distance, common spoken languages and the stock of emigrants between current Lithuania's export partners and other countries) were indeed important for the creation of Lithuania's export network, and resulted in the clustering of Lithuania's destination markets.

Thesis structure

The main part of the thesis consists of 3 separate Sections. In each of the Sections, we shall examine interrelated topics under the umbrella of the country's competitiveness.

The first part of the thesis (Section 1) is mostly theoretical with a small empirical part. It contributes towards the achievement of the 1st and the 2nd research objectives. Section 1 reviews the literature on the concept and the assessment of the competitiveness of a country. It presents and critically evaluates three main composite measures of country's competitiveness: the Global Competitiveness Index, the IMD World Competitiveness Ranking and the EU Regional Competitiveness Index. In the final Subsections, we shall focus on the export approach to a country's competitiveness.

Following the recent scientific developments acknowledging that export is a highly important aspect of the competitiveness of a country, Sections 2 and 3 are devoted to the more in-depth analysis of Lithuania's export competitiveness. Section 2 seeks to find out whether Lithuania's export is resilient to external shocks. It analyses the influence of Covid-19 pandemic to Lithuania's export structure in terms of the product groups and destination countries. Section 3 examines the development of Lithuania's export network. It seeks to determine which factors were the most important during the process of the formation of Lithuania's export network and how their influence changed throughout the years.

All three Sections examine distinct, yet interrelated, topics of the competitiveness of a country, and mainly focus on Lithuania's competitiveness. Section 1 aims to present the very concept of a country's competitiveness, its development and the main measures of competitiveness. Meanwhile, the two other Sections delve into one of the main aspects of the competitiveness of a country – exports. They focus on Lithuania's export structure: how current Lithuania's export competitiveness developed and if Lithuania's export competitiveness changed during the pandemic.

The final results of the thesis are presented in the conclusions.

1 THE CONCEPT OF COUNTRY'S COMPETITIVENESS AND ITS ASSESSMENT

1.1. Development of the concept of country's competitiveness

The earliest attempts to examine a country's competitiveness were made as early as the 16th century by the mercantilists (Salvatore, 2014). They attempted to find out why some countries are richer and more economically successful than others. For the mercantilists, competition among countries was an analogy to competition between companies, i.e. it was believed that if one country gains from the foreign trade, its trading partner must lose. The mercantilists believed that the country that accumulated more wealth would be better off; hence, export must be encouraged, and import must be restricted. Those countries which had higher exports than imports were deemed to be more competitive.

Classical economists, unlike the mercantilists, believed that international trade is beneficial for both countries (Salvatore, 2014). According to Adam Smith, a country exports those goods that have the lowest production costs comparing with the other countries. This country has an absolute advantage in the production of those goods, and is, therefore, more competitive.

David Ricardo developed A. Smith's concept by stating that a country has a comparative advantage in the production of a certain product (therefore, it is competitive in the production of this product) if the price of this product inside the country is lower than in the other countries, i.e. opportunity costs of producing this product are lower for this country (Salvatore, 2014). Based on this theory, the *Revealed Comparative Advantage* (Balassa, 1965) and similar indices are still being widely calculated by the economists.

The neoclassical approach to competitiveness is usually described by the *Hecksher-Ohlin* theory (Salvatore, 2014). According to it, a country produces and exports those goods for which it uses its surplus (and therefore cheaper) production factors.

Overall, classical and neo-classical economists understood a country's competitiveness simply as the country's exporting power: its power to gain from international trade by exporting cheap and low-cost goods. For them, the concept of a country's competitiveness was rather obvious: it was defined as the ability to export, no matter what kind of goods. However, nowadays, the importance of low cost and price competition has declined dramatically, ant it remains important only in those sectors where the main factors of production are natural resources and low-skilled labour (Reiljan et al., 2000). This process is explained by the growth of the share of services in trade and the relative

increase in the income of the developed countries, which leads to the fact that consumers no longer want a 'pure' product (e.g. a car to drive from point A to point B), but an 'extended' one (e.g.: a car of a certain size, colour and manufacturer, with the appropriate service and additional equipment). In the past, the low-cost approach to competitiveness could be acceptable because the most successful countries were those that had something 'physical': more natural resources, a more modern technology, or more capital than their competitors. Nowadays, competitiveness is determined not as much by the resources that a country has, but rather by the resources it develops: knowledge, skills, ability to implement innovations and others. This explains why even relatively small countries that do not have either a lot of natural resources or cheap labour (e.g. Switzerland, Singapore, Finland) often occupy the highest places in the world competitiveness rankings. Even if these countries produce goods that are cheaper than their competitors', still, that cheapness is usually achieved not by sacrificing quality of products or their external attractiveness, but by introducing innovations faster than others and thus maintaining advantage in the production costs.

Porter (1992) introduced a 'diamond' model which offered a multi-variable approach to competitiveness and made the notion of a country's competitiveness a complex concept. According to Porter (1992), a country's competitiveness depends not only on its export, but also on many factors showing the overall economic success of the country. Such an elaboration of the notion of competitiveness allowed to move from associating it with exclusively export success to a broader concept: a "*country's ability to provide an environment that enables companies to improve and innovate faster than foreign rivals*" (Cornelius, 2002). Aghion & Howitt (2006) argue that a country's economic conditions are the key factor determining the level of the firm competition, the efficiency of the legal environment, and the influence of the firm competition and the legal environment on the country's competitiveness.

Porter et al. (2001) claim that a country's ability to develop and strengthen its competitiveness, flexibility and resilience to external shocks largely depends on the ability to grow according to the country's level of development. They argue that countries usually go through several stages of development, the change of which requires a completely new approach to the country's economic priorities. Porter et al. (2001) distinguish three stages of a country's development:

1. ***Factor-driven growth*** is the initial phase of economic growth that occurs in the lowest income countries. The competitiveness of these countries is determined by the use of such resources as cheap,

uneducated labour force, land, and natural resources. Companies produce relatively simple, labour intensive goods, often designed overseas. Technology is introduced through importing, imitation or foreign direct investment (FDI). Competition is usually based on price, which makes these economies very sensitive to price and exchange rate fluctuations. At this stage, the main task of a government which is seeking economic growth, is to ensure political and macroeconomic stability, free market, and an access to production factors.

2. ***Investment-driven growth*** becomes important when an economy moves to a higher level. In this stage, companies compete by producing standard goods (often under contracts with foreign manufacturers), use mainly foreign technologies which they acquire through licensing, FDI, and imitation. As development in this stage focuses mainly on production, exports and attracting FDI, the economy becomes sensitive to financial crises and demand fluctuations. Governments should also change their priorities and focus on improving the infrastructure (e.g. building roads), supporting investments in the modern technologies and creating conditions for the country's economy to integrate into the world market (e.g. by legal agreements on customs, tariffs or taxes).
3. ***Innovation-driven growth*** occurs in high-income countries which convert from technology-importing to technology-creating economies. At this stage of development, a country should focus on strengthening its business environment and services, invest in higher education and encourage innovations and R&D. A country's competitiveness is associated with the ability to learn and implement new technologies quickly. Companies jointly conduct scientific research, and increase investment in human resources. At the same time, competition among companies is increasing, which further encourages innovations. The economy becomes less dependent on external shocks.

Porter et al. (2001) argue that the first stage of development is typical for low-income economies, the second one for middle-income countries, and the third one is reserved for high-income countries. This approach is supported by Aghion & Howitt (2006) who claim that the countries which have already reached a certain level of economic development need to reconsider their priorities.

The transition from one stage of development to another requires not as much expansion, as the fundamental change of the previous priorities of the country. In the second stage of development, it is important to strengthen institutions, improve the infrastructure, expand education (mainly by improving the quality and availability of secondary education), and adopt the

experience of foreign countries. However, after reaching the highest stage of development, those factors that have previously ensured economic growth start to hinder competitiveness by diverting resources from more important activities.

Economists also widened the concept of a country's competitiveness by arguing that it is integral to a country's internal prosperity. Fagerberg (1988) believes that a competitive country is the one that ensures its citizens a high level of social welfare. Tyson (1992) agrees that a country's competitiveness is the "*ability to produce goods and services that meet the test of international competition while our citizens enjoy a standard of living that is both rising and sustainable*."

However, the concept of a country's competitiveness still remained a 'dangerous obsession' (Krugman, 1994). Krugman (1994) noted that although the word 'competitiveness' is widely used, and evaluations of various measures of competitiveness are often made, the concept of a country's competitiveness remains undefined. According to Krugman (1994), the concept of competitiveness is 'elusive' because if "*a corporation is uncompetitive, <…> unless it improves its performance, it will cease to exist. Countries, on the other hand, do not go out of business. They may be happy of unhappy with their economic performance, but they do not have a well-defined bottom line*" (Krugman, 1994, p. 31).

Therefore, economists used to choose different angles to define and analyse a country's competitiveness. Most often, it was associated with two indicators: *export* (according to the classical concept of competitiveness) and *productivity*. Some economists (e.g. Balassa, 1965) claimed that a country's ability to export successfully shows its competitiveness. Still, Fagerberg (1988) argued that competitiveness cannot be fully described by the country's export abilities because various export measures – when taken alone – do not show either the sustainability of the country's economy, or the standard of living of its citizens. On the other hand, export is "*a link between a country's external and internal performance*" (Gaglio, 2015, p. 4), and it shows the ability of domestic companies which use their given domestic input to export to foreign markets. Therefore, export may still be a fairly good proxy of a country's competitiveness.

Other economists (e.g. Krugman, 1994) believed that competitiveness is simply "*a poetic way of saying productivity*" (Krugman, 1994, p. 35) and has nothing to do with competing in the world markets. However, according to Gaglio (2015), the meaning of productivity is fundamentally different. Productivity shows the efficiency of using the country's internal production factors to achieve a certain production volume, while competitiveness is

associated with competition in external markets. Still, competitiveness cannot be linked solely to export achievements, as individual export indicators do not reflect either the stability of the country's economy, or the standard of living. Gaglio (2015) agrees with Krugman by saying that productivity helps to reallocate the resources to the most productive products and companies, and, hence, it is related to competitiveness by making internal companies and industries efficient and competitive in foreign markets. However, this explanation supports the relationship of export and the concept of competitiveness more than the one of productivity and the concept of competitiveness.

Still, export-based country competitiveness is not fundamentally different from productivity-based country competitiveness. An increase of export increases the demand for goods, which leads to an increase of their production within the country. The increased production leads to the redistribution of domestic resources towards the exported commodity. This, in turn, increases productivity in the relevant sector. Hence, a country's export competitiveness can be defined as "*the ability to initiate a structural transformation process through the reallocation of productive resources in favour of the exporter's best performing products*" (Gaglio, 2015, p. 22). Weinhold & Rauch (1999) examine the relationship between export specialisation and the growth of productivity in different countries. They claim that, in less-developed countries, export specialization and productivity are directly and positively related, i.e. a greater specialization leads to a higher productivity growth. However, this correlation vanishes in highly developed countries. According to Ribeiro et al. (2016), exporting to highly developed or growing countries accelerates technological progress in the country of origin by forcing its companies to constantly invest in technology and search for ways to increase their productivity in order to survive in the new export markets.

Some economists also emphasise the role of the exchange rate on the country competitiveness. Still, we would not like to agree with this statement because exchange rates are mainly determined by macroeconomic policies, and affect competitiveness just by helping or hindering firms to export. Productivity also influences exporting; however, it can be considered an indicator of competitiveness, as productivity affects not only the export, but also the economic standing of the country (e.g. the strength of companies, the working conditions of employees). Thus, both export and productivity could reveal a country's competitiveness. These two indicators are influenced by all the other factors of a country's competitiveness (e.g. macroeconomic environment, education, technological readiness). It is the high productivity along with the significant, well-structured export volumes that allow the

country to become competitive in the world markets, i.e. to achieve a high level of development, welfare for its residents, and successful economic growth.

A country's competitiveness is related not only to the internal factors of the country and the relations with its neighbours, but also to the country's size and its geographical location. According to Krugman (1994), a large market allows producers to take advantage of the economies of scale.

The other group of economists claim that competitiveness is a complex notion which cannot be represented by any single measure. They propose calculating composite indexes including many aspects of the country's economic, cultural, technological and other performance scores, e.g. the World Economic Forum calculated the Global Competitiveness Index, the Centre for International Competitiveness calculated Competitiveness indexes for the UK and the EU regions, the World Competitiveness Centre is still calculating the IMD World Competitiveness Ranking, the European Commission calculates the EU Regional Competitiveness Index which estimates competitiveness of different EU regions at the NUTS-2 level. There are also many organizations which calculate 'smaller' indexes evaluating different aspects of competitiveness: human development, environment, technologies, and others. Composite indexes of competitiveness combine various points of view, seek to analyse different aspects of a country's performance and provide a complex approach to its competitiveness. Most often, they treat a country's competitiveness as a combination of economic and social welfare. Still, other economists (e. g. Lall 2001; Xia et al., 2012) criticise these indexes for the lack of their theoretical and methodological background.

The theory of competitiveness, although indirectly, was also applied in the regional economics to examine the development of different regions. According to this theory, regions grow because of two different effects: the concentration effect (Fujita et al., 2001) and the demonstration effect (Barry et al., 2003). The concentration effect is the process when a region becomes preferred by any sort of businesses (perhaps because of a large market or plenty of labour having any specific skills), and this results in a greater variety of goods, lower prices, higher salaries, and, later, in a larger workforce and a greater number of firms. The demonstration effect represents the common beliefs of the market players that the place where the others go must be worth going. Therefore, a country's competitiveness should be related to developing both of these effects.

According to Aghion & Howitt (2006) and Barry et al. (2003), the level of competition between companies and the overall country competitiveness is

determined by the development of the country's economy. They argue that a higher competition and free market entrance exert a more positive effect in those countries that are closer to the technological frontier, as the companies operating in these markets will be forced to innovate in order to deter newcomers. Meanwhile, companies operating in the markets that are further from the technological frontier will not be afraid of, most probably, weak newcomers. Therefore, in less technologically developed markets, R&D will be focused not on the long-term effects (which may never succeed), but on the short-term capital improvements (which is a less risky strategy). In this sense, the more developed economies have more means to increase their competitiveness than the less developed ones.

Overall, today, different researchers understand competitiveness in many different ways. Some of them claim that competitiveness is just another notion for successful exporting or productivity, while others argue that it is a complex measure which should be estimated by evaluating every aspect of a country's economic and social life.

1.2. Composite measures of a country's competitiveness

In this Section, we shall present and compare a couple of the most well-known composite measures of a country's competitiveness: the Global Competitiveness Index calculated by the World Economic Forum, the World Competitiveness Ranking calculated by the IMD World Competitiveness Centre, and the EU Regional Competitiveness Index.

1.2.1. Global Competitiveness Index

The Global Competitiveness Index (GCI) was estimated by the World Economic Forum (WEF), and it was one of the best-known measures of a country's competitiveness. GCI was started to calculate in 2006 and replaced its previous version, known as the Growth Competitiveness Index. In 2018, the GCI index was renewed for the last time so far, and changed its name to GCI 4.0. However, Covid-19 pandemic made WEF pause the calculations of the index, with 2019 being the most recent year for which the country competitiveness was measured.

1.2.1.1. Concept of Global Competitiveness Index

Prior to 2018, the World Economic Forum defined a country's competitiveness as "*the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of*

prosperity that the country can earn" (Schwab, 2015, p. 4). WEF economists argued that the growth of the total factor productivity allows countries to use their resources more efficiently and is the main driver for prosperity, because "*the productivity level also determines the rates of return obtained by investments in an economy, which in turn are the fundamental drivers of its growth rates. In other words, a more competitive economy is one that is likely to grow faster over time*" (Schwab, 2016, p. 35). These definitions reveal that WEF economists took Krugman's notion of a country's competitiveness (i.e. competitiveness as determined by productivity), however, they tried to broaden it by relating it to the concept of economic growth.

After 2018, WEF shortened their definition of the country competitiveness to the "*full set of factors that determine productivity*" (Schwab, 2019, p. V). Yet, demonstrating a country's abilities to achieve sustainable economic growth and high social welfare remained the main goal of the GCI. The GCI theory is based on the understanding that the main driver of competitiveness is the economic prosperity of the country and its citizens, depending not only on its export, but also on the economic, legal, social and other conditions inside the country. According to (Schwab, 2019), GCI "*provides guidance on what matters for long-term growth*" (Schwab, 2019, p. 2), and higher competitiveness should lead to "*growing, sustainable and inclusive economies that provide opportunity for all*" (Schwab, 2019, p. V). Schwab (2018) claims that competitive economies should be resilient to crises and any external shocks, agile (i.e. quickly adapting to the changes), innovative and human-centric.

1.2.1.2. Measuring the Global Competitiveness Index

Both old and new versions of GCI include 2 types of data: statistical (from IMF, UN, and other international agencies) and a survey (made annually by the WEF itself in order to capture the respondents' opinions about their country and to fill the gaps in the statistical data). Yet, the use of not only statistical, but also survey data is widely criticised by the economists (e.g. Zinnes et al., 2001) who believe that opinions are subjective and depend upon the cultures and attitudes of the countries. Hence, the survey data is not a good basis for comparing countries and judging which country is more or less competitive. However, WEF economists believe that the survey data is essential to get either qualitative assessment (e.g. the government's position, the success of the country's economic policy, the common business practice, the level of competition, expectations), or to substitute the data that is not easily evaluated or comparable.

In the next two Subsections, we shall present the estimation methodology and the theory behind the old and new versions of the Global Competitiveness Index in more detail.

1.2.1.2.1. Measuring GCI before 2018

Based on Porter et al. (2001), before 2018, GCI had been measured according to the theory of a country's development stages. According to (Schwab, 2016), the competitiveness of a country stands on 12 pillars which are grouped in three segments (Schwab, 2016):

1. ***Basic requirements*** are the most important for those countries that are in the stage of the factor-driven growth (the first stage of development, which is common for the low-income countries). The competitiveness of these countries depends on the cheap labour force and natural resources. These factors are effective institutions, a good infrastructure, a stable macroeconomic environment, as well as the quality of health care and primary education.
2. ***Efficiency enhancers*** are the most important for those countries that are in the stage of investment-driven growth (the second stage of development, which is common for the medium-income countries). Their competitiveness depends on the infrastructure, the foreign direct investment, and the modern technologies. These factors are higher education and training, efficient goods and labour markets, developed financial markets, technological readiness, and the market size.
3. ***Innovation and sophistication*** are the most important for those countries that are in the stage of innovation-driven growth (the third stage of development, which is common for the high-income countries). The competitiveness of these countries depends on R&D and a highly educated labour force. These factors are business sophistication and innovation.

Based on the theory of the development stages, the calculation of GCI slightly differed for countries depending on their stage of development. For the countries that, at the time, were in the first stage of development (factor-driven), the lion's share of GCI (60%) was made of the basic requirements, 35% of GCI was made of the efficiency enhancers, and only 5% was left for innovation and sophistication. For the countries that were in the second stage of development (investment-driven), WEF took the efficiency enhancers as the most important factors for growth (50%), then the basic requirements (40%), and, finally, innovation and sophistication (10%). Finally, for the countries that were in the highest stage of development (innovation-driven),

the efficiency enhancers still made 50% of GCI, however, innovation and sophistication made up 30%, thus leaving only 20% for the basic requirements. For the countries that were in any transition stage, these shares were modified according to their actual development level.

Different ways to calculate GCI for the countries that were in different stages of development allowed to avoid punishing any country for investing in the factors that were needed for its particular development stage. Still, the methodology of GCI was exposed to severe criticism by the economists (e.g. Lall, 2001). First, this method made the Global Competitiveness Indexes different for different countries. Hence, it was questionable whether the indexes that were calculated in five different ways could be compared among each other. Another critique for this methodology was the division of countries *per se*, e.g. it is questionable if an underdeveloped country which had a large workforce pool of skilled labour should be considered less competitive than another similarly underdeveloped country which had less skilled labour, but a slightly better infrastructure.

1.2.1.2.2. GCI measurement since 2018

The new GCI 4.0 is based on another concept. Following Schwab (2018), the 12 pillars of competitiveness have to show a country's ability to embrace the 4th Industrial Revolution. A competitive country is the one which is resilient to financial crises and external shocks, agile (i.e. quickly adapting to changes), innovative (i.e. innovations in such a country are efficiently promoted, created and developed) and human-centric (i.e. recognising people as both: the most important factor for creating prosperity, and the most important receiver of the created prosperity). Therefore, the 12 pillars were modified and divided to the four following blocks that represent how successfully countries develop while adapting to the ongoing changes (Schwab, 2018):

1. ***Enabling environment***: the pillars included in this block are: institutions, infrastructure, adoption of information and communication technology and macroeconomic stability.
2. ***Human capital***: health and skills.
3. ***Markets***: product market, labour market, financial systems, and the market size.
4. ***Innovations ecosystem***: business dynamism and innovation capability.

According to Schwab (2018) and Schwab (2019), because of the decrease of the costs of capital and technology, knowledge and new technologies are disseminating faster among countries. Hence, relying on the low cost labour is much less important for the developing countries than it used to be before.

Therefore, the sequence of the development of economies has become less clear. Many developing countries today are relying on services and start to de-industrialise earlier than today's developed economies did half a century ago. Therefore, it is not so clear which factors are more or less important in any developmental stage. All countries should try to develop *all* pillars to increase their competitiveness. Hence, the twelve pillars which comprise GCI 4.0 have equal weight in the calculation of the renewed index, and they are not country-specific (Schwab, 2019). The modified calculation of GCI 4.0 solved the above-mentioned problems of its previous version. Now, GCI indexes are comparable for all countries, and economies are not punished for trying to choose their own path to prosperity.

1.2.1.3. What does the Global Competitiveness Index really show?

Defining a competitive economy as the one which "*is likely to grow faster over time*" (Schwab, 2016, p. 35), and the Global Competitiveness Index as an estimator which "*provides guidance on what matters for long-term growth*" (Schwab, 2019, p. 2) suggests that a higher competitiveness ranking should lead to a higher and more sustainable economic growth. In other words, higher competitiveness index values should show a country's ability to grow faster than the countries with lower competitiveness index rates.

In the light of this definition, in this Subsection, we shall check the hypothesis that if a country is ranked to be more competitive (i.e. its GCI value is higher), it should have higher and more sustainable economic growth rates than the less competitive countries. In other words, it should grow faster and be more resilient to economic crises if compared to the less competitive countries.

In order to check this hypothesis, we use the graphical analysis method and examine the relationship between the Global Competitiveness Index and the economic growth of countries during the period of 2013–2021.

The following data was used in the research:

1. GCI data for the period of 2013–2019 taken from the World Economic Forum (World Economic Forum, 2017; Schwab, 2016; Schwab, 2018 and Schwab, 2019).
2. GDP growth data for the period of 2013–2021, represented by the annual percentage growth rate of GDP at market prices based on the constant local currency. The source of this data was the World Bank Group (2022).

Our aim is to check whether GCI and GCI 4.0 are capable to forecast a country's ability to achieve and sustain high economic growth rates and a

country's resilience to economic shocks. Therefore, the GDP growth rates of countries are compared to their GCI and GCI 4.0 values of the previous periods.

1.2.1.3.1. Global Competitiveness Index and the GDP growth of a country

In this Subsection, we shall examine whether higher GCI scores are able to forecast higher future GDP growth rates. According to the definition of the Global Competitiveness Index, it should reveal a country's growth perspectives in the long term. Hence, we check the relationship between GCI at year *t* and the GDP growth at year *t*+5. Such a time lag was chosen because of two main reasons. First, 5 years is the shortest period widely understood as the 'long term' which is mentioned in the definition of GCI. Second, the lag of more than 5 years was not chosen due to the frequent minor changes in the methodology of the calculation of GCI. Due to this reason, the most updated results would be examining the latest possible GCI measures. Still, modifying either the periods or the lag has no significant influence on the results.

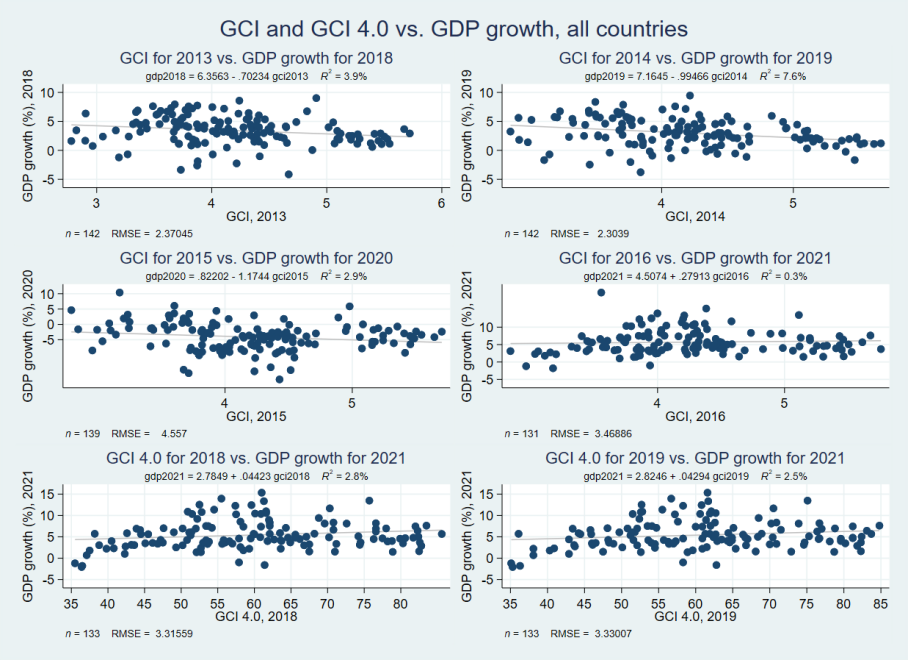
As the methodology of calculating the Global Competitiveness Index was changed in 2018, we also graph the relationship between GCI 4.0 for 2018 and 2019 and GDP growth for the latest available year (2021). We expect a positive relationship between a country's GCI score and its GDP growth rates, which would demonstrate that more competitive countries are bound to achieve faster economic growth.

Figure 1.1 presents scatterplots and determination coefficients of GCI scores and GDP growth rates for all the countries in the dataset. The upper and middle graphs represent the old version of GCI, whereas the lower graphs represent its new version GCI 4.0. For the sake of clarity, a couple of outlaw countries were dropped from the graphs (Lebanon and Libya were dropped from the middle and upper-right graphs, East Timor from the upper-right graph, Guyana from the middle-left graph, Myanmar from the middle-right graph, and Myanmar and Lebanon from the lower graphs).

As it is evident from Figure 1.1, there is no relationship between the GCI scores and the future GDP growth rates. Moreover, the regression lines in some of the graphs even have a negative slope, thus showing that the more competitive a country is, the lower GDP growth rate this country could expect in the period of the subsequent five years. Analogous results were obtained by taking the GCI scores for the other periods and modifying the lag. A slightly stronger relationship was detected between the GCI score and the future GDP growth rates if only high income countries were analysed (see: Figure 4.1 in the Appendix). However, the highest determination coefficient is only 13.9%,

and the slopes for different years also largely vary. We also checked if there is a relationship between the GCI score and the average GDP growth in various periods. However, none is observed for any income group.

Figure 1.1. Relationship between GCI scores and GDP growth rates for all the analysed countries.



Overall, this analysis shows that there is no relationship between a country's GCI and its GDP growth. Hence, there is no evidence that GCI could forecast a country's GDP growth in the medium and long term.

1.2.1.3.2. Global Competitiveness Index and standard deviation of the GDP growth of a country

The analysis in the previous Subsection allows us to reject the hypothesis that the countries denoted by higher GCI values grow faster in the long term. However, we can judge about a country's economic performance not only by the country's GDP growth rates as such, but also by the sustainability of the country's GDP growth rates. In other words, a more competitive country should be the one that grows steadily and avoids sharp fluctuations in its GDP growth rates, i.e. its regular GDP growth may be *not* very high, but it should not decrease severely in the years of economic crises.

Therefore, this Subsection offers the hypothesis that the countries which have higher GCI values are able to maintain the sustainability of their GDP growth rates even in the years of economic downturn.

In order to check this hypothesis, we shall graphically examine whether there is any relationship between the GCI values for 2013 and the standard deviation of a country's GDP growth. The standard deviation of the GDP growth was calculated by taking the GDP growth data for the period of 2014–2021.

Figure 1.2. Relationship between GCI score for 2013 and standard deviation of GDP growth rates in the period of 2014-2021 for high income countries.

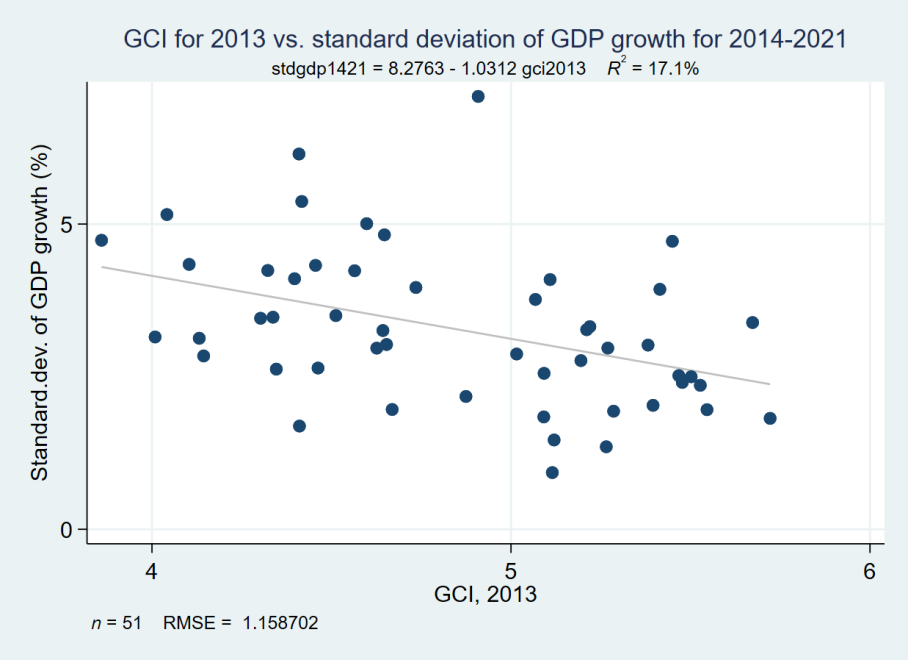


Figure 1.2 shows that there is a small negative relationship between the GCI values of a country for 2013 and the standard deviation of the GDP growth for high income countries. However, this relationship vanishes if we take all the countries for which GCI is calculated. This result partly validates the hypothesis that the high income countries having higher GCI values avoid sharp fluctuations in their GDP growth rates and are more resistant to economic crises.

1.2.1.4. Concluding remarks on the Global Competitiveness Index

The aim of this Subsection is to present the Global Competitiveness Index as one of the measures of a country's competitiveness, and to analyse whether the GCI values serve as the indicators of a country's future economic growth and its resilience to economic crises. The results of the research imply no relationship between the GCI and GCI 4.0 values of specific countries and their GDP growth rates for any period. However, there is a small negative relationship between the GCI values of a country and the standard deviation of its GDP growth. Still, it holds only for the high income country group.

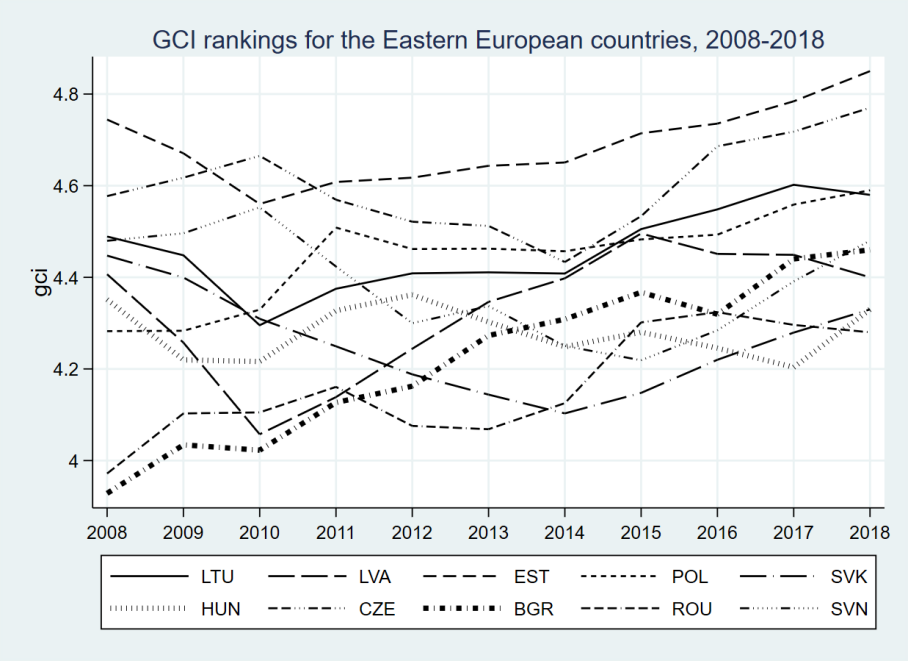
The findings suggest that, although GCI is not able to predict a country's future GDP growth rates, the higher GCI values may indicate that those economies will be growing steadier and will be experiencing gentler fluctuations than the economies with the lower GCI scores, which is valid at least among the highly developed countries. Hence, GCI as a measure of a country's competitiveness *does* show the resilience of high income countries to economic crises: the more competitive countries are also more resistant to economic downturns. Such countries avoid sharp fluctuations in their GDP growth rates and are able to maintain sustainable economic growth throughout the period.

Still, although GCI by itself does not predict economic growth, other researchers have shown that at least some of its components are positively related to the country's GDP level. Nogueira & Madaleno (2021) examined 50 countries which had the highest GCI scores in 2018, and showed that the GDP level of a country is significantly and positively impacted by the quality of institutions, infrastructure and innovations. In some models, health care, primary education, skills, technologies, and market efficiency also have positive signs and are significant. Idris et al. (2021) support these findings by showing that, for the most developed countries, GCI is also positively related to the high-tech trade. Hence, the components of the GCI indeed show the development of at least some spheres of a country's economic and social life. However, this is mostly applicable to the high income countries.

Figure 1.3 shows the dynamics of the GCI scores for the Eastern European countries. According to the GCI measures, the most competitive country in the Eastern Europe is Estonia, the second best is the Czech Republic, then come Poland and Lithuania, and these two get almost the same score. The least competitive countries are Romania, Hungary, and Slovakia. Still, the whole group of countries show a clearly rising trend of competitiveness. Since 2010, the GCI score for Lithuania has also been increasing; however, Lithuania's

competitiveness rank dramatically dropped from the 35th place in 2017 to the 40th place in 2018 among all the estimated economies.

Figure 1.3. Dynamics of GCI rankings for the Eastern European countries in the period of 2008–2018.



In 2019, Lithuania slightly increased its competitiveness and moved up the competitiveness ladder. After being the 40th among 141 evaluated countries in 2018, in 2019, Lithuania reached the 39th position. According to these measures, among the Eastern European economies, in 2019, Lithuania lagged behind Estonia, Slovenia, and Poland, and had higher competitiveness than the other countries of the region.

1.2.2. IMD World Competitiveness Ranking

The World Competitiveness Center (WCC) created by the International Institute for Management Development calculates the IMD World Competitiveness Index (IMD). WCC defines competitiveness as a country's abilities to "*manage their competencies to achieve long-term value creation*" (IMD, 2022). WCC believes that a country's competitiveness comes from the competitiveness of firms. Hence, the competitiveness of an economy should be related not only to the GDP growth and productivity, but also to the

decisions of the government that ensure an efficient and sustainable business environment.

Although it is unclear which measures could represent the value creation of companies, such a definition of competitiveness implies that WCC mostly relies on the concept of trade competitiveness, i.e. the competitive countries are the ones which enable their companies to compete successfully in the domestic and international markets. Therefore, the most important task of the government is to ensure the efficient functioning of institutions, transparent laws and a good infrastructure. All of these enable countries to create an environment in which companies can successfully compete and expand.

WCC groups the factors that determine a country's competitiveness into four groups:

1. ***Economic performance***, including the size, growth and wealth of the domestic economy, international trade, FDI, employment rate and prices.
2. ***Government efficiency***, which includes public finance, fiscal policy, institutions and business legislation.
3. ***Business efficiency***, i.e. productivity, labour market, corporate finance, business ethics, the attitudes and values of market participants.
4. ***Infrastructure***, including basic, technological, scientific infrastructure, healthcare and education.

For the assessment of a country's competitiveness, WCC uses both 'hard' (i.e. statistical), and 'soft' (i.e. the results of surveys of the upper-level managers of domestic or international companies residing in the assessed country for at least a year) data. The 'hard' data makes up 2/3 of the country's competitiveness measures, whereas the 'soft' data contributes only 1/3. The 'hard' data helps to objectively assess the components of the country's competitiveness, while the 'soft' data looks at how the country's competitiveness is perceived. The latter evaluates the data that is difficult to express quantitatively, such as the extent of corruption in the country, labour relations, or the attitude of the business participants towards environmental protection. The 'soft' data also helps to bring the measures of competitiveness closer to the current situation of the country, since the 'hard' statistical data is usually published with a certain time lag.

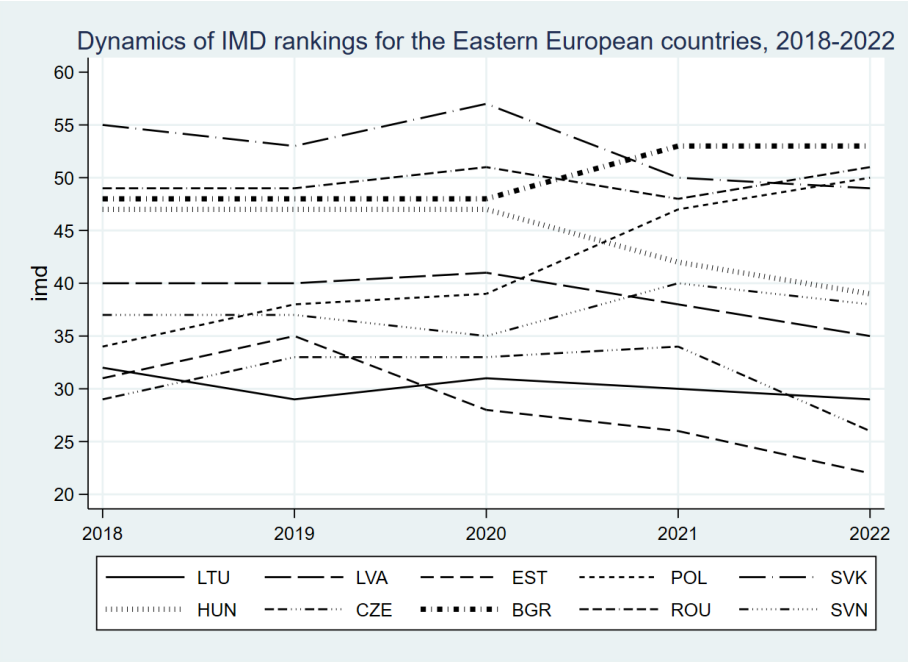
As in the case of GCI, the use of the subjective survey data for the calculation of IMD helps to collect useful information about the perception of competitiveness in individual countries. However, due to the differences in culture and the attitudes of individual countries or regions, such subjective information may lead to difficult comparisons of the data for each individual country. Still, the subjectivity of the assessment of a country's

competitiveness is reduced by the smaller share of the 'soft' data in the final measure of a country's competitiveness.

We do not undertake to check in this research whether the scores of IMD correspond to its definition in this thesis because there is no conventional measure for the "*long-term value creation*" which this index is supposed to reveal.

Figure 1.4 shows the IMD rankings for the Eastern European countries in the period of 2018–2022. We note that, due to the limited data, Figure 1.4 actually represents not the IMD scores, but the IMD rankings for the selected countries. Hence, the highest IMD rank, thus showing the most competitive country, is '1' (in 2022, this was Denmark), and the lowest is '63' (in 2022, it was Venezuela).

Figure 1.4. Dynamics of IMD rankings for Eastern European countries in the period of 2018–2022.



In 2022, IMD ranked Lithuania as the 29th among the 63 countries (in comparison, Lithuania was the 30th in 2021). Figure 1.4 reveals that, among the other Eastern European countries, Lithuania's rank is one of the highest. Moreover, in 2019, Lithuania's economy (ranked 29) had the highest competitiveness rank in this country group. However, in 2020, Lithuania was overtaken by Estonia, and, in 2022, also by the Czech Republic. Both of these

countries, as well as Hungary, the Slovak Republic and Latvia made a considerable improvement in their IMD rankings in recent years, while Lithuania's position remained almost the same. On the other hand, the rankings of Poland and Bulgaria sharply dropped after 2020.

1.2.3. The EU Regional Competitiveness Index

The EU Regional Competitiveness Index (RCI), calculated every 3 years by the European Commission, is another composite measure of competitiveness. The main difference from the above discussed indexes is that RCI evaluates not only the competitiveness of a country, but also the competitiveness of a region, classified according to the NUTS-2 classification (e.g. Lithuania consists of two regions: Vilnius Region and the rest of the country).

The European Commission argues that a region cannot be imagined as a smaller version of a country, and defines regional competitiveness as "*the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work*" (Annoni & Dijkstra, 2019, p. 3). This definition follows the social notion of competitiveness and strives to include both the well-being of individuals, and the business success. According to Annoni & Dijkstra (2019), RCI measures the long-term potential of a region.

The computation of RCI is based on a very similar methodology to that of the computation of the previous version of GCI. The European Commission follows the theory of a country's development stages, as presented by Porter et al. (2001). A region's development stage is evaluated by its GDP per capita level. RCI is made up of 11 pillars which are grouped into three groups:

1. ***The basic group*** includes the pillars of institutions, macroeconomic stability, infrastructure, health and basic education. Following Porter et al. (2001), these factors should be the most important for the least developed countries. Annoni & Dijkstra (2019) claim that a region cannot perform well in the other factor groups if it does not perform well in the basic group. Therefore, this factor group has the highest weight for the least developed regions (up to 35%), and the lowest weight for the regions having the highest GDP per capita values (as low as 20%).
2. ***The efficiency group*** includes higher education, training and lifelong learning, the labour market efficiency, and the market size pillars. This group is perceived as a very important step in creating competitiveness; therefore, its weight is the same for all the regions (50%).
3. ***The innovation group*** consists of the pillars of technological readiness, business sophistication, and innovation. Annoni & Dijkstra (2019)

assume that, in order to achieve competitiveness, before pursuing the implementation of the innovation group factors, a region must first reach the sufficiently high levels of development in the basic and efficiency groups. Therefore, the weight of the innovation group differs from only 15% for the least developed regions to 30% for the wealthiest regions.

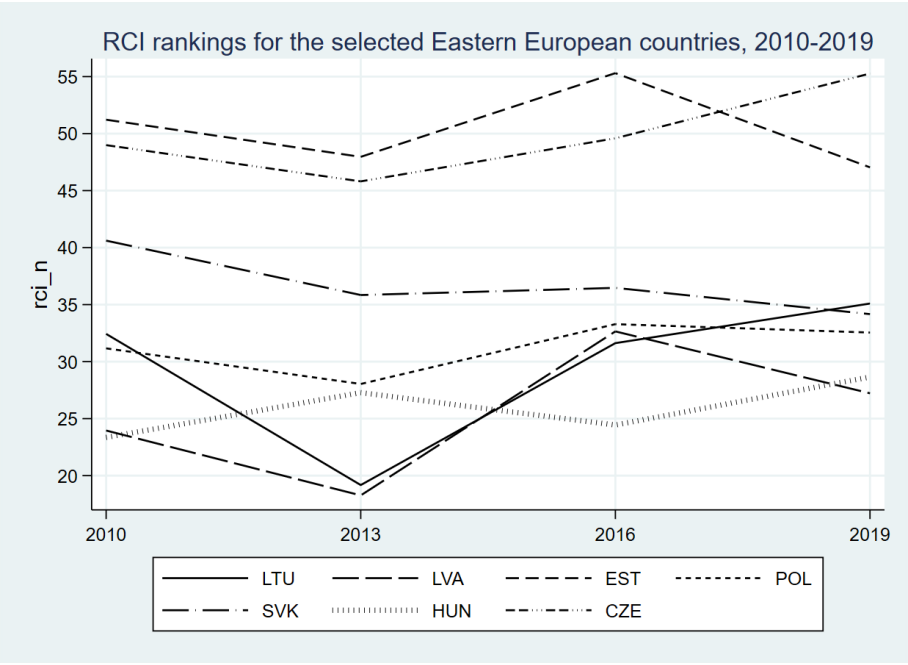
According to the definition of RCI, a region's competitiveness should ensure attractive and sustainable conditions for its people and companies. Annoni & Dijkstra (2019) claim that RCI also demonstrates a positive relationship with the GDP per capita of the previous years, although this relationship gets looser and almost vanishes for the higher GDP per capita levels. Still, according to Annoni & Dijkstra (2019), the high GDP levels are not the ultimate goal of competitiveness. The higher GDP per capita only shows that the region has enough means to create and to sustain attractive environment for its firms and residents, and, hence, it is more competitive.

Similarly to GCI, RCI also shows a somewhat negative relationship to the GDP growth (see: Annoni & Dijkstra, 2019). This finding once more confirms the theory that the less competitive economies which are in their lower development stage usually grow faster while trying to catch-up with the more developed ones while learning and imitating.

Figure 1.5 shows the dynamics of RCI for the selected Eastern European countries. For the years prior to 2019, the European Commission had been measuring RCI only on the regional level. Hence, for each country having more than one region, we calculated simple means of their regional RCI values. Due to the differences in scaling of the RCI score for 2013, the RCI values for all the years were normalised between 0 (the lowest level of competitiveness in that year) and 100 (the highest level of competitiveness in that year), by using the following formula: $RCI_{norm} = 100 * (RCI - RCI_{min}) / (RCI_{max} - RCI_{min})$. Bulgaria and Romania were dropped from the graph for the illustrative purposes due to the lowest RCI values in the EU. Slovenia was also dropped for the illustrative purposes because of incredibly high score for 2010.

Judging from Figure 1.5, the highest RCI values in Eastern Europe belong to Estonia and the Czech Republic. The least competitive countries are Latvia, Hungary, and Poland. Before 2016, Lithuania's competitiveness was one of the lowest among the Eastern European countries. However, it sharply increased afterwards. In 2019, Lithuania was in the middle of this country group with a normalised RCI score of 35.1, while lagging behind Estonia and the Czech Republic, and leaving all the other countries behind.

Figure 1.5. Dynamics of the RCI index (normalised) for selected Eastern European countries in the period of 2010–2019.



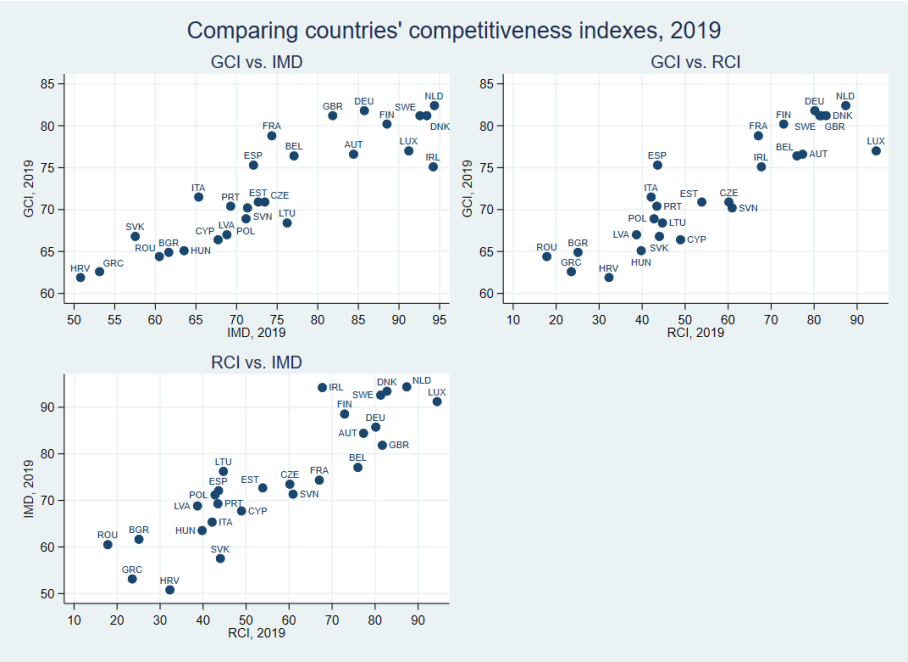
1.2.4. Comparison of the indexes of a country's competitiveness

In this Section, we shall compare the scores of the three composite indexes of a country's competitiveness GCI 4.0, IMD and RCI for 2019. This year was chosen because of two reasons. First, 2019 was the most recent year when the Global Competitiveness Index was calculated. Second, 2019 was the last year before the world faced Covid-19 pandemic, which may have had an adverse impact for the calculations and scores of the indexes. As RCI is calculated only for the EU countries, and IMD does not evaluate the competitiveness of Malta, we are left with only 27 'scored' countries to compare.

The results of the comparison are presented in Figure 1.6. The upper-left graph compares the values of the IMD and GCI 4.0 indexes, the upper-right graph compares the values of the RCI and GCI 4.0 indexes, and the lower graph compares the scores of the RCI and IMD indexes. Figure 1.6 shows that all the three measures of a country's competitiveness are comparable. The relationships between the values of the indexes are also strong. The determination coefficients amount to 90.27 for the GCI and RCI indexes, 88.9 for the IMD and RCI indexes, and 88.69 for the GCI and IMD indexes.

As all the three indexes are highly correlated with each other, and GCI do not show any relationship with the GDP growth, most probably, the other competitiveness indicators are not much related to the GDP growth, either. However, we shall not check it in this research, as the definitions of IMD and RCA indexes are not the same as that of GCI.

Figure 1.6. Comparison of the indexes of the competitiveness of countries.



Judging by the results of all the three indexes, the most competitive countries of the EU are the Netherlands, Sweden, Denmark, and Luxembourg, while the least competitive ones are Greece, Croatia, Romania and Bulgaria. Lithuania is somewhere around the middle with its IMD giving the highest values.

1.3. The export approach to a country's competitiveness

In this Subsection, we shall present the most recent developments on a country's competitiveness in terms of export. The export approach to a country's competitiveness is perhaps the oldest, starting with the works of Adam Smith and David Ricardo. Later, it was superseded by the approaches of productivity (e.g. Krugman, 1994), composite indexes (e.g. GCI, IMD, RCI) or social welfare (e.g. Fagerberg, 1988). Still, productivity is already

rather well defined, and is constantly being measured for different sectors and companies. Hence, it hardly needs another concept to name it. Composite indexes are widely developed and measured; however, as we demonstrated in the previous Subsections of the thesis, for instance, the GCI index does not actually show what its definition implies.

In the recent years, many economists (Lall et al., 2006; Rodrik, 2006; Hidalgo & Hausmann, 2009; Caldarelli et al., 2012; Tacchella et al., 2013; Zaccaria et al., 2016; Travkina, 2015) mostly agree that the competitiveness of countries is best reflected by how much and what kind of goods countries export, i.e. the export structures of the countries. Hence, export has once more been considered to be one of the best proxies of the competitiveness of a country.

Still, today the relationship between export and a country's competitiveness is very different from whatever it used to be before. Classical and neoclassical economists understood a country's competitiveness simply as the ability to earn money by exporting cheap, low-cost goods. According to the classical Ricardian and neoclassical Hecksher-Ohlin approach, the most competitive countries should produce a few specialized, high value-added products, while the 'privilege' of producing low value-added goods should be left to the poorer countries (Zaccaria et al., 2016).

However, empirical studies reveal that the most developed countries do not export only a few high value-added goods, and it is the country's flexibility and adaptability that has the greatest impact on its competitiveness.

Recent empirical studies of the export competitiveness of countries (e.g. Hidalgo & Hausmann, 2009; Zaccaria et al., 2016) show that more competitive are those countries which produce and export more goods of various levels of complexity. This theory is also supported by Tacchella et al. (2013) who claim that the wealthiest and the most successful countries are the ones which produce and export as many goods of various levels of complexity as possible.

Lall et al. (2006) introduced the concept of 'export sophistication' to the economic literature. They assumed that "*an export is more sophisticated the higher the average income of its exporter*" (Lall et al., 2006, p. 233). The rationale behind this theory is that the goods exported by high-wage producers must have characteristics that allow them to be competitive in the world markets, e.g. technological superiority, know-how and R&D. Hence, highly sophisticated products also are high-tech goods. According to Lall et al. (2006), the more competitive countries are the ones which have a more sophisticated export structure because such economies are better positioned in the world markets and have better prospects for growth.

Rodrik (2006) developed the same idea and focused on the relationship between the export structure and the economic growth in case of China. Rodrik (2006) claimed that one of the reasons of China's economic success and exceptionally high GDP growth rates which were being observed at the beginning of the century was that it did not specialise in manufacturing and exporting products according to its development stage. Instead of specialising in the export of labour-intensive products, China exported more sophisticated goods which are associated with the countries having much higher productivity and income levels. Rodrik (2006) concluded that what matters for a country's competitiveness is "*not the volume of exports or its relation to GDP, but the 'quality' of these exports*" (Rodrik, 2006, p. 17).

Following the findings of Rodrik (2006) and Lall et al. (2006), Gertler (2006) analysed the export structure and the economic growth of the EU-25 countries. He examined if a higher product sophistication level leads to the higher level of GDP per capita and the growth of the GDP per capita in the exporting country. According to Gertler (2006), a country's GDP per capita grows when its companies, successfully producing high value-added goods, are imitated by the other companies in the same country. Imitators shift their resources from the production of less productive goods to the production of more productive, and, at the same time, more profitable goods. Both Lall et al. (2006) and Gertler (2006) follow the assumption of the revealed preferences, thereby assuming that the more sophisticated export reveals a higher level of the country's development (i.e. a higher GDP per capita), while the less sophisticated export reveals a lower level of the country's development (i.e. a lower GDP per capita). Thus, the more similar the export basket of a given country is to the export baskets of the most developed economies, the more sophisticated is the country's export structure and, hence, the higher is the country's competitiveness. Empirically Gertler (2006) finds a strong positive correlation between the EU-25 countries' export sophistication and the growth of their GDP per capita.

Following the definition of a country's competitiveness as ensuring high and stable levels of economic growth, Ribeiro et al. (2016) proposed the theory of export-led growth. By using the data of the EU countries for the period of 1995–2010, they examined how export, and especially the export structure (a country's exported products and its export markets), contributed to the country's GDP growth. Ribeiro et al. (2016) found a strong relationship between the GDP growth and both the country's export growth as a whole and the country's export structure. They argued that the population growth, inflation, the number of the export partners, and the concentration of the export partners negatively affect the GDP growth of the EU countries.

Meanwhile, the high-technology exports, the economic growth of the export partners and the concentration of the exported goods have a positive effect on the economic growth of the exporter. Ribeiro et al. (2016) claimed that export diversification across partners (due to a lower dependency on the fluctuations of the economy in each of them, and, hence, an increased economic stability in the country of origin), exporting to the countries which are denoted by higher potential growth rates, and the export of high-technology products increases the GDP growth of the country of origin. Meanwhile, exporting to the less developed countries decreases the possibility of learning and therefore exerts a negative impact on the productivity and growth of the exporting country. Hence, European countries should export either to other highly developed countries, or to economically less developed countries which are demonstrating high economic growth rates.

These findings are supported by the research of Crespo Cuaresma & Wörz (2005) and Hausmann et al. (2007) who argue that the export of manufacturing goods (especially technology-intensive goods) positively affects the economic growth of the exporter. Hence, it should also positively affect the country's competitiveness.

However, these results are not confirmed in all studies. Damijan & Kostevc (2006), who examined the heterogeneity of Slovenia's export markets, partly contradicted the findings that learning is fostered by exporting to the more developed countries. They argued that, although the productivity of the companies exporting to the more developed countries was growing (e.g. the labour productivity of the Slovene companies exporting to the OECD countries grew much faster than the scores of those companies which were exporting to the less-developed countries of ex-Yugoslavia), productivity improvements tended to be only temporary. Still, according to Damijan & Kostevc (2006), such contradictory findings could disappear if the development gap between the exporter and the importers was greater.

Wagner (2007) summarised the findings of other researchers and concluded that the exporting companies are more productive than the non-exporting ones. However, the assumption that the productivity of the exporting companies grows faster has been confirmed only in some of the studies. Therefore, Wagner (2007) claimed that export does not affect the productivity growth, and that these two measures are more connected through self-selection, i.e. the companies that are more productive than others are the ones which start exporting. Exporting by itself does not necessarily increase the productivity of companies; however, the suspension of exports may lead to a decrease in the productivity of a company.

1.3.1. Linking international trade analysis to economics of networks

The most recent and even pioneering developments in the field of a country's competitiveness have been made by investigating exports and relating international trade theories to the economics of networks (e.g. Hidalgo et al., 2007; Hidalgo & Hausmann, 2009). A country's export structures were analysed with the objective to explain why countries with a similar level of development are facing prominently different opportunities for the export diversification and economic growth.

According to Hidalgo & Hausmann (2007), previously, the two main theories that had been applied to explain a country's export specialisation were as follows:

1. The first approach is based on how many and what factors of production a country *possesses* (e.g. low-skilled labour, high-skilled labour, land, capital), and what factors of production are needed to produce various goods. According to this theory, such countries as China or India, which have a lot of low-skilled labour, should mainly produce labour-intensive goods, while Switzerland, which is in possession of an abundance of skilled labour and well-developed institutions, should specialise in exporting sophisticated goods. According to this theory, any country can start producing any goods once it has acquired the resources necessary for its production. Thus, the products exported by the country today do not in any way influence its future economic achievements.
2. The second theory (e.g. the model of product varieties as of Romer (1986) and the 'quality ladder' model as of Aghion & Howitt (2006)) emphasise the technological differences among countries and divide products according to their level of technological sophistication. Thus, by improving the technology they are using, countries can produce increasingly sophisticated products and stay up above at the quality, productivity and competitiveness 'ladder'.

Both of these theories make a strict distinction between a country's economic growth and the products this country exports. Still, Hausmann et al. (2007) claim that the goods that a country exports determine not only the present, but also the future economic growth of that country. This is the essence of the theory of export complexity, developed in very influential papers of Hausmann & Rodrik (2002), Hidalgo et al. (2007), Hidalgo & Hausmann (2007), Hausmann et al. (2007), Hidalgo & Hausmann (2009), Hausmann & Klinger (2011), Hausmann et al. (2014), and others. They

assume that goods are linked to each other by their production factors, and, in this way, they form a network of relatedness, i.e. a 'product space'.

Hidalgo et al. (2007) observed that different goods require countries to possess completely different factors of production (e.g. exporting microchips requires completely different skills than exporting cereals). Thus, a country's ability to start exporting a new product is largely determined by how similar in terms of production factors this new product is to the country's currently exported goods, i.e. how close these products are in the product space.

The product space could be also understood in the geographic context. According to Hidalgo & Hausmann (2007), it explains why a few hundred years ago Eurasian civilizations located at small distances from each other and horizontally on a globe were flourishing, while American civilizations, which were located at large distances from each other and in very different climate zones, were less developed.

Hidalgo et al. (2007) argues that if products require similar factors of production (i.e. they are close to each other in the product space), it is easier for countries to start exporting this product than another one which is somewhere further in the product space: the "*most upscale products are exported by rich countries and located in the core of the product space, while lower-income products populate the less connected periphery*" (Hidalgo et al., 2007, p. 1). Hidalgo et al. (2007) claim that countries develop by starting to manufacture and export other products that are close to their position in the product space. Therefore, countries are facing highly different development opportunities which depend upon their export structures. The countries which are equally developed today may be facing very different growth opportunities, as the products manufactured and exported by one country could be more sophisticated and closer to the core than the goods exported by the other country.

Hidalgo et al. (2007) argue that if a product space is not very well connected, i.e. products are further away from each other in terms of production factors and have fewer linkages, the less developed periphery-occupying countries find it very difficult or even impossible to catch up with the most developed countries. On the other hand, the most developed core-occupying countries are in the preferential position to grow and to increase their competitiveness even more. The reason is that the most sophisticated products located in the core of the product space seek for the 'global maximum'. However, low-income generating goods (e.g. those located in the periphery of the product space, but relatively productive) also have their 'local maximums' preventing countries from reaching the global maximum. For example, livestock or cereal products appear as small, discrete local centres

clustered at the edge of the product space, with relatively few connections to other products. Thus, the countries that happen to be near or within such a local centre will be doomed to reach only a local maximum and will further specialise in exporting these low value-added goods. Without some external push, it becomes almost impossible for them to break through to the global centre, i.e. to start specialising in the export of high value-added goods because there are simply no or too few links leading there.

Hidalgo & Hausmann (2009) developed this theory further by examining why different countries have different GDP levels. The authors claimed that cross-country differences in their GDP levels can be explained by their economic complexity, i.e. the diversity of capabilities which are present in a country and their interactions. Hidalgo & Hausmann (2009) assumed that there exists a tripartite network of *countries* which have different *capabilities* to produce and export different *products*. Hence, by knowing which products a country exports we can reveal which capabilities this country possesses. The country's capabilities, in turn, determine the complexity of the future export, along with the economic growth and competitiveness of a country. Hidalgo & Hausmann (2009) concluded that the countries which are below the income expected from their capabilities may easily develop all the products that are available with their existing capabilities. Hence, they are expected to grow quicker than the countries which have first to accumulate new capabilities, and only then to start exporting new products. Because of this reason, incentives to accumulate capabilities depend on how the new capabilities complement with the already existing ones.

Hausmann & Hidalgo (2010) claimed that the more capabilities a country has, the more new products it will be able to produce and export (i.e. a country's export diversification increases) with each additional capability. The authors also showed that acquiring new capabilities brings increasingly more gains for the developed countries exporting products of higher complexity than for the less developed countries exporting less complex products. Thus, the continuous increase of the product complexity leads to a growing gap between the less developed countries and the leaders, which results in an even greater poverty trap. Hausmann & Hidalgo (2010) argued that a country's ability to start producing and exporting a new product depends not only on the proximity of that particular product to the already produced products, but also on how many capabilities the country has and how it uses them for the production of other, not necessarily close-by, products.

Therefore, Hidalgo et al. (2007) claimed that different countries should choose different strategies for developing their own competitiveness. The high-income core-occupying countries which are already exporting a number

of high value added products should start exporting new products that are closely related to the already exported goods. Unfortunately, the same strategy is completely ineffective for the less-developed countries located in the periphery of the product space. Based on Hausmann & Hidalgo (2010), the less-developed countries tend to fall into the quiescence trap, i.e. countries having scant capabilities receive very little or no return from acquiring new capabilities (probably because they have too few capabilities to create new products and thus cannot fully exploit their newly acquired capabilities). Whereas, capability-abundant countries are able to fully utilise their newly acquired capabilities; hence, they receive significant returns from their acquisitions. The more complex the goods are, the deeper the quiescence trap is as well, thus making it increasingly difficult for the less developed countries to compete and to catch up with the leaders (Hausmann & Hidalgo, 2010). By choosing the same strategy as the highly developed countries, the less-developed countries fall into a trap and begin to specialise even more deeply in exporting low value-added goods. Instead they should try to leap-frog and develop the capabilities needed for the export of high value-added products.

Still, Atkin et al. (2021) raised another issue of catching up. They argued that open borders and globalisation could even push less developed countries down to the less complex sectors, as they are not able to compete with the more developed countries either in the international or in their own internal markets.

Imbs & Wacziarg (2003) studied the relationship between GNP per capita and the level of concentration of various sectors of the economy (according to the share of the number of employees and the value added in different sectors). Imbs & Wacziarg (2003) claimed that the growth of the GDP per capita of the less-developed countries accelerates as the country's economic sectors diversify (due to the process of adopting technologies from the more developed countries). On the contrary, the economic growth of the more developed countries accelerates as their companies specialise (due to the greater openness to the international trade and stronger competition). Imbs & Wacziarg (2003) concluded that a competitive country is the one which has a high GDP per capita level and where the process of the sectoral diversification of export is replaced by the process of the sectoral specialisation of export. The country may still be exporting products of various sophistication levels; however, it starts specialising more and more in the export of the more sophisticated goods. However, Hidalgo & Hausmann (2009) contradicted by claiming that the highly developed countries having more capabilities will be more diversified because they can produce not only more products, but also more products requiring different capabilities. Still, Hidalgo & Hausmann

(2009) agreed that diversified high-income countries will specialise in exporting less widespread products.

Petralia et al. (2017) explained the above by emphasising that although countries *do* diversify exports by moving to the products that are related to their current profile of capabilities, the highly developed countries are able to make larger steps and start exporting products which are technologically less related to their currently exported products.

On the other hand, Dam & Frenken (2020) argued that the development of a country's export diversification is hump-shaped. Initially, the country's export diversification increases as more new capabilities are acquired, but, after reaching a certain level, the diversification stops growing and begins to fall, as the most economically developed countries start abandoning the production of simpler goods and get on to concentrate on the export of more and more complex goods.

Pinheiro et al. (2021) separated the product diversification of a country's export to related (i.e. a country exports diversified, however mostly related (similar) products) and unrelated (i.e. a country exports unrelated products as well) diversification. They claimed that unrelated product diversification is very difficult to achieve and is more frequent for the more complex economies. However, if a less complex economy is able to achieve unrelated product diversification, it has much higher chances to leapfrog others and to start exporting more sophisticated products.

Although the above mentioned models attempted to determine a country's economic complexity, these models could also be used for estimating a country's competitiveness. For example, Schetter (2020) empirically relates a country's complexity and diversification of its export to its GDP per capita growth, which is one of the indicators of a country's competitiveness. According to Balland et al. (2022), "*A country is complex, <…> if it produces many products (i.e., is highly diversified), especially those that are relatively rare*" (Balland et al., 2022, p. 4). Therefore, a greater export diversification of a country which shows a greater complexity of the country could also be associated to a greater competitiveness of the discussed country. Hence, more competitive are those economies that have more capabilities, and thus they are able to produce and export not only more goods, but also more complex goods. However, a country's competitiveness also depends upon the complexity and diversification of the export of other countries. Following Hausmann et al. (2014), if a country exports a very rare commodity (e.g. diamonds), but is undiversified and other countries exporting the same commodity are also undiversified, it is likely that the complexity of this country, and thus its competitiveness, is low. On the other hand, it may also be that the countries

which are undiversified and export not many types of goods are highly complex and competitive (e.g. Switzerland). This happens if the goods that they export are not widespread and if the other countries exporting the same goods are diversified. According to Hausmann et al. (2014), on average, over time, a country's GDP more or less corresponds to its capabilities. Otherwise, this discrepancy is adjusted during a certain period when the country's economy grows faster or slower than expected.

Based on the models of economic complexity, *The Growth Lab* at Harvard University (2019) measures the economic complexity indexes (ECI) of products and countries; these scores are intended to reveal a country's economic complexity and the perspectives of its development. The basis of this methodology is widely used by economists with the objective to evaluate the economic complexity of specific countries (e.g. Zaccaria et al., 2016) and regions (e.g. Jarreau & Poncet, 2012). This strategy is also used to evaluate the complexity of the different spheres of a country's economy, e.g. Mealy & Teytelboym (2020) applied the methodology to examine a country's potential to start exporting green products.

Still, the economic complexity index of a country is not the only one. Schetter (2021) proposed a modified indicator of a country's complexity which yields very similar results to the original one. Tacchella et al. (2012) and Tacchella et al. (2013) argued that if the product is exported by highly developed countries, no information about the complexity of this product is revealed, as these countries produce virtually all products. Only the information that a product has been produced by a developing country is likely to signal the low complexity of this product. Therefore, when estimating a product's complexity, they proposed to give more weight to the less-developed countries. Tacchella et al. (2012) also argued that countries exporting not only complex goods, but also diversifying export, should be considered to be more competitive, as export diversification *per se* is a positive phenomenon. However, Gertler (2006) and Kumakura (2007) criticised the approach of giving higher scores for larger countries, as their exports are naturally more diversified than those of the smaller economies.

It should be noted that Hidalgo-Hausmann type models contradict the traditional Ricardo and Hecksher-Ohlin theories. The latter propose the idea that countries should specialise in exporting the goods which they can produce most efficiently. Meanwhile, Hidalgo-Hausmann theory and the empirical data reveal that the most developed countries export almost the entire spectrum of goods, while the less developed countries produce only less complex goods.

1.4. Concluding remarks on country competitiveness

Based on the above, we assume that a competitive country is the one which ensures high income, stable and resilient GDP growth, along with the effective international trade, and which exports high complexity products. We believe that international trade also embraces the other above-mentioned factors and is a highly important determinant of a country's competitiveness (e.g. in order to be able to manufacture and export high complexity products, a country must have already reached a certain level of economic development and income). The key factor here is export which demonstrates how successfully countries are able to manufacture and to sell their products to other countries, i.e. to compete in the world market.

Hence, our analyses of the competitiveness of Lithuania in the subsequent parts of the thesis are exclusively based on the export approach. Following the latest theoretical and empirical developments, we shall combine the gravity and networks theories and examine the development of Lithuania's export structure, its viability and resiliency to external shocks.

The other parts of the thesis are organised in the following way. Section 2 analyses how Lithuania's export structure was affected by the recent major shock for the global economy stemming from Covid-19 pandemic. Section 3 examines which factors were the most important for the initial formation of Lithuania's export network after 1990 and how it shaped the competitiveness of Lithuania.

2. LITHUANIA'S EXPORT COMPETITIVENESS AND COVID-19 PANDEMIC

2.1. Introduction

The year 2020 was exceptional in many countries. Covid-19 pandemic broke up in China at the end of 2019 and reached Europe and Lithuania at the beginning of 2020 (Worldometer, 2022). In response, mainland European countries started to impose travel restrictions at the end of January, and, before the middle of March, most of the countries (Lithuania was among them) had imposed travelling bans, closures of stores and entertainment places. They also imposed 'stay-home' and other requirements (European Centre for Disease Prevention and Control, 2021). These restrictions affected not only a significant part of the population, but also the competitiveness of the countries: not only their internal economies, but also their export structures (Arriola et al., 2021; Hayakawa & Mukunoki, 2021; Espitia et al., 2022; Vidya & Prabheesh, 2020).

The most likely impact of such restrictions could be the drop in demand and supply, along with higher transport costs leading to the reduction of manufacturing as well as to the drop of both domestic and international trade (Hayakawa & Mukunoki, 2021; Brinca et al., 2020). Higher transport costs could be a result of more stringent regulations of border crossing that were imposed by almost all the relevant countries. These regulations not only differed by country, but they also changed often and unpredictably. Therefore, transporting goods from one country to another resulted in higher costs of both tracking these changes and trying to adhere to the requirements.

Still, such shocks tend not only to reduce, but also to divert consumption (Hayakawa & Mukunoki, 2021). People had much lower possibilities to travel; therefore, they could go camping or sailing, or they could buy a holiday home. People could no longer spend their free time in the cinema or at a restaurant, hence, they could decide to buy a larger TV and a more comfortable sofa. People had to work from home, and schools were closed, therefore, consumers were likely to reduce their spending on perfume, clothing and footwear, and invest in computers and fast Internet instead.

Such changes in consumption could result in heterogeneous changes in the export structure (Zainuddin et al., 2021; Zainuddin et al., 2022). The export of countries could be diverted in terms of products, e.g. less clothes and more TVs could be demanded and exported. Yet, the export structure could also be diverted in terms of the export destinations, e.g. the closer-by markets could

become preferred to the further-away markets because of the increased transportation costs.

All these possible changes are strongly related and could either positively or negatively affect a country's competitiveness. For instance, the countries of lower competitiveness which were exporting clothes could suffer a reduction of export and become even less competitive, while countries of higher competitiveness which were exporting TVs could increase their exports and become even more competitive. Therefore, this Section analyses if and how Lithuania's export, and, consequentially, its competitiveness, was affected by Covid-19 pandemic. We shall examine Lithuania's goods export and how it shifted in terms of products and regarding export markets during the first year of the pandemic. Such an analysis could reveal how Lithuania's export structure changed during the pandemic and how these changes influenced the competitiveness of the country.

Here, we are focusing on the short-term impact of Covid-19 pandemic on the export structure of Lithuania. We are referring to trade in goods only. The impact of the pandemic on the trade of services could be even larger, but the available data is not as comprehensive as for the trade in tangible goods. Another reason is that, according to Hidalgo et al. (2007), Hidalgo & Hausmann (2009) and Hausmann (2022), a country's complexity, and thus its export competitiveness, depends mainly on the export of goods, but not on the export of services.

Lithuania is a prominently interesting country for this analysis because of three reasons. First, as a small and open economy and a member of the European Union, Lithuania is strongly related both to the European and to the world markets, and is therefore vulnerable to any external shocks. Second, compared to the other EU countries, Lithuania had slightly above average numbers of the total Covid-19 cases per million of population in 2020 (Ritchie et al., 2020). Hence, Lithuania was affected by the pandemic, but was not an outlier. Third, according to the World Bank (2021), Lithuania's GDP growth amounted to -0.1% in 2020, and it was the lowest decline in the entire European Union (e.g. the economy of Latvia decreased by 3.6%, that of Belgium shrank by 5.66%, whereas the GDP of Spain declined by a staggering 10.8%). As Lithuania's GDP remained more or less immune to the pandemic, we question if Covid-19 could influence Lithuania's export structure and the overall competitiveness of the country.

For the sake of simplicity, we assume that there were no major changes in Lithuania's international relations with any of its export partners during the first year of the pandemic. To the best of our knowledge, Lithuania's export in 2020 could have been affected by another reason than the pandemic to only

two countries: Belarus (due to the political turmoil and the beginning of economic sanctions imposed on this country), and the United Kingdom (due to the Brexit and its changing of trade regulations with the EU). For the other countries, the primary reason of any changes in the structures of their export from Lithuania is possibly related to Covid-19 pandemic.

Another interesting pandemic-related research question analysed in this Section of the thesis is to examine the change of the importance of distance on the export. Covid-19 pandemic resulted in various kinds of restrictions for businesses and border crossings. They affected not only tourism, but also logistics, and disrupted the supply chains (Ivanov, 2020). Therefore, it is possible that the physically longer supply chains in terms of intermediate countries and business partners could have been changed to shorter ones with fewer border crossings and intermediaries.

In this Section, we aim to check two main hypotheses:

1. During the first year of the pandemic, Lithuania's export structure changed heterogeneously in terms of product groups and destination countries.
2. When the pandemic started, the physical distance between Lithuania and its export markets became more important than it had been before.

The setup of this Section is as follows: first, we briefly review the literature, then we present the methodology and give insight to the data. Descriptive statistics of the variables is presented in Subsection 2.4. All the empirical findings are reported in Subsections 2.5–2.7. In Subsection 2.5, we estimate a static gravity model and decompose the effects of Covid-19 on different products and countries. Subsection 2.6 estimates a dynamic gravity model and evaluates the heterogeneity of the effects of the pandemic on Lithuania's export structure. In Subsection 2.7, we examine whether the importance of distance for export increased in 2020. Finally, the main conclusions and recommendations are presented.

2.2. Concise literature review and contribution

This Section briefly reviews the literature on the effects of Covid-19 pandemic on trade (in the first Subsection) and the literature on gravity modelling (in the second Subsection).

2.2.1. Literature review on the effects of the pandemic on trade

Current studies on the economic effects of the pandemic could be divided into two main groups: investigation of the effects of Covid-19 on entire economy or trade structures of specific countries, and examination of the effects of the pandemic on different economic sectors.

The first group of papers mainly determine negative trade effects of the pandemic. Arriola et al. (2021) investigated the changes in the world trade structure throughout 2020. They concluded that trade in services declined twice as much as trade in goods and claimed that there is no relationship between the amount of the decline and the product complexity. Davidescu et al. (2021) constructed a gravity model for Romania's export and claimed that more efficient institutions (e.g. lower corruption) positively affected the country's export and observed clustering with other institutionally similar countries. Hayakawa & Mukunoki (2021) applied the gravity model to assess the impact of Covid-19 on the international trade. They concluded that, although the impact of the pandemic was negative both for the importers and for the exporters, this effect became insignificant in July 2020. The findings of other authors (e.g. Espitia et al., 2022; Vidya & Prabheesh, 2020) were even more pessimistic. Vidya & Prabheesh (2020) showed that the pandemic could result in a drastic decline of trade and broken trade networks. Espitia et al. (2022) found that the pandemic had mostly negative effects on trade, and the least negative impact was observed for the sectors which relied more on remote work.

However, the impact of Covid-19 was not homogeneous. Zainuddin et al. (2022) examined the effects of the pandemic on Malaysia's export of three types of goods: capital goods, intermediate goods, and consumption goods. They found out that more Covid-19 cases in the trade partners resulted in increased Malaysia's export of capital and consumption goods. On the other hand, Malaysia's export of capital goods decreased together with an increase of the stringency in its trading partners. These results were supported by Zhao et al. (2021) who examined the effects of the pandemic on China's export. Zhao et al. (2021) claimed that Covid-19 situations inside China had significant negative effects on its trade, while Covid-19 situations in other countries had significant positive effects on China's trade.

The heterogeneity of the influence of Covid-19 on trade was supported by the literature examining the impact of the pandemic on various economic sectors. Zainuddin et al. (2021) discovered that Malaysia's export of products protecting from the illness (e. g. rubber gloves) increased; meanwhile, the export of non-basic products (e. g. tobacco, furs and leather) experienced the

sharpest decrease during the pandemic. These findings were supported by Shahriar et al. (2021). They employed a number of specifications of the gravity model to research the leather export by Bangladesh, and claimed that this sector was negatively affected by Covid-19. Barichello (2021) analysed the impact of Covid-19 on Canada's agricultural export and found out that it even increased during 2020, however, not because of the pandemic. Still, the impact was not the same in other countries. Although the Chinese agricultural export of some products (e.g. grain and oil) increased, the average effect of the pandemic on the Chinese agriculture was negative, especially for the smaller producers (Lin & Zhang, 2020).

A large number of services sectors were affected negatively by the pandemic (e.g. tourism (Sigala, 2020), or microfinance (Sangwan et al., 2021)). Still, there are sectors for which Covid-19 created not only challenges, but also new opportunities. The sector of education had to become much more innovative (Yong Zhao & Watterston, 2021). The health care sector became more flexible and better prepared for possible future shocks (Kaye et al., 2021). The diminished economic activity could also result in improved air and water quality in cities (Cheval et al., 2020; Pradhan et al., 2021).

2.2.2. Literature review on gravity modelling

The first well-known scientist to propose a gravity model was Tinbergen (1962). Afterwards, it has been elaborated, modified, corrected and used for international trade analysis a number of times. Anderson (1979) was the first to give strong theoretical foundations for gravity equation, which was later elaborated by Anderson & Van Wincoop (2003) and Anderson (2011). Today, we see its revival with a better theoretical background, improved estimation techniques, and more complicated extensions.

Gravity models could be divided into two main groups: static and dynamic. We shall present the main aspects of each of them in the following Subsections.

2.2.2.1. Static gravity models

A static gravity model is a classical tool dedicated to model international trade. Its classical version is simple and intuitive. Tinbergen (1962) proposed that the value of trade between any two countries could be explained by as little as three variables: the size of the exporter (a proxy for the supply), the size of the importer (a proxy for the demand), and the distance between the exporter and the importer (a proxy for the transportation costs). The size of both economies

is to be measured by taking their gross national products (GNP). Therefore, the classical gravity equation is the following:

$$X_{ij} = \frac{Y_i Y_j}{d_{ij}} \tag{2.1}$$

Here, X_{ij} is for the export from country i to country j, Y_i is for the gross national product of country i, and d_{ij} shows the distance between countries i and j. Rauch (2016) suggested that, when rewriting and estimating such an equation in a simple linear OLS form, the coefficients of Y_i and Y_j should be close to 1, and the coefficient of d_{ij} should be close to -1. It indicates that the export from country i to country j positively depends on the size of both countries and negatively depends of the distance between them. The main idea of the classical gravity equation is that "*we expect larger country pairs to trade more, but we expect countries that are further apart to trade less*" (Shepherd, 2012, p. 9).

Still, Tinbergen himself thought that there may be more exogenous variables than the gross national product and the distance. In his second model, Tinbergen (1962) included three additional dummy variables: one for contiguity (i.e. a shared border) and two for the Commonwealth and Benelux memberships.

Although the gravity equation was first proposed as an intuitive tool for modelling export, there were two major problems associated with its intuitive approach. First, the existing gravity model did not have any theoretical background. Second, the classical gravity equation simplified trade costs to merely the distance between the countries. It neglected such important issues as the possible price changes which could result in a possible trade diversion. These problems were solved by Anderson & Van Wincoop (2003) and Anderson (2011) who derived their gravity model theoretically. Their new gravity equation has the following form (Anderson, 2011):

$$X_{ij} = \frac{Y_i E_j}{Y_w} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma} \tag{2.2}$$

Where:

$$(\Pi_i)^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \frac{E_j}{Y_w} \tag{2.3}$$

$$(P_j)^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} \frac{Y_i}{Y_w} \tag{2.4}$$

Here, X_{ij} shows the export from country i to country j, Y_i shows the nominal GDP of country i, E_j shows the expenditure of country j (in a special case, if we have a trade balance, it could also be equal to the nominal GDP of country j, i.e. Y_j (Anderson, 2011)), Y_w shows the nominal GDP of the whole world, and t_{ij} is the transportation costs between countries i and j. Transportation costs in a theoretical model are much broader than the physical distance. In practice, transportation costs are specified as a combination of variables determining the trade costs, i.e. distance, contiguity, a common language, colonial ties, tariffs, trade restrictions. Π_i and P_j are interrelated special price indexes called multilateral resistance terms which capture how the bilateral trade between countries i and j depends on the trade costs across all of their possible trade partners (Shepherd, 2012). Neither of these terms is observed, and they cannot be directly taken from any statistical data. σ is the elasticity of substitution.

If rearranging Eq. (2.2) and assuming balance in trade, the static gravity equation could be written in the following form:

$$X_{ij} = Y_w^{\alpha_0} Y_i^{\alpha_1} Y_j^{\alpha_2} d_{ij}^{\frac{\alpha_3}{1-\sigma}} T_{ij}^{\frac{\alpha_4}{1-\sigma}} \Pi_i^{\frac{\alpha_5}{1-\sigma}} P_j^{\frac{\alpha_6}{1-\sigma}} \tag{2.5}$$

Here, X_{ij} is the export from country i to country j, Y_i and Y_j are the nominal GDPs of both countries, Y_w is the nominal GDP of the whole world, d_{ij} is the distance between countries i and j, T_{ij} shows all the other transportation costs between countries i and j, and all α's are coefficients which could be either '1' or '-1'.

By taking logarithms of the both sides, we could write Eq. (2.5) in a linear logarithmic form:

$$\begin{aligned} \ln X_{ij} = {} & \alpha_0 \ln Y_w + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \frac{\alpha_3}{1-\sigma} \ln d_{ij} + \frac{\alpha_4}{1-\sigma} \ln T_{ij} + \\ & + \frac{\alpha_5}{1-\sigma} \ln \Pi_i + \frac{\alpha_6}{1-\sigma} \ln P_j \end{aligned} \tag{2.6}$$

Finally, a static gravity equation in the empirical form could be written as follows:

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln d_{ij} + \beta_4 \ln T_{ij} + \beta_5 F_i + \beta_6 F_j \quad (2.7)$$

Here, β's are the coefficients to be estimated, and T_{ij} is a linear combination (it could also be written as a vector) of the other chosen proxies of transportation costs than distance. Today, the 'standard' proxies for transportation costs in empirical gravity modelling are such variables as: distance, contiguity, remoteness, colonial ties, membership in various political and economic organisations, common spoken language(s), religion, free trade agreements, tariffs, migration patterns.

Both F's are the exporter (i) and importer (j) fixed effects, respectively. They are commonly used proxies for the multilateral resistance terms that could be found in the theoretical model. As the world GDP is constant across all the countries, it is incorporated in the regression constant β_0.

Still, most commonly, more than one period is analysed, and a set of equations have to be estimated. Hence, we can include the time dimension (t) and rewrite the model as follows:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln d_{ijt} + \beta_4 T_{ijt} + \beta_5 F_i + \beta_6 F_j \quad (2.8)$$

Another extension is to estimate the gravity model not for the countries as a whole, but for different economic sectors or even firms. In these models, we take export not on the country level, but for each sector, product, or firm.

Helpman et al. (2008) and Chaney (2008) extended the gravity theory by presenting a model for the firm-level trade. According to Chaney (2008), the gravity equation when different firms from different economy sectors trade between the countries is the following:

$$X_{ij}^{k} = \mu_k \frac{Y_i Y_j}{Y} \left(\frac{w_i \tau_{ij}^{k}}{\theta_j^{k}} \right)^{-\gamma_k} \left(f_{ij}^{k} \right)^{-\frac{\gamma_k}{(\sigma_k - 1) - 1}} \quad (2.9)$$

Here, X_{ij}^{k} is the total export in sector k from country i to country j, Y_i and Y_j show the sizes of each of the two countries, w_i is the labour productivity at country i, τ_{ij}^{k} shows variable trade costs, f_{ij}^{k} shows fixed trade costs, and θ_j^{k} shows country j remoteness from the rest of the world. σ_k is the elasticity of substitution between two heterogeneous goods in sector k. Finally, μ_k and γ_k are specific parameters.

One of the novelties of the model of Chaney (2008) was the separating variable and fixed trade costs as well as extensive and intensive export margins. Chaney (2008) claimed that "*A reduction in variable [trade] costs not only causes an increase in the size of exports of each exporter, but also allows some new firms to enter. The extensive margin comes on top of the intensive margin and amplifies the impact of variable costs*" (Chaney, 2008, p. 1714).

These findings were developed by Chaney (2014) who modelled the entrance of firms to the international trade market and used the gravity model to estimate the development of an extensive trade margin for the French firms. Although the model of Chaney (2014) was silent about the intensive trade margin, it explained the development of the extensive margin of the international trade at the firm level.

2.2.2.2. Dynamic gravity models

The dynamic gravity model is an extension of the static gravity model which helps to account for the possible persistence in trade. These models are mainly based on the developments of Campbell (2010) and Olivero & Yotov (2012), and include into the static gravity equation an additional term which shows previous export values.

Campbell (2010) derived a theoretic dynamic gravity model showing that "*trade today depends on the size of each country's home market, current trade costs, and past trade costs*" (Campbell, 2010, p. 10). By keeping the notations from the previous Subsection and abbreviating parameter expressions, Campbell's (2010) dynamic gravity model in in the logarithmic form could be written in the following way:

$$\ln\left(X_{ijt}X_{jit}\right) = \ln\left(C_{it}C_{jt}\right) - \alpha \ln T_{ijt} - \sum_{k=1}^{\infty} \gamma T_{ij(t-k)} \qquad (2.10)$$

Here, X_{ijt} is the export from country i to country j at time t, C_i and C_j shows the consumption in each of the two countries at time t, T_{ijt} shows transportation costs from country i to country j at time t, k is the time lag, and α and γ are specific parameters depending on the elasticity of substitution.

Campbell (2010) claimed that any deviations from the fixed export values must arise either because of the current transport costs (the second term in Eq. (2.10)), or because of the transport costs in the previous periods (the third term in Eq. (2.10)).

Olivero and Yotov (2012) derived an empirical gravity equation which is a generalisation of the static gravity models:

$$\ln X_{ijt} = \beta_0 + (1-\delta)\ln X_{ijt-1} + (1-\sigma)\ln T_{ijt} - (1-\sigma)(1-\delta)\ln T_{ijt-1} + F_{it} + F_{jt} \quad (2.11)$$

Here, σ is the elasticity of substitution, and δ is the depreciation rate. F_{it} and F_{jt} are the fixed effects of the origin and the destination countries, respectively. In this gravity equation, fixed effects account not only for the multilateral resistance terms, but also for the importer's GDP and the world's GDP in both periods.

This equation could be easily transformed to the simple empirically testable version of a dynamic gravity model:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln X_{ijt-1} + \beta_2 \ln T_{ijt} - \beta_3 \ln T_{ijt-1} + \beta_4 F_{it} + \beta_5 F_{jt} \quad (2.12)$$

By keeping the same notations, here, X_{ijt} is the export from country i to country j at time t, Y_i and Y_j shows GDP in each of the two countries at time t, T_{ijt} shows the transportation costs from country i to country j at time t, and F_{it} and F_{jt} are the fixed effects of the origin and the destination countries, respectively (they are proxies for the multilateral resistance terms).

2.2.2.3. Estimating gravity models

Researchers use a number of different estimation techniques for gravity models. The first static gravity equations were simply rewritten in logarithms like in Equations (2.7) and (2.8), and they provided estimations by using the traditional OLS estimation technique. Still, soon it appeared that simple OLS is unable to deal with the problems of the omitted variable bias, heteroscedasticity and nonlinearity. These problems are common in gravity models and result in biased estimates. Therefore, a number of other estimation techniques were introduced in gravity modelling. Santos Silva & Tenreyro (2006) proposed using Poisson pseudo-maximum likelihood (PPML) approach to deal not only with the problem of biased estimators, but also with the problem of zeros which are abundant in the trade data; however, they were dropped from the sample after taking the logarithms of export (i.e. no country exports all the possible goods to all the other countries of the world, hence, there are many rows of 'zero' exports, and the logarithm of 'zero' is undefined). Martin (2020) argued that both OLS and PPML estimators are

biased (although PPML not so badly), and proposed to estimate gravity models by using Eaton-Kortum maximum likelihood approach (Eaton & Kortum, 2001). Helpman et al. (2008) proposed using a 2-stage procedure to estimate the gravity equation. In the first stage, they estimated a Probit model of the extensive trade margin, whereas, in the second stage, they evaluated a log-linear gravity model by using the predicted components from the first stage. Other authors estimated gravity models by using a number of various estimation techniques: 2-stage OLS (e.g. Bussière & Schnatz, 2006; Greene, 2013), 2-step Heckman estimator (e.g. Mnasri & Nechi, 2021), and various functional forms (Kristjánsdóttir, 2005).

According to Shepherd (2012) and based on the theoretical gravity model developed by Anderson & Van Wincoop (2003) and Anderson (2011), symmetric gravity models should be used for estimations by including country fixed effects. However, Egger (2002) and Carrère (2006) proposed to estimate gravity models including random effects because ordinary fixed effect models do not allow the estimation of the effects of time-invariant variables.

Overall, the main rules for empirical gravity modelling for static models are the following (Shepherd, 2012):

1. Export and GDP data is to be taken in the nominal terms, as they will be deflated by the special unobserved price indexes.
2. Unidirectional trade flows should be taken in one gravity model, i.e. either export, or import, but not both.
3. GDP data could be used instead of expenditure data, which is not possible in many cases.
4. The possible problems of omitted variables, heteroscedasticity and nonlinearity should be addressed.
5. Fixed individual effects of exporters, importers, and time are to be applied. When estimating sectoral gravity models, sector fixed effects are recommended (Head & Mayer, 2014).

Dynamic gravity equations in the empirical literature are also estimated by using various kinds of models. Along with the static gravity models, dynamic gravity models usually are estimated by using OLS (e.g. De Grauwe & Skudelny, 2000; Nguyen, 2010; Demir & Hu, 2021) and PPML specifications (e.g. Santos Silva & Tenreyro, 2006; Martin, 2020; Olivero & Yotov, 2012). The latter, according to Santos Silva & Tenreyro (2006), helps to solve the problem of bias and inconsistency of the OLS estimates in the case of heterogeneity, which is very typical in trade data.

However, other methods are also used. Olivero & Yotov (2012) also estimated a dynamic gravity model by using instrumental variables (IV).

Many researchers (e.g. Bekele & Mersha, 2019; Martínez-Zarzoso et al., 2009) applied generalised method of moments (GMM) estimators proposed by Arellano & Bond (1991) and Blundell & Bond (1998). However, Arellano & Bond (1991) themselves acknowledged that the GMM estimator is downward biased. Bun & Klaassen (2005) claimed that this bias of GMM estimators increases if we have more time periods (T) and recommended OLS estimators for moderate or large Ts.

In special cases when we analyse an extensive trade margin, and the dependent variable is not the volume of exports, other estimation techniques are selected. If we examine the probability of exporting and the dependent variable has the values of either 0 (not exported) or 1 (exported), Probit or Logit regressions are used. Chaney (2014), Berthou & Fontagne (2008) and Helpman et al. (2008) used Probit regressions to estimate extensive trade margins (probability of exporting) of static or dynamic gravity models on the firm and country level. Baldwin & Di Nino (2006) used Logit regression to estimate an extensive trade margin on the country and sector level. On the other hand, if the dependent variable is the number of sectors or products traded, other models were proposed. Santos Silva et al. (2014) examined techniques suitable for the estimation of gravity models where the dependent variable is the number of sectors exporting to other countries. Santos Silva et al. (2014) argued that neither simple OLS, nor PPML methods are suitable for such analysis because of a double-bounded endogenous variable (the number of sectors cannot be less than zero and higher than the total number of sectors in the economy), and proposed to apply other flexible estimation techniques.

Overall, in order to ensure robustness of the results, researchers usually estimate gravity equations by applying at least two different estimation techniques.

2.2.3. Contribution

Most of the current studies are focusing on the impact of the pandemic either on trade in general, or on the trade of different product groups. We still lack analyses as to how Covid-19 affected trade in terms of the trade partners, and on the possible changes in the importance of various export determining factors during the pandemic. This research fills the gap in the current literature by providing extensive analysis of Lithuania's export structure in terms of all these aspects. It empirically analyses the possible heterogeneity of exports in terms of both products and destination markets. It also examines if the importance of any export determining factors changed during the pandemic.

This research contributes to the literature on empirical gravity modelling and the economic effects of the pandemic. Compared to the already existing papers, it differs in 3 main aspects:

1. We use a larger and more detailed 3-dimensional (i.e. time, product and country) dataset. Having both a wide range of goods (almost 100) and a wide range of export partners (more than 150) in the dataset allows us to examine the heterogeneous effects of the pandemic on both different product groups and different export destinations.
2. The effects of Covid-19 are researched by constructing and estimating different specifications of Lithuania's gravity model which include many important export variables (e.g. GDP, distance, languages, contiguity, the EU and the WTO membership). This approach ensures the robustness of the results and allows us to conduct comprehensive analysis.
3. To the best of our knowledge, this is the first research to analyse the changes of the importance of different determinants of export during the year of the pandemic.

2.3. Methodology and data

In order to assess the changes of Lithuania's export structure during the first year of the pandemic, we apply a two-step estimation procedure:

1. First, we estimate a gravity model for Lithuania. The gravity model was chosen because it allows researching heterogeneity in different economic sectors and export markets. We estimate two types of gravity model: a static and a dynamic one.
2. Second, having estimated the values of the coefficients of the gravity models, we forecast Lithuania's export of different products to different markets for 2020. Analysis of the differences between the actual and the forecasted export values in 2020 gives a rough view of the impact of Covid-19 pandemic on Lithuania's export. If the difference between the actual and the predicted export is large, it indicates atypical changes of Lithuania's export. Assuming that there were no major changes in the international relations or trade agreements, the most probable reason for the discrepancies between the actual and the predicted export could be the pandemic.

In the following Subsections, we present our research methodology (see: Sections 2.3.1 and 2.3.2) and the data (see: Section 2.3.3).

2.3.1. Model specification

The gravity model was constructed following its theoretical foundations presented by Tinbergen (1965), Anderson (1979), Anderson & Van Wincoop (2003) and Anderson (2011). However, based on the availability of data (international statistic offices still did not provide the export data for the full year 2020), and following Davidescu et al. (2021), Shahriar et al. (2021) and Zainuddin et al. (2022), we chose the gravity model of only one exporting country. We estimate two types of Lithuania's gravity model: a static model and a dynamic one.

Our static gravity model follows the specification presented in Eq. (2.8). We describe transport costs as a combination of such variables as the distance, a shared border, common spoken language(s), as well as the EU and the WTO membership.

Following De Grauwe and Skudelny (2000), Campbell (2010), Olivero and Yotov (2012) and Chaney (2014), we also estimate a dynamic gravity model including all the regressors which are present in the static gravity model (the GDP variables are lagged) and one additional factor: the export of the previous year. The previous year's export shows the continuation (persistence) of export and is highly significant. Its inclusion helps to reduce autocorrelation and endogeneity problems by catching up some of the omitted variables and has no effect on the efficiency of the estimates, as export is correlated with its previous value.

To minimise the risk of other potential discrepancies, in both models, we also apply individual effects, clustering and robust standard errors.

Our **static gravity model** to be estimated in this Section is represented as follows:

$$Export_{i,c,t} = f\begin{pmatrix} \log GDP_{LT,t}, \log GDP_{c,t}, \log Distance_c, \\ Language_c, EU_{c,t}, Border_c, WTO_{c,t} \end{pmatrix} + \varepsilon_{i,c,t} + u_{i,c,t} \quad (2.13)$$

Here, $Export_{i,c,t}$ stands for the export of product i from Lithuania to country c in year t. $GDP_{LT,t}$ is Lithuania's GDP at time t. $GDP_{c,t}$ is country's c GDP in year t. $Distance_c$ is the distance between Lithuania and country c. $Language_c$ stands for an index that the average citizen of Lithuania and country c could understand each other. EU_c and WTO_c shows if Lithuania and country c both belong to the European Union (EU) and to the World Trade Organisation

(WTO), respectively. $Border_c$ shows if Lithuania and country c share a border. Finally, $\varepsilon_{c,t}$ is an error term, and u is an individual effect.

Dynamic gravity model is based on the specification of Olivero & Yotov (2012) and is represented as follows:

$$Export_{i,c,t} = f\begin{pmatrix} Export_{i,c,t-1}, \log GDP_{LT,t-1}, \log GDP_{c,t-1}, \\ \log Distance_c, Language_c, EU_{c,t}, Border_c, WTO_{c,t} \end{pmatrix} + \varepsilon_{i,c,t} + u_{i,c,t} \quad (2.14)$$

Here, all the notations are the same as in the static gravity model, and u is the individual effect on the country, product, year, or a combination of these (see the following Section for the discussion). The main difference from the static gravity model is the introduction of the previous export

We estimate Lithuania's gravity model for the period of 2015–2019. The model takes one source country (Lithuania), 157 Lithuania's export partners and 96 product groups.

2.3.2. Model estimation techniques

As already presented in the previous Sections, researchers have been applying a number of different estimation techniques for the estimation of gravity models: simple OLS, Poisson pseudo-maximum likelihood (PPML) model (Santos Silva & Tenreyro, 2006), Eaton-Kortum maximum likelihood approach (Eaton & Kortum, 2001), various 2-stage procedures (Bussière & Schnatz, 2006; Helpman et al., 2008; Greene, 2013; Mnasri & Nechi, 2021), various functional forms (Kristjánsdóttir, 2005), GMM (Bekele & Mersha, 2019; Martínez-Zarzoso et al. 2009; Bun & Klaassen 2005). Still, the most popular tools among the researchers are either OLS, or PPML models. In order to ensure robustness of the results, we estimate Lithuania's gravity models under both OLS and PPML specifications.

Egger (2002) and Carrère (2006) proposed to estimate gravity models by including random effects because the ordinary fixed effect models do not allow estimation of the effects of time-invariant variables. In our case with only one source country, such variables would be the distance, a common spoken language, and the dummies for the EU, the WTO membership, and contiguity. As all of these variables are time-invariant, the ordinary fixed effects model would leave us with only 3 exogenous variables: Lithuania's GDP, export partner's GDP, and the previous export. Hence, we apply random

effects OLS as a baseline estimation technique, by taking the combined individual effects of the destination country and the product.

According to Shepherd (2012) and based on the theoretical gravity model developed by Anderson & Van Wincoop (2003), symmetric gravity models should be estimated by including country fixed effects. However, the models that we estimate have only one source country and a number of product groups. Hence, to be in line with the theory and to avoid losing regressors, we follow Gaure (2011) and Guimarães & Portugal (2010), and estimate OLS models by taking individual fixed effects either of the product or of the product and the year. In this way, we allow for the differences in different product groups and different years, and we estimate coefficients of country-specific explanatory variables, i.e. destination, languages, contiguity, and the EU and the WTO membership.

According to Santos Silva and Tenreyro (2006), the heteroscedasticity OLS estimator of log-linearized models would be both biased and inconsistent. They suggested that the problem for gravity models would be solved by using the PPML estimator. Moreover, this approach solves the problem of zeros which are abundant in trade data; however, they drop out of the sample after taking the logarithms of export. Based on the findings of Martin (2020) who claims that both OLS and PPML estimators are biased, though the PPML estimator is to a lesser extent, and, by following Correia et al. (2020), we also estimate the gravity model by using the PPML approach with high dimensional fixed effects. In order to have estimates of all the exogenous variables, in our fixed effects specifications, we use individual fixed effects either for the product or for the product and the year.

Lithuania's static gravity model is estimated based on 3 different specifications: OLS with random effects, OLS with fixed effects, and PPML with fixed effects. Following De Grauwe & Skudelny (2000), Campbell (2010), Olivero & Yotov (2012), in order to ensure comparability of the models, we use the same model specifications for the estimation of the dynamic gravity models.

2.3.3. Data sources

We are using the data on the goods export of Lithuania, the GDP of Lithuania and its export partners, the distance between Lithuania and its export partners, the common spoken languages, contiguity, as well as the EU and the WTO membership.

The export data is measured in euros and retrieved from the *Statistics Lithuania* (the Lithuanian Department of Statistics) database. It provides the annual data of export from Lithuania to different countries in terms of each of 96 products classified according to the HS 2-digit classification. Lithuania

exported its products to 199 countries in 2020; however, after combining the export data with the GDP, language and destination data, only 157 countries are left. There is no lower bound for the amount of export accounted. That helps to avoid a significant number of zeros in the data which would become meaningless in the OLS model after taking logs. As Lithuania does not export every product to every destination country, there is an unbalanced panel of 39,138 non-missing observations.

The annual nominal GDP data for Lithuania and its export partners is taken from the World Bank database. As GDP is measured in constant USD 2010, it was recalculated in euros by using the yearly averages of the EUR/USD exchange rate, as retrieved from the ECB database.

Distance, language, the EU and the WTO membership and the common border data were retrieved from the CEPII database designed for gravity modelling.

For the distance, we use the population-weighted distance between the biggest cities in thousands of kilometres ('*distw*') which is "*based on bilateral distances between the biggest cities of the two countries, those inter-city distances being weighted by the share of the city in the overall country's population*" (Mayer & Zignago, 2011, p. 3).

The measure of the common spoken languages ('*cls*') shows a country's ability to communicate with each other (in any language). It can be anywhere between '0' (i.e. nobody in the two countries can understand each other) and '1' (any two people taken from the two countries will be able to communicate with each other) (Mélitz & Toubal, 2012).

$EU_{c,t}$ is equal to '1' if both Lithuania and country c were the members of the EU in year t, and '0' otherwise. $WTO_{c,t}$ is equal to '1' if both Lithuania and country c were the members of the WTO in year t and 0 otherwise. As Lithuania was a member of both of these organisations during the analysed period, the values of these dummies depend solely on the destination countries.

Contiguity is a dummy variable, and it shows if Lithuania has a land border with the destination countries. There are 4 countries contiguous to Lithuania: Latvia, Poland, Russia, and Belarus. For these countries, the dummy is equal to '1', whereas for all the others it amounts to '0'.

Following Shepherd (2012), the OLS model is estimated by taking the logs of export, GDP and distance variables. Following Santos Silva and Tenreyro (2006), the PPML model is estimated by taking the logs of GDP and distance variables.

2.4. Descriptive statistics

Table 2.1 provides descriptive statistics for all the variables. 35.4% of export data is either zero or missing, and a further 7.6% is below 1000 euros. Out of

157 Lithuania's export partners, 27 countries belong to the EU, 141 countries belong to the WTO, and 4 countries have a shared border with Lithuania. These three variables, as well as the common spoken languages, are constant over the analysed time period.

Table 2.1. Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max	Skew.	Kurt.
Export, MEUR	52 848	3.92	24.9	0	1 070	20.78	633.75
Zero / missing values		*35.4 %*					
Values lower than 1000 eur		*7.55 %*					
GDP_{dest}, BEUR	52 848	654	1 930	34.3	16 400	6.06	43.4
GDP_{LT}, MEUR	52 848	42 900	2 090	40 300	46 300	0.50	1.81
Distance (weighted)	52 848	4 793	3 804	225	17 226	0.83	2.95
Language	52 848	0.19	0.22	0	0.87	1.53	5.02
EU	52 848	0.28	0.45	0	1	0.96	1.92
EU member countries		*27 (17 %)*					
Non-EU countries		*130 (83 %)*					
WTO	52 848	0.92				-2.96	9.98
WTO member countries		*141 (90 %)*					
Non-WTO countries		*16 (10 %)*					
Contiguity	52 848	0.04	0.20	0	1	4.47	20.98
Contiguous countries		*4 (3 %)*					
Non-contiguous countries		*153 (97 %)*					

The smallest geographical distance is between Lithuania and Latvia. Both countries also share a border. The longest geographical distance separates Lithuania and New Zealand. The index for the common spoken language is the highest (above 0.7) between Lithuania and the countries where Russian is either the mother tongue, or widely spoken in general (Russia, Belarus, Latvia, Kazakhstan, Kyrgyzstan and Estonia). The countries where English is either the mother tongue, or is widely spoken (i.e. the majority of the EU, as well as the Anglo-Saxon countries) comprise the second largest country group. The index between these countries and Lithuania for common spoken languages is on average 0.2–0.4.

It is clear from Table 2.1 that the majority of the non-dummy variables are not normally distributed. We resolve the problem by taking logarithms before regressing (see: Table 4.1 in the Appendix).

2.5. Static analysis

This Section applies the static gravity model to examine how Covid-19 pandemic affected Lithuania's export structure.

2.5.1. The model and correlations between the variables

A reduced form of the static gravity equation for the OLS specification is presented below. Following Shepherd (2012), we take the logs of the export, GDP and distance variables.

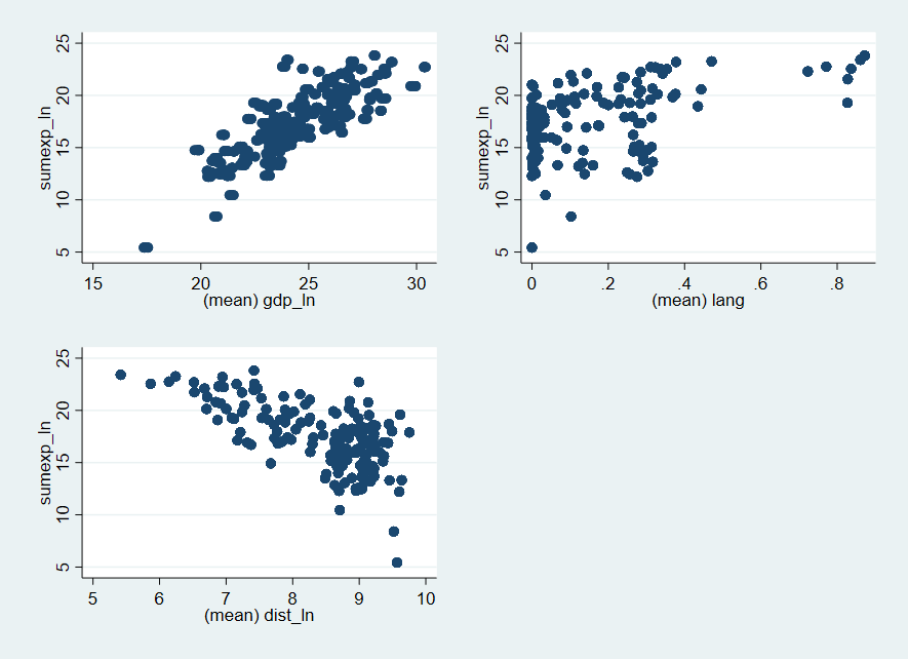
$$\begin{aligned}\log Export_{i,c,t} = \beta_0 + \beta_1 \log GDP_{LT,t} + \beta_2 \log GDP_{c,t} + \\ + \beta_3 \log Distance_c + \beta_4 Language_c + \beta_5 EU_{c,t} + \\ + \beta_6 Border_c + \beta_7 WTO_{c,t} + \varepsilon_{i,c,t} + u\end{aligned} \quad (2.15)$$

A reduced form of the static gravity equation for the PPML specification, where the dependent variable is the mean of export, is presented below. Following Santos Silva & Tenreyro (2006), we take the logs of the GDP and distance variables.

$$\begin{aligned}\overline{Export}_{i,c,t} = \exp(\beta_0 + \beta_1 \log GDP_{LT,t} + \beta_2 \log GDP_{c,t} + \\ + \beta_3 \log Distance_c + \beta_4 Language_c + \beta_5 EU_{c,t} + \\ + \beta_6 Border_c + \beta_7 WTO_{c,t}) + \varepsilon_{i,c,t} + u\end{aligned} \quad (2.16)$$

Graphically, the correlations between the log of the export and non-dummy exogenous variables (the log of the destination's GDP, the log of the distance and an index of the common spoken languages) are given in Figure 2.1. The origin's GDP is not included in the graphs because it does not vary by country. For the visibility purposes, the means of exogenous variables are calculated, and the export data is summed over products. As expected, export is positively correlated to the destination's GDP and common spoken languages. The relationship is negative between export and distance.

Figure 2.1. Correlations between endogenous and exogenous variables.



2.5.2. Estimating static gravity model

The estimation results of Lithuania's gravity models (Equations (2.15) and (2.16)) are given in Table 2.2. GDP of the destination, GDP of the origin, distance, common spoken languages, and WTO membership have the expected signs and are highly significant in both models. The EU membership and contiguity are mostly insignificant.

The results presented in Table 2.2 are in line with the theory and are similar to the mean results of the other structural gravity models, as given by Head & Mayer (2014) (see: the rightmost column of Table 2.2). The determination coefficient and the result of the Hausmann test show that fixed effects are more suitable for the model than random effects. Our estimates for the destination's GDP and the distance are very close to the average values of these variables. The coefficient of the origin's GDP is higher for Lithuania (around 1.6) than the average estimate, which is 0.74. The reason could be purely Lithuania-specific because we model only one country of origin.

Although the average estimate of a common spoken language amounts to 0.39 (Head & Mayer, 2014), for Lithuania, this estimate is between 3 and 4. Such high values for a common spoken language may be specific to Lithuania

and represent the influence of other cultural, historical and geographical factors for Lithuania's export. In Lithuania, Russian is the widest spoken foreign language (according to Statistics Lithuania (2022), 63% of Lithuanians are able to speak it), and Lithuania has indeed developed strong trade relations with the former Soviet bloc countries. However, this factor could also include other, non-accounted factors as the knowledge of the Russian work culture, the historical trade relations and Lithuania's position as a gateway between the east and the west.

Table 2.2. Results of the static gravity model

Variables	**OLS re**	**OLS fe**	**OLS fe**	**PPML fe**	**PPML fe**	***Mean***
Endog. var.	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	***estimates****
GDP_{LT}	3.10620***	1.86511***		1.40508***		*0.74*
	(0.31007)	(0.34072)		(0.23944)		
GDP_{dest}	0.49302***	0.67261***	0.67280***	0.62002***	0.62042***	*0.58*
	(0.03241)	(0.02889)	(0.02887)	(0.04290)	(0.04294)	
Distance	-0.91254***	-1.24760***	-1.24800***	-0.96074***	-0.96137***	*-1.1*
	(0.07685)	(0.06024)	(0.06018)	(0.12152)	(0.12156)	
Language	3.38232***	4.36370***	4.36618***	3.07735***	3.07820***	*0.39*
	(0.32675)	(0.27101)	(0.27131)	(0.38469)	(0.38473)	
EU	0.29183**	0.08897	0.08935	0.01718	0.01683	*0.16*
	(0.11592)	(0.09507)	(0.09514)	(0.13326)	(0.13327)	
WTO	0.01322	0.28186***	0.27916***	0.50888***	0.50886***	*0.36 (FTA)*
	(0.09873)	(0.08841)	(0.08843)	(0.19263)	(0.19259)	*0.76 (NAFTA)*
Contiguity	0.86340***	0.29034*	0.28926*	-0.01780	-0.01848	*0.66*
	(0.18582)	(0.15377)	(0.15389)	(0.12867)	(0.12871)	
Constant	yes	yes	yes	yes	yes	
Ind. effects	ctry, prod	product	prod, year	product	prod, year	
R-squared	26.93	54.33	54.37	73.70	73.78	
Obs	28,077	28,077	28,077	28,077	28,077	

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
* Mean estimates of structural gravity models (Head & Mayer, 2014)

Our estimate of contiguity is highly fluctuating: from strongly significant and amounting to 0.86 in the random effects OLS model to even and non-significant in the PPML model. These values strongly differ from the average value of contiguity in other papers, which is around 0.66. These ambiguous results for contiguity could also be Lithuania-specific. Two of Lithuania's neighbours are EU member states Latvia and Poland with which Lithuania has been expanding its trade relations. However, the other two neighbours are

authoritarian and aggressive countries Russia and Belarus with which Lithuania has been trying to narrow its trade relations.

Head & Mayer (2014) found that the average value of the coefficient for free trade agreements is 0.36, and, for NAFTA, 0.76. Our findings are in line with these values, as the coefficient of the WTO membership for Lithuania amounts to around 0.4, and this is close to the average value of the FTA coefficient. Head & Mayer (2014) claim that, on average, the significance of the EU estimator is much lower than these of the other trade agreements and amounts to 0.16. We find it to be insignificant for Lithuania. The reason for insignificance could be that Lithuania is a member of the EU itself, and the effect of the EU is already captured by the distance variable.

Overall, the estimation results are robust and in line with the average results of the other gravity models, as summarised in Head & Mayer (2014).

2.5.3. Changes of Lithuania's export structure by product group

In this Subsection, we are using coefficients estimated by the static gravity model in the previous Subsection with the objective to forecast Lithuania's export for the year 2020. For the predictions, we estimate the OLS gravity model with the product fixed effects for the period of 2015–2019. Next, the estimated coefficients and the product fixed effects are used to calculate the predicted export values for each product group in 2020. The difference between the actual and the predicted export values would be a rough estimation of the effect of the pandemic on Lithuania's goods export in 2020.

Table 2.3. Product groups showing the largest negative differences between their actual and predicted export values in 2020

HS	Product description**	q*
11	Products of the milling industry; malt; starches; inulin; wheat gluten	2
19	Preparations of cereals, flour, starch or milk; pastry cooks' products	2
2	Meat and edible meat offal	3
88	Aircraft, spacecraft, and parts thereof	4
86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds	5

* q shows the quantile of product complexity (1 – the least complex, 5 – the most complex), as given by the *Growth Lab* at Harvard University (2019)

Table 2.3 lists product groups classified according to the HS 2-digit classification which in 2020 had much lower export values than the model predicted. The table also gives the quantile of the product complexity, as

calculated by the *Growth Lab* at Harvard University (2019). Table 2.3 shows that the products which in 2020 had the greatest negative differences between the actual and the predicted export values are: aircraft and railway products, meat and preparations of cereals, flour, starch or milk.

The decrease of Lithuania's export of the railway and aircraft industries could be directly related to the pandemic because, in the face of Covid-19 pandemic, travelling decreased substantially. The decrease of the export of meat could be a result of the closure of restaurants.

Table 2.4 gives products for which Lithuania's export in 2020 was much higher than predicted. The quantile of product complexity is also listed. The product groups having the largest positive differences between their actual and predicted export values are: leisure goods (beverages, spirits and tobacco), housing (furniture, articles of wood and electric appliances), optical, medical and pharmaceutical goods, food (fish, seeds and cereals), mineral fuels, oils and chemical products, and vehicles.

An increase of Lithuania's export of beverages and spirits together with a sharp increase of the export of tobacco, ships and boats could be a direct consequence of the pandemic. The pandemic resulted in a shutdown of such traditional entertainment places as cafés, theatres and restaurants. Therefore, people most probably switched to other still available ways of entertaining and spent more on such leisure goods as alcohol and cigarettes. Lithuania's export of goods related to housing (i.e. furniture, wood products and electric appliances) also increased. This could also be an effect of Covid-19 pandemic. As people needed working space at home and could not spend money on their usual leisure activities, they could invest in more spacious apartments, new furniture and appliances. The increase of the export of optical, medical and pharmaceutical products is also directly related to the pandemic.

The difference between Lithuania's actual and fitted export values for vehicles and mineral fuels is high and positive. However, in the face of Covid-19 pandemic, which resulted in decreased commuting and, therefore, in a lower usage of vehicles and fuels, we could expect nearly the opposite. This result remains unclear and should be compared to the results of other model specifications.

Overall, the analysis shows that the influence of the pandemic was negative for Lithuania's export of aircraft and railway products, meat and preparations of cereals, flour, starch and milk. The OLS model predicts positive effects for the export of tobacco, beverages, furniture, electronics, articles of wood, food, fuels, vehicles, and medical and pharmaceutical products.

Table 2.4 reveals that 45% of the products for which the actual export was higher than predicted were of the highest complexity (i.e. they belong to the 5th

complexity quantile). Another 10% of the products belong to the 4th complexity quantile. Hence, in total, the high complexity products make up 55% of all Lithuania's export products, for which the first pandemic year had a positive effect. On the other hand, three out of four items of goods for which the actual export value was lower than predicted were of low complexity (see: Table 2.3). We can conclude that the export of products of higher complexity is more likely to be higher than predicted for 2020.

Table 2.4. Products groups having the largest positive differences between their actual and predicted export values in 2020

HS	Product description**	q*
3	Fish and crustaceans, molluscs and other aquatic invertebrates	1
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	1
24	Tobacco and manufactured tobacco substitutes	1
31	Fertilisers	2
44	Wood and articles of wood; wood charcoal	2
10	Cereals	2
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	2
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	3
22	Beverages, spirits and vinegar	3
72	Iron and steel	4
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings	4
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	5
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	5
73	Articles of iron or steel	5
30	Pharmaceutical products	5
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	5
38	Miscellaneous chemical products	5
39	Plastics and articles thereof	5
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	5
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories	5

* q shows the quantile of product complexity (1 – the least complex, 5 – the most complex), as given by the *Growth Lab* at Harvard University (2019)

The results suggest that pandemic-related export changes were mostly positive for the goods of a higher complexity. Therefore, static analysis reveals that Covid-19 pandemic was not extremely harmful for Lithuania's export competitiveness. Quite the opposite! It could have had even positive effects for the competitiveness of Lithuania.

2.5.4. Changes of Lithuania's export structure by destination country

This Section examines the changes of Lithuania's export structure by the destination country in 2020. We employ a similar method of analysis to the one in the previous Section. The only difference is that the coefficients and product fixed effects estimated by the OLS gravity model for the period of 2015–2019 are used to calculate the predicted export values in 2020 for each destination country. The differences between the actual and the predicted export values show a possible impact of the pandemic for Lithuania's export structure in terms of the destination markets.

Table 2.5. Lithuanian export partners having the largest differences between the actual and the predicted export values in 2020

Actual export lower than predicted			Actual export higher than predicted		
Country	**Share[1]**	**ECI[2]**	**Country**	**Share[1]**	**ECI[2]**
Belarus	2.15	0.89	Germany	8.19	2.09
Slovakia	0.35	1.41	Netherlands	5.31	0.98
Luxembourg	0.04	-	USA	4.49	1.55
Iran	0.01	-0.71	Sweden	4.61	1.70
			UK	4.25	1.51
			Russia	13.7	-0.04
			Estonia	4.60	0.96
			Norway	3.03	0.44
			France	2.54	1.37
			Ukraine	3.20	0.37
			Italy	2.18	1.44
			Belgium	2.15	1.18
			Denmark	2.61	1.09
			Finland	2.02	1.55
			Germany	8.19	2.09

[1] Share of Lithuania's export to the specific country in the totality of Lithuania's export in 2020, %

[2] The country's economic complexity index as of 2018 (The *Growth Lab* at Harvard University, 2019)

Table 2.5 lists Lithuania's export partners having the highest differences between their actual and predicted export values in 2020 (sorted by the

magnitude of the difference, starting from the highest). On the left, there are the countries for which the difference between Lithuania's actual and predicted export was the largest negative. On the right, there are countries which imported from Lithuania in 2020 much more than the fitted values, i.e. the difference between the actual and the predicted export values was the largest positive. The shares of Lithuania's export to these countries in 2020 and the countries' economic complexity indexes (ECI) as of 2018, calculated by the *Growth Lab* at Harvard University (2019), are also given in Table 2.5.

Judging by the findings given in Table 2.5, the positive difference between the actual and the predicted export values is more likely for the recipient countries which had stronger relations with Lithuania, i.e. had a larger share in the total export of Lithuania. Also, there may be a positive relationship between the above-mentioned difference and the country's economic complexity. The more complex destination markets of Lithuania are more likely to have actual export values higher than predicted. The relationship between the difference between the actual and the predicted export values as well as the distance between Lithuania and the destination country is ambiguous and requires further investigations. Almost all the countries on both sides of Table 2.5 geographically are not located remotely from Lithuania.

We conclude that, judging from the static gravity model, Covid-19 pandemic could have had a small impact on Lithuania's export structure in terms of the export partners. Yet, we find no evidence of any relationship between the effects of the pandemic and the closeness of the destination countries to Lithuania. However, the results show that the stronger trade relations with Lithuania and the higher economic complexity index of the destination country could result in positive pandemic-related effects on Lithuania's export.

2.5.5. Concluding remarks on static analysis

The empirical findings from static analysis suggest that the pandemic negatively influenced Lithuania's export of aircraft, railway products, meat and preparations of cereals, flour, starch and milk. All these effects could be associated to the 'stay-home' requirements and the closure of cafés, bars and restaurants.

The pandemic had a positive impact on Lithuania's export of beverages, spirits, tobacco, furniture, articles of wood, various electric appliances, food, fuels, vehicles and optical, medical and pharmaceutical products. The increase of the export of beverages, tobacco and ships could be explained by the shift of leisure activities when all the usual entertainment places were closed. The higher values of the exported furniture, products made of wood, and electric

appliances could be associated to people working from home and the need/choice of spending more money on their surroundings. Finally, medical and pharmaceutical products seem to be directly influenced by the pandemic. Still, the increase of the export of fuels and vehicles is not fully clear.

The findings suggest that the products denoted by higher complexity were more likely to be exported more during 2020.

We find that the pandemic could have had a minor impact on the export structure of Lithuania in terms of the export partners. A larger export share and a higher economic complexity of the destination country resulted in the pandemic-related increase of the export. Still, we find no clear relationship between the changes of the export and the distance of the destination country from Lithuania.

2.6. Dynamic analysis

In this Section, we shall employ a dynamic gravity model to analyse the effects of Covid-19 pandemic on Lithuania's export structure.

2.6.1. The models and cross-correlations between the variables

The reduced form gravity equation for the OLS specification is as follows:

$$\begin{aligned}\log Export_{i,c,t} = {} & \beta_0 + \beta_1 \log Export_{i,c,t-1} + \beta_2 \log GDP_{LT,t-1} + \\ & + \beta_3 \log GDP_{c,t-1} + \beta_4 \log Distance_c + \beta_5 Language_c + \\ & + \beta_6 EU_{c,t} + \beta_7 Border_c + \beta_8 WTO_{c,t} + \varepsilon_{i,c,t} + u\end{aligned} \tag{2.17}$$

The reduced form gravity equation for the PPML specification, where the dependent variable is the mean of export, is presented below:

$$\begin{aligned}\overline{Export}_{i,c,t} = {} & \exp(\beta_0 + \beta_1 Export_{i,c,t-1} + \beta_2 \log GDP_{LT,t-1} + \\ & + \beta_3 \log GDP_{c,t-1} + \beta_4 \log Distance_c + \beta_5 Language_c + \\ & + \beta_6 EU_{c,t} + \beta_7 Border_c + \beta_8 WTO_{c,t}) + \varepsilon_{i,c,t} + u\end{aligned} \tag{2.18}$$

Both model specifications were estimated by taking different individual effects.

Correlations between the log of export in year *t* and all the exogenous variables (the log of the export of the previous year, the logs of the GDP data, the log of distance, the index of common spoken languages, the EU and the

WTO membership, and contiguity) are given in Table 2.6. Evidently, export has the strongest (positive) relationship with its own history. It also seems to be negatively related to distance and positively related to the common spoken languages, the GDP of the destination of the previous year, contiguity, and the EU membership. The relationship between Lithuania's goods export and its own GDP as well as the WTO membership is very weak.

Table 2.6. Matrix of correlations

Variables	$lnExport_{i,c,t}$	$lnExport_{i,c,t-1}$	$lnGDP_{LT,t-1}$	$lnGDP_{c,t-1}$	$lnDistance_c$	$lnLanguage_c$	$EU_{c,t}$	$Contiguity_c$	$WTO_{c,t}$
ln $Export_{i,c,t}$	1.000								
ln $Export_{i,c,t-1}$	0.880	1.000							
ln $GDP_{LT,t-1}$	0.010	0.023	1.000						
ln $GDP_{c,t-1}$	0.251	0.241	0.038	1.000					
ln $Distance_c$	-0.368	-0.372	0.024	0.079	1.000				
ln $Language_c$	0.338	0.344	-0.025	-0.079	-0.531	1.000			
$EU_{c,t}$	0.266	0.258	-0.015	0.169	-0.625	0.179	1.000		
$Contiguity_c$	0.279	0.284	-0.014	0.009	-0.437	0.576	0.051	1.000	
$WTO_{c,t}$	0.026	0.022	0.009	0.176	0.090	-0.067	0.247	-0.180	1.000

2.6.2. Lithuania's gravity model for 2015–2019

Table 2.7 presents estimation results for different specifications of Lithuania's gravity model. The first 5 columns provide estimation results of a static gravity model. The final 5 columns give the results of a dynamic gravity model, including last year's export.

Table 2.7 shows similar results for all the specifications. The GDP of the destination, the distance and the common spoken language have the expected signs and are highly significant in all the models. The effects of the origin's GDP, the EU and the WTO membership are ambiguous.

Judging by the determination coefficients, the fixed effects OLS and PPML models are more suitable to model Lithuania's export. The dynamic gravity model specified under PPML specification explains the export fluctuations best of all. If the year fixed effects are included, they eliminate the origin's GDP. However, it does not have any significant impact on the results.

Table 2.7. Results of the gravity equations*

Variables	OLS re	OLS fe	OLS fe	PPML fe	PPML fe	OLS re	OLS fe	OLS fe	PPML fe	PPML fe
Dependent variable	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**	**Exporting**
$GDP_{LT,t-1}$	1.27322***	0.63714***		0.24771*		0.03779	-0.10567		0.47800***	
	(0.17126)	(0.18358)		(0.13997)		(0.11440)	(0.11552)		(0.09659)	
$GDP_{dest,\ t-1}$	0.49046***	0.67090***	0.67102***	0.61623***	0.61693***	0.18377***	0.18323***	0.18306***	0.05126***	0.05081***
	(0.03228)	(0.02880)	(0.02881)	(0.04278)	(0.04284)	(0.01697)	(0.01176)	(0.01175)	(0.00648)	(0.00655)
Distance	-0.90572***	-1.24510***	-1.24509***	-0.95487***	-0.95584***	-0.27479***	-0.29332***	-0.29350***	-0.10298***	-0.10131***
	(0.07631)	(0.06012)	(0.06013)	(0.12161)	(0.12167)	(0.03720)	(0.02351)	(0.02347)	(0.02069)	(0.02118)
Language	3.38139***	4.36068***	4.36278***	3.06216***	3.06331***	1.00830***	1.08814***	1.08704***	0.14941**	0.15180**
	(0.32659)	(0.27085)	(0.27121)	(0.38578)	(0.38582)	(0.15168)	(0.10866)	(0.10856)	(0.06899)	(0.06981)
EU	0.30979***	0.09383	0.09410	0.02523	0.02490	0.14298***	0.08855***	0.08806***	-0.05850*	-0.05600*
	(0.11585)	(0.09501)	(0.09509)	(0.13352)	(0.13351)	(0.04115)	(0.02593)	(0.02589)	(0.03111)	(0.02969)
Contiguity	0.85904***	0.28941*	0.29002*	-0.00750	-0.00831	0.28751***	0.07325	0.07312	-0.00485	-0.00472
	(0.18571)	(0.15383)	(0.15396)	(0.12824)	(0.12824)	(0.07171)	(0.04766)	(0.04761)	(0.02474)	(0.02486)
WTO	-0.02765	0.28568***	0.28479***	0.51987***	0.51890***	-0.01820	0.01880	0.01974	0.10759**	0.10516**
	(0.09866)	(0.08846)	(0.08846)	(0.19270)	(0.19275)	(0.05221)	(0.03434)	(0.03434)	(0.05101)	(0.05126)
$Exporting_{t-1}$						0.62314***	0.72562***	0.72570***	0.86836***	0.86898***
						(0.01576)	(0.01084)	(0.01082)	(0.01624)	(0.01625)
Constant	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. effects	ctry, prod	product	prod, year	product	prod, year	ctry, prod	product	prod, year	product	prod, year
R-squared	26.97	54.34	54.37	73.64	73.77	76.19	79.32	79.33	95.62	95.67
Obs	28,077	28,077	28,077	28,077	28,077	24,020	24,020	24,020	24,838	24,838

* Robust standard errors are clustered by product and given in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Introducing the lagged variable also helps to deal with the endogeneity problem. Table 4.2 in the Appendix shows that the inclusion of the lagged export variable results in a significantly lower correlation between the regressor and the residuals. Moreover, it confirms that applying the PPML model solves the endogeneity problem.

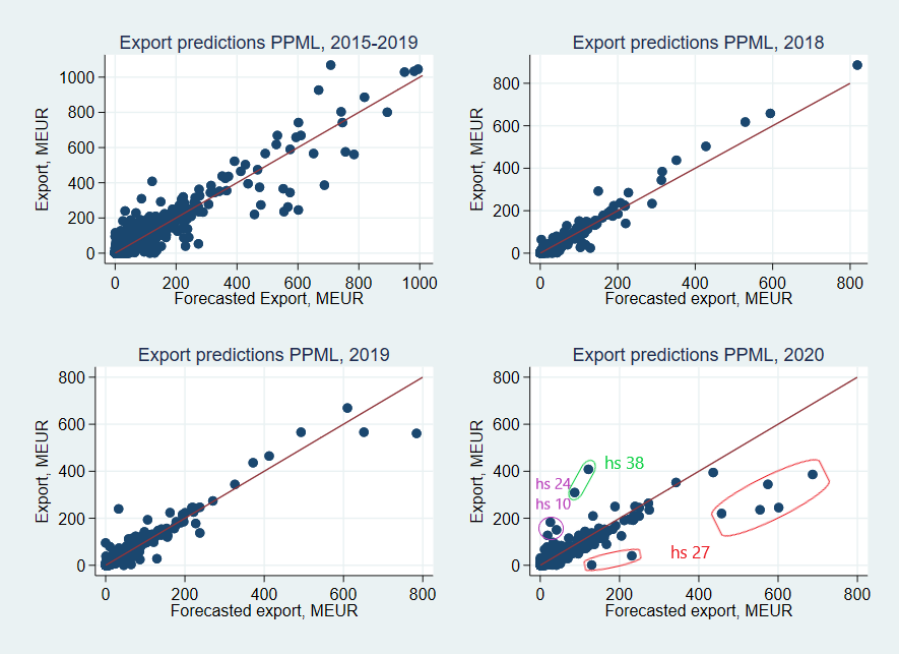
Estimation results suggest that Lithuania's goods export depends on its own history, the GDP of the destination, the distance and the common spoken languages most of all, while the other explanatory variables remain ambiguous and tend to change signs depending on the model or inclusion of other variables.

2.6.3. Results of comparison of the actual and fitted export in 2020

In this Section, we shall use coefficients estimated in the gravity model to forecast export for the year 2020. For our predictions, we estimate the dynamic gravity model under the PPML specification with product-only fixed effects for the period of 2015–2019. This model was chosen because it is denoted by a much stronger explanative power in terms of the determination coefficients. Next, the estimated coefficients and the product fixed effects are used to calculate the predicted export values of each product to each destination country for 2020.

Figure 2.2 plots the actual export against the fitted export values (in millions EUR) for the entire regression period (2015–2019), as well as for the most recent three years (2018, 2019 and 2020). The graphs also contain a 45-degree line. For illustration purposes, each annual graph lacks one outlier point: every year since 2017 Lithuania was exporting machinery, mechanical appliances and their parts (HS 84) to Russia for more than 1000 MEUR. The model predictions of this point were accurate: very close to 1000 MEUR for all the years.

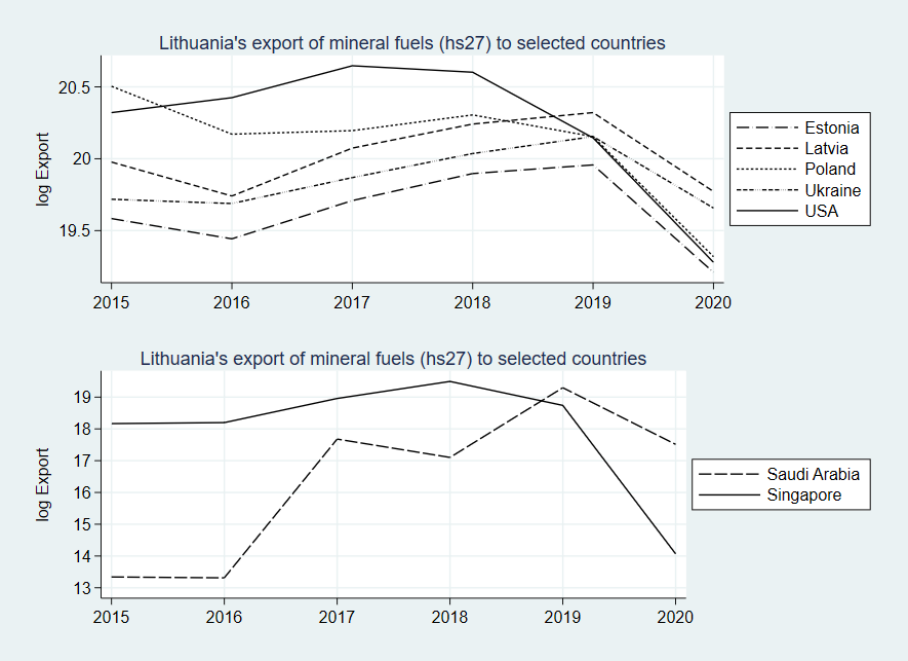
Figure 2.2. Actual versus fitted export plots including a 45-degree line.



The upper left graph shows that the export predictions made by the PPML model are reasonably good. The upper right graph shows that the predictions of the model fit to the actual data very well for 2018. For 2019, (the lower graph on the left), there are 2–3 outliers. All of them mispredicted Lithuania's export of mineral fuels.

The lower right graph in Figure 2.2 also shows that the export predicted for 2020 was a good fit for the actual values of 2020. Still, there are three groups of points for which the predictions were not very accurate.

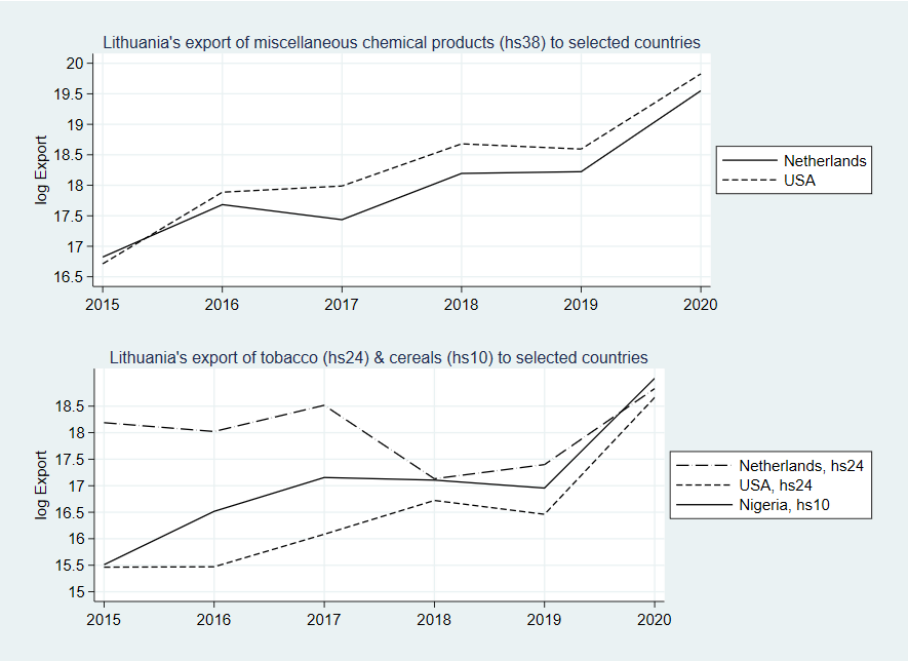
Figure 2.3. Lithuania's export of mineral fuels to selected countries.



All the 7 points that are below the 45-degree line in the lower right graph in Figure 2.2 show Lithuania's export of mineral fuels (HS 27) to Estonia, Latvia, Poland, Ukraine, Singapore, Saudi Arabia, and the USA. The export of mineral fuels to these countries was gradually increasing since 2016, however, it dropped dramatically in 2020 (see Figure 2.3). This could be a direct effect of the Covid-19 pandemic because, in 2020, many people started working from home and commuting less.

Two points above the 45-degree line for which the predicted export was below 200 MEUR, whereas the actual export exceed 300 MEUR show Lithuania's export of miscellaneous chemical products (HS 38) to the Netherlands and the USA. This export shows a steep and under-predicted increase in 2020 (see the upper graph in Figure 2.4). The reason for it could be either the outbreak of the pandemic, or the result of the strengthening of business relations with these countries.

Figure 2.4. Lithuania's export of chemical products, tobacco and cereals to selected countries.



Finally, the 3 points above the 45-degree line where the predicted export was below 50 MEUR, whereas the actual export was either close to or even exceeded 150 MEUR, are Lithuania's export of tobacco to the Netherlands and the USA, and cereals to Nigeria (see the lower graph in Figure 2.4). In 2020, Lithuania produced almost 30% more cereals than in 2019 (Statistics Lithuania, 2022); however, its overall export of cereals decreased sharply. Hence, the cause of the increase of the export of cereals to Nigeria could be the sign of a trade diversion and the strengthening of business relations with this country. The rise of the tobacco products export could be influenced by the Covid-19 restrictions when, after the closure of the regular entertainment places (e.g. theatres, cinemas, cafés, supermarkets), people probably increased their spending on the still available leisure goods: alcohol and tobacco.

Overall, the analysis shows that the pandemic year negatively affected Lithuania's export of mineral fuels and positively affected its export of tobacco and chemical products to a number of countries. We find no significant impact of the pandemic year on Lithuania's export of other goods to any specific countries

2.6.4. Changes of Lithuania's export structure during the pandemic

In order to analyse the changes of Lithuania's export structure more thoroughly, we include a dummy for 2020 and estimate separate dynamic gravity model regressions specified under the PPML and OLS specifications for each of the 96 product groups (see Section 2.6.4.1) and for each of 157 export destinations (see Section 2.6.4.2). The aim of this research is to investigate whether Lithuania's export structure changed during the first year of the pandemic.

2.6.4.1. Effects of the pandemic year by product group

In this Subsection, we estimate dynamic gravity model regressions including a dummy for 2020 for each of the 96 product groups. We estimate each regression for one country of origin (Lithuania) and only one product group; hence, there are no fixed effects. The dependent variable is Lithuania's export of product *i* to country *c* in year *t* (logged in the OLS model). The independent variables are: the export of product *i* to country *c* of the previous year (logged in the OLS model), the log of the GDP of country *c* of the previous year, the log of the distance to country *c*, the common spoken languages between Lithuania and country *c*, the EU and the WTO memberships, and contiguity.

The products for which both regressions and the dummy were significant are listed in Table 2.8. Both OLS and PPML models indicate that 2020 significantly negatively affected Lithuania's export of 2 product groups: the articles of apparel and clothing accessories (HS 61), and articles of stone, plaster, cement and similar (HS 68). Both models indicate a significant positive effect of 2020 on only one product group: albuminoidal substances, modified starches, glues and enzymes (HS 35).

Table 2.8. Products for which both the regression and the dummy of 2020 was significant

Dynamic gravity model, PPML			Dynamic gravity model, OLS		
hs	**Product description****	**Effect***	**hs**	**Product description****	**Effect***
02	Meat and edible meat offal	Negative	07	Edible vegetables and certain roots and tubers	Positive
11	Products of the milling industry; malt; starches; inulin; wheat gluten	Negative	08	Edible fruit and nuts; peel of citrus fruit or melons	Positive
24	Tobacco and manufactured tobacco substitutes	Positive	19	Preparations of cereals, flour, starch or milk; pastry-cooks products	Positive
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	Negative	21	Miscellaneous edible preparations	Positive

Dynamic gravity model, PPML			Dynamic gravity model, OLS		
hs	**Product description****	**Effect***	**hs**	**Product description****	**Effect***
32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks	Negative	29	Organic chemicals	Positive
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	Negative	**35**	**Albuminoidal substances; modified starches; glues; enzymes**	**Positive**
35	**Albuminoidal substances; modified starches; glues; enzymes**	**Positive**	51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric	Negative
38	Miscellaneous chemical products	Positive	53	Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	Negative
39	Plastics and articles thereof	Negative	56	Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof	Positive
50	Silk	Negative	**61**	**Articles of apparel and clothing accessories, knitted or crocheted**	**Negative**
59	Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use	Negative	**68**	**Articles of stone, plaster, cement, asbestos, mica or similar materials**	**Negative**
60	Knitted or crocheted fabrics	Negative	96	Miscellaneous manufactured articles	Negative
61	**Articles of apparel and clothing accessories, knitted or crocheted**	**Negative**			
62	Articles of apparel and clothing accessories, not knitted or crocheted	Negative			
63	Other made up textile articles; sets; worn clothing and worn textile articles; rags	Positive			
64	Footwear, gaiters and the like; parts of such articles	Negative			
68	**Articles of stone, plaster, cement, asbestos, mica or similar materials**	**Negative**			
74	Copper and articles thereof	Negative			
75	Nickel and articles thereof	Negative			
78	Lead and articles thereof	Negative			

Dynamic gravity model, PPML			Dynamic gravity model, OLS		
hs	**Product description****	**Effect***	**hs**	**Product description****	**Effect***
82	Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal	Negative			
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	Negative			
89	Ships, boats and floating structures	Positive			
92	Musical instruments; parts and accessories of such articles	Positive			
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings	Negative			

* Effect shows whether the dummy of 2020 is positive or negative.

** Products significant under both PPML and OLS specifications are marked in bold.

According to the OLS model, the year 2020 positively affected Lithuania's export of albuminoidal substances, fruits, vegetables, various edible preparations, organic chemicals, and wadding products. Negative effects were observed for the export of wool, vegetable textile fibres, clothing accessories, articles of stone, plastic, cement or similar and miscellaneous manufactured articles.

According to the PPML model, the year 2020 positively affected Lithuania's export of albuminoidal substances, tobacco, chemical products, worn textiles, ships or boats, and musical instruments. Significantly negative export effects were observed for meat, products of the milling industry, tanning or dying extracts, oils, plastics, silk, textile, knitted or crocheted fabrics, clothing accessories, footwear, articles of stone, plastic, cement, copper, nickel, lead, cutlery, mineral fuels, vehicles, and furniture.

The results indicate that the year 2020 had some effects on Lithuania's goods export. Negative effects were recorded mainly for the export of meat, clothing, footwear, cutlery, vehicles, furniture and various articles of stone, plastic, cement, copper, nickel and lead. Positive effects were observed mainly

for albuminoidal substances, food, tobacco, chemical products, ships or boats, and musical instruments.

Although the effect of the pandemic year on Lithuania's export was very moderate, the results do show some heterogeneity. As expected, the export of leisure goods, such as tobacco, ships or boats, and musical instruments increased during the pandemic year. Expectedly negative effects include the export of clothing, footwear, vehicles, and mineral fuels. Surprisingly, the export of furniture decreased significantly during the pandemic year.

2.6.4.2. Effects of the pandemic year by destination country

In this Section, we estimate dynamic gravity model regressions including a dummy for 2020 for each of Lithuania's 157 export markets. As each regression is estimated for one country of origin and only one export destination, regressors are limited to the export of product *i* to country *c* in the previous year (logged in the OLS model), the log of the GDP of country *c* of the previous year and the dummy for 2020.

The list of the countries for which both regressions and the dummy variable were significant is presented in Table 2.9. Although there are a number of export destinations for which the year 2020 was significant, almost all of these markets have negligible shares in Lithuania's export structure. The only countries having significant dummies and the shares in Lithuania's export structure exceeding 1% are Russia, Estonia, Belarus and Ukraine. Still, the only country which has a significant dummy for 2020 in both PPML and OLS models is Russia. For all these countries, the sign of the dummy for 2020 was negative, i.e. the pandemic year negatively affected Lithuania's export to these markets.

Lithuania's export dynamics to the countries for which regressions and the dummy variables were significant, and for which Lithuania's export share in 2020 exceeded 0.1% is presented in Figure 2.5. Figure 2.5 shows that Lithuania's export to Russia, Estonia, Ukraine and Belarus was gradually increasing in the period of 2016–2019, but dropped in 2020. Similar patterns could be detected for Slovenia, Tajikistan and Kyrgyzstan. The growth of Lithuania's export to Greece also slowed down in 2020. For Belarus, this decrease could show either the effect of the pandemic restrictions, or the political instability and the beginning of economic sanctions imposed onto this country. Since there were no significant changes in the political situation in other countries, the pandemic and its restrictions are most probable reasons for the decline of export.

Table 2.9. Countries for which both the regression and the dummy of 2020 were significant

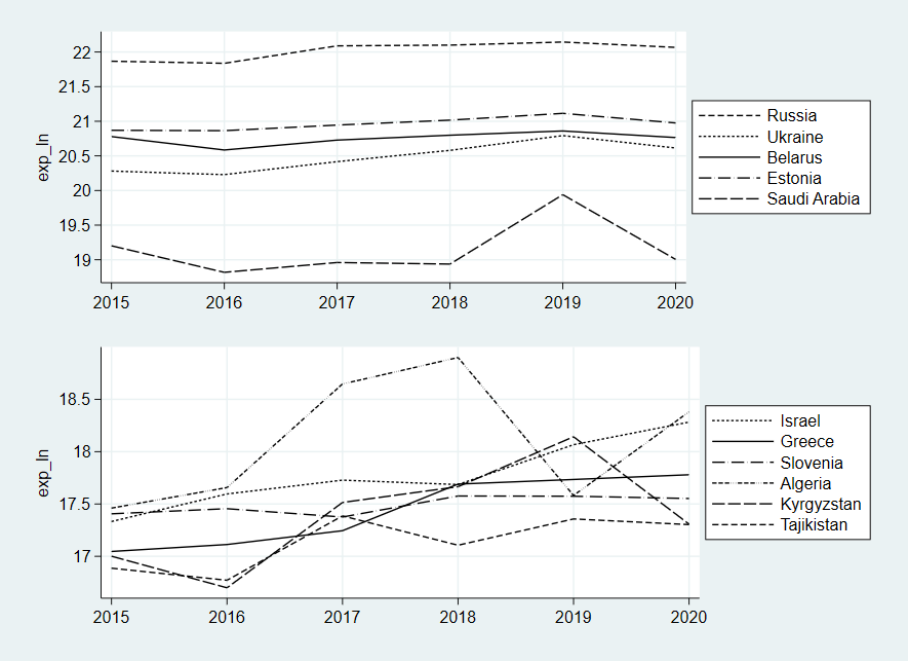
Dynamic gravity model, PPML				Dynamic gravity model, OLS			
iso3	Country	Effect*	Export share**, %	iso3	Country	Effect*	Export share**, %
643	Russia	Negative	13.71	643	Russian	Negative	13.71
804	Ukraine	Negative	3.20	233	Estonia	Negative	4.60
682	Saudi Arabia	Negative	0.64	112	Belarus	Negative	3.73
012	Algeria	Negative	0.34	300	Greece	Negative	0.19
376	Israel	Positive	0.31	705	Slovenia	Negative	0.15
417	Kyrgyzstan	Negative	0.12	120	Cameroon	Positive	0.03
762	Tajikistan	Negative	0.12	716	Zimbabwe	Positive	0.00
504	Morocco	Negative	0.10				
218	Ecuador	Positive	0.01				
008	Albania	Negative	0.01				
694	Sierra Leone	Negative	0.00				
68	Bolivia	Positive	0.00				
148	Chad	Positive	0.00				
598	Papua New Guinea	Positive	0.00				
328	Guyana	Negative	0.00				
624	Guinea-Bissau	Negative	0.00				
096	Brunei Darussalam	Positive	0.00				
140	Central African Republic	Negative	0.00				
242	Fiji	Negative	0.00				

* Effect shows whether the dummy of 2020 is positive or negative.

** Share of Lithuania's export to the specific country in total Lithuania's export in 2020, %

Lithuania's export to Algeria and Saudi Arabia fluctuated dramatically in 2019; meanwhile, in 2020, it mainly regained the level of 2018. Finally, Israel shows an increase of Lithuania's export and a positive effect of the dummy for 2020. Since Lithuania's export to Israel already started to increase in 2019, the reason for another increase in 2020 could be simply the strengthening of business relations, and not necessarily some trade diversion due to the effective pandemic management in Israel.

Figure 2.5. Lithuania's export dynamics to selected countries, 2015–2020.



Since Lithuania's export to the majority of the other countries listed in Table 2.9 was rather negligible, and most of these countries are remote and casual Lithuania's trade partners, a significant dummy for 2020 could show not the effect of the pandemic, but rather a random trade development or diversion.

Overall, the analysis shows that the pandemic year had some effect on Lithuania's goods export to a limited number of countries.

2.6.5. Concluding remarks on dynamic analysis

Empirical findings from the dynamic analysis suggest that the first year of the pandemic indeed had a heterogeneous impact on Lithuania's export. As expected, the export of leisure goods, such as tobacco, ships or boats, and musical instruments increased. Positive effects are also observed for food, albuminoidal substances, and chemical products. Expected negative effects were marked for Lithuania's export of meat, clothing, footwear, vehicles, and mineral fuels. However, the decrease of the export of cutlery, furniture and various articles of stone, plastic, cement, copper, nickel and lead is somewhat of a surprise.

We find that the year of Covid-19 negatively affected Lithuania's goods export to Estonia, Ukraine, Russia, Slovenia, Kyrgyzstan and Tajikistan, and positively affected Lithuania's export to Israel. Still, the analysis does not allow to claim that Covid-19 pandemic was the primary reason of these changes.

The research shows that the first year of the pandemic had negligible, yet heterogeneous effects on Lithuania's goods export in terms of both countries and product groups.

2.7. The impact of distance during the pandemic

In this Section, we examine the changes of regression coefficients over time. The pandemic resulted in border closures, as well as in a number of restrictions which changed unpredictably, differed by country, and made international trade far more complicated. Therefore, it could be hypothesised that distance became significantly more important in 2020 because these trade burdens could result in the exporters' focus on the closer markets.

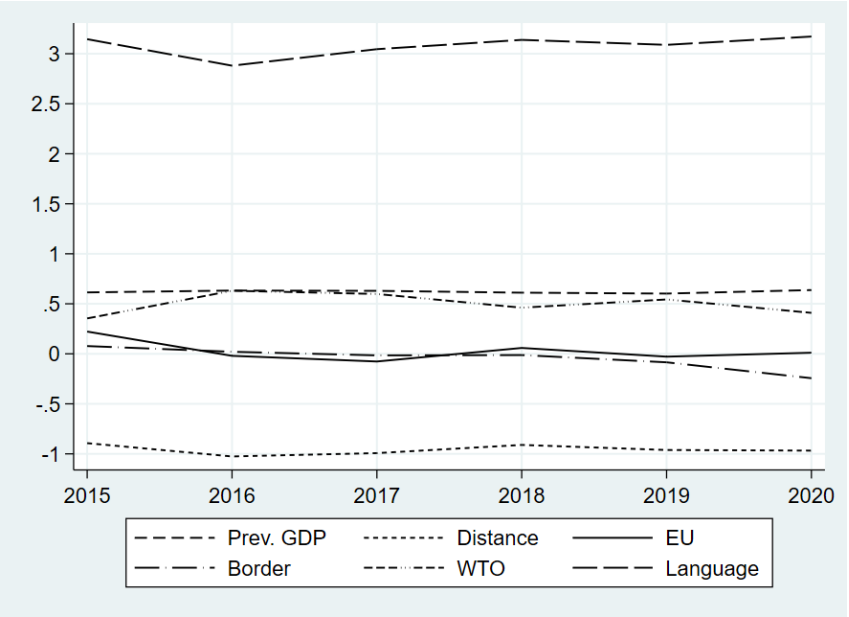
We estimate a static gravity model for Lithuania specified under the PPML specification for each year between 2015 and 2020. The reduced form gravity equation is as follows:

$$\begin{aligned}\overline{Export}_{i,c,t} = \exp(&\beta_0 + \beta_1 \log GDP_{c,t-1} + \beta_2 \log Distance_c + \\ &+ \beta_3 Language_c + \beta_4 Border_c + \beta_5 EU_{c,t} + \\ &+ \beta_6 WTO_{c,t}) + \varepsilon_{i,c,t} + u_i\end{aligned} \tag{2.19}$$

Here, $\overline{Export}_{i,c,t}$ stands for the mean of Lithuania's export of product i to country c in year t, and u_i, represents the product's fixed effect. The origin's GDP is omitted because it varies only by year, and, in this analysis, we estimate separate regressions for each year.

The estimation results are given in Figure 2.6. Contrary to the hypothesis, the importance of distance for the trade does not demonstrate any significant changes in 2020. Nor does the importance relate with the GDP of the destination country of the previous year and its EU membership. Although the coefficient of the WTO membership slightly dropped, and the coefficient of the common spoken languages slightly increased, these changes were minor. The only seemingly prominent change was in terms of the common border coefficient, however, this coefficient by itself was insignificant throughout the whole period.

Figure 2.6. Dynamics of the coefficients of the static PPML gravity model.



We also tested for structural breaks in both static and dynamic gravity models specified under the OLS specification. In both cases, the result was that the regression coefficients in 2020 were not different from their values in the previous years.

Therefore, we conclude that, for Lithuania's international trade, the year of the pandemic was not different from any previous years. There were no significant changes in the importance of any trade-affecting factors.

2.8. Concluding remarks

Challenged by the start of the Covid-19 pandemic, which resulted in massive travel restrictions, border closures and business losses, we investigate the competitiveness of Lithuania by examining the effects of the pandemic year on Lithuania's export structure and its resilience to the shock. We apply the theory of gravity modelling and seek to examine the heterogeneity of the effects of the pandemic year for various product sectors and various export markets of Lithuania.

Either positive or no effects of the pandemic year on Lithuania's export of high complexity products could show the strong position of the country in the international trade of these products or the increasing competitiveness of the

country. On the contrary, the decrease of the export of high complexity products would show declining export-related competitiveness of Lithuania.

The results show that the pandemic year had a minor and heterogeneous impact on Lithuania's export. In terms of the product groups, it resulted in the increase in the export of albuminoidal substances, chemical products, ships, musical instruments, tobacco and cereals. The negative effects include a decreased export of meat, clothing, footwear, vehicles, mineral fuels, cutlery, furniture and various articles of stone, plastic, cement, copper, nickel and lead. In terms of the export partners, Covid-19 resulted in the decreased Lithuanian goods export to Estonia, Ukraine, Russia, Slovenia, Kyrgyzstan and Tajikistan, and the increased export to Israel.

As the pandemic did not negatively affect Lithuania's export either of high complexity products (the export of some of these products even increased), or to more complex economies, we can conclude that Lithuania's export structure was adaptive and resilient to the external shock of the pandemic.

Our other question was to uncover whether distance became more important for choosing export destinations in 2020. Our analysis showed that, in spite of a number of travel restrictions, distance did not become more important for international trade than it was before the pandemic. Similarly, other factors did not change.

3. THE DEVELOPMENT OF LITHUANIA'S EXPORT NETWORK

3.1. Introduction

In the small world we have today, countries have formed complex trade relations with each other. We see elaborated trade networks where every country exports different goods to almost every other country. Analysis of the existing trade networks gives information about the resources that different countries lack or that are abundant, country competitiveness as well as their growth limits and perspectives. According to Hidalgo & Hausmann (2009), the level of a country's economic development and its growth perspectives highly depend on its export structure: the products it sells and the markets it serves. The structure of its trade network and its intersectoral relations also affect a country's volatility to idiosyncratic shocks (Acemoglu, 2012).

Therefore, this Section of the thesis combines the gravity and networks theories and empirically examines a number of direct and network factors determining a country's ability to export and, hence, its competitiveness. We focus on Lithuania and analyse which factors were the most important in shaping the country's export network and how their importance changed throughout the years. The results of the research help to reveal the main determinants of the export network which shape the competitiveness of a country.

Any trade, either export or import, could be analysed in two ways: by taking either the extensive trade margin, or the intensive trade margin. The intensive trade margin shows the value of trade (either total, or of some product A). The extensive trade margin shows either the number of markets served, or the number of products traded (for definitions, see: Helpman et al., 2008; Felbermayar & Kohler, 2006; Albornoz et al., 2012; Conconi, 2022). In this Section, we focus only on the extensive trade margin, namely, on the number of export markets.

The idea of the research is to apply the gravity and networks theories and to empirically test a number of factors that could influence the expansion of the extensive trade margin. We seek to determine the most important ones and to disclose the dynamics of their effects over time.

In particular, we aim to answer the following research questions:

1. Which factors were the most important for the spread of the export network of Lithuania?
2. How did the influence of these factors change throughout the years?

The setup of this Section is as follows: first, we shortly present the historical background and review the literature on trade networks. In Subsection 3.4, we present our own contribution. In Subsection 3.5, we elaborate on the methodology and give an insight to the data and the variables. Subsection 3.6 is intended for the descriptive statistics. Subsections 3.7 and 3.8 present the main results of the analysis, and Subsection 3.9 gives robustness checks. Finally, Subsection 3.10 provides the conclusions.

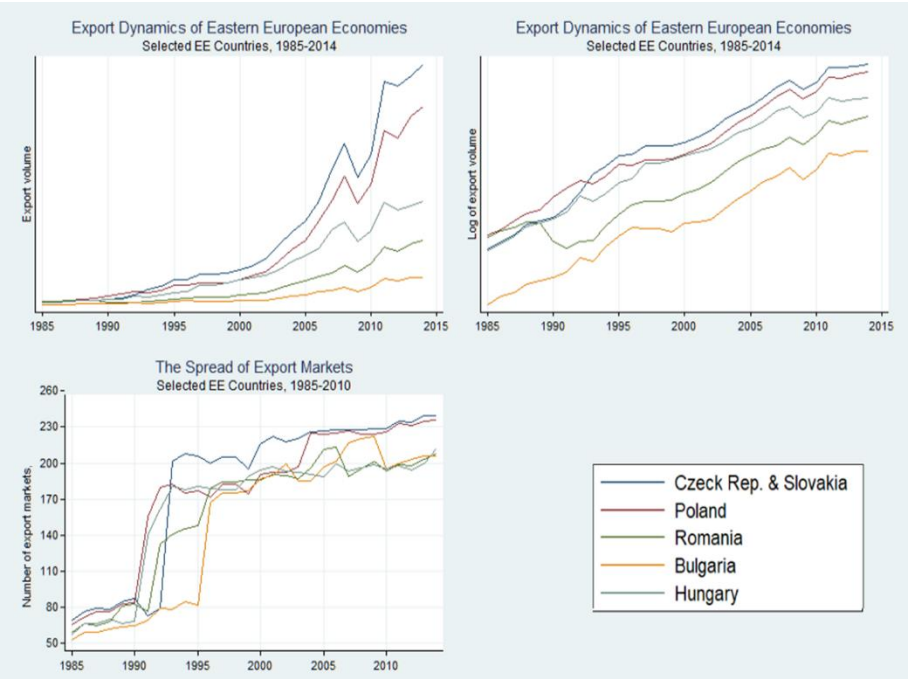
3.2. Historical background

In 1990, when the Soviet Union collapsed, a number of Eastern European countries once again became players in the international market and started creating their own trade relations. Before 1990, some of them (e.g. Lithuania, Latvia and Estonia) had been part of the Soviet Union, whereas others (e.g. Poland and Romania) were puppet states of the Soviet Union. For all of them, almost no free trade was possible. The borders were closed, personal and economic relations with the outside world were strictly limited and prohibitive trade restrictions were imposed. Economies were centrally planned, and the government institutions were directing which goods and in what quantities should be manufactured, as well as for what prices and where they should be exported. After gaining independence in 1990, the markets were liberalised, and regular foreign trade ultimately became possible.

These changes in the international trade can be observed in Figure 3.1. It shows a dramatic increase of export after 1990 both in volumes (the upper graphs) and in the sheer number of export markets (the lower graph) in the selected Eastern European countries. Export in volumes (the intensive trade margin) in these economies started to increase after 1990, but the sharpest rise is seen between 2000 (admission to the EU) and 2009 (economic crisis). On the other hand, the sharpest increase of the number of the export markets (the extensive trade margin) in the five Eastern European countries was immediately after regaining the independence: between 1990 and 1996.

These facts allow us to build on a natural experiment of trade network formation and to analyse the process of a country's export network development almost from the very beginning.

Figure 3.1. Export dynamics of the selected Eastern European economies in the period of 1985–2014.



In this Section, we take Lithuania as a newly opening market which is as close to the beginning of its network formation process as possible, and empirically examine the factors that have influenced the formation of Lithuania's export network. There are two other reasons why Lithuania is a good choice for such analysis. First, before 1990, Lithuania was not a separate country, as it was incorporated in the USSR. Hence, by virtue of being a completely new market after declaring its independence, Lithuania stands closer to the headwaters of its trade network than those countries that, although belonging to the Soviet bloc and controlled by the USSR, were always separate entities (e.g. Poland). Second, Lithuania is a developed and democratic Eastern European country which has reliable statistical data since 1995.

We admit that analysing a group of countries could give us more reliable and generalised results, however, following Baldwin & Di Nino (2006), we have to take only one exporting country due to computational feasibility. Although we analyse Lithuania, however, as all the ex-Soviet bloc countries had similar history, the results of this analysis is likely to be applicable for the other ex-Soviet bloc countries as well.

3.3. Brief literature review

Literature on international trade determinants and trade networks is extensive. Perhaps the most intuitive and undisputable trade determinant is the trade costs, and their most common proxy the distance. The role of distance was researched both theoretically and empirically by a number of researchers. Felbermayar & Kohler (2006) examined the effect of distance on both the intensive and extensive margins of trade. They concluded that the importance of distance falls over time both on the intensive and on the extensive trade margins.

Allen (2014) elaborated that the trade reduction with distance, as well as the price differences, could be explained not only by transport costs, but also by the search costs due to information frictions (i.e. the costs of the search for the information about the market conditions in the other countries). He argued that the extensive trade margin is mostly influenced by the transport costs (as firms export only if the difference of prices in the two countries exceeds the transport costs). On the other hand, the intensive trade margin is mostly determined by the information frictions (as the amount of international trade depends not only on the transport costs, but also on the number of firms which manage to discover opportunities to export).

Lawless (2013) agreed that the distance (as a proxy of the transport costs) between two markets is especially influential. She claimed that the firm's experience in exporting to a nearby market both increases the probability to enter and decreases the probability to exit that new market.

Bailey et al. (2021) widened the concept of trade costs (i.e. distance) by constructing a new index of social connectedness between countries and regions. They claimed that social connectedness is closely related to distance and other gravity variables describing transport costs (e.g. languages, religion, colonial ties, migration). Moreover, social connectedness is positively related to the amount of export. Hence, it could be a good proxy for trade-facilitating relationships between countries or regions.

Another group of literature focuses on the effects of product heterogeneity on international trade. Mayer et al. (2014) and Melitz (2018) modelled the export of heterogeneous products and analysed the determinants of the mark-ups of exporters. They found that the larger is the market size of the destination, the higher is the competition in that market, and, hence, the lower are the mark-ups of the exported products. This results in the exporters shifting their export to the better performing products in their larger destination markets. Mayer et al. (2021) also showed that these changes result in an

increase of the productivity of multi-product firms, while the productivity of a single-product firm is unaffected.

Rauch (1999) also examined heterogeneous goods. He constructed gravity models to estimate which factors matter more for the trade of different types of commodities. Rauch (1999) claimed that a country's proximity, common spoken languages and the common colonial heritage are more important for differentiated goods. Also, search barriers affect the trade of differentiated goods more than the trade of homogeneous goods.

Broda & Weinstein (2006) related heterogeneity of the products to a country's development. They showed that the greater is the variety in the imported products, the greater is the welfare of the importing country. Basile et al. (2018) also confirmed that the more developed and larger countries export not only more products, but also more diversified products. Being close to larger countries accelerates the process of diversification in other countries.

Regolo (2017) divided exportable goods into 'traditional' and 'new' ones. The traditional export goods are the ones which a country exported continuously in the period of 1995–2000. Whereas, the new goods are the ones which were not exported in this period, but were exported for at least 3 years in a row between 2000 and 2010. Regolo (2017) claimed that the newly exported goods are far less geographically (in terms of distance), culturally (in terms of language) and economically (in terms of tariffs) dispersed than the traditional goods. In other words, the new goods are exported by the groups of the nearby countries (clustered) and do not spread with time (i.e. they show trade regionalisation), while the export of the traditional goods is either widespread or scattered, and it does not show any specific clustering patterns.

Another group of articles examine the effects of migration on international trade. Parsons & Vézina (2018) examined the Vietnamese migration networks in the USA and their effects for international trade. They argued that migration results in positive long-term benefits for the export creation, which, in turn, results in an increased economic development.

Zhang (2020) assumed that emigrants may facilitate export not only by keeping close personal and economic relations with the people living in the country of their origin, but also by purchasing goods form their home countries, and included three additional components to the gravity model: the ethnicity of the people living in the destination, the income per capita, and the trade costs. Zhang (2020) argued that half of the export bias could be explained by the ethnic taste, and the anti-immigration policy sharply reduced the trade with the country from which the immigrants came.

Baiardi & Ammon (2022) used firm-level data to analyse if the positive effects on the trade of the migrant networks are also viable in the long run.

They claimed that migration has positive effects on export not only in the short run but also in the long run. The positive impact is also seen for the other firm-level variables: the employees' skills, wages, assets, and capital.

Political factors are also important for global trade structures. Kim et al. (2019) examined the relationship between international trade and political institutions of the country. They found that open political regimes which feel secure about their survival (e.g. democracies) result in a higher extensive trade margin than the vulnerable regimes (e.g. autocracies). The effect is the highest for the products that require more of the interpersonal contact. However, political institutions have no effect on the intensive trade margin. The reason for such a result may be that the vulnerable autocratic regimes are afraid of their 'non-chosen' citizens communicating with the outside world and perhaps taking over the current government. The intensive margin may be unaffected because international trade is not prohibited, although it is reserved for the 'chosen' citizens that are close and loyal to the government.

Albornoz et al. (2012) examined Argentinian firm-level export and showed that trade liberalisation in a country can promote entry not only to this country, but also to the other countries because of the spread of network relations. They also claimed that new exporters are more likely to enter and quicker to leave a new market than the experienced exporters.

Lo Turco & Maggioni (2018) applied the linear probability model to analyse the impact of religion on the extensive margin of the firm-level trade. They found that the similarity of religious beliefs increases the probability to enter and reduces the probability to exit the first market for the Islamic communities. However, this relationship fades away within three years after the start of exporting and is not valid for the intensive trade margin. Also, there is no relationship between religious beliefs and international trade for Christian communities.

Many authors use gravity models to examine other, not so widely analysed, trade determinants. Rindler (2021) used the panel gravity model to examine the effect of the changes of the language skills on international trade. He found out that, during the last twenty years prior to his research, the value of the index of common spoken languages increased, which resulted in the decreased trade costs and in the rise of the bilateral trade. Still, the rate of the rise in trade due to the increased knowledge of other languages tends to diminish as the abilities to communicate are increasing.

Berthou & Fontagne (2008) examined the effect of the adoption of the euro on the firm-level and product-level export in France. They claimed that the change of the currency resulted in an increase of the number of products exported by the French firms. However, on the firm-level, there was no effect

either on the intensive, or on the extensive trade margins. Baldwin & Di Nino (2006) argued that the effect of the adoption of the euro was stronger for the product-level trade. The Euro not only increased the probability of exporting (the extensive margin), but also boosted the trade among the euro-zone countries (the intensive margin).

Conconi (2022) used the firm-level data of Belgium and analysed how international trade is affected by multinational corporations. She argued that foreign ownership reduces country-specific trade frictions. Hence, domestic firms acquired by international companies tend to increase their trade with other countries, especially with the ones that are close to the trade network of their parent companies. Significant increases of trade are noticed both in export and import, and both in the intensive and extensive trade margins.

Moussa & Varsakelis (2022) analysed if a country's position in trade is related to international patenting networks. They suggested that, although globalisation facilitates the trade flows, the trend is that a smaller number of countries take a larger share of the global export. Patenting becomes more global, and most exporters register their innovation in another country before starting to export.

Helpman et al. (2008) decomposed the role of trade frictions to the extensive and the intensive margins and proposed a model of the self-selection of firms into different markets. Chaney (2014) followed Helpman et al. (2008) and introduced a network approach to the extensive margin of the dynamic gravity model. He included the indirect distance (i.e. the distance between the current export partners of the origin and the destination country) to the empirical gravity model when analysing the determinants of the spread of the extensive margin in the case of the French firm-level exports. Chaney (2014) claimed that the higher is the number of the export markets of a firm, the more likely it is that the firm will enter new markets in the future. Chaney (2014) also argued that new export relations tend to be created from the places where export relations have already been created. Hence, it is important not only *how much* you export, but also *where* you export. The model of Chaney (2014) was applied by a number of other researchers (e.g. Berthou & Ehrhart (2017); Chen & Sun (2021)) who also obtained similar results.

Berthou & Ehrhart (2017) examined trade relations of the former colonies of France and the United Kingdom. They claimed that colonialisation indeed helped the former colonies to create trade relations with other countries. The former colonies traded more with the countries that are closer to the former coloniser either geographically or economically (i.e. which belong to the same currency or trade organisations). The effect is the same for both export and import, and it is more robust for differentiated goods.

Chen & Sun (2021) also applied the model of Chaney (2014) and focused on the trade of Chinese firms. They found out that the trade network structure is important for the further development of a firm as firms tend to choose either economically, or geographically related markets as their new export destinations. Still, firms having an export history are less affected by the geography when choosing their new export destinations.

Morales et al. (2019) agreed with Chaney (2014) and argued that the costs of entering a new market for a firm depend on two factor groups. First, they depend on how similar is the destination market to the firm's home market (they called it the 'gravity' factor group). Second, it depended on how similar the destination market is to the previous destination markets of the firm (they called it the 'extended gravity' factor group). The rationale behind the latter is that it is less costly to enter a new market which is similar to the market where the firm has been already exporting. The extended gravity factors analysed by Morales et al. (2019) are: sharing the same border, continent, languages, or similarity in income per capita. After estimating a couple of firm-level dynamic gravity models, Morales et al. (2019) concluded that the existence of different extended gravity factors considerably (even by 20–40%) lowered the entry costs for a firm.

The findings of Morales et al. (2019) were confirmed by Defever et al. (2015) and Fernandes & Tang (2014). Defever et al. (2015) defined 'spatial exporters' as "*time-varying firm-specific heterogeneity in export destination choices shaped by firms' previous export experience in spatially close countries*" (Defever et al., 2015, p. 1) and estimated 'spatial exporters' on the extensive margin of the firm-level trade. They claimed that the probability to start exporting is the highest to the destination which shares a common border either with the origin, or with the previous export destination of the origin. Moreover, firms choose export destinations which are close to the origin much more often than it is predicted by the standard gravity models which do not take into account the 'spatial exporters'.

Fernandes & Tang (2014) developed a firm-level signalling model and empirically tested it with the Chinese transaction-level data. They claimed that the probability of exporting to a new market increases with the good export performance of other neighbouring firms. If firms have more knowledge about the market or if the markets are more similar (i.e. the distance is lower, and/or if the similarity measures are higher), the importance of the export performance of the firm's neighbours on the probability to export to a new market decreases. Wang & Zhao (2013) examined the extensive trade margin of the Chinese product-level export and claimed that successful previous export experience is important for entering other similar and geographically

close markets. However, the previous export experience is limited to the same destination and sector.

Jun et al. (2020) linked the models of the type of Hidalgo et al. (2007) and Hidalgo & Hausmann (2009) to the models of the type of Helpman et al. (2008) and Chaney (2014). Jun et al. (2020) introduced the relatedness measures of a product (exporting a lot of similar products to the analysed market), the importer (exporting the same product to the neighbours of the analysed market) and the exporter (the country's neighbours export the same product to the analysed market). By acknowledging that countries tend to trade with the similar countries and to export those products that are similar to their currently exported products, Jun et al. (2020) estimated a gravity type regression and argued that all these relatedness measures are positively related to the amount of export. Jun et al. (2020) also claimed that export is higher for the products of the higher levels of complexity, sophistication and differentiation.

Overall, the research investigating international trade and its determinants is abundant. Economists analyse both the intensive trade margin (e.g. Felbermayar & Kohler, 2006; Rindler, 2021) and the extensive trade margin (e.g. Felbermayar & Kohler, 2006; Kim et al., 2019; Lawless, 2013). There are papers examining country-level, sector-level (e.g. Jun et al., 2020 ; Regolo, 2017; Kim et al., 2019) and firm-level (e.g. Chaney, 2014; Albornoz et al., 2012) trade. Estimation methods are also diverse. The intensive trade margin is usually estimated by the OLS and PPML methods. Extensive trade margin estimations are made by applying various probabilistic techniques: Probit (e.g. Chaney, 2014; Felbermayar & Kohler, 2006; Lawless, 2013), Logit (e.g. Berthou & Fontagne, 2008; Wang & Zhao, 2013; Baldwin & Di Nino, 2006), Tobit (e.g. Felbermayar & Kohler, 2006; Berthou & Ehrhart, 2017; Baldwin & Di Nino, 2006) and linear probability (e.g. Berthou & Ehrhart, 2017; Regolo, 2017; Lo Turco & Maggioni, 2018) methods.

3.4. Contribution

This research contributes to the literature on international trade networks and empirical gravity modelling. Although both extensive and intensive trade margins have always interested economists, and the role of the network effects on the spread of international trade has already been modelled, still, most of the papers take a very limited number of variables determining the costs of the search for new export destinations.

This Section of the thesis attempts to combine gravity models with the network formation theory and empirically analyses the extensive margin of

Lithuania's export structure. The aim of this research is to empirically examine the importance of a wide range of network effects for the development of the extensive trade margin. To the best of our knowledge, this is the first research to include so many network effects to the gravity model.

The research relates mostly to the articles of Chaney (2014) and Morales et al. (2019), but it will differ from the above literature regarding 2 main aspects:

1. It focuses on the new entrants to the international trade market and analyses the very origins of the export network formation of a country, while the current empirical research (e.g. Chaney, 2014; Rauch & Trindade, 2002; Felbermayar & Kohler, 2006) is based mainly on the mature markets (e.g. the USA, France, China).
2. It examines an extremely large number of network effects (distance, common culture, language, trade organisations, emigration network and others) on the extensive margin of foreign trade.

3.5. Methodology

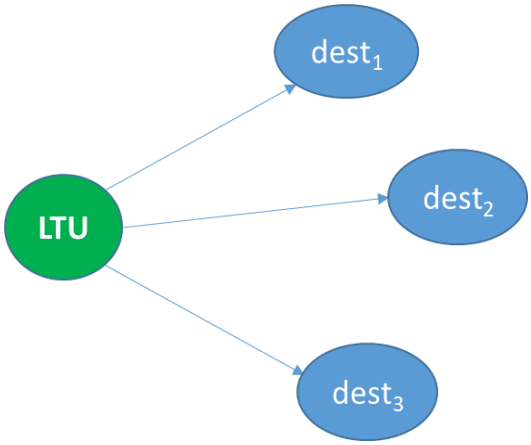
3.5.1. Theoretical aspects

To analyse the formation of Lithuania's export network, we apply the model developed by Chaney (2014) and Chaney (2018). We follow the assumption that a country's export network develops gradually. In the first stage, the country of origin finds a couple of export destinations directly (see the upper part of Figure 3.2). In the second and further stages, the country of origin finds more export destinations in two ways: directly from the origin, and indirectly from its current export destinations which have already been found in the previous stages (see the lower part of Figure 3.2). We shall refer to the factors affecting this indirect search procedure the 'network effects'.

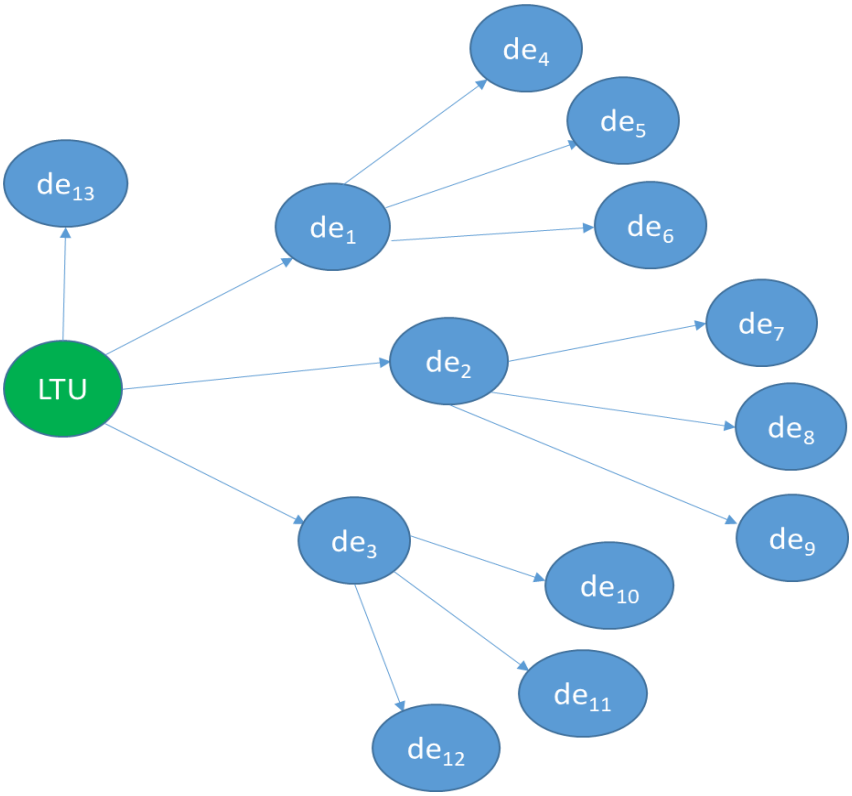
If there were more than one country of origin in the model, the same steps of the trade development would be made by the other countries. Hence, after a couple of stages, we would have a huge highly interconnected trade network similar to the one of the real world.

The notion of the 'network effects' in this thesis comes from the concept of networks in trade as of Chaney (2016). In their essence, these 'network effects' are very similar to 'extended gravity factors' as of Morales et al. (2019) and 'spatial exporters' as of Defever et al. (2015). Along with the 'network effects', we may also use the notions of 'indirect' effects/factors and 'friends-of-friends' effects/factors as synonyms.

Figure 3.2. Stages of the development of a new export network



Stage 1. Finding the initial export partners directly



Stage 2. Finding new export partners not only directly, but also indirectly (by the friends-of-friends search)

More formally, the model developed by Chaney (2014) examines the firm-level trade. In this model, there is a discrete set S of locations x (countries), each having a finite set of firms. The number of firms grows (by birth) at each location at a constant rate γ, they never change their initial location and never die. Firms sell their production to firms at other locations. During each period, a firm meets new consumers in 2 ways (based on the model of Jackson & Rogers, 2007):

1. Directly at random. Firms search for $\gamma\mu$ new consumers from their original locations (μ is a parameter) while choosing the destination (location) of every new customer randomly according to the probability function $g(0, x)$. The probability function depends on the distance between the destination and the firm's origin (0) and on the size of the destination (x).
2. By the friends-of-friends method. For each existing consumer in each location, firms search for $\gamma\mu\pi$ new consumers in other locations (here, π measures the relative importance of friends-of-friends versus direct search). The destinations (locations) of the new consumers of a firm are chosen randomly according to the probability function $g(y, x)$. This probability depends on the distance between the previously found destination of the origin y and a newly found destination x, and the size of the new destination x.

Chaney (2014) examines the development of the international trade network of the French firms. The assumption is that firms look for their new consumers depending on the distance between the origin and the destination and the size of the destination country. He claims that, over time, the distribution of the served locations of two initially identical firms diverges, and that any firm's consumers become more and more geographically dispersed and clustered.

In this Section, we empirically apply the elaborated version of the model of Chaney (2014) to the analysis of the formation of the Lithuanian export network. Chaney (2014) assumes that the probability function, which defines the friends-of-friends search procedure of the new consumers, depends only on the distance and the import growth between the current destination of the origin and its new destination. However, based on the gravity theory, distance is just a proxy for the trade costs, and it should be combined with the other variables representing the trade costs (Shepherd, 2012). Therefore, we propose to include more variables representing the trade costs, and construct a regression including more factors that may be important for the search procedure and which consequently affect the export network. These are the direct and indirect versions of the factors that are commonly used in the

classical gravity models: common spoken languages, belonging to the same economic unions, free trade agreements, migration, historical aspects, etc. We attempt to test which direct and indirect effects are the most important for the development of the extensive margin of international trade.

Following Berthou & Ehrhart (2017), we expect to find that, during the early years of the opening to the foreign trade, the cultural, language and historical factors should matter more to the formation of Lithuania's export network than the geographical and economic growth factors. In the later years, the geography and economic factors are expected to dominate over the initial ones. It is based on the assumption of inertia, the fear of changes, and the need for time to learn the new things. According to Morales et al. (2019), Wang & Zhao (2013), Chen & Sun (2021) and other authors, it is easier to start exporting to these markets which are either the same or very similar to the current export destinations. However, after some time, the exporters seeking larger profits, which could be gained by exporting to richer countries, would learn new languages (see Rindler (2021) for the discussion on languages), gather information about other markets, and form links with the other, less similar, but more economically developed countries (Basile et al., 2018).

Moreover, we expect to find the growing importance of the friends-of-friends search of the foreign markets and clustering with every year. This expectation comes from the network theory which relates higher clustering to the lower costs of the search of new partners that are geographically close (Jackson, 2010). Empirical estimations also claim that "*if a firm exports to countries that are close to country c, it is more likely to enter that country c in the future*" (Chaney, 2014, p. 9). With every time period, the network becomes larger, and the importance of the indirect search becomes higher. According to the 'preferential attachment' link formation process, new relations, formed by the current export partner of the origin, should form with the other markets that are close (either by distance or by other kind of similarities (in our case: cultural, historical, economic, language)) to the existing export partners of the origin. Hence, we also expect an increase of the clustering of the export partners.

3.5.2. The model and definition of the variables

In order to examine the factors that are important for the export network formation, the following dynamic gravity-type model was estimated:

$$\mathbf{1}\left[Export^{s}_{i,c,t+1} > 0 \right] = \alpha Markets^{s}_{i,t} + \boldsymbol{\beta}_1 \mathbf{X}^{s}_{\underset{(direct)}{i,c,t}} + \boldsymbol{\beta}_2 \mathbf{X}^{s}_{\underset{(f\text{-}o\text{-}f)}{i,c,t}} + \\ + \delta \mathbf{1}\left[Export^{s}_{i,c,t} > 0 \right] + Controls^{s}_{c,t} + \varepsilon^{s}_{i,c,t} + u^{s}_{i,c} \tag{3.1}$$

Here, $\mathbf{1}\left[Export^{s}_{i,c,t} \right]$ is an identity function indicating if product *i* from the country of origin *s* (i.e. Lithuania) was exported to country *c* at time *t*. $Markets^{s}_{i,t}$ shows the number of country *s* export markets of product *i* at time *t*. Vector $\mathbf{X}^{s}_{\underset{(direct)}{i,c,t}}$ stands for all the factors influencing the direct search procedure (e.g. the average growth of import of country *c*, distance, language, cultural and historical similarities, organisational dependency, free trade agreements between the country of origin *s* and country *c*). Vector $\mathbf{X}^{s}_{\underset{(f\text{-}o\text{-}f)}{i,c,t}}$ stands for all the factors influencing the friends-of-friends search procedure (e.g. the average growth of imports of country *c* from the current export markets of country *s*, distance, language, cultural and historical similarities, organisational dependency, free trade agreements between country *c* and the current export markets of country *s* at time *t*). The controls stand for any additional controls needed (e.g. the country size, the industry dummy). Finally, ε is an error term, and *u* is the individual effect for the destination and product.

Following Chaney (2014), Berthou & Fontagne (2008), Helpman et al. (2008), we specify the model under the linear probability (OLS), Probit and Logit specifications.

The **endogenous variable** is *Exporting*, which shows if product *i* was exported from the country of origin *s* to the country of destination *c* at time *t+1*. Its value can be either 0 (not exported) or 1 (exported).

$$Exporting^{s}_{i,c,t+1} = \mathbf{1}\left[Export^{s}_{i,c,t+1} > 0 \right] \tag{3.2}$$

All **exogenous variables** follow the set-up of the dynamic gravity model. The mass variables are the GDP of the destination and the growth of imports in the destination countries. Dynamics comes from the inclusion of the exporting of the previous year. Finally, we include a number of search (i.e. trade) costs. One of the variables of the search costs is the number of the current export markets of the origin (a proxy of experience). The other options

could be divided into two groups: the direct effects, and the indirect, or friends-of-friends, effects.

Direct costs are related to finding an export destination via the direct search procedure (e.g. the distance or common spoken languages between the origin and the destination). Indirect costs are linked to finding an export destination via the indirect (i.e. friends-of-friends) search procedure (e.g. the sum of the distances between a new destination and all the current export partners of the origin, the average measure of the new destination's abilities to communicate with the current export partners of the origin).

All exogenous variables are presented below.

- Logarithm of nominal GDP ($lngdp_{c,t+1}$) of the destination country in millions of USD at time $t+1$. Based on the basic gravity theory, it is expected that a higher nominal GDP, as an indicator of the country's economic development, leads to greater and more diverse imports, as the exporting countries see a larger export market and a greater potential there.

- Previous exporting ($Exporting^{s}_{i,c,t}$) shows if product i was exported from the country of origin s to the country of destination c in year t:

$$Exporting^{s}_{i,c,t} = \mathbf{1}\left[Export^{s}_{i,c,t} > 0 \right] \tag{3.3}$$

  It reveals the widely acknowledged in the scientific literature importance of the history of exporting product i to the country of destination (see for example Olivero & Yotov, 2012).

- Export markets ($Markets^{s}_{i,t}$) give the number of product i export markets that Lithuania had in year t.

$$Markets^{s}_{i,t} = \sum\nolimits_{c} \mathbf{1}\left[Export^{s}_{i,c,t} > 0 \right] \tag{3.4}$$

  Following Albornoz et al. (2012), Lawless (2013), Defever et al. (2015), Wang & Zhao (2013) and other authors arguing that 'sequential exporting' is easier, less costly and usually more successful, we expect that a higher number of already existing export markets results in an increase of the new export markets, due to the indirect search procedure.

- Import growth ($grimp_{c,t}$) is calculated as the growth of the total import (from all the other countries c') to destination c between years t and $t+1$, i.e. during the whole year t.

$$grimp_{c,t} = \ln\left[\sum_{c'} Imports^{c'}_{c,t+1}\right] - \ln\left[\sum_{c'} Imports^{c'}_{c,t}\right] \quad (3.5)$$

It is expected that the higher overall growth of import to country *c* shows the growth of potential in this market which, in turn, attracts more import to country *c* from the country of origin *s*.

- Import growth f-o-f (*impgrow_fof*$_{i,c,t}$) gives the total growth of import during the whole year *t* of the destination country *c* from all the countries in which the country of origin *s* exported product *i* at year *t*. Here, *c* and *c'* both stand for any destination country.

$$impgrow\_fof_{i,c,t} = \ln\left[\sum_{c'} Exporting^{s}_{i,c',t} \cdot Imports^{c'}_{c,t}\right] - \ln\left[\sum_{c'} Exporting^{s}_{i,c',t-1} \cdot Imports^{c'}_{c,t-1}\right] \quad (3.6)$$

We expect the country of origin to have a higher probability of starting exporting to the country in which the export of its other export partners is growing because of imitating i.e. if my neighbour thinks that it is worth exporting there, it seems good for me to start exporting there as well.

- Distance from the origin (*distance_or*$_c$) is calculated as the log of the distance (in thousands of kilometres) between the origin country *s* (Lithuania) and the destination country *c*.

$$distance\_or_c = \ln\left(distance_{s,c}/1000\right) \quad (3.7)$$

Distances between countries are taken from the CEPII database. We use the measure of a weighted distance *distw* which is "*based on bilateral distances between the biggest cities of the two countries, those inter-city distances being weighted by the share of the city in the overall country's population*" (Mayer & Zignago, 2011). Such a distance between the countries *i* and *j* (*distw*$_{ij}$) was calculated by CEPII according to Formula (3.8) presented below. Here, *pop*$_k$ stands for the population of agglomeration *k* belonging to country *I*, whereas parameter θ is set equal to '1'. For the 10 countries having only one city counted in the dataset, CEPII replaced the weighted distances by the simple distances between the largest cities of the countries.

$$distw_{ij} = \left(\sum_{k \in i} \left(pop_k / pop_i \right) \sum_{l \in j} \left(pop_l / pop_j \right) d_{kl}^{\theta} \right)^{1/\theta} \quad (3.8)$$

According to the basic gravity theory and by following Felbermayar & Kohler (2006), Allen (2014) and other economists, both the probability of starting to trade and the trade volume are expected to increase with a lower distance because of the lower trade costs.

- Distance f-o-f (*distance_fof*$_{i,c,t}$) indicates the sum of the distances between any destination country *c* and all the other countries to which the country of origin exported product *i* in year *t*. It is calculated as follows:

$$distance\_fof_{i,c,t} = \sum_{c'} \left[\ln \left(distance_{c,c'} / 1000 \right) \cdot Exporting_{i,c',t}^{s} \right] \quad (3.9)$$

We expect that the larger is the indirect distance, the lower is the probability to start exporting to country *c*.

- Soviet bloc membership (*sb*$_{s,c}$) is a dummy variable which can be either '0' or '1'. *sb*$_{s,c}$ = 1 if both country *s* and country *c* belonged to the Soviet bloc before 1990, and it is '0' otherwise. This variable stands for cultural and historical similarities.

$$sb_{s,c} = sb_s \cdot sb_c \quad (3.10)$$

It is expected for Lithuania, which belonged to the Soviet bloc before 1990, in the earliest years covered in this research to have a higher probability to export to the countries that also belonged to the Soviet bloc, i.e. *sb*$_{s,c}$ should positively affect the endogenous variable.

- Soviet bloc f-o-f membership (*sb_fof*$_{i,c,t}$) is a variable indicating the indirect effect of belonging to the Soviet bloc. It is calculated as follows:

$$sb\_fof_{i,c,t} = \frac{\sum_{c'} \left[sb_{c,c'} \cdot Exporting_{i,c',t}^{s} \right]}{\sum_{c'} Exporting_{i,c',t}^{s}} \quad (3.11)$$

During the earliest years, we expect *sb_fof*$_{i,c,t}$ to be more important for the spread of international trade because of the lower indirect transport costs.

- EU membership ($eu_{s,c,t+1}$) is a dummy variable which can be either '0' or '1'. $eu_{s,c,t+1} = 1$ if both country *s* and country *c* belonged to the European Union at time $t+1$, and it equals '0' otherwise. It is expected that the EU, as a zero tariff zone and even a currency union which is promoting trade among its member states, should positively affect Lithuania's exporting after joining it.

$$eu_{s,c,t+1} = eu_{s,t+1} \cdot eu_{c,t+1} \tag{3.12}$$

- EU f-o-f membership ($eu\_fof_{i,c,t+1}$) is a variable indicating the indirect effect of belonging to the EU. It shows the average number of the EU membership between country *c* and all the current Lithuania's (*s*) export partners (*c'*) of a good *i*, and is calculated as following:

$$eu\_fof_{i,c,t+1} = \frac{\sum_{c'} \lfloor eu_{c,c',t+1} \cdot Exporting^{s}_{i,c',t} \rfloor}{\sum_{c'} Exporting^{s}_{i,c',t}} \tag{3.13}$$

  We expect that a higher value of $eu\_fof_{i,c,t+1}$ positively affects Lithuania's exporting to country *c* due to the benefits of the same trade bloc.

- Free trade agreements (FTA) ($fta_{s,c,t+1}$) is a dummy variable indicating that there was a free trade agreement between the country of origin *s* and the destination country *c* at time $t+1$. If both countries had a free trade agreement at the time, $fta_{s,c,t+1} = 1$, otherwise it is '0'. We expect that the countries having a free trade agreement are more likely to have trade relations with each other.

$$fta_{s,c,t+1} = fta_{s,t+1} \cdot fta_{c,t+1} \tag{3.14}$$

- FTA f-o-f ($fta\_fof_{i,c,t+1}$) is a variable, indicating the indirect effect of having a free trade agreement at time $t+1$. This measure shows the average number of free trade agreements between country *c* and all the current Lithuania's (*s*) export partners (*c'*) with a good *i*. It is calculated as follows:

$$fta\_fof\_a_{i,c,t+1} = \frac{\sum_{c'} \lfloor fta_{c,c',t+1} \cdot Exporting^{s}_{i,c',t} \rfloor}{\sum_{c'} Exporting^{s}_{i,c',t}} \tag{3.15}$$

  Positive relationship is expected due to the same reasons as above.

- Language ($lang_{s,c}$) shows countries' abilities to communicate with each other. It is measured by "*cls*" measure evaluated by CEPII and can be between 0 (nobody in the two countries can understand each other) and 1 (every two people taken from the two countries will be able to communicate with each other) (Mélitz & Toubal, 2012). Based on the literature (e.g. Rindler, 2021), the increase of the common spoken languages decreases trade costs and positively affects the probability of exporting.

- Language f-o-f ($lang\_fof_{i,c,t}$) stands for the indirect ability of countries to communicate, and it is calculated as following:

$$lang\_fof\_a_{i,c,t} = \frac{\sum_{c'} \left\lfloor cls_{c,c'} \cdot Exporting^{s}_{i,c',t} \right\rfloor}{\sum_{c'} Exporting^{s}_{i,c',t}} \tag{3.16}$$

  It is an average sum of all 'cls' measures between country *c* and all Lithuania's export partners of a good *i*. A higher value of $lang\_fof_{i,c,t}$ shows that country *c* is more capable to communicate with the current Lithuania's export partners, hence, Lithuania is more likely to find this market by the indirect search procedure.

- Migration ($migr\_ln_{s,c}$) is the log of the migration stock from the country of origin *s* to the destination country *c* in 1990. We hypothesise that a higher number of immigrants living in country *c* promotes export from their country of origin to country *c*. We follow a number of studies, e.g. Rauch & Trindade (2002), Burchardi & Hassan (2013), Bailey et al. (2021). Rauch & Trindade (2002) noted positive effects on trade triggered by the Chinese migrants network. Burchardi & Hassan (2013) found a positive effect of social relations between East and West Germany on the economic growth of specific German regions after the fall of the Berlin Wall. Although we do not have the most recent migration data, Baiardi & Ammon (2022) and Bailey et al. (2021) argue that "*past migration movements continue to influence social connections today*" (Bailey et al., 2021, p. 5). Therefore, we also expect migration to have a positive relationship on exporting not only in the short run, but also in the long run.

- Migration f-o-f ($migrln\_fof_{i,c,t}$) is the log of the average indirect migration calculated for the destination country *c*:

$$migrln\_fof\_a_{i,c,t} = \ln\left\lfloor \frac{\sum_{c'} \left\lfloor migr_{c,c',1990} \cdot Exporting^{s}_{i,c',t} \right\rfloor}{\sum_{c'} Exporting^{s}_{i,c',t}} \right\rfloor \quad (3.17)$$

A higher number of $migrln\_fof_{i,c,t}$ represents a higher average stock of immigrants in country *c* from all Lithuania's exports partners of a good *i*. Following the above, indirect migration should boost social relations between current Lithuania's export partners and other countries. Consequently, it is expected to create social relations and positively affect Lithuania's export to country *c* because of a chain reaction.

For the regressions, all the variables were normalised simply by subtracting the means and dividing by the standard deviations of each variable.

3.5.3. Data description

The research uses detailed product and country level data from a number of different databases. The main product level 'bilateral trade data' (between Lithuania and other countries) comes from the *BACI* world trade database developed by CEPII. The period used for the analysis covers the period between 1995 and 2015. The year 1995 was chosen because it was the first year that any statistics for Lithuania were started to be collected. The year 2015 was the final analysed time period because, in this Section, we are mostly interested in the very beginning of the formation of a country's export network. Hence, 20 years since the first reliable statistical data and 12 years after Lithuania joining the EU should deliver a clear image of the initial development of Lithuania's export network.

The model we are using is mostly designed for the firm-level data. As we do not have purely micro-level data, following Baldwin & Di Nino (2006), we are using the most detailed sector-level dataset. Trade is classified according to hs92 6-digits classification which is the lowest possible aggregation distinguishing about 5000 commodities (Gaulier & Zignago, 2010). The size of Lithuania's economy and the aggregation of the data makes it so detailed that many cells may have as little as only one firm in them. Therefore, the data is very close to micro-level data, and the use of this model may be justified. In the data, export is accounted for if its value is at least 1,000 USD per year.

The aggregated bilateral import data by country is taken from Robert Feenstra's database (www.robertfeenstra.info). The nominal GDP and migration data comes from the World Bank's database. The migration data

is represented by the immigrant stock, i.e. "*the total number of international migrants present in a given country at a particular point in time*" (United Nations, 2020, p. 10), in the destination country by each country of origin as of the year 1990. We do not have any later migration data; however, based on Baiardi & Ammon (2022) and Bailey et al. (2021), the effect of migrants on trade does not fade even in the long run. Finally, the data for the weighted average distances between countries, the measure of common spoken languages between a pair of countries as of the year around 2012, and free trade agreements (FTA) between different countries (based on the information provided by the WTO) are retrieved from www.cepii.org. FTA is specified by a dummy variable which is equal to '1' if WTO reported a free trade agreement between the two covered countries in year *t*, and it equals '0' otherwise.

The European Union membership is accounted for each year. The Soviet bloc membership is marked if a country is considered to have belonged to the Soviet bloc before the 1990s. The countries included in the Soviet bloc in the analysis are: Lithuania, Latvia, Estonia, Moldova, Ukraine, Belarus, Hungary, Poland, Romania, Slovakia, the Chech Republic, Bulgaria, Russia, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Afghanistan, Vietnam, Mongolia, Laos, Mozambique, Yemen, Ethiopia, Cuba, North Korea, Benin, Angola, and the Republic of Congo. Both the EU membership and the Soviet bloc membership are accounted by dummy variables. The EU dummy is equal to '1' if both countries were members of the EU in year *t*, and it equals '0' otherwise. The Soviet bloc dummy is equal to '1' if both countries belonged to the Soviet bloc at any time before the 1990s, and it equals '0' otherwise.

For the sake of the computational feasibility, we analyse one country of origin *s* (Lithuania) and its export to the other countries of destination *c*. We have a total of 183 countries of destination. The exported products are identified by index *i*. The total number of Lithuania's exported products is 4,863, and the number of products exported from Lithuania to any of these 183 countries in any year between 1995 and 2015 is 2,099. As this research deals with an extensive margin of international trade, we are interested only in the fact whether Lithuania exported product *i* to country *c*, or not. The exact volume of such export is irrelevant for this analysis. However, the data records the yearly export of a product only if it is not less than 1,000 USD. Therefore, the identity function $Exporting^{s}_{i,c,t} = \mathbf{1}\left[Export^{s}_{i,c,t} > 0 \right]$ gives '1' for any export of commodity *i* from the country of origin *s* to the country of destination *c* if it was at least 1,000 USD in year *t*, and it gives '0' otherwise.

3.6. Descriptive statistics

In Table 3.1, we provide descriptive statistics of all the variables before normalisation. The number of observations differs due to the differences in the variables (e.g. GDP is given for each country and year, while export is given for each country, year, and product), and the panel is unbalanced (e.g. the GDP of Afghanistan is known only since 2001).

Table 3.1 shows that 94% of the export data is either zero or missing, i.e. Lithuania's export basket varies across its exports partners. The situation is similar for all the countries of the world.

16% of all 183 countries belonged to the Soviet bloc. 15% of all the countries belonged to the EU in the year 2014, however, only 8% of the countries belonged to the EU in 1995.

Table 3.1. Descriptive statistics

Variable	Obs	Mean	St. dev.	Min	Max
Bilateral exports, thou USD	7 338 104	30 118	1 980 000	0	1.28e+09
Zero / missing values	*94%*				
GDP, mill USD (current prices)	3 511	278 642	1 155 826	11	1.74e+07
No. of migrants (1990, stock, 1000s)	711	4	67.5	0	5 212
Common spoken languages	707 112	0.117	0.227	0	1
Distance (weighted)	3 680	6 234	3 872	132	17 226
Import growth	3 496	0.080	0.271	-3.365	4.063
Free Trade Agreements (all years)	707 112	0.091	0.288	0	1
Existing bilateral FTAs, %	*9%*				
No bilateral FTAs, %	*91%*				
Soviet bloc membership (2000)	33 672	0.026	0.159	0	1
Ex-Soviet bloc countries, %	*16%*				
Non-Soviet bloc countries, %	*84%*				
EU membership (2014)	33 672	0.021	0.1429	0	1
EU member countries, %	*15%*				
Non-EU member countries, %	*85%*				

9% of all the observations have a positive bilateral free trade agreement. The number of countries having bilateral FTAs increased during the analysed period. In 1995, only 4% of the analysed 183 countries had bilateral FTAs. Meanwhile, in 2014, the number of such countries reached almost 14%. The number of countries having bilateral FTAs with Lithuania (22% of the countries, if taking all the years) also grew over the period: in the year 1995 Lithuania, had a free trade agreement with only 8% of the analysed 183

countries, whereas, in the year 2014, this number increased to 39%. The fact shows that Lithuania is a small and open economy.

In Figure 3.3, we notice a sharp increase in both margins of Lithuania's export during the entire period. The upper panel presents the change of the intensive margin of Lithuania's export, i.e. the log of the volume of export during the years 1995–2014. The middle panel shows how the number of Lithuania's export markets increased over the period. The increase was by nearly 70%: from 109 export markets in 1995 to 184 destinations in 2014. Finally, the lower panel represents the growth of the average number of Lithuania's export markets by the exported products. Different Lithuanian products in different years ranged between 0 and 121 export markets. In 1995, one Lithuanian export product on average had 4.6 export markets, while, in 2014, one product on average was being exported to 12.1 destinations.

Figure 3.3. The spread of Lithuanian export, 1995–2014.

The greatest increase and the general formation of Lithuania's trade pattern is observed between the years 1999 and 2008. After 2008, the export shrank due to the effect of the world economic crisis, and the numbers were slowly recovering afterwards. The data shows the same export dynamics for the other Eastern European countries (not shown in the graphs).

Due to a large number of variables, there is a high possibility of the multicollinearity problem. According to the cross-correlations data, as given in, it is highly likely that direct variables are correlated with the corresponding indirect variables. It is especially true for the Soviet bloc, the EU, FTA, and language variables. The direct migration variable is also correlated with the direct language variable. The distance from the origin, which is correlated with direct migration as well as the indirect EU and FTA variables, seems to contain the highest number of cross-correlations.

Table 3.2. Cross-correlations among the variables

	Exporting	Dist.$_{or}$	Dist.$_{f\text{-}o\text{-}f}$	Sov.bl.	SB$_{f\text{-}o\text{-}f}$	EU	EU$_{f\text{-}o\text{-}f}$	FTA	FTA$_{f\text{-}o\text{-}f}$	Lang.	Lang$_{f\text{-}o\text{-}f}$	Migr.
Exporting	**1**											
Distance$_{or}$	**-0.37**	1										
Distance$_{f\text{-}o\text{-}f}$	**-0.03**	0.39	1									
Soviet block	**0.21**	-0.42	-0.14	1								
Sov. bloc$_{f\text{-}o\text{-}f}$	**0.18**	-0.38	-0.18	0.90	1							
EU memb.	**0.28**	-0.45	-0.16	0.11	0.09	1						
EU$_{f\text{-}o\text{-}f}$	**0.28**	-0.50	-0.19	0.09	0.07	0.85	1					
FTA	**0.21**	-0.41	-0.10	-0.07	-0.07	0.55	0.57	1				
FTA$_{f\text{-}o\text{-}f}$	**0.25**	-0.53	-0.17	0.13	0.11	0.47	0.58	0.82	1			
Languages	**0.41**	-0.43	-0.15	0.38	0.34	0.26	0.25	0.20	0.30	1		
Language$_{f\text{-}o\text{-}f}$	**0.25**	-0.29	-0.07	0.10	0.15	0.25	0.32	0.25	0.37	0.75	1	
Migrants	**0.40**	-0.50	-0.19	0.46	0.41	0.32	0.31	0.23	0.35	0.57	0.32	1
Migrants$_{f\text{-}o\text{-}f}$	**0.29**	-0.42	0.08	0.34	0.28	0.21	0.25	0.16	0.32	0.27	0.25	0.47

3.7. Main findings

In this Section, we present the main findings of our research. The first Subsection gives the results of the simple benchmark regressions, i.e. the classical static and dynamic gravity models of the extensive trade margin. Subsection 3.7.2 describes the findings of the general regression, which includes both types of the exogenous variables: the direct and indirect ones. In Subsections 3.7.3 and 3.7.4, the direct and indirect determinants of the extensive trade margin are analysed separately.

3.7.1. Benchmark regressions

First of all, we estimate a couple of simple benchmark regressions which include only the most important gravity variables: GDP and the distance from the origin in the first regression and adding previous exporting and a number of export markets in the second regression. We estimate the following reduced-form equations:

$$\mathbf{1}\left[Export^{s}_{i,c,t+1} > 0 \right] = \alpha + \beta_1 \ln GDP_{c,t+1} + \beta_2 distance^{s}_{c} + \varepsilon^{s}_{i,c,t} + u^{s}_{i,c} \quad (3.18)$$

$$\begin{aligned} \mathbf{1}\left[Export^{s}_{i,c,t+1} > 0 \right] = \alpha + \beta_1 \ln GDP_{c,t+1} + \beta_2 distance^{s}_{c} + \\ + \beta_3 Markets^{s}_{i,t} + \beta_4 \mathbf{1}\left[Export^{s}_{i,c,t} > 0 \right] + \varepsilon^{s}_{i,c,t} + u^{s}_{i,c} \end{aligned} \quad (3.19)$$

Here, $\mathbf{1}\left[Export^{s}_{i,c,t} \right]$ is an identity function indicating if product i from the country of origin s (Lithuania) was exported to the country of destination c at time t. $\ln GDP_{c,t+1}$ gives the logarithm of the nominal GDP of the destination country c, $distance^{s}_{c}$ shows the distance between Lithuania and the destination country, and $Markets^{s}_{i,t}$ shows the number of country s export markets at time t. Finally, ε is an error term, and u is the individual effect for the destination and the product.

We estimate each model applying the OLS, Probit and Logit methods. Following Chaney (2014) and Morales et al. (2019), we estimate these models with random effects of the destination and the product. We also estimate the Probit regression with correlated random effects by following Mundlak (1978). Still, according to Shepherd (2012) and Anderson and van Wincoop (2003), symmetric gravity models should be estimated by including country

fixed effects. Since our models have only one source country and a number of product groups, in order to be in line with the theory and to avoid losing regressors, we follow Baldwin & Di Nino (2006), Wang & Zhao (2013) and Berthou & Fontagne (2008), and estimate the OLS (by applying the method of Correia, 2017) and Logit models by taking the individual fixed effects of the destination and the product. We also tried to classify products to 15 sectors and to control for the industry, as products from different sectors are more or less likely to be exported to any particular country, however, sector controls do not have any noticeable impact for the results (see: Table 4.3 in the Appendix). Estimating regressions with the individual effects of the product and the year does not have any significant impact on the results, either.

The results of the benchmark models are given in Table 3.3. As expected, the GDP, the number of markets, and the previous exporting affect the future exporting positively, while the distance affects exporting negatively. Judging by the determination coefficient, adding the previous exporting and a number of markets improves the model significantly. Still, the fact of having such a simple model leaves a huge amount of information unexplained.

Table 3.3. Results of the benchmark model regressions

Variables, normalised	OLS				PROBIT marginal effects		LOGIT marginal effects			
Dependent variable	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+3}$	$Exporting_{t+6}$	$Exporting_{t+12}$	$Exporting_{t+15}$	$Exporting_{t+21}$	$Exporting_{t+23}$	$Exporting_{t+27}$
GDP (log mill)	0.05092***	0.01306***	0.03303***	0.01333***	0.06762***	0.03649***	0.06925***	0.03860***	0.28308***	0.22311***
	(0.00101)	(0.00029)	(0.00083)	(0.00031)	(0.00030)	(0.00019)	(0.00030)	(0.00020)	(0.00008)	(0.00065)
Distance (origin)	-0.07533***	-0.03098***	-0.08087***	-0.03091***	-0.05079***	-0.03967***	-0.05150***	-0.04157***		
	(0.00078)	(0.00029)	(0.00081)	(0.00029)	(0.00022)	(0.00018)	(0.00021)	(0.00018)		
Exporting, t		0.15208***		0.15204***		0.01191***		0.01014***		0.02825***
		(0.00054)		(0.00053)		(0.00006)		(0.00006)		(0.00022)
Markets, t		0.01819***		0.00836***		0.02003***		0.02024***		0.07539***
		(0.00016)		(0.00050)		(0.00010)		(0.00010)		(0.00085)
Constant	yes	yes	yes	yes	yes	yes	yes	yes	no	no
Individual effects (dest, prod)	random	random	fixed	fixed	random	random	random	random	fixed	fixed
Sector controls	no	no	no	no	no	no	no	no	no	no
R-squared	15.56	51.33	19.58	51.39	-	-	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	1,406,741	1,406,741

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented. Individual effects are by the destination and the product, robust standard errors are clustered by product.

3.7.2. General results

Next, we investigate the effect of our 17 exogenous variables on the probability of exporting. We estimate 3 types of regressions: the OLS method introducing either random or fixed effects by the destination and the product (for the fixed effects estimation method see Correia, 2017), 2 kinds of Probit regressions introducing either random or correlated random effects by the destination and the product (for the correlated random effects estimation method see Mundlak, 1976), and the Logit regression introducing either random or fixed effects. In order to have coefficient values of all the exogenous variables (including the ones that vary by destination only), we also estimate the OLS model with the fixed effects of the product and the year.

Due to the evident cross-correlations of the corresponding direct and indirect (f-o-f) variables (see Table 3.2), we constructed 3 types of regressions for each method: the first one includes all the exogenous variables, the second one contains only the direct factors, and the third one uses only the indirect variables (see Table 3.4, Table 3.5 and Table 3.6, respectively).

As we can see from Table 3.4, almost all the factors are reported to be highly significant (except for the Soviet bloc, the free trade agreements, indirect languages and indirect migration in some of the models). This is mainly due to the very large number of observations (7.3 million). Most of the signs are similar among the specifications, and are as expected, except for the distance from the origin in the OLS model which unexpectedly becomes positive. Most probably, it is because of the more significant cross-correlations between the distance from the origin and the other variables (see Table 4.4 and Figure 4.2 in the Appendix for the estimation results excluding the distance from the origin).

Other interesting differences by specification include indirect migration and the EU membership. The first one is significant and positive in all Logit and Probit specifications. However, it has different levels of significance and even different signs for the OLS models. The latter is significantly positive for the OLS specification, however, it is negative for the Logit and Probit with the random effects specification. The greatest differences in the results are observed between OLS and the two other models. The reason for this might be because the coefficients are very small numbers, therefore, only the very beginning of the non-linear distribution function is taken into account, and linear smoothing in this part changes the results severely. Overall, the estimation results are robust and similar for all the specifications.

Table 3.4. Results of the regressions including both direct and indirect variables

Variables, normal.	OLS			LOGIT		PROBIT	
Dependent variable	$Exporting_{t+1}$	$Exporting_{t+3}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$
GDP	0.00905***	0.00921***	0.00971***	0.19080***	0.02798***	0.0257***	0.02913***
	(0.00008)	(0.00031)	(0.00029)	(0.00091)	(0.00021)	(0.000195)	(0.00030)
Distance (origin)	0.00315***	0.11596***	0.00344***		-0.01229***	-0.0105***	-0.00038***
	(0.00011)	(0.00077)	(0.00025)		(0.00016)	(0.000157)	(0.000095)
$Exporting_t$	0.13340***	0.08727***	0.13319***	0.02330***	0.00918***	0.0108***	0.00790***
	(0.00008)	(0.00078)	(0.00060)	(0.00022)	(0.00005)	(0.000057)	(0.00004)
$Markets_t$	0.06839***		0.05951***	0.09890***	0.02830***	0.0289***	0.01626***
	(0.00019)		(0.00072)	(0.00120)	(0.00019)	(0.000192)	(0.00014)
Import growth	0.00080***	0.00073***	0.00072***	0.00518***	0.00173***	0.00168***	0.00109***
	(0.00006)	(0.00005)	(0.00004)	(0.00053)	(0.00011)	(0.000106)	(0.000082)
Soviet bloc	-0.00935***		-0.01034***		-0.00283***	-0.00311***	-0.00010
	(0.00016)		(0.00035)		(0.00021)	(0.000210)	(0.00013)
EU mebership	0.00091***	0.00253***	0.00128***	-0.00452***	-0.00109***	-0.000751***	0.00089***
	(0.00013)	(0.00037)	(0.00035)	(0.00034)	(0.00009)	(0.000088)	(0.00007)
FTA	-0.00237***	-0.00283***	-0.00197***	-0.00003	0.00016	-0.000058	-0.00024**
	(0.00013)	(0.00022)	(0.00020)	(0.00056)	(0.00013)	(0.000127)	(0.00011)
Languages	0.03610***		0.03693***		0.01853***	0.0185***	0.00186***
	(0.00013)		(0.00049)		(0.00016)	(0.000156)	(0.000087)
Migrants	0.01418***		0.01395***		0.00939***	0.00908***	0.00149***
	(0.00010)		(0.00023)		(0.00016)	(0.000153)	(0.00008)
Distance f-o-f	-0.05299***	-0.07911***	-0.05325***	-0.04771***	-0.01052***	-0.0123***	-0.00347***
	(0.00020)	(0.00088)	(0.00063)	(0.00119)	(0.00023)	(0.000221)	(0.00012)
Imp.growth f-o-f	0.00017**	0.00033***	0.00016***	0.00595***	0.00114***	0.00109***	0.00059***
	(0.00007)	(0.00002)	(0.00002)	(0.00088)	(0.00017)	(0.000166)	(0.00012)
Sov. Bloc f-o-f	0.00674***	0.00413***	0.00821***	0.01031***	0.00357***	0.00359***	0.00129***
	(0.00015)	(0.00033)	(0.00034)	(0.00073)	(0.00016)	(0.000158)	(0.00010)
EU f-o-f	0.00909***	0.00609***	0.00900***	0.00583***	0.00121***	0.00138***	0.00161***
	(0.00013)	(0.00041)	(0.00038)	(0.00048)	(0.00011)	(0.000105)	(0.00010)
FTA f-o-f	-0.00223***	0.00379***	-0.00209***	0.01654***	0.00383***	0.00336***	0.00238***
	(0.00013)	(0.00028)	(0.00025)	(0.00064)	(0.00014)	(0.000139)	(0.00012)
Language f-o-f	-0.00869***	0.00967***	-0.00953***	0.00031	0.00034**	0.000242*	0.00094***
	(0.00011)	(0.00033)	(0.00035)	(0.00073)	(0.00014)	(0.000141)	(0.00009)
Migrants f-o-f	0.00094***	-0.00285***	-0.00009	0.01353***	0.00620***	0.00542***	0.00364***
	(0.00008)	(0.00015)	(0.00014)	(0.00068)	(0.00014)	(0.000131)	(0.00009)
Constant	yes	yes	yes	no	yes	no	no
Ind.effects (dest, prod)	random	fixed		fixed	random	random	corr.random
Ind.effects (prod, year)			fixed			-	-
Sector controls	no	no	no	no	no	yes	yes
R-squared	53.32	55.47	53.39	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	1,406,741	7,338,104	7,338,104	7,338,103

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented.

According to these results, the most important factors influencing Lithuania's decisions to export are:

- The history of exporting (positive),
- The development of a trade network and the openness of the origin (positive),
- Development of the economy of the destination market (positive),
- Ability to communicate (positive),

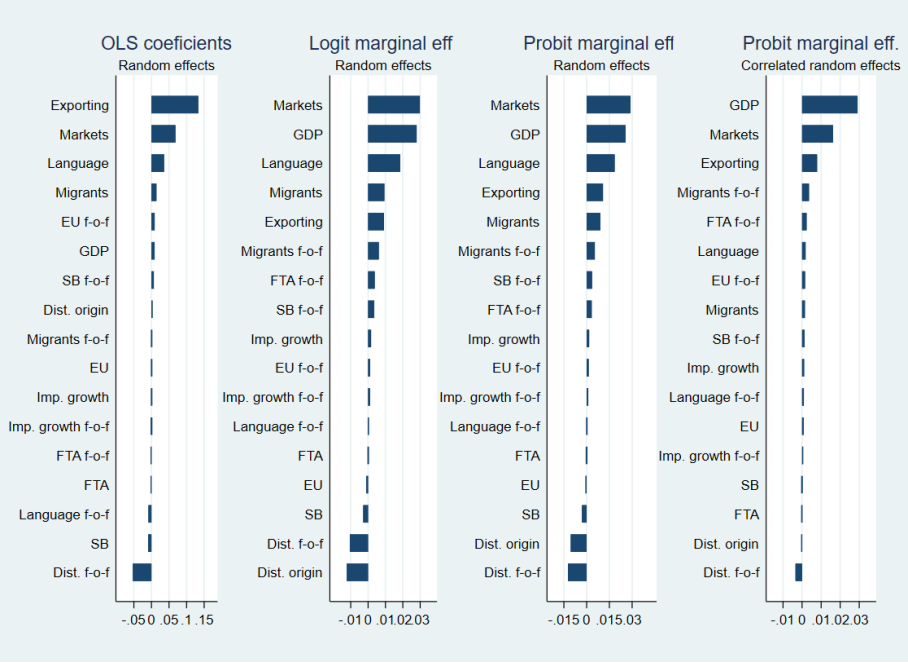
- Direct stock of migrants in the destination countries (positive),
- Direct and indirect geographic distances (negative).

Other robust factors are: indirect effects of belonging to the EU and the Soviet bloc and both direct and indirect effects of the import growth of the export partners (all positive). The effects of the other factors seem to be ambiguous, as the estimated coefficients of the regressions differ by specification.

A graphic comparison of the general regression results for the models which provide the results for all of the exogenous variables is presented in Figure 3.4. We skipped the graph for the OLS fixed effects model for the sake of visibility, as its results are very similar to the results of the OLS random effects model. The results are displayed starting from the most influential positive (GDP, the number of markets, or exporting) and finishing with the most influential negative value (indirect distance). We note that it is possible to compare the coefficients directly as all exogenous variables have been normalised.

The results confirm the hypothesis of the importance of the network effects for the development of the extensive margin of international trade. The most important network effect is the indirect distance. The results are in line with the economic theory by showing the negative effects of both direct and indirect distances. The other important network effects are: migration, the import growth of the destination market, and the membership in the EU and in the Soviet bloc. However, the direct effects of the Soviet bloc and the EU variables, the indirect effect of the common spoken languages, as well as both effects of the free trade agreements are controversial. The lack of influence of the participation in any trade union could be explained by the rather late starting point of the data. Lithuania became independent from the Soviet Union in 1990 and was located in the middle of Europe, i.e. it had good opportunities to create trade relations with its neighbouring countries due to the small distances. Therefore, in 1995, Lithuania could have already created strong relations with the other EU and the Soviet bloc countries and made successful free trade agreements. Hence, when examining just the extensive margin, we are not able to see any strong effects of these factors for the creation of Lithuania's trade relations, as Lithuania already had trade relations with most of these countries previously. However, these three factors could still be influential for the development of Lithuania's trade relations in terms of an intensive trade margin. The lack of evidence of the indirect effect of the common spoken languages may be due to the possible multicollinearity with the direct language variable.

Figure 3.4. Comparison of the general regression results.



To check if these results are affected by the possibility of a multicollinearity, we introduced separate models for direct and indirect variables.

3.7.3. Analysis of direct factors

Table 3.5 shows the estimation results of the regressions which contain only the direct factors, i.e. the number of markets, the previous exporting, the GDP, the growth of import, the distance from the origin, the membership in the Soviet bloc, the EU and a free trade union, the common spoken languages and the stock of migrants. Omitting the network variables helps to avoid the problems that may arise because of the multicollinearity between similar direct and indirect variables (see Table 3.2). In spite of the positive and significant coefficients for the Soviet bloc and the FTA in the Probit and Logit models, the ‘direct’ regression gives very similar results which are in line with the expectations. We may conclude that the multicollinearity problem does not have any significant impact on the other results.

Table 3.5. Results of the regressions analysing only the direct effects

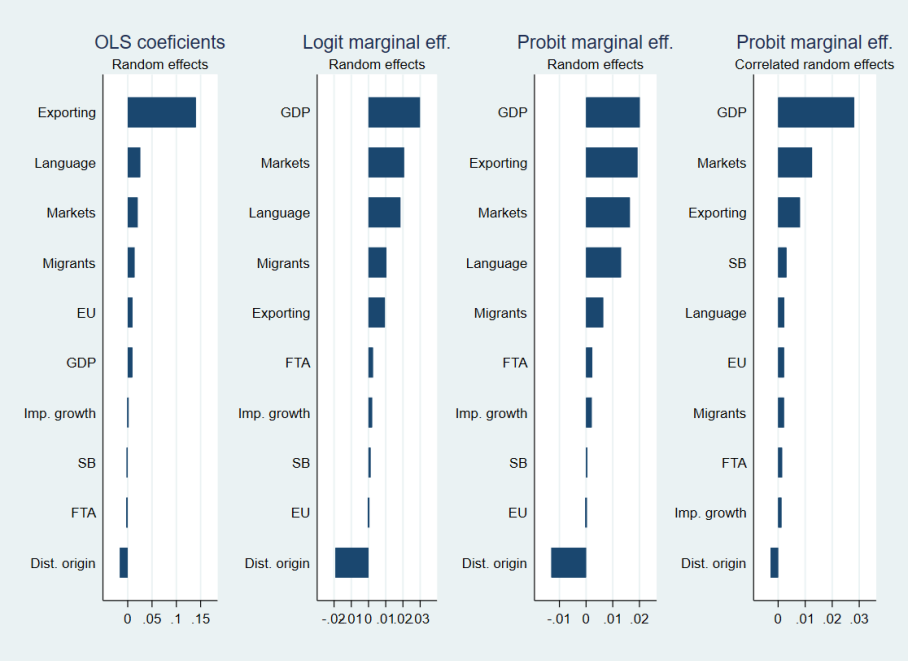
Variables (normalised)	**OLS**			**LOGIT**		**PROBIT**	
Dependent variable	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+3}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**
GDP	0.00968***	0.01095***	0.01011***	0.20903***	0.02987***	0.02010***	0.02814***
	(0.00008)	(0.00030)	(0.00026)	(0.00102)	(0.00021)	(0.00026)	(0.00030)
Distance (origin)	-0.01617***		-0.01556***		-0.01925***	-0.01301***	-0.00282***
	(0.00009)		(0.00018)		(0.00014)	(0.00013)	(0.00008)
Exporting$_t$	0.14017***	0.12666***	0.14009***	0.02915***	0.00953***	0.01925***	0.00808***
	(0.00007)	(0.00079)	(0.00060)	(0.00023)	(0.00005)	(0.00010)	(0.00003)
Markets$_t$	0.02042***	0.01385***	0.01099***	0.07755***	0.02064***	0.01642***	0.01255***
	(0.00007)	(0.00041)	(0.00050)	(0.00089)	(0.00009)	(0.00027)	(0.00009)
Import growth	0.00068***	0.00056***	0.00070***	0.00807***	0.00208***	0.00210***	0.00123***
	(0.00006)	(0.00005)	(0.00004)	(0.00045)	(0.00009)	(0.00009)	(0.00007)
Soviet bloc	-0.00232***		-0.00189***		0.00118***	0.00050***	0.00309***
	(0.00008)		(0.00018)		(0.00015)	(0.00016)	(0.00008)
EU mebership	0.00978***	0.01169***	0.01024***	0.00243***	0.00009	-0.00001	0.00219***
	(0.00008)	(0.00035)	(0.00027)	(0.00030)	(0.00007)	(0.00009)	(0.00005)
FTA	-0.00300***	0.00068***	-0.00228***	0.01038***	0.00257***	0.00234***	0.00147***
	(0.00008)	(0.00012)	(0.00016)	(0.00058)	(0.00011)	(0.00009)	(0.00009)
Languages	0.02572***		0.02579***		0.01852***	0.01309***	0.00228***
	(0.00008)		(0.00024)		(0.00014)	(0.00015)	(0.00007)
Migrants	0.01395***		0.01354***		0.01041***	0.00624***	0.00216***
	(0.00010)		(0.00021)		(0.00017)	(0.00014)	(0.00008)
Constant	yes	yes	yes	no	yes	no	no
Individual effects (destination, product)	random	fixed		fixed	random	random	corr.random
Individual effects (product, year)			fixed			-	-
Sector controls	yes	no	no	no	no	yes	no
R-squared	52.81	54.49	52.88	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	1,406,741	7,338,104	7,338,104	7,338,104

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented. Standard errors are clustered by product.

Figure 3.5 presents a visual comparison of the regression coefficients for the OLS model and the marginal effects for the Logit and Probit models. The most influential direct factors for the expansion of the trade of Lithuania are: the number of the current export markets, exporting to the same destination in the previous year, common spoken languages and the GDP growth (all of these have a positive effect), as well as the distance from the origin, which has a negative effect. Other robust, however, less influential factors include: the number of migrants and the import growth in the destination country.

Figure 3.5. Comparison of the results for direct regression.



Similarly, as in the case of the general regression, the EU, the Soviet bloc, and the FTA membership tend to have very low values and get to change signs depending on the specification. The reason for it might be the same as in the general case.

We get almost identical results if we use the indirect distance instead of the distance from the origin in these regressions (see: Table 4.5 and Figure 4.3 in the Appendix). The major change comparing these two models is that the indirect distance appears to be more influential for the development of the extensive margin of Lithuania's foreign trade than the direct distance.

3.7.4. Analysis of indirect factors

In this Subsection, we examine the 'indirect' regressions including only the control variables (i.e. the number of markets, the previous exporting, and the GDP) and the network variables (i.e. the indirect import growth, the distance, the membership of the Soviet bloc, the EU and a free trade union, common spoken languages and the stock of migrants). The results of these regressions are presented in Table 3.6. The greatest change in the results of the 'indirect' regressions comparing with the general models is in the effect of the indirect common spoken languages. In the reduced model, it becomes clearly positive and significant for all the specifications. It shows that this factor is influential for the development of the extensive trade margin of Lithuania, but possibly suffers from a significant multicollinearity in the general model. Similarly, as in the previous models, the results for belonging to the FTA and to the EU are unstable. The only unclear result is the coefficient of the indirect distance which becomes positive in the fixed effects Logit model. As other results do not change, we may conclude that the multicollinearity problem in the general regression is not severe.

Table 3.6. Results of the regressions analysing only the indirect effects

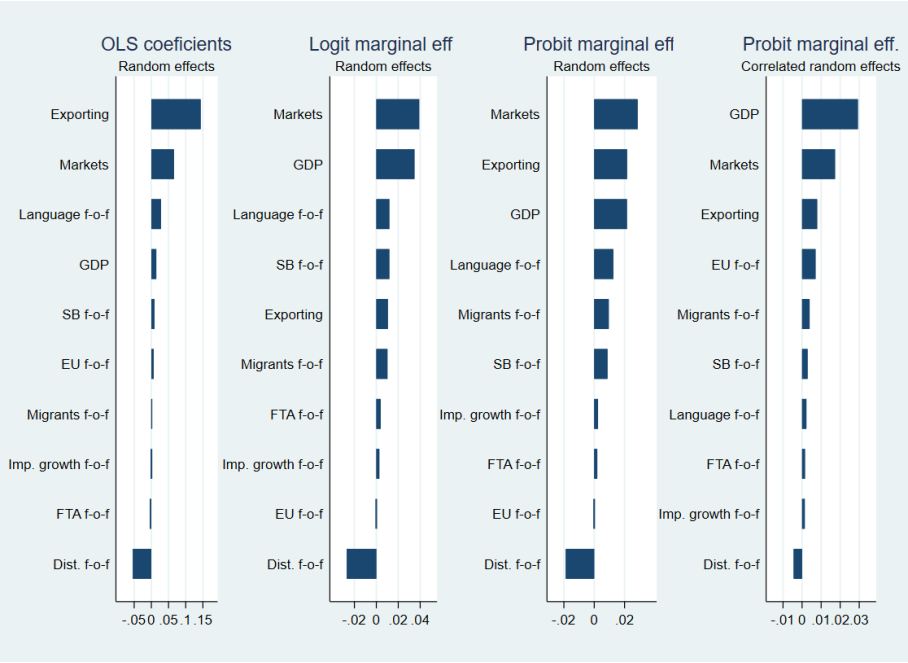
Variables (normalised)	**OLS**			**LOGIT**		**PROBIT**	
Dependent variable	**Exporting$_{t+1}$**	**Exporting$_{t+3}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**
GDP	0.01442***	0.00885***	0.01456***	0.22098***	0.03479***	0.02159***	0.0293***
	(0.00008)	(0.00033)	(0.00031)	(0.00066)	(0.00018)	(0.00020)	(0.000286)
Exporting$_t$	0.14348***	0.11597***	0.14340***	0.02958***	0.01056***	0.02165***	0.00792***
	(0.00007)	(0.00076)	(0.00052)	(0.00022)	(0.00006)	(0.00008)	(0.000035)
Markets$_t$	0.06589***	0.08756***	0.05681***		0.03913***	0.02864***	0.0173***
	(0.00016)	(0.00078)	(0.00066)		(0.00019)	(0.00028)	(0.000122)
Distance f-o-f	-0.05381***	-0.07955***	-0.05338***	0.05614***	-0.02697***	-0.01879***	-0.00443***
	(0.00016)	(0.00088)	(0.00052)	(0.00084)	(0.00023)	(0.00033)	(0.000101)
Imp.growth f-o-f	0.00051***	0.00057***	0.00044***	0.00880***	0.00275***	0.00252***	0.00142***
	(0.00006)	(0.00003)	(0.00003)	(0.00063)	(0.00012)	(0.00012)	(0.000098)
Sov. Bloc f-o-f	0.00917***	0.00421***	0.00908***	0.00223***	0.01186***	0.00877***	0.00290***
	(0.00007)	(0.00033)	(0.00018)	(0.00070)	(0.00010)	(0.00010)	(0.000056)
EU f-o-f	0.00706***	0.00797***	0.00729***	0.00782***	-0.00015*	-0.00009	0.00246***
	(0.00008)	(0.00029)	(0.00022)	(0.00035)	(0.00008)	(0.00009)	(0.000068)
FTA f-o-f	-0.00441***	0.00163***	-0.00399***	0.02143***	0.00403***	0.00202***	0.00153***
	(0.00008)	(0.00018)	(0.00014)	(0.00056)	(0.00012)	(0.00012)	(0.000099)
Language f-o-f	0.01879***	0.00995***	0.01881***	0.00118*	0.01189***	0.01264***	0.00228***
	(0.00007)	(0.00035)	(0.00019)	(0.00069)	(0.00011)	(0.00011)	(0.00006)
Migrants f-o-f	0.00220***	-0.00269***	0.00219***	0.01944***	0.01017***	0.00959***	0.00396***
	(0.00008)	(0.00014)	(0.00012)	(0.00066)	(0.00016)	(0.00018)	(0.000083)
Constant	yes	yes	yes	no	yes	no	no
Indidivual effects (destination, product)	random	fixed		fixed	random	random	corr.random
Individual effects (produst, year)			fixed				
Sector controls	yes	no	no	no	no	yes	no
R-squared	52.23	55.46	52.30	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	1,406,741	7,338,104	7,338,104	7,338,104

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented. Standard errors are clustered by product.

Figure 3.6 presents a visual comparison of the indirect regression coefficients for the OLS model and the marginal effects for the Logit and Probit models. It shows that the most influential robust factors are the number of the export markets, the previous exporting, the GDP growth, the indirect common spoken languages (all of which affect the probability to export positively) and the indirect distance (which affects negatively). The results for the indirect migration and the import growth are also stable and positive.

Figure 3.6. Comparison of the results for indirect regression.



We may conclude that Lithuania developed its export network by creating links to other countries not only directly from the origin, but also indirectly from its current export markets.

3.7.5. Summary of the results

The results above indicate that:

- Network variables are important for the development of an extensive trade margin.
- Lithuania's extensive trade margin is mostly affected by the previous exporting to the destination market, the number of the current export markets of Lithuania, the GDP of the destination, both the direct and

indirect knowledge of languages, both direct and indirect migration (all positively) and both the direct and indirect distance (negatively). Direct and indirect import growth in the destination country and the EU membership also has a small positive impact for Lithuania's trade creation.

- The indirect distance matters more than the direct distance.
- There is no clear effect of the Soviet bloc membership and the free trade agreements. The reason for the lack of the Soviet bloc influence could be that the trade was already created with the Soviet bloc countries, while the motivation for the lack of the influence of the FTA could be that the most important free trade agreements were made during the first 2–4 years of Lithuania's independence. Hence, after 1995, there was not much fluctuation in Lithuania's extensive trade margin with these markets.

These findings show that the probability to export any product to any destination market mostly depends on the export history of the origin and of the economic factors (i.e. the destination's GDP level). Lithuania's export network developed in an accelerating pace due to the friends-of-friends search procedure, and this conclusion is in line with the network theory.

As already shown in a number of previous papers (e.g. Rauch (1999), Felbermayar & Kohler (2006), Allen (2014), Chaney (2014)), even in the globalised world in which we are living today, the larger is the distance between the countries, the lower is the probability to export. The results remain the same for the indirect distance.

As it was already shown by Rauch (1999), the ability to communicate with each other facilitates export. We find that the ability to communicate also plays an important role during the friends-of-friends search procedure. We also find strong evidence that emigration boosts export from the country of origin. The reason for it could be that emigrants maintain close relations with their country of origin and wish to consume the goods that they were used to consuming at home.

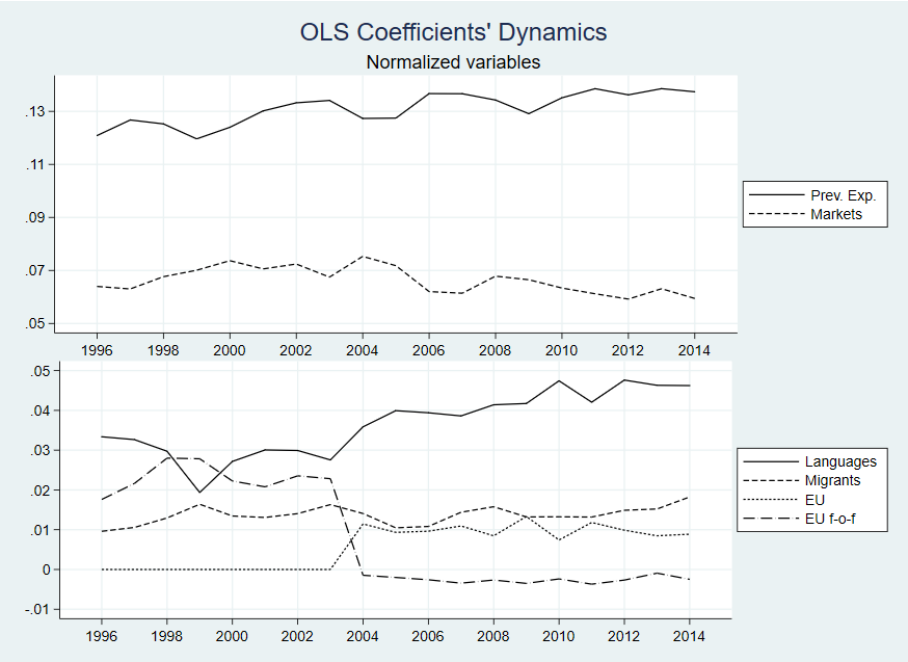
3.8. Analysis of the dynamics of the coefficients

In this Section, we examine the dynamics of the effects of various determinants of Lithuania's extensive trade margin over time. Our hypothesis is that, during the earliest years of the opening to the foreign trade, the influence of cultural, language and historical factors dominated, i.e. Lithuania traded with the other former Soviet bloc countries. Meanwhile, in the later

years, the geographical and economic factors are expected to become more important, i.e. trade is expected to expand further from the former USSR countries.

In order to analyse the dynamics, we apply the OLS random effects model. In Figure 3.7 and Figure 3.8, we graph coefficients for each year from 1996 till 2014. The OLS model was chosen because of the computational feasibility. As the coefficients of OLS with random effects and OLS with fixed effects models were very similar, we chose to graph only one of them. To avoid at least some of the multicollinearity effects, we shall omit the distance from the origin and have only the indirect distance in the model.

Figure 3.7. Dynamics of the coefficients of OLS regression with the most influential positive regressors.

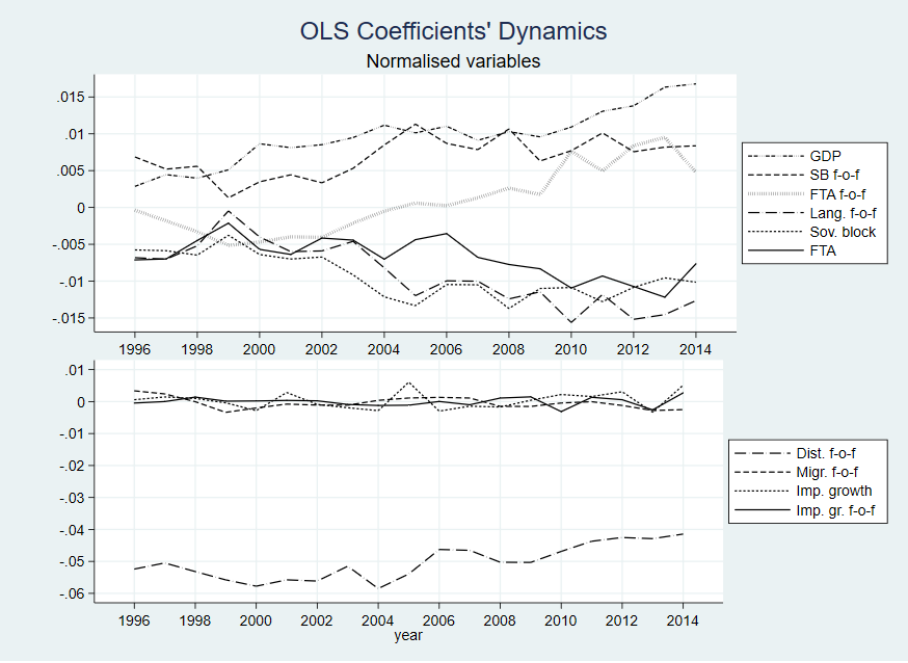


The upper panel of Figure 3.7 depicts the two most influential factors for the probability of exporting. The most influential factor is the previous exporting to the destination market. According to the OLS model, the probability to export a particular product to any destination in year 1996 increased by ~12% with one standard deviation increase in exporting of this product to the same destination in year 1995. The influence of this factor gradually increased throughout the years. The second most influential factor

is the number of the current export markets. The influence of this factor is stable throughout the period and does not have a clear trend.

The lower panel of Figure 3.7 shows an interesting trend of the coefficients of the direct and indirect membership of the EU. It could be explained by the fact that Lithuania joined the EU in 2004. Based on the construction of the direct EU dummy, it equals '0' in all the years when Lithuania was not an EU member. On the other hand, the indirect EU membership was much more influential before the admission. It could show that, before joining the EU, indirect contacts with the EU members were crucial for Lithuania to get access to the EU market. However, both of these coefficients are infinitely small, and the overall effects of the EU membership on the endogenous variable are negligible. Direct migration has a stable significant long-term effect on the probability to export, and this result is in line with the findings of Parsons & Vézina (2018) and Baiardi & Ammon (2022). By confirming the results of Rindler (2021), we find that the importance of the common spoken languages, although had decreased after 1995, reverted and has been increasing gradually since 2003.

Figure 3.8. Dynamics of the coefficients of OLS regression with other regressors.



The other increasingly important positive factors, as shown in the upper panel of Figure 3.8, are the destination country's GDP (which had a negligible

effect on starting to export in 1996, however, has increased sharply since 2009), the indirect Soviet bloc membership and the indirect free trade agreements.

Increasingly important negative factors affecting the probability to start exporting are the Soviet bloc membership, free trade agreements and the indirect effects of the common spoken languages. Their effects were close to '0' (that of the indirect FTAs were even negative) prior to 2002. However, later on, these factors became more influential. Still, the overall effects of these variables are negligible.

The indirect distance, given in the lower panel of Figure 3.8, is one of the most influential factors of the endogenous variable. By confirming the results of Felbermayar & Kohler (2006) and Allen (2014), its effect was stable for the first decade and started to slightly decrease in the recent years. The reason for it could be that Lithuania had already created trade relations with the majority of not-very-remote countries, as well as some other factors, such as the economic strength and ability to communicate, which became more important for the trade expansion to the more distant regions.

The other variables (indirect migration and both the direct and indirect import growth) have no clear trend and make a stable and significant, although negligible, influence on the probability of starting to export.

We draw the following conclusions from the analysis:

- The influence of the economic factors (i.e. the GDP of the destination) increases throughout the years.
- The indirect effect of the common spoken languages becomes more negative, and the direct one increases. It is in line with the other findings, and can be explained by Lithuanian exporters' attempts to learn foreign languages and to communicate with their export partners directly.
- The direct effect of the Soviet bloc membership becomes more negative and is in line with the hypotheses. The indirect effect of belonging to the Soviet bloc increases, and that shows the expected increase of clustering of the export markets.
- The indirect effect of the free trade agreements increased in the recent years. It may signal an increase of clustering and the importance of the indirect search procedure.
- Indirect EU membership was significant only before Lithuania became a member of the EU. On the other hand, direct EU membership was important after entering the EU. These findings show that Lithuania's

indirect contacts with the EU members before joining the EU could have been crucial for getting the access to the EU market.

Overall, the results confirm our hypothesis that the cultural, language and historical factors (i.e. common spoken languages and the Soviet bloc membership) were more important during the early years of the formation of Lithuanian export network, and the influence of the economic factors (i.e. GDP) increased gradually. These results also confirm the hypotheses about the increase of clustering, as the effects of the Soviet bloc and the free trade membership have been growing.

3.9. Robustness checks

3.9.1. Results for eleven most important products

In order to check the robustness of our results, we have estimated the same regression containing the data for only eleven products (HS 6-digits classification) which are the most important for Lithuania's export. We assumed that the most important products are the ones that were exported to the largest number of markets.

The products used for the estimation (sorted in the descending order by their importance) are given in Table 3.7.

Table 3.7. The widest exported products of Lithuania in the period of 1995–2014.

No	HS92	Meaning
1	270300	Peat, incl. peat litter, whether or not agglomerated
2	901890	Instruments and appliances used in medical, surgical or veterinary sciences, n.e.s.
3	271000	Petroleum oils, etc, (excl. crude); preparation
4	382200	Diagnostic or laboratory reagents on a backing, prepared diagnostic or laboratory reagents whether or not on a backing, and certified reference materials (excl. compound diagnostic reagents designed to be administered to the patient, blood-grouping reagents, animal blood prepared for therapeutic, prophylactic or diagnostic uses and vaccines, toxins, cultures of micro-organisms and similar products)
5	940360	Wooden furniture (excl. for offices, kitchens and bedrooms, and seats)
6	350790	Enzymes and prepared enzymes, n.e.s.
7	392690	Articles of plastics and articles of other materials of heading 3901 to 3914, n.e.s (excl. goods of 9619)
8	852990	Parts suitable for use solely or principally with transmission and reception apparatus for radio-broadcasting or television, television cameras, digital cameras, video camera recorders, radar apparatus, radio navigational aid apparatus or radio remote control apparatus, monitors and projectors, n.e.s.
9	732690	Articles of iron or steel, n.e.s. (excl. cast articles or articles of iron or steel wire)
10	940390	Parts of furniture, n.e.s. (excl. of seats and medical, surgical, dental or veterinary furniture)
11	840999	Parts suitable for use solely or principally with compression-ignition internal combustion piston engine "diesel or semi-diesel engine", n.e.s.

All the regressions were estimated by using the same models as for the main regressions. As the results (see Table 3.8) are similar to the ones containing all the products, we can conclude that our findings are robust.

As the third most important Lithuanian export product, petroleum oil, is in its nature not an export good, but mainly re-export, the same model was estimated by taking only the other 10 top products (without petroleum oil). The results were almost identical.

Table 3.8. Results of the regressions taking the 11 most important export products of Lithuania

Variables	OLS random effects			OLS fixed effects			OLS fixed effects			LOGIT fixed effects			LOGIT random effects			PROBIT random effects		
(normalised)	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.
Dependent variable	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$
GDP	0.05544***	0.06270***	0.06310***	0.03491***	0.05088***	0.03544***	0.05628***	0.06306***	0.06402***	0.09354***	0.10757***	0.09785***	0.09443***	0.10880***	0.11733***	0.0921***	0.106***	0.114***
	(0.00340)	(0.00303)	(0.00209)	(0.00758)	(0.00766)	(0.00767)	(0.00453)	(0.00433)	(0.00399)	(0.01729)	(0.01734)	(0.01768)	(0.00446)	(0.00402)	(0.00441)	(0.00437)	(0.00396)	(0.00434)
Distance (origin)	0.01518**	-0.02868***					0.01544**	-0.02819***					-0.01570*	-0.05350***		-0.0153*	-0.0519***	
	(0.00593)	(0.00335)					(0.00590)	(0.00542)					(0.00826)	(0.00437)		(0.00805)	(0.00431)	
$Exporting_t$	0.14034***	0.14386***	0.14881***	0.12123***	0.12702***	0.12138***	0.14015***	0.14370***	0.14866***	0.01861***	0.02051***	0.01946***	0.02499***	0.02640***	0.02750***	0.0279***	0.0293***	0.0305***
	(0.00238)	(0.00233)	(0.00098)	(0.00933)	(0.00945)	(0.00930)	(0.00898)	(0.00889)	(0.00794)	(0.00170)	(0.00130)	(0.00174)	(0.00122)	(0.00121)	(0.00130)	(0.00127)	(0.00126)	(0.00135)
$Markets_t$	0.03405***	0.00932***	0.02571***	0.06285***	0.01542***	0.05904***	0.02874***	0.00449	0.02073***	0.04337***	0.04547***	0.03807***	0.04231***	0.02394***	0.05214***	0.0410***	0.0236***	0.0507***
	(0.00367)	(0.00088)	(0.00157)	(0.00783)	(0.00159)	(0.00728)	(0.00629)	(0.00279)	(0.00405)	(0.00599)	(0.00115)	(0.00571)	(0.00433)	(0.00132)	(0.00275)	(0.00421)	(0.00128)	(0.00270)
Import growth	0.00524***	0.00315***		0.00332*	0.00317*		0.00508***	0.00346*		0.00582	0.00769***		0.00507	0.00592***		0.00666*	0.00556***	
	(0.00137)	(0.00109)		(0.00161)	(0.00165)		(0.00149)	(0.00172)		(0.00550)	(0.00237)		(0.00409)	(0.00176)		(0.00374)	(0.00172)	
Soviet bloc	-0.02116***	-0.00494**					-0.02707***	-0.00463*					-0.02598***	-0.00416		-0.0241***	-0.00401	
	(0.00626)	(0.00230)					(0.00716)	(0.00208)					(0.00709)	(0.00388)		(0.00694)	(0.00375)	
EU mebership	-0.00035	0.00624***		-0.00557*	-0.00131		-0.00028	0.00677**		-0.00879**	-0.00470*		-0.00325	-0.00145		-0.00236	-0.000693	
	(0.00290)	(0.00202)		(0.00280)	(0.00269)		(0.00246)	(0.00249)		(0.00385)	(0.00283)		(0.00330)	(0.00259)		(0.00314)	(0.00247)	
FTA	-0.01860***	0.01527***		-0.00868**	0.00941***		-0.01728***	0.01582***		-0.00917**	0.00377		-0.00886***	0.00721***		-0.00925***	0.00754***	
	(0.00355)	(0.00230)		(0.00280)	(0.00228)		(0.00219)	(0.00123)		(0.00414)	(0.00338)		(0.00335)	(0.00241)		(0.00333)	(0.00231)	
Languages	0.03199***	0.02348***					0.03255***	0.02354***					0.03384***	0.03311***		0.0336***	0.0329***	
	(0.00380)	(0.00252)					(0.00756)	(0.00561)					(0.00499)	(0.00415)		(0.00492)	(0.00400)	
Migrants	0.03777***	0.03815***					0.03763***	0.03789***					0.04106***	0.04524***		0.0403***	0.0442***	
	(0.00377)	(0.00375)					(0.00357)	(0.00371)					(0.00453)	(0.00477)		(0.00447)	(0.00469)	
Distance f-o-f	-0.02243***		-0.01637***	-0.04498***		-0.04220***	-0.02275***		-0.01622***	0.00322		0.00809	-0.01652***		-0.02780***	-0.0158***		-0.0270***
	(0.00365)		(0.00132)	(0.00728)		(0.00710)	(0.00623)		(0.00362)	(0.00604)		(0.00602)	(0.00440)		(0.00257)	(0.00429)		(0.00252)
Imp.growth f-o-f	-0.00687**		0.00396	-0.00087		0.00607	-0.00670*		0.00339	0.00391		0.01838***	0.00252		0.01577***	-0.00346		0.0133***
	(0.00323)		(0.00335)	(0.00410)		(0.00398)	(0.00357)		(0.00413)	(0.01482)		(0.00622)	(0.01149)		(0.00527)	(0.0105)		(0.00515)
Sov. Bloc f-o-f	0.02750**		0.03820***	0.03819		0.03633	0.04029**		0.03987***	0.04853***		0.04401***	0.04153***		0.06169***	0.0381***		0.0605***
	(0.01176)		(0.00307)	(0.02135)		(0.02035)	(0.01707)		(0.00767)	(0.01501)		(0.01509)	(0.01247)		(0.00647)	(0.0122)		(0.00632)
EU f-o-f	0.01474**		0.00886***	0.00749		-0.00312	0.01522		0.00946	0.02377***		0.00720	0.00440		-0.00118	0.00374		-0.000345
	(0.00631)		(0.00287)	(0.00755)		(0.00597)	(0.00941)		(0.00579)	(0.00889)		(0.00639)	(0.00602)		(0.00502)	(0.00587)		(0.00491)
FTA f-o-f	0.05871***		0.03531***	0.04828***		0.04007***	0.05677***		0.03522***	0.02686***		0.02057***	0.03428***		0.02959***	0.0359***		0.0301***
	(0.00569)		(0.00273)	(0.00586)		(0.00418)	(0.00344)		(0.00257)	(0.00757)		(0.00626)	(0.00581)		(0.00445)	(0.00571)		(0.00427)
Language f-o-f	-0.00808**		0.02804***	0.05883***		0.06527***	-0.00872		0.02789***	0.02519*		0.03673***	0.00256		0.04793***	0.00214		0.0467***
	(0.00386)		(0.00204)	(0.01036)		(0.01058)	(0.00555)		(0.00485)	(0.01312)		(0.01319)	(0.00620)		(0.00497)	(0.00604)		(0.00480)
Migrants f-o-f	0.00868**		0.02006***	0.00333		0.00520	0.00778		0.01876***	0.02218*		0.02722**	0.03753***		0.05979***	0.0341***		0.0556***
	(0.00375)		(0.00312)	(0.00793)		(0.00819)	(0.00574)		(0.00490)	(0.01295)		(0.01298)	(0.00664)		(0.00713)	(0.00645)		(0.00698)
Constant	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no	no	no	no	no	no
Ind.effects (dest, prod)	random	random	random	fixed	fixed	fixed				fixed	fixed	fixed	random	random	random	random	random	random
Ind.effects (prod, year)							fixed	fixed	fixed									-
Sector controls	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	yes	no	yes
R-squared	66.42	66.16	65.71	68.12	67.79	68.11	66.48	66.22	65.77	-	-	-	-	-	-	-	-	-
Observations	38,456	38,456	38,456	38,456	38,456	38,456	38,456	38,456	38,456	18,506	18,506	18,506	38,456	38,456	38,456	38,456	38,454	38,456

* Robust standard errors (clustered by product) in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All the variables were normalized. For the OLS models regressions' coefficients and for the Probit and Logit models marginal effects are presented.

3.9.2. Results for eleven most important export partners of Lithuania

We also estimated the same regression containing the data for only ten major Lithuania's export partners. We assume that the major export partners are the countries in which the largest number of products were exported (by calculating the number of the exported products according to the HS 6-digits classification throughout all the years). These countries are (sorted in the descending order): Latvia, Russia, Estonia, Belarus, Germany, Poland, Ukraine, Denmark, Sweden and the UK. All the regressions were estimated by using the same models as the main regressions.

As the signs of the results (see Table 3.9) are similar to the ones containing all the countries, we can conclude that our results are robust. The differences in the numbers could be associated with the non-linearity of the distribution function, and the results are distributed mostly in the tail.

Table 3.9. Results of the regressions taking ten most important export partners of Lithuania

Variables	OLS random effects			OLS fixed effects			OLS fixed effects			LOGIT fixed effects			LOGIT random effects			PROBIT random effects		
(normalised)	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.	General reg.	Direct reg.	Indirect reg.
Dependent variable	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$
GDP	0.11858***	0.07501***	0.00546***	0.17030***	0.16119***	0.17132***	0.19034***	0.14987***	-0.00026	0.13966***	0.18440***	0.14478***	0.14070***	0.12967***	0.00682***	0.143***	0.131***	0.00799***
	(0.00301)	(0.00318)	(0.00130)	(0.00467)	(0.00487)	(0.00469)	(0.00478)	(0.00424)	(0.00147)	(0.00247)	(0.00198)	(0.00226)	(0.00396)	(0.00414)	(0.00215)	(0.00388)	(0.00406)	(0.00213)
Distance (origin)	-0.05243***	-0.06084***					-0.09423***	-0.09252***					-0.08854***	-0.10820***		-0.0871***	-0.108***	
	(0.00238)	(0.00206)					(0.00266)	(0.00247)					(0.00308)	(0.00321)		(0.00302)	(0.00313)	
$Exporting_t$	0.10589***	0.11572***	0.11810***	0.09846***	0.10420***	0.09858***	0.10133***	0.10579***	0.11503***	0.01952***	0.02848***	0.02003***	0.04544***	0.04763***	0.05025***	0.0476***	0.0500***	0.0521***
	(0.00062)	(0.00081)	(0.00068)	(0.00080)	(0.00077)	(0.00080)	(0.00080)	(0.00077)	(0.00070)	(0.00050)	(0.00041)	(0.00051)	(0.00051)	(0.00046)	(0.00054)	(0.000513)	(0.000475)	(0.000550)
$Markets_t$	0.17580***	0.08657***	0.14771***	0.08305***	0.02434***	0.08017***	0.07652***	0.01928***	0.03166***	0.09521***	0.09886***	0.09237***	0.20604***	0.14708***	0.20887***	0.204***	0.140***	0.204***
	(0.00190)	(0.00241)	(0.00219)	(0.00274)	(0.00189)	(0.00272)	(0.00284)	(0.00195)	(0.00259)	(0.00214)	(0.00234)	(0.00211)	(0.00258)	(0.00182)	(0.00269)	(0.00254)	(0.00190)	(0.00265)
Import growth	0.00840***	0.01281***		0.00336**	0.00804***		0.01201***	0.01779***		-0.00033	0.00858***		0.00571***	0.01234***		0.00578***	0.0120***	
	(0.00128)	(0.00081)		(0.00134)	(0.00079)		(0.00178)	(0.00131)		(0.00087)	(0.00077)		(0.00134)	(0.00086)		(0.00131)	(0.000846)	
Soviet bloc	-0.00310	-0.02280***					0.00611**	-0.00879***					-0.03112***	-0.03757***		-0.0271***	-0.0363***	
	(0.00234)	(0.00141)					(0.00253)	(0.00161)					(0.00284)	(0.00239)		(0.00280)	(0.00235)	
EU mebership	-0.01059***	-0.00015		-0.00450***	0.00569***		0.00473***	0.01621***		-0.00402***	0.00070		-0.01139***	-0.00310***		-0.0113***	-0.00283***	
	(0.00066)	(0.00069)		(0.00079)	(0.00077)		(0.00102)	(0.00101)		(0.00048)	(0.00054)		(0.00080)	(0.00071)		(0.000777)	(0.000689)	
FTA	0.02663***	0.02778***		0.00808***	0.00953***		0.01405***	0.02252***		0.01058***	0.02193***		0.02906***	0.03577***		0.0285***	0.0349***	
	(0.00124)	(0.00116)		(0.00142)	(0.00125)		(0.00135)	(0.00125)		(0.00096)	(0.00123)		(0.00157)	(0.00151)		(0.00153)	(0.00147)	
Languages	0.11471***	0.11149***					0.13512***	0.14063***					0.16574***	0.17156***		0.165***	0.170***	
	(0.00176)	(0.00201)					(0.00243)	(0.00221)					(0.00226)	(0.00216)		(0.00220)	(0.00210)	
Migrants	-0.00124	0.00859***					-0.03144***	-0.02572***					0.01201***	0.00931***		0.00960***	0.00738**	
	(0.00201)	(0.00198)					(0.00282)	(0.00251)					(0.00276)	(0.00294)		(0.00272)	(0.00293)	
Distance f-o-f	-0.18652***		-0.11146***	-0.10166***		-0.10030***	-0.09357***		-0.00387	-0.06555***		-0.06332***	-0.15091***		-0.09171***	-0.161***		-0.104***
	(0.00356)		(0.00588)	(0.00480)		(0.00483)	(0.00477)		(0.00416)	(0.00321)		(0.00321)	(0.00630)		(0.00705)	(0.00633)		(0.00723)
Imp.growth f-o-f	0.00919***		0.01568***	0.01099***		0.01460***	0.00860***		0.01902***	0.01405***		0.01289***	0.01349***		0.01755***	0.0128***		0.0169***
	(0.00237)		(0.00155)	(0.00248)		(0.00150)	(0.00256)		(0.00196)	(0.00145)		(0.00095)	(0.00226)		(0.00153)	(0.00222)		(0.00150)
Sov. Bloc f-o-f	-0.00335**		0.02154***	0.01321***		0.01308***	0.00738***		0.03050***	0.00093		0.00117	0.00469***		0.03546***	0.00183		0.0344***
	(0.00132)		(0.00096)	(0.00163)		(0.00161)	(0.00164)		(0.00107)	(0.00088)		(0.00087)	(0.00132)		(0.00106)	(0.00132)		(0.00106)
EU f-o-f	0.00857***		0.00753***	0.01117***		0.00945***	0.01336***		0.00543***	0.00662***		0.00580***	0.01065***		0.01383***	0.0104***		0.0133***
	(0.00091)		(0.00068)	(0.00107)		(0.00075)	(0.00109)		(0.00082)	(0.00068)		(0.00053)	(0.00098)		(0.00080)	(0.000970)		(0.000775)
FTA f-o-f	-0.00679***		-0.01716***	0.00361**		0.00570***	-0.00063		-0.00926***	0.00755***		0.01090***	0.00544***		0.00670***	0.00468***		0.00605***
	(0.00130)		(0.00132)	(0.00146)		(0.00139)	(0.00147)		(0.00136)	(0.00089)		(0.00086)	(0.00136)		(0.00140)	(0.00133)		(0.00137)
Language f-o-f	0.04513***		0.04195***	0.03220***		0.03192***	0.04478***		0.04645***	0.00662***		0.00585***	0.02867***		0.01591***	0.0295***		0.0153***
	(0.00142)		(0.00122)	(0.00188)		(0.00185)	(0.00177)		(0.00131)	(0.00094)		(0.00094)	(0.00137)		(0.00126)	(0.00137)		(0.00125)
Migrants f-o-f	0.00618***		0.02256***	0.00940***		0.00875***	-0.00811***		0.00182	0.00520***		0.00426***	0.00133		0.01932***	0.00115		0.0188***
	(0.00126)		(0.00116)	(0.00154)		(0.00154)	(0.00142)		(0.00123)	(0.00101)		(0.00103)	(0.00149)		(0.00152)	(0.00145)		(0.00146)
Constant	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no	no	no	no	no	no
Ind.effects (dest, prod)	random	random	random	fixed	fixed	fixed				fixed	fixed	fixed	random	random	random	random	random	random
Ind.effects (prod, year)							fixed	fixed	fixed									-
Sector controls	yes	yes	yes	no	no	no	no	no	no	no	no	no	no	no	no	yes	yes	yes
R-squared	44.91	43.51	43.00	46.79	45.86	46.78	46.56	45.60	44.55	-	-	-	-	-	-	-	-	-
Observations	398,810	398,810	398,810	398,810	398,810	398,810	398,810	398,810	398,810	318,269	318,269	318,269	398,810	398,810	398,810	398,810	398,810	398,810

* Robust standard errors (clustered by product) in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All the variables were normalized. For the OLS models regressions' coefficients and for the Probit and Logit models marginal effects are presented.

3.10. Concluding remarks

Motivated by the theories that a country's competitiveness and its growth perspectives depend on the country's export structure, in this Section of the thesis, we investigate the factors influencing the country's export structure which, in turn, influences the country's competitiveness. As a country's export network usually takes a long time to form, and as it spreads gradually, we employed the theories of gravity modelling and network economics to empirically examine the importance of the network effects for the development of an extensive trade margin of Lithuania. Choosing to examine the development of Lithuania's export network enabled us to analyse the spread of the country's export network almost from the very beginning of its creation process.

We confirm the results of Morales et al. (2019) and Albornoz et al. (2012) who claimed that the network variables are important for the spread of a country's export network. The growth of the extensive trade margin depends not only on the usual gravity model variables (e.g. the economic standing and growth of the destination countries and the trade costs between the origin and the destination markets). The development of the country's export network also depends on the extensive network effects between the current export partners of the country of origin (the intermediate markets) and their own export partners (e.g. the distance and the ability to communicate between the intermediate markets and their own export partners, the economic standing and growth of the export partners of the intermediate markets). Our results confirm the previous findings that migration has long-term positive effects for the extensive margin of international trade, and that the importance of the common spoken languages increases steadily.

Our analysis shows that the factor which influences the spread of the extensive trade margin the most is the current trade relations of the country of origin (the wider is a country's export network, the faster it grows). Other important factors are the previous exporting to the same market, the better economic standing of the destination market, the ability to communicate between the export partners, the stock of emigrants, and the distance (the latter factor yields a negative effect). We prove that both the direct and indirect migration and both the direct and indirect ability to communicate significantly increase the chance to start exporting to a new destination market.

We find that, as the market develops, the importance of economic factors grows, and the importance of the direct belonging to various economic and trade unions tends to become less significant. The importance of knowing

more languages and being able to communicate directly with the trade partners is also increasingly important. Moreover, we find strong evidence of an increase of clustering of trading partners.

These findings imply that Lithuania's competitiveness was shaped by a number of factors: some of them could not be influenced, whereas other ones were created by Lithuania itself, and the third section of factors seemed like an unequivocally negative phenomenon, however, it still had positive influence on Lithuania's export network, and, hence, its competitiveness. First, Lithuania's competitiveness was positively affected by its geographical position. By virtue of being situated in the centre of Europe, it is located at a small distance to all of the following: highly developed Western European countries (e.g. Germany and Sweden), former satellites of the Soviet Union (e.g. Poland) and former members of the USSR (e.g. Latvia, Belarus and Russia); Lithuania had excellent opportunities to create new trade relations with the West, while, at the same time, maintaining and further developing its old trade links to the East. Second, Lithuania is a small country, and it does not have the advantage of a big internal market. However, being small may have given Lithuania more incentives to join the EU, to enter into free trade agreements and to learn foreign languages. Third, relatively high rates of emigration, which are often considered a failure of Lithuania, created a relatively large stock of Lithuanian emigrants across a wide range of countries. Those emigrants wishing to keep their ties to Lithuania and to consume Lithuanian products helped to boost the number of Lithuania's export markets and positively affected the country's competitiveness.

CONCLUSIONS AND PROPOSALS

The final Section of the thesis summarises the main conclusions of the research, presents suggestions, limitations and directions for the future research. Conclusions and directions for the future research are presented separately for each Section of the thesis.

Conclusions on the concept of a country's competitiveness and its assessment

- Having reviewed the literature on the concept and measures of a country's competitiveness, we find that a country is usually considered competitive if it ensures a high income, a stable and resilient GDP growth, effective trade in the world markets, and if it has a prospective export structure, i.e. if it engages in the manufacturing and exporting of high technology products. The key factor here is export which demonstrates how successfully countries are able to manufacture and to sell their products to other countries, i.e. to compete in the world market.
- Our results show that the Global Competitiveness Index does not correspond to its definition, and does not reveal the potential future economic growth of the countries. No relationship between the countries' GDP growth rates and the countries' Global Competitiveness Index values for any period was detected.
- The findings suggest that, in the group of high-income countries, there is a small negative relationship between the countries' GCI values and the standard deviation of their GDP growth. We conclude that higher GCI values may indicate that those high-income economies will be growing steadier and will be experiencing gentler fluctuations than the economies with the lower GCI scores.
- Following the recent developments of Rodrik (2006), Hidalgo et al. (2007), Hidalgo & Hausmann (2009), Schetter (2020) and Balland et al. (2022), we choose export as the main proxy for a country's competitiveness. Export is the key factor determining the competitiveness of a country because it indicates not only what kind of products a country is able to produce and how it is successful in selling them to other countries. The latter shows the country's true ability to compete in the global market and is closely related to the primary understanding of competitiveness as 'competition'. A country's ability to produce more sophisticated products reveals that the country possesses the corresponding capabilities (i.e. skills and technologies) and, hence, it

has better perspectives to develop, produce and export other, even more sophisticated products.

Conclusions on Lithuania's export competitiveness and the effects of Covid-19 pandemic

- Analysis on the pandemic-related changes of Lithuania's export structure revealed that Lithuania's export was resilient to the global crises. The export of the majority of the product groups was not affected by the pandemic. Lithuania's export structure by export partners also remained the same. The research did not imply any negative changes of the competitiveness of Lithuania in terms of the export structure.
- Most of the changes in Lithuania's export structure by product groups are directly linked to the restrictions of the pandemic. These are: travelling bans (e.g. decreased export of vehicles, aircraft and railway products, and mineral fuels), closure of restaurants and transition to the distant working mode (e.g. diverse effects on the export of different food items, decreased export of clothing and footwear), and the increased need for various leisure activities (e.g. increased export of tobacco, beverages, ships or boats, musical instruments and electronics).
- The pandemic had no significant effects on Lithuania's export structure by export partners.
- Our analysis revealed that the influence of the distance or any other factors determining the value of exports did not change during the first year of the pandemic.
- In more detail, the results of this part of the research are summarised below:
  - The static analysis suggests even positive effects of the first year of the pandemic on Lithuania's export structure:
    - Positive effects of the pandemic for Lithuania's export of tobacco, beverages, furniture, electronics, articles of wood, food, fuels, vehicles and medical and pharmaceutical products were revealed.
    - Aircraft and railway products, meat and preparations of cereals, flour, starch and milk were the products which experienced the greatest pandemic-related decreases in Lithuania's export structure in 2020.
    - The findings suggest that the products of higher complexity were more likely to be exported more during the first year of the pandemic.

        - During the first year of the pandemic, Lithuania strengthened its export relations with other highly developed countries and Lithuania's largest export partners.
    - The dynamic analysis of the effects of the first year of the pandemic on Lithuania's export structure does not imply any negative pandemic-related changes of the competitiveness of Lithuania in terms of its export structure:
        - The effects of the pandemic on Lithuania's goods export were moderate and mostly foreseeable. The export of leisure goods (such as tobacco, ships or boats and musical instruments) and household products (such as food and chemical products) increased, while the export of clothing, footwear, vehicles, mineral fuels and various articles of stone, plastic, cement, copper, nickel and lead dropped.
        - The year of the pandemic had a negligible effect on Lithuania's goods export to a very limited number of countries. Almost all of them had negligible shares in Lithuania's export structure.

Conclusions on the development of Lithuania's export network

- In line with the conclusions of Morales et al. (2019) and Albornoz et al. (2012), the conducted research has shown that network variables were important for the development of Lithuania's extensive trade margin. The spread of Lithuania's export markets depended not only on the direct effects (between Lithuania and other countries), but also on the indirect factors (between the current Lithuania's trade partners (the intermediate markets) and their own export destinations).
- The most important factor for the spread of the export network of Lithuania was the number of the current export markets (the wider is a country's export network, the faster it grows). Other important factors which significantly increased the chances of exporting to a destination market were: exporting to this destination in the previous periods, a shorter distance, the ability to communicate with the destination market (either directly or through the intermediate markets), and the stock of migrants in the destination market (either directly from Lithuania, or indirectly from Lithuania's intermediate markets).
- The results show that Lithuania was more tempted to start exporting to economically stronger countries. Moreover, economic factors not only demonstrated to be more and more important as the years passed, but they could be one of the main reasons to redirect Lithuania's export from the

former USSR countries to Western Europe in the early stages of the trade creation.

- The indirect distance (which is the sum of distances between the current export destinations of an origin and the analysed country) proved to be more important than the direct distance (which is the distance between the origin and the analysed country) for the probability that the origin country exports to the analysed country.
- Lithuania's membership in various trade organisations (i.e. the EU, the free trade agreements) appeared to be losing significance as the years passed. Most probably, this factor is important only at the moment of change. It helped to increase the number of Lithuania's export markets at the time of becoming a member of such organisations, however, it lost importance and became an accepted norm afterwards. Still, if Lithuania decided to leave any trade agreement, most probably, such a decision would negatively affect its export network.
- Migration had long-term positive effects for the extensive margin of Lithuania's international trade. This finding confirms that Lithuania's emigrants do not lose connections with Lithuania, and that having a part of the population living abroad positively affects the spread of the export network and the overall competitiveness of Lithuania.
- We found a steady increase of the importance of the common spoken languages on the development of Lithuania's extensive export margin. This result proves that the ability to communicate with the export market is a very important factor for export success.
- The research provided strong evidence on an increase of clustering of the trading partners. This fact confirms the finding that the indirect search procedure was indeed important for the creation of Lithuania's export network.
- The research revealed that Lithuania's export network developed in a couple of stages. At first, when Lithuania had few connections with the non-Soviet bloc countries and its residents were hardly able to communicate with the non-Russian speaking world, the spread of the extensive export margin was mainly affected by the indirect membership in various organisations. Later, when Lithuania's export network developed, Lithuania joined the EU and the FTA, and English became widespread in the country, and the main export driver became the GDP of the destination.
- Lithuania's competitiveness was positively affected by three main export determinants. First, Lithuania's geographic position, which is close to the

other developed countries and is in the crossroads between Eastern and Western Europe. Second, incentives to learn foreign languages, to join the EU and to enter into free trade agreements with other countries. Third, a relatively large stock of Lithuanian emigrants in other countries.

Proposals

- The finding that a number of products having higher complexity were exported more during the first pandemic year implies that these goods are the most important for Lithuania's export competitiveness. Therefore, Lithuania's policy makers should try to strengthen the sectors producing complex and high technology products.
- In the light of the findings that the most important drivers of the export creation were the existing number of the export markets, previous exporting to the same destination, a closer distance, the ability to communicate and the stock of emigrants, it is recommended that the relevant legislative basis is formed and designed to:
  - Maintain close relations with the emigrants.
  - Strengthen the teaching of foreign languages and broaden their choice.
  - Support companies searching for the new export markets and business partners from other countries.

Directions for future research and limitations

Our findings suggest the following possible further extensions of the research.

From Section 1:

- We analysed whether the Global Competitiveness Index corresponds to its definition and compared three measures of competitiveness. It might be of interest to investigate other measures of a country's competitiveness, and to examine what they really indicate and if they could be compared to each other.

From Section 2:

- We analysed only Lithuania's export structure. A wider coverage of the countries of origin with the available relevant data would allow to estimate a full gravity model and generalise the findings for a greater number of countries.

- Any crisis usually has not only short-term, but also long-term effects. The impact of Covid-19 pandemic might appear not at once, but with a time lag. Hence, similar analysis in a couple of years after the pandemic is over may provide deeper insight and more robust results.
- The availability of monthly data and the inclusion of variables showing the severity of Covid-19 would allow researchers to apply different research methods and to analyse the impact of the pandemic in the new light.

From Section 3:

- For the sake of computational feasibility, we examined only one exporting country (Lithuania). Including more trading pairs and undertaking symmetric analysis would allow more general results and conclusions.
- We analysed only the extensive trade margin. Examining the intensive trade margin would produce a new angle for the topic and possibly lead to other interesting results.
- It might be interesting to model the possible diversification of the export products (e.g. if a country exports apples, perhaps it would be easier for it to start exporting pears as well, but not cars).
- It might be useful to include the possible intermediaries (i.e. the countries from which the export spreads to the other markets) to the analysis.

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APPENDICES

APPENDIX TO SECTION 1

Figure 4.1. Relationship between GCI and GCI 4.0 scores and GDP growth rates for high-income countries.

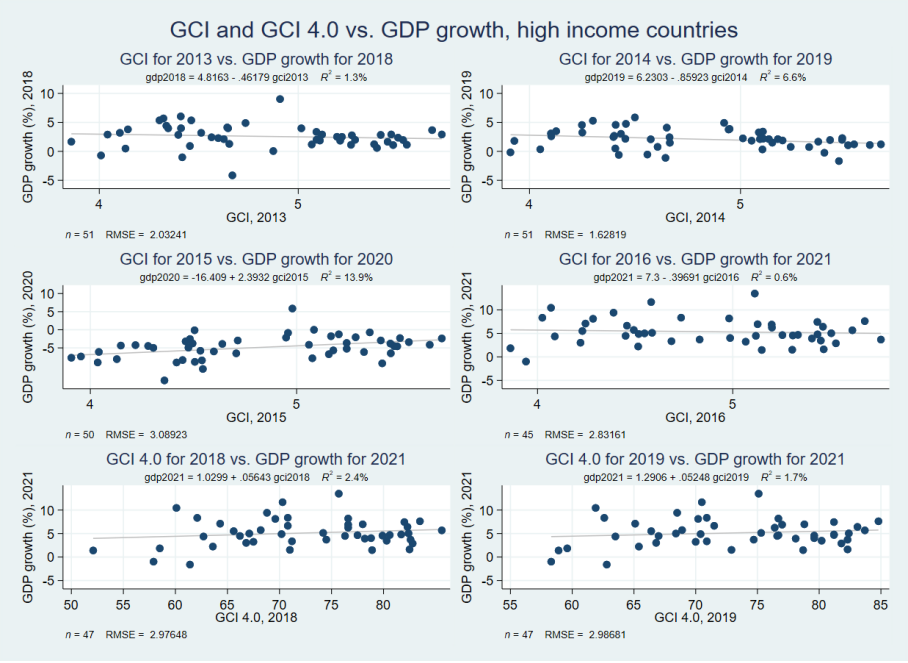


Table 4.1. Normality of non-dummy variables

Variable	Skew.	Kurt.	lnVariable	Skew.	Kurt.
Export	20.78	633.75	lnExport	-0.36	2.87
GDP_{dest}	6.06	43.4	$lnGDP_{dest}$	-0.08	2.72
GDP_{LT}	0.50	1.81	$lnGDP_{LT}$	-0.45	1.79
Distance	0.83	2.95	lnDistance	-0.41	2.31

Table 4.2. Correlation coefficients between the regressor and the residuals in static and dynamic OLS and PPML models

OLS	Corr.	PPML	Corr.
Static	0.6757	Static	0.1013
Dynamic	0.4546	Dynamic	0.0456

Table 4.3. Results of the benchmark model regressions including sector controls

Variables, normalised	OLS				PROBIT marginal effects		LOGIT marginal effects			
Dependent variable	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$	$Exporting_{t+1}$
GDP (log mill)	0.05088***	0.01307***	0.03303***	0.01333***	0.0674***	0.03661***	0.28308***	0.22314***	0.06925***	0.03860***
	(0.00101)	(0.00029)	(0.00083)	(0.00031)	(0.00106)	(0.0004)	(0.00008)	(0.00065)	(0.00023)	(0.00019)
Distance (origin)	-0.07534***	-0.03097***	-0.08087***	-0.03091***	-0.0509***	-0.03973***	-	-	-0.05150***	-0.04157***
	(0.00078)	(0.00029)	(0.00081)	(0.00029)	(0.000460)	(0.00023)	-	-	(0.00020)	(0.00015)
Exporting, t		0.15208***		0.15204***		0.01189***		0.02825***		0.01014***
		(0.00054)		(0.00053)		(0.0001)		(0.00022)		(0.00005)
Markets, t		0.01804***		0.00836***		0.01969***		0.07539***		0.02024***
		(0.00017)		(0.00050)		(0.00023)		(0.00085)		(0.00009)
Constant	yes	yes	yes	yes	yes	yes	no	no	no	yes
Ind. effects (dest, prod)	random	random	fixed	fixed	random	random	fixed	fixed	random	random
Sector controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	15.75	51.33	19.58	51.39	-	-	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	7,338,104	1,406,741	1,406,741	7,338,104	7,338,104
Number of ID	386,216	386,216	386,216	386,216	386,212	386,213	-	-	-	-

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented. Individual effects are by the destination and the product, standard errors are clustered by product.

Table 4.4. General regression results excluding distance from the origin

Variables, normalised	**OLS**		**LOGIT**		**PROBIT**	
Dependent variable	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**
GDP	0.00896***	0.00958***	0.19080***	0.02786***	0.0257***	0.0291***
	(0.00026)	(0.00029)	(0.00091)	(0.00020)	(0.000357)	(0.00030)
Exporting$_t$	0.13357***	0.13338***	0.02330***	0.00890***	0.0105***	0.00789***
	(0.00061)	(0.00061)	(0.00022)	(0.00005)	(8.87e-05)	(0.00004)
Markets$_t$	0.06555***	0.05635***	0.09890***	0.03390***	0.0339***	0.0165***
	(0.00050)	(0.00068)	(0.00120)	(0.00018)	(0.000323)	(0.00013)
Import growth	0.00076***	0.00068***	0.00518***	0.00180***	0.00174***	0.00109***
	(0.00005)	(0.00004)	(0.00053)	(0.00010)	(0.000116)	(0.00008)
Soviet bloc	-0.00957***	-0.01062***		-0.00061***	-0.00124***	-0.00006
	(0.00033)	(0.00035)		(0.00021)	(0.000245)	(0.00013)
EU mebership	0.00108***	0.00141***	-0.00452***	-0.00153***	-0.00117***	0.00085***
	(0.00035)	(0.00036)	(0.00034)	(0.00009)	(0.000123)	(0.00007)
FTA	-0.00254***	-0.00221***	-0.00003	0.00143***	0.00102***	-0.00024**
	(0.00020)	(0.00021)	(0.00056)	(0.00013)	(0.000158)	(0.0001)
Languages	0.03559***	0.03638***		0.02096***	0.0205***	0.00194***
	(0.00050)	(0.00051)		(0.00016)	(0.000186)	(0.00009)
Migrants	0.01404***	0.01384***		0.00991***	0.00956***	0.00149***
	(0.00023)	(0.00023)		(0.00016)	(0.000173)	(0.00008)
Distance f-o-f	-0.04961***	-0.04962***	-0.04771***	-0.01885***	-0.0196***	-0.00370***
	(0.00050)	(0.00052)	(0.00119)	(0.00020)	(0.000276)	(0.00010)
Imp.growth f-o-f	0.00015***	0.00015***	0.00595***	0.00123***	0.00115***	0.00059***
	(0.00002)	(0.00002)	(0.00088)	(0.00016)	(0.000152)	(0.00012)
Sov. Bloc f-o-f	0.00642***	0.00788***	0.01031***	0.00392***	0.00395***	0.00131***
	(0.00031)	(0.00034)	(0.00073)	(0.00016)	(0.000211)	(0.00010)
EU f-o-f	0.00863***	0.00852***	0.00583***	0.00177***	0.00194***	0.00162***
	(0.00038)	(0.00038)	(0.00048)	(0.00011)	(0.000139)	(0.00010)
FTA f-o-f	-0.00249***	-0.00239***	0.01654***	0.00446***	0.00393***	0.00237***
	(0.00024)	(0.00024)	(0.00064)	(0.00015)	(0.000187)	(0.00012)
Language f-o-f	-0.00854***	-0.00936***	0.00031	0.00048***	0.000345*	0.00093***
	(0.00035)	(0.00035)	(0.00073)	(0.00014)	(0.000184)	(0.00009)
Migrants f-o-f	0.00065***	-0.00042***	0.01353***	0.00623***	0.00545***	0.00366***
	(0.00013)	(0.00015)	(0.00068)	(0.00014)	(0.000202)	(0.00009)
Constant	yes	yes	no	yes	no	no
Ind. effects (dest, prod)	random		fixed	random	random	corr.random
Ind. effects (prod, year)		fixed				
Sector controls	yes	no	no	no	yes	yes
R-squared	53.32	53.39	-	-	-	-
Observations	7,338,104	7,338,104	1,406,741	7,338,104	7,338,104	7,338,103

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented.

Figure 4.2. Comparison of the general regression results excluding distance from the origin

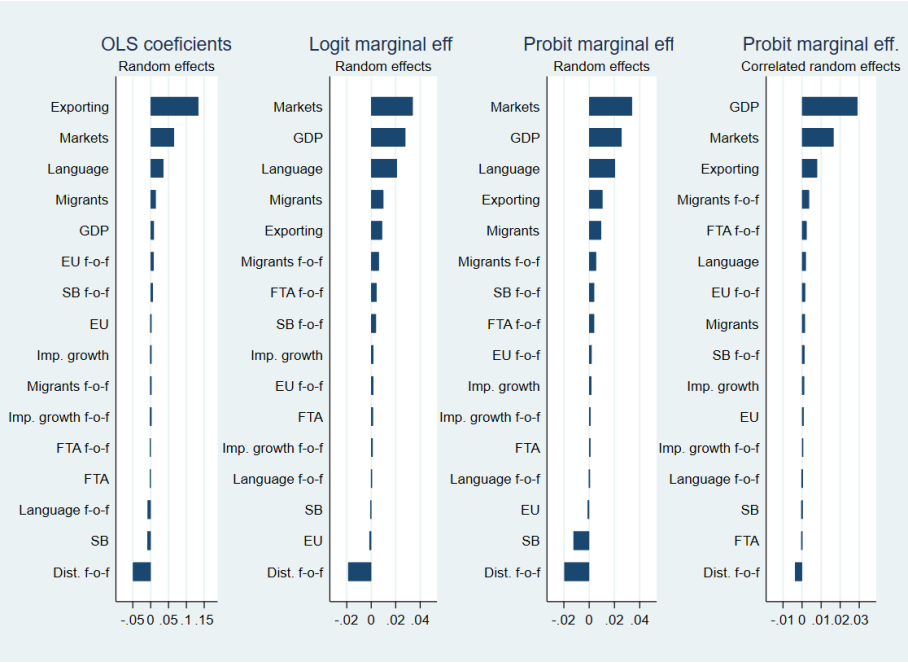


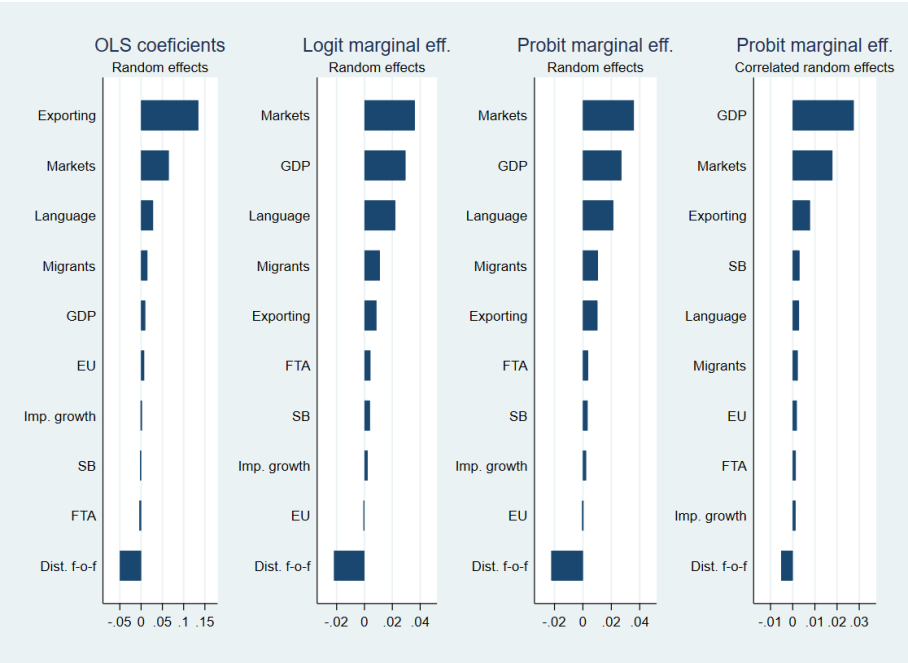
Table 4.5. Direct regression results including indirect distance instead of distance from the origin

Variables (normalised)	**OLS**			**LOGIT**		**PROBIT**	
Dependent variable	**Exporting$_{t+1}$**	**Exporting$_{t+2}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**	**Exporting$_{t+1}$**
GDP	0.00958***	0.00903***	0.00982***	0.20117***	0.02941***	0.0271***	0.0275***
	(0.00008)	(0.00032)	(0.00026)	(0.00093)	(0.00020)	(0.000186)	(0.000293)
Distance (origin)							
Exporting$_t$	0.13449***	0.11591***	0.13445***	0.02467***	0.00854***	0.0102***	0.00776***
	(0.00008)	(0.00077)	(0.00058)	(0.00023)	(0.00005)	(0.000056)	(0.000035)
Markets$_t$	0.06491***	0.08618***	0.05519***	0.11551***	0.03613***	0.0359***	0.0179***
	(0.00015)	(0.00080)	(0.00066)	(0.00129)	(0.00018)	(0.000175)	(0.000121)
Import growth	0.00080***	0.00086***	0.00078***	0.00832***	0.00233***	0.00224***	0.00130***
	(0.00006)	(0.00005)	(0.00004)	(0.00042)	(0.00008)	(0.000082)	(0.000068)
Soviet bloc	-0.00252***		-0.00233***		0.00389***	0.00330***	0.00303***
	(0.00008)		(0.00018)		(0.00014)	(0.000127)	(0.000082)
EU mebership	0.00720***	0.00610***	0.00747***	-0.00123***	-0.00069***	-0.000195***	0.00182***
	(0.00008)	(0.00028)	(0.00024)	(0.00028)	(0.00007)	(0.000066)	(0.000053)
FTA	-0.00408***	0.00013	-0.00369***	0.00899***	0.00424***	0.00368***	0.00139***
	(0.00008)	(0.00012)	(0.00015)	(0.00054)	(0.00010)	(0.000097)	(0.000088)
Languages	0.02812***		0.02811***		0.02210***	0.0214***	0.00286***
	(0.00008)		(0.00025)		(0.00014)	(0.000132)	(0.000064)
Migrants	0.01475***		0.01447***		0.01102***	0.0106***	0.00223***
	(0.00010)		(0.00022)		(0.00016)	(0.000151)	(0.000077)
Distance f-o-f	-0.04985***	-0.07890***	-0.04943***	-0.06159***	-0.02184***	-0.0222***	-0.00521***
	(0.00015)	(0.00091)	(0.00050)	(0.00126)	(0.00020)	(0.000193)	(0.000099)
Constant	yes	yes	yes	no	no	no	no
Individual effects (destination, product)	random	fixed		fixed	random	random	corr.random
Individual effects (product, year)			fixed				
Sector controls	yes	no	no	no	no	yes	yes
R-squared	53.26	55.389	53.32	-	-	-	-
Observations	7,338,104	7,338,104	7,338,104	1,406,741	7,338,104	7,338,104	7,338,104

* Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

** All the variables in the regressions were normalized. For the OLS models regressions coefficients are given and for the Probit and Logit models marginal effects are presented. Standard errors are clustered by product.

Figure 4.3. Comparison of the direct regression results excluding distance from the origin



PRESENTATIONS AT CONFERENCES

1. Petrylė V., Does Global Competitiveness Index Show Countries' Resilience to Economic Crises?, 2ndEuRun-BIS SYMPOSIUM *Responses of Eastern & Western Economies to the Global Financial Crisis*, Vilnius University, Vilnius, Lithuania, 3–4 November, 2016.

2. Petrylė V., Building A New Export Network: The Case of Lithuania, The Winter Meeting of the Annual Lithuanian Conference on Economic Research, Vilnius University and the Bank of Lithuania in association with Baltic Economic Association, 28 December, 2020.

3. Petrylė V., The Impact of the Pandemic Year on Export: Lithuanian Gravity, 12th International Scientific Conference *Business and Management 2022*, Vilnius Tech, Vilnius, Lithuania, 12–13 May, 2022.

LIST OF PUBLICATIONS

1. Petrylė V. (2016). Does Global Competitiveness Index Demonstrate the Resilience of Countries to Economic Crises? *Ekonomika*, 95(3), 28 – 36, https://doi.org/10.15388/Ekon.2016.3.10326.

2. Petrylė V. (2022). The Impact of the Pandemic Year on Export: Lithuanian Gravity. *Proceeding to the 12th International Scientific Conference "Business and Management 2022"*, Vilnius Gediminas Technical University, 96-102, https://doi.org/10.3846/bm.2022.754.

3. Petrylė V. (2022). COVID-19 Pandemic and Export: Evidence from Lithuania. *Organizations and Markets in Emerging Economies*, 13(1), 139–162, https://doi.org/10.15388/omee.2022.13.74.

NOTES

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