Universidade de Aveiro Departamento de Economia, Gestão, Engenharia Industrial e Turismo
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MAKSYM ZHALOMSKYI

ANÁLISE DOS FLUXOS BILATERAIS DE COMÉRCIO DE BENS ENTRE A UCRÂNIA E A UNIÃO EUROPEIA: APLICAÇÃO DO MODELO GRAVITACIONAL

ANALYSING UKRAINE'S BILATERAL TRADE FLOWS IN GOODS WITH THE EUROPEAN UNION: A GRAVITY MODEL APPROACH

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Economia, realizada sob a orientação científica da Professor Doutor João Paulo Cerdeira Bento, Professor Auxiliar do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro e da Doutora Jonė Kalendienė, Professora da Faculty of Economics and Management de Vytautas Magnus University, Kaunas.

Aos meus pais Oleksandr Zhalomskyi e Olena Brzhostovska. À minha primeira universidade na Ucrânia, a Universidade Tecnológica Estadual de Jitomir, que me deu o conhecimento principal em economia. À Universidade de Vytautas Magnus, que me deixou frequentar o curso de Mestrado e depois estudar na Universidade de Aveiro. À Universidade de Aveiro e todos os professores pela possibilidade de obter o “Dual Degree”. Uma gratidão especial aos Professores João Paulo Cerdeira Bento da Universidade de Aveiro e Jonė Kalendienė da Universidade de Vytautas Magnus.

o júri

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Palavras chave

Modelo gravidade, modelo de gravidade aumentada, estimador de pseudo-máxima verossimilhança de Poisson, dados em painel, Ucrânia, União Europeia, UE-28, comércio exterior, comércio total, exportações, importações

Resumo

Estudamos os principais determinantes dos fluxos de comércio internacional de mercadorias entre a Ucrânia e os países membros da UE-28 no período 1995-2017. Estimamos o modelo de gravidade aumentada do comércio internacional com robustos Quadrados Mínimos Ordinários (QMO) e Poisson (PPML), e o PPML com efeitos fixos também estima as elasticidades do comércio para as funções de comércio total, exportações e importações. Os resultados da regressão são utilizados para recomendar os decisores políticos comerciais sobre a implementação do Acordo de Comércio Livre da Associação com a Ucrânia. As principais conclusões revelam que o rendimento da Ucrânia, o rendimento dos parceiros comerciais da UE-28, distância, mas também as diferenças de rendimento entre a Ucrânia e os seus parceiros comerciais (hipótese de Linder) e a taxa de câmbio real são determinantes importantes do comércio internacional. Estes resultados são robustos para diferentes funções de especificação comercial do modelo de gravidade aumentada do comércio internacional.

Keywords Gravity model, Augmented gravity model, Poisson pseudo-maximum likelihood estimator, panel data, Ukraine, European Union, EU-28, foreign trade, total trade, exports, imports

Abstract We study the main determinants of international trade flows in goods between Ukraine and the EU-28 member states in the period 1995-2017. We estimate the augmented gravity model of international trade with robust Ordinary Least Squares (OLS) and Poisson (PPML), and PPML with fixed effects too estimate trade elasticities for total trade, exports and imports functions. The regression results are used to recommend trade policy makers on the implementation of the EU Association Free-Trade Agreement with Ukraine. The main findings reveal that, the income of Ukraine, the income of the EU-28 trading partners, distance but also income differences between Ukraine and its trading partners (Linder hypothesis), and the real exchange rate are important determinants of international trade. These results are robust to different trade specification functions of the augmented gravity model of international trade.

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1. INTRODUCTION

1.1 Background

Ukraine and Europe have been tied by economic, political and social relations throughout centuries. Beginning from the times of "Kyiv Rus", the states and people, existing on the terrains of modern Ukraine, directly or indirectly had influential impacts on the states to the west, and conversely, some impacts from the Western countries had an influence on local states and people. This concerned economy, particularly trade relations. Unfortunately, when Ukraine was as part of Russian empire and, afterwards made part of the USSR, the role of Ukraine had been diminishing throughout all the time being a dependent state. After restoring the independence in 1991 Ukraine became an important player and economic partner in Eastern Europe and the main transitional centre between Asia and Europe. Since 1991 relations between Ukraine and the EU have been getting closer and more important for each other. In 2014 some tragic events took place, The Russian Federation annexed Crimea peninsula and keeps the unstable and dangerous situation in separate districts of Donetsk and Luhansk regions. This affected the international trade policy of Ukraine. Yet, there were also positive moments. Signing "Ukraine-European Union Association Agreement" in 2014 which finally became effective in 2017 may be considered one of the important factors, which impacts the EU-Ukraine trade. Due to these circumstances, Ukraine reconfigures its international trade, orientating more to the markets of the European Union. In this case, trade turnover between EU and Ukraine is going to increase significantly in the nearest future.

1.2 Research problem

Recognition of factors and evaluation of factors that influence trade in goods between the Ukraine and the European Union. There are not many research papers on this topic, hence this dissertation contributes to the understanding of this trade issue. For that reason, this work is supposed to be an additional instrument to help to study trade relations in terms of both the

determinants of exports and imports in goods between the EU and countries of Association Agreement, and Ukraine, in particular.

The research objectives can be summarized as follows:

i) Modelling and analysing trade relations between Ukraine and the EU-28 member states;

ii) Performing a cross-country analysis on the main determinants of international trade flows in goods between Ukraine and EU-28 member states;

iii) Applying the gravity model of trade to get a deeper understanding and importance of the main determinants of trade between Ukraine and the EU-28 member states by applying the gravity model for international trade for total trade and its decomposition into exports and imports;

iv) Estimating trade elasticities for total trade, exports and imports functions;

v) Using the regression results to recommend trade policy makers on the implementation of the EU Association Free-Trade Agreement with Ukraine.

1.3 Research questions

We use the most employed and the most influential model for estimating international trade flows, its determinants which influence the trade, namely the Gravity Model of International Trade. The reason for the name is the analogy to Newton's law of gravity: just as the gravitational attraction between any two objects is proportional to the product of their masses and diminishes with distance, the trade between any two countries is, other things equal, proportional to the product of their incomes and diminishes with geographical distance.

Using the gravity model of international trade in international economics, we ask the following research question(s):

i) What are the main determinants of international trade flows in goods between the Ukraine and EU-28?

ii) Which determinants such as income, geographical distance, real exchange rate, trade barriers in the form of trade tariffs, common border, cultural ties or landlocked have to be taken into account in trade relations between Ukraine and the EU?
iii) How is Linder's hypothesis functioning in modern trade relations between Ukraine and the EU?
iv) How to promote trade in manufactured goods between Ukraine and the EU partner countries? By gradually eliminating trade barriers in the form of tariffs?

1.4 Relevance of the study

The given problem of trade relations between the EU and Ukraine has directed my interest to study this topic, which is of interest nowadays. While there are many scientific papers dedicated to international trade between various countries, and even regions, however, there is almost no study about the trade relations between EU and Ukraine, which would provide an understanding about the process of trade and factors which may influence this trade. Diving deeper into this topic will allow to have a look at the evolving processes to the East of European Union.

The actuality of this work is to get a better understanding how trade relations between Ukraine and European Union were evolving throughout the time, what factors occurred and which of them had significant impact on the relations between these two economic subjects. And how and to what extent these factors had a role in forming such kinds of relations, international trade structure and so on. This work can be interesting and/or important for those, who are interested in the international trade process between European Union and members of Association Agreement, the specifications of their economic and trade partnership, and the perspectives of future cooperation.

As it was mentioned before, there is an enormous amount of scientific papers which study Gravity model of trade and calculate "revealed comparative advantage" indices. However, the majority of them are about developed countries. And, working papers which study trade relations especially between Ukraine and the EU are scarce. In this case, we contribute to bring new insights on the pattern of trade between EU and Ukraine, and, also, help those, who would be interested to continue the research in this field.

1.5 Structure of the dissertation

In part one of this dissertation, we have discussed important aspects of this study such as research background, research problem, research questions, including the relevance and main motivations of the study.

Next, in part two, we briefly review important aspects of trade theory: from classic to modern trade theories. A great attention will be paid to the Gravity Model of International Trade as it is the main empirical model which will be used in this dissertation to analyses trade relations between Ukraine and the EU 28 member states. In this regard, we present a brief and recent literature review of empirical studies that have analysed bilateral trade between Ukraine and the EU.

What specifications of empirical trade models, data, and estimation methods are used in researching the determinants of international trade, specifically in trade of goods, between Ukraine and the EU-28 member states are presented in part three of this dissertation.

2. EMPIRICAL RESEARCH

2.1 Introduction

In chapter 2 we will present the main trade theory and its origins and evolution throughout the time for a better theoretical understanding of trade relations between trade partners.

Also, in this chapter we present a review of empirical literature on the foreign trade with particular emphasis on the gravity model of trade. This chapter consists of both theoretical and empirical review and provides an overview of findings in the international trade literature.

Moreover, chapter 2 also empirically estimates different augmented gravity models of international trade between Ukraine and its European trade partners. We specify the augmented gravity model of foreign trade with total trade, exports and imports as our dependent variables, and estimate those models to test the main determinants of international trade between the Ukraine and EU-28.

And, in the end of this chapter, we present the regression results and a discussion of those results will be provided.

2.2 Trade theory and the gravity model of international trade

In this section we briefly overview important aspects of the trade theory and the gravity model of international trade.

Absolute and comparative advantage: In the subsection we will take a look on how the theories about international trade was evolving during the history, starting from the incipience of international relations and trade, since the ideas of capitalistic ideas of economy started existing.

During centuries, since modern economic studies and economic order were emerging, scientists were evolving various theories about foreign and international trade, which, probably, were applicable to that or another period of time, however, may be no longer applicable nowadays. The first theory and principle of economic policy was mercantilism ("Eli Heckscher and His Mercantilism Today," 2006). In 1776 Scottish economist and political philosopher

published his famous work “An inquiry into the Nature of the Wealth of Nations”, which is known to be fundamental work in classical economics. Also, he developed absolute advantage theory, where the nation which has an absolute advantage in producing a certain type of product should trade with this product with other nations (Schumacher, 2012). Another English economist, David Ricardo (who also was an opponent to Adam Smith), evolved the latter theory into comparative advantage theory, where he stated that just absolute advantage is not enough for a country and that two countries can trade even if they have no absolute advantage (Ruffin, 2002). In the middle of the XX century Swedish economists Eli Heckscher and Bertil Ohlin evolved a theorem on factor endowment, which was named after them Heckscher-Ohlin theory, which claims: “A country exports those commodities produced with relatively large quantities of the country's relatively abundant factor” (Jones, 1956). The latest theory on international trade, which is being in use, is Competitive advantage, developed by American economist Michael Porter. Shortly, competitive advantages are conditions that allow a company or a country to produce a good or service of equal value at a lower price or in a more desirable fashion. These conditions allow the productive entity to generate more sales or superior margins compared to its market rivals. Competitive advantages are attributed to a variety of factors, including cost structure, branding, the equality of product offerings, the distribution networks, intellectual property and customer service (Mahmood, 1998).

The first theory of international trade - theory of **mercantilism** was developed by European scientists, such as Thomas Mun, Charles Davenant, Jean Baptiste Colbert, Sir William Petty. Mercantilism is an economic study and policy, which represents interests of trade bourgeoisie in times of feudalism and the incipience of capitalism.

According to the theory of mercantilism the wealth of the country is in owning gold and silver. Mercantilists assumed that the wealth of the country consists in its possession of gold and silver, and for achieving this goal the countries must: export goods than they import; regulate external trade for increasing export and decreasing import; forbid or limit the export of raw materials and allow non tariffed import of raw materials; forbid any trade of own colonies with other countries (“Eli Heckscher and His Mercantilism Today,” 2006).

To conclude, it is necessary to mention, that proponents of the classical school showed direct relation of international trade with domestic economic development of the country. Neo

Mercantilists explain the desire of some countries to have active trade balance as their social or political target. The part of terminology from mercantilism times preserved until modern days, and often used in wrong way by their nature: passive trade balance (unfavourable) is not necessarily lossmakin; active trade balance (favourable) may be disadvantageous.

The founder of classical school of economic studies was Adam Smith, who criticized the statement of mercantilists that the wealth of the country depends on the ownership of treasures as gold or precious metals which income to the country as a result of the excess of export over import.

Instead he claimed that the base of the wealth of nations is international division of labour and respective specialization of different countries on production of goods where they have absolute advantages.

The idea of absolute advantage theory is that the nation's export goods they produce with the least costs (i.e., in production they have **absolute advantage**) and import the goods which are produced by other nations with lower costs (i.e., in production the absolute advantage belongs to their trade partners).

According to views of A. Smith, governments should not interfere in foreign trade: they must maintain regime of open markets and trade liberty. Nations as well as individuals must specialize on production of the goods where they have advantages and trade them in exchange of the other goods, where other nations have advantages in production. Foreign trade stimulate productivity by expanding market out of national boundaries. Export is a positive factor for economy because it provides the sale of excessive goods which cannot be sold in domestic market. Subsidies on export is a tax for populations and leads to increasing of domestic prices and that's why they must be cancelled (Ruffin, 2002; Schumacher, 2012).

Pros of the absolute advantage theory is that it is based on labour theory of value and confirms advantages of labour division not only at national but at international level.

Cons of this theory for explaining international trade is that it doesn't answer the question "why countries trade between each other even in the condition of the absence of absolute advantage in production of all goods.

David Ricardo developed absolute advantage theory of A. Smith proving that absolute advantages are only a partial case from general rule. He showed that trade is profitable for each of two countries even if they have no absolute advantage in producing of both goods.

The concept of comparative advantages means that if countries specialize in production of those products which they can produce with relatively less costs comparing with other countries (or, in other words, with less alternative costs) then the trade will be mutually advantageous for both nations regardless of that if the production in one is more efficient than in another.

Comparative advantage theory for the first time described the balance of aggregate demand and aggregate supply. Though it was foreseen that value of the good is determined by the amount of labour necessary for production, comparative advantages theory showed that this value, indeed, is determined by relation of aggregate demand and supply for the good in domestic and foreign markets. Then it proved the existence of gains from specialization and trade for all members but not only for one country due to the loss of others (Ruffin, 2002). Also, it allows to perform external economic activity on scientific background.

Cons of comparative advantages result from assumptions on which it is based. That's why during the usage of comparative advantage theory for analysis of foreign economic relations it is necessary to take into account that the theory: (a) it does not count costs for transportation; (b) it ignores the influence of foreign trade on income distribution inside the country, price and wage fluctuations, inflation and international capital movement; (c) it comes from existing of one mean of production; (d) it ignores existing such important preconditions of international trade, as excellences in factor endowments; (e) it comes from precondition of full employment, that is workers of one industry can find the job in other and more productive industry at the moment. In other words, an assumption is made about fixed costs and, thereby, the law of increasing costs is neglected; and (f) it does not allow to explain the trade between approximately the same countries by economic growth, none of them has no advantage over the other one.

Heckscher-Ohlin model: In the middle of the XX century Swedish economists-neoclassics Eli Heckscher and Bertil Ohlin designed factor endowments theory, which later got its name Heckscher-Ohlin theory.

The content of the theory lies in the following: Goods that require significant costs (surplus means of production) and low costs (deficit factors) for their production are exported in exchange for goods produced using inverse supply factors. So in hidden form surplus factors are exported and deficit factors of productions are imported.

Or in other way: countries export goods of intensive consumption of surplus factors and import goods of intensive consumption of deficit for them factors.

Country is considered to be in surplus of labour if the ratio between its quantity and other factors is higher than the rest of the world (Jones, 1956; Ruffin, 2002; Schumacher, 2012).

The essence of **theory of country size**: countries with bigger territory usually have more various climate conditions and natural resources and that's why they are closer to economic independence, rather than small sized countries. The theory consists of four main constituents. Firstly, big countries comparing with small ones export less share of produced output and import less share of goods. Secondly, big countries, despite of small countries, have more various resources. Thirdly, bigger countries have higher transportation costs in international trade. And the last constituent is the bigger countries usually can perform large-scale production (Crucini, 1997).

In 1948 American economist Paul Samuelson proved factor price equalization theory which was named Heckscher-Ohlin-Samuelson – international trade leads to equalization of absolute and relative prices for homogeneous factors of production in trading countries.

Homogeneous capital is capital, which has the same productivity and riskiness; homogeneous labour is labour with equal level of training, education and productivity; homogeneous land is land with same fertility, soil condition etc. From the above it is possible to make conclusions from the theory. According to the Heckscher-Ohlin theory countries tend to export goods, production of which requires relatively rare factors. Also, according to the Heckscher-Ohlin-Samuelson theory in international trade in appropriate conditions there is a tendency to equalization of factor prices. Meanwhile goods export can be replaced by movement of means of production. And, under the factor price is understood the award, which gets the owner of the factor its usage. For labour it is wage, for capital it is interest, for land it is rent.

Leontief paradox – factor endowment of Heckscher-Ohlin is not confirmed on practice: labour-intensive countries export capital-intensive production while capital-intensive countries export labour-intensive production.

Leontief paradox does not answer numerous questions but many other tests including qualification of labour and other factors, covering large groups of countries, confirmed the appropriateness of Heckscher-Ohlin theory.

Given paradox warns against straightforward use of Heckscher-Ohlin theory in practice of international trade. Besides, Heckscher-Ohlin theory together with added lately specifications remains one of the main tool for analysis of international trade and its influence on income distribution and redistribution. International product life-cycle theory claims that many new products firstly will be produced in countries where these products were studied and designed. It is almost always industrials countries, moreover, lately the significant proportion falls on the USA, though Japan and Germany could outdrive the USA, being specialized in certain types of product. During product's life-cycle which consists of four stages (introduction, growth, maturity and decline), production steers to more capital intensity and moves to other countries. Theory does not apply on some product types and almost all outputs of transnational corporations. International product life-cycle theory only claims that when and if scientific researches and developments stop being decisive factor of comparative advantage, production will shift to countries which have comparative advantage at other elements of costs, for example, unqualified labour (Leamer, 1980).

Linder's theory of overlapping demands implies that significant share of international trade volume nowadays falls on good trade between industrial countries because they have similar segments of market. It also explains international trade not from point of good supply but from perspective of their demand. Trade between two countries will be performed with the goods with approximately similar quality. And the more people in trading countries have same incomes, the higher level of trade is between trading countries (Södersten, Burenstam-Linder, & Sodersten, 1961).

New trade theory (Krugman, 1979), suggests that a critical factor in determining international patterns of trade are very substantial economies of scale and network effects that can occur in key industries.

These economies of scale and network effects can be so significant that they outweigh the more traditional theory of comparative advantage. In some industries, two countries may have no discernible differences in opportunity cost at a particular point in time. But if one country specialises in a particular industry then it may gain economies of scale and other network benefits from its specialisation.

Another element of new trade theory is that firms which have the advantage of being an early entrant can become a dominant firm in the market. This is because the first firms gain substantial economies of scale meaning that new firms can't compete against the incumbent firms. This means that in these global industries with very large economies of scale, there is likely to be limited competition, with the market dominated by early firms which entered, leading to a form of monopolistic competition.

Monopolistic competition is an important element of New Trade Theory. It suggests that firms are often competing on branding, quality and not just simple price. It explains why countries can both export and import designer clothes (Krugman, 1979).

This means that the most lucrative industries are often dominated in capital-intensive countries, which were first to develop these industries. Therefore, being the first firm to reach industrial maturity gives a very strong competitive advantage (some may say unfair advantage).

New trade theory also becomes a factor in explaining the growth of globalisation.

It means (Krugman, 1979) that poorer, developing economies may struggle to ever develop certain industries because they lag too far behind the economies of scale enjoyed in the developed world. This is not due to any intrinsic comparative advantage but more the economies of scale the developed firms already have .

Paul Krugman was a leading academic in developing New Trade Theory. He was awarded a Nobel Prize (2008) in economics for his contributions in modelling these ideas. *"For his analysis of trade patterns and location of economic activity"*.

One examples of New Trade Theory is specialisation of IT in Silicon Valley - the US. Hewlett and Packard started their computer business. Success attracted more IT firms to that area. Not because of any particular intrinsic benefit but new firms start to get the network

benefits of being around other IT setups. Another example is that globalisation has led to increased variety for consumers. The proliferation of brand clothing labels. Firms competing in the model of monopolistic competition and heavy branding. Neither UK or Italy has a particular comparative advantage in producing clothes but consumers are attracted to brand image of Italian and British fashion labels.

New Trade Theory and Government regulation. New trade theory suggests that governments might have a role to play in promoting new industries and supporting the growth of key industries. Some point of the Japanese car industry in the 1950s which received substantial government support. Other south-eastern Asian economies also had some government protection and support.

A developing economy may need tariff protection and domestic subsidy to encourage the creation of capital-intensive industries. If the industry gets support for a few years, it will be able to exploit economies of scale and then be competitive without government support. This is similar to earlier arguments surrounding infant industries.

Problems of government intervention arise. This idea of government supporting new industries is controversial. Many economists say that it is likely to create other problems such, as the government is likely to have poor information about which industry to support and how to go about it and, secondly, it creates a tendency for powerful business interests which rely on state support. This state support may encourage inefficiency in the long-term.

New trade theory and gravity model. Gravity model suggests that trade is influenced by countries geographical proximity and similarities in terms of culture and economic development. It suggests neighbouring countries are more likely to trade with each other. Gravity theory is an element of "New trade theory" as it emphasis factors which influence trade - other than traditional "comparative advantage".

Krugman (1990) brings increasing returns together with capital and labour migration and transport costs into one model. Krugman's (1990) model has become a workhorse of economic geography and international trade. When everything becomes "endogenous" small initial differences can make for big effects. To minimize transport costs, for example, firms want to locate near consumers but consumers want to locate near work. Thus, there are multiple equilibria and at a tipping point the location decisions of a single firm or consumer can snowball

into big effects. So Krugman has been a leader in introducing tipping points, network effects and thus the importance of history into international trade as well as into economics more generally.

In conclusion, new trade theory is not primarily about advocating government intervention in industry; it is more a recognition that economies of scale are a key factor in influencing the development of trade. It also suggests that free trade and laissez-faire government intervention may be much less desirable for developing economies who find themselves unable to compete with established multi-nationals.

Competitive advantage theory. According to this theory the answer to the question "Why country achieves success in that or another area?" lies in four features of the country which are of the general nature and form environment where local firms compete between each other. This environment can stimulate creating of competitive advantage on one hand or, on the other hand, can intervene it (Porter 1998).

The main postulates of given theory are: the four main parameters (determinants) of competitive advantage of the country are the following factors and conditions: demand conditions, related and servicing industries, firm strategy and competition; competitive advantage theory shows interaction of four determinants, united in national "rhombus", where country's competitiveness on global markets depends on; support of competitiveness in the industry at high level is the result of "self-reinforcing" interaction of advantages in several spheres at the same time which determines environment which is hard to replicate for foreign competitors (Mahmood, 1998).

We distinguished the Gravity model into a separate subsection because it is the main instrument, which will be used in the following estimations on international trade between the European Union and Ukraine. By the way, we must clarify that the only a group of the EU-28 will be taken instead of analysing the whole list of European Union countries. However, it will be discussed later.

The gravity model of international trade is a model that predicts bilateral trade flows based on the economic sizes (mainly using GDP measurements) and distances between two units. The Gravity model of international trade is quite similar in the definition and design of the Newton's law of universal gravitation which states that every particle attracts every other particle in the universe with a force which is directly proportional to the product of their masses and

inversely proportional to the square of the distance between their centres (Krugman, Obstfeld, & Melitz, 2015).

Three of the top 15 U.S. trading partners are European nations: Germany, the United Kingdom and France. Why does the United States trade more heavily with these three European countries than with others? The answer is that these are the three largest European economies. That is, they have the highest values of gross domestic product (GDP), which measures the total value of all goods produced in an economy. There is a strong empirical relationship between the size of a country's economy and the volume of both its imports and its exports.

Looking at world trade as a whole, economists have found that an equation of the following form predicts the volume of trade between any two countries fairly accurately,

$$T_{ij} = A * Yi * Y_j / D_{ij} \qquad (2.1)$$

Where A is a constant term, T_{ij} is the value of trade between country *i* and country *j*, Y_i is country *i*'s GDP, Y_j is country *j*'s GDP, and D_{ij} is the distance between the two countries. That is, the value of trade between any two countries is proportional, other things equal, to the product of the two countries' GDPs and diminishes with the distance between the two countries.

An equation such as (2.1) is known as a **gravity model** of world trade. The reason for the name is the analogy to Newton's law of gravity: Just as the gravitational attraction between any two objects is proportional to the product of their masses and diminishes with distance, the trade between any two countries is, other things equal, proportional to the product of their GDPs and diminishes with distance (Krugman et al., 2015).

Economists often estimate a somewhat more general gravity model of the following form:

$$T_{ij} = A * Y_i^a * Y_j^b / D_{ij}^c \qquad (2.2)$$

This equation says that the three things that determine the volume of trade between two countries are the size of the two countries' GDPs and the distance between the countries, without specifically assuming that trade is proportional to the product of the two GDPs and inversely

proportional to distance. Instead, *a*,*b*, and *c* are chosen to fit the actual data as closely as possible. If *a*, *b*, and *c* were all equal to 1, Equation (2.2) would be the same as Equation (2.1). In fact, estimates often find that (2.1) is a pretty good approximation.

Following Krugman (2015), large economies tend to spend large amounts on imports because they have large economies. Also they tend to attract large shares of other countries' spending because they produce a wide range of products. So, other things equal, the trade between any two economies is larger — the larger is either economy.

In fact, among the top 15 biggest trade partners, the United States trade with Canada and Mexico much more than with European partners. One main reason of this is the simple fact that Canada and Mexico are much closer. All estimated gravity models show a strong negative effect of distance on international trade; typical estimates say that a 1 percent increase in the distance between two countries is associated with a fall of 0.7 to 1 percent in the trade between those countries. This drop partly reflects increased costs of transporting goods. Economists also believe that less tangible factors play a crucial role: Trade tends to be intense when countries have close personal contact and this contact tends to diminish when distances are large. For example, it's easy for the U.S. sales representative to pay a quick visit to Toronto but it's a much bigger project for that representative to go to Paris. Unless the company is based on the West Coast, it's an even bigger project to visit Tokyo.

In addition to being U.S. neighbours, Canada and Mexico are part of a trade agreement with the United States, the North American Free Trade Agreement, or NAFTA, which ensures that most goods shipped among three countries are not subject to tariffs or other barriers to international trade. If a trade agreement is effective, it should lead to significantly more trade among its partners than one would otherwise predict given their GDPs and distances from one another.

It's important to note, however, that although trade agreements often end all formal barriers to trade between countries, they rarely make national borders irrelevant. Even when most goods shipped across a national border pay no tariffs and face few legal restrictions, there is much more trade between regions of the same country than between equivalently situated regions in different countries. The Canadian-U.S. border is a case in point. The two countries are part of a free trade agreement (indeed, there was a Canadian-U.S. free trade agreement even before NAFTA); most Canadians speak English; and the citizens of either country are free to

cross the border with a minimum of formalities. Yet data on the trade of individual Canadian provinces both with each other and with U.S. states show that, other things equal, there is much more trade between provinces than between provinces and U.S.

Apart from the said above, it is important to highlight that gravity model of foreign trade has become a basic, ad hoc tool for estimating bilateral trade relations between economic subjects at macro level. The model has been used by economists to analyse the determinants of bilateral trade flows such as common borders, common languages, common legal systems, common currencies, common colonial legacies, and it has been used to test the effectiveness of trade agreements and organizations such as the NAFTA - North American Free Trade Agreement and the WTO - World Trade Organization (Head & Mayer, 2014).

The model has also been applied to other bilateral flow data (also 'dyadic' data) such as migration, traffic, remittances and foreign direct investment (Head & Mayer, 2014).

The same data like, common colonial legacies, common borders and other variables will be used in given work, but we will talk about it later.

2.3 Empirical literature review and research hypothesis

Analysing empirical part of literature, studying the given subject we point attention at the specifications of indicators on the country level (at macro level), as this research mainly is focused on foreign trade on macro level and the main tool for estimation trade is the Gravity model. Due to my topic about the international trade between European Union and Ukraine considering it is reasonable to investigate macroeconomic parameters.

For structural comprehension and visualisation of the scientific papers, analysed during literature review, the following table is provided, shortly describing the research papers.

There are empirical studies that use the gravity model of international trade to analyse trade relations between the European Union and Ukraine at the country level (Moroz et al., 2017)**;** (Melnyk, Kalyuzhna, & Pugachevska, 2018) where the main trade variables were imports and exports between countries of Visegrad group and Ukraine. In other case, foreign trade of Ukraine with the EU with the similar indicators was reviewed with adding foreign direct investments indicator and analysing the trade structure itself.

Another example assessments with gravity trade model, however, not touching Ukraine-EU relations is (Burger, van Oort, & Linders, 2009), who studied specifications of the gravity model: zeros, excess zeros and zero-inflated estimations. According to Burger (2009), the Poisson and modified Poisson (negative bi-nominal, zero-inflated) modelling techniques applied may provide a viable alternative to the lognormal specification of the gravity trade model.

On the other hand, Yatsenko (2017) in her research of the realization of the potential of the Ukraine-EU free trade area reviewed the balance of trade (and related to it indicators) of Ukraine during 2006-2015, specifically in agriculture sector. And the dynamics of foreign trade in agricultural and industrial goods with the EU countries in 2006-2015 had a clear trend to increase during the whole period. Also, EU's share in Ukrainian export of goods from 2010 was increasing year by year (Yatsenko, Nitsenko, Karasova, James, & Parcell, 2017). Besides, other authors studied this problem in the similar field (Qineti, Rajcaniova, & Matejkova, 2009).

Another field of studies, low-tech and high-tech firms in Europe exclusively (in Spain, to be precise) was developed in case of intellectual capital and managerial innovations coming at the conclusion that the IC-innovation linkage differs depending on the type of innovation studies and the technology level of the innovating organization (Buenechea-Elberdin, Kianto, & Sáenz, 2018). Also, (Trott & Simms, 2017) pay their attention at low- and medium-technology industries, particularly, packaged food sector in the United Kingdom.

The development of the world economy is accompanied by a rapid growth not only in international trade volumes in general, but especially in high-tech exports characterized by a great value-added share. The analysis of high-tech export changes and trends in the world in 2004-2015 revealed, on the one hand, a stable consolidation of China's position in this market, which became a leader in 2006, the stable positions of the US, EU and Japan. In the current conditions, the leading countries in the market of high-tech export accumulated a considerable and diverse experience of regulation and support of high-tech export. In order to strengthen the positions of Ukrainian high-tech companies in the world markets, it is feasible to implement a system of immediate action in two areas: macroeconomic and sectoral

However, it is necessary to recall that none of the previous authors reviewed the trade between the EU and Ukraine in context of division of industry on low- and high-tech sectors and studying this problem from this perspective.

In recent studies (Petrov, Van der Loo, & Van Elsuwege, 2015) reviewed and took into account an integration instrument such as for accelerating international trade between the EU and Ukraine Association Agreement, as a tool which helps both parties to get more involved in trade performance apart from being a member of the European Union. They state that Ukraine-European Union Association Agreement "creates a single legal framework opposed to the Swiss model of sectoral biletarism and it is not sector-specific such as the multilateral EnC Treaty or the ECAA. Rather, the EU-Ukraine AA incorporates certain bits and pieces derived from other agreements and policies. Accordingly, it forms a new type of integration without membership, with all legal complexities this entails".

The further researches about gravity model found that a common language, common currency, common border, colonial ties, an open trade policy and remoteness are positively linked to trade, while higher tariffs, greater surface area, and being landlocked are negatively related to trade. Furthermore, with membership in five of the twelve regional trading arrangements leading to greater trade within the trade bloc. However, issues such as causality, coefficient size, and potential multicollinearity prevent from completely answering the question of what determines bilateral trade (Head & Mayer, 2014; Yamarik & Ghosh, 2005).

Other research using the gravity model has also sought to evaluate the impact of various variables in addition to the basic gravity equation. Among these, price level and exchange rate variables have been shown to have a relationship in the gravity model that accounts for a significant amount of the variance not explained by the basic gravity equation. According to empirical results on price level, the effect of price level varies according to the relationship being examined. For instance, if exports are being examined, a relatively high price level on the part of the importer would be expected to increase trade with that country. A nonlinear system of equations are used by Anderson and van Wincoop (2003) to account for the endogenous change in these terms from trade liberalization (Anderson & van Wincoop, 2003).

Leitão (2010) argues and puts forth results supporting that bilateral trade has a positive effect on the share of tourism demand. The lagged tourism demand presents an expected positive sign. Other explanatory variables such as geographical distance and relative price are statistically significant. The results prove the dynamic nature of tourism demand and suggests that a dynamic approach is needed to order to better understand the demand for tourism determinants (Leitão, 2010).

Sarantis (1999) rejected the linearity hypothesis for the real effective exchange rate in eight industrial countries (the G-8). These exchange rates are classified as logistic STAR models in three ERM countries, and as exponential STAR models in the other countries. The exchange rate process is strongly asymmetric in Belgium and Italy, and close to asymmetry in Canada and France. In general, the evidence on the dynamic properties and the transition parameter is in line with the observation of large swings in real exchange rates and the extremely low convergence to long-run PPP reported by long-horizon data studies (Sarantis, 1999).

Expanded export opportunities can have a positive effect on firm performance. The evidence is consistent with falling trading partners' tariffs increasing revenues for exporters and making adoption of new technologies profitable for more firms. The finding that falling trading partners' tariffs induce firms to take actions can increase their productivity suggests that the cross-sectional differences between exporters and non exporters are not completely explained by selection of the most productive firms into the export market but are partly induced by participation in export markets. Therefore, trade policies oriented to facilitate access to foreign markets, like multilateral liberalizations, can have a positive effect on firm-level performance (Bustos, 2011).

According to Awokuse (2008), empirical evidence from selected Latin American countries provides empirical support for both export-led growth (ELG) and import-led growth (ILG) hypothesis. The study shows that the strength of the effect of imports on growth is relatively stronger than the effect of exports. Thus, it is reasonable to conclude that for several Latin American countries both exports and imports play a very important role in stimulating economic growth (Awokuse, 2008). The number of labour force, openness to trade and economic freedom are other key to determination of FDI. In other words, the results suggest that it is not only the direct growth experience per se that matters for foreign investors, but also domestic endowments, trade restrictions and friendly investment climate. Due to the dynamic relationships between FDI and economic growth, these elements will influence FDI into the country and potentially stimulate economic growth through FDI inflows. Hence, the government must generate and maintain the availability of labour force, good macroeconomic environment and diminish trade barriers (Awokuse, 2008; Iamsiraroj, 2016).

While reviewing scientific literature and looking for suitable theoretical framework, it is necessary to look at the Linder hypothesis again. The Linder hypothesis is an economic

hypothesis that posits countries with similar per capita income will consume similar quality products and that this should lead to them trading with each other. The Linder hypothesis suggests countries will specialize in the production of certain high quality goods, and will trade these goods with countries that demand these goods (Södersten et al., 1961). Choi (2002) revisited the Linder hypothesis, confirming the significance of the given hypothesis. It was found that countries with a smaller difference of per capita GNP tend to trade more. It was also found that richer countries trade more (Choi, 2002).

According to what has been presented before, we posit the following research hypothesis:

Hypothesis 1: Higher levels of income in Ukraine lead to more trade between Ukraine and the EU-28 member states.

Hypothesis 2: Higher levels of income in the EU-28 trading partners lead to more trade between the Ukraine and the EU-28 member states.

Hypothesis 3: According to the Linder hypothesis the more similar the demand structures of trading countries, the more they will trade with one another.

Hypothesis 4: Countries tend to trade more if they are geographically closer to each other.

Hypothesis 5: The real effective exchange rate towards US dollar has a positive or negative impact on bilateral trade between Ukraine and the EU-28 countries.

Hypothesis 6: Countries with higher tariffs for manufactured goods tend to trade less.

Hypothesis 7: Common border promotes international trade between Ukraine and the EU-28 countries.

Hypothesis 8: Former colony ties (Post-Soviet ties) promote international trade between Ukraine and the EU-28 countries.

Hypothesis 9: Landlocked countries are expected to have higher transportation costs so it will negatively impact on foreign trade.

Table 1: Overview of empirical studies on analysing trade relations

Authors and study date	Methodology	Sample (area of study)	Main research findings
Melnyk et al (2018)	Gravity model	Trade turnover between Ukraine and the EU (country study)	The actual values of mutual trade turnover between Ukraine and the EU for the 1996-2017 are sufficiently consistent with the model predictions in the respective years. Thus, the proposed specification of gravity equation of foreign trade between Ukraine and the EU is statistically significant, adequately describes the source data, and can be used for modelling and forecasting of foreign relations between partners
Nagyová et al. (2018)	Multi-factorial analysis of variance, log-log linear model	Trade (exports) from Ukraine to the Czech Republic, Hungary, Poland and Slovakia during 2002-2013 (country study)	Exports of goods from Ukraine to the 4 countries throughout the analyzed period were rising, but in recent years in Poland they have decreased slightly A significant decrease in exports occurred in 2009, when fully reflected an economic crisis, which did not escape these countries. After this period, the positive turnover was observed
Trott and Simms (2017)	Multiple case studies	UK food industry (industry level)	Low- and medium-technology industries rely on non- formal Research and Development (R&D) activities such as firm interaction and shared experiences
Bruzst and Langbein (2017)	Case study	Eastern neighbourhood countries (in relation to the EU)	From the perspective of the integration capacity of the EU, the lesson is thus that encompassing deep integration may yield superior developmental results, but the beneficial effects will be sustainable only to the extent that the EU can create effective institutional capacities to manage the specific developmental problems of these economies
Romanenko and Lebedeva (2017)	Method of analysis and synthesis	Exports, imports and FDI of Ukraine with EU countries (country study)	Directions of investment from EU countries in the industry of Ukraine certify on the one hand that the country is viewed, first of all, as a supplier of raw materials and semi-finished products, products with insignificant share of added value and lower technological structure.
Yatsenko et al. (2017)	Gravity model	EU-28 and Ukraine (agricultural sector)	The main advantage of Deep and Comprehensive Free Trade Area for agricultural trade consists in the partial elimination of asymmetry in the trade conditions between EU and Ukraine which increased after Ukraine joined the World Trade Organization (WTO). The asymmetry decreases due to the reduction an average rate of customs tariff for agricultural products from 23.8% to 0.3% and for food products from 23.2% to 0.7%, and introduction of tariff quotas with a zero rate for Ukrainian exports to the EU, which promotes a

			15% increase in the turnover of agricultural food products by 2017
Moroz et al. (2017)	Elasticity of indexes estimation, correlation analysis	Foreign trade between Ukraine and 4 EU member countries (country study)	The results of Ukraine's export trade with the four EU countries analysis showed that the country's operations with Poland, Czech Republic and Slovak Republic were focused mainly on raw materials. There was a different situation regarding Hungary, where machine building sector export showed a sound increase
Qineti et al. (2009)	Competitiveness and comparative advantage	Slovak and the EU-27 agro-trade with Ukraine and Russia (country study)	Based on the regression analysis of the Balassa Indexes, the degree of specialization in the agro-trade between Slovakia and the EU-27 in one hand, and Ukraine in the other had different developments In the case of Slovakia, the number of commodity groups with comparative advantage has been increasing, while for the EU 27, they have been decreasing. The preliminary conclusion is that the competitiveness of the Slovak agri-food commodities in the Ukrainian market has been slightly increasing since the accession, while, on the contrary, the EU-27 shows the tendencies
Buenechea-Elberdin et al. (2017)	Structural equation modelling	180 Spanish companies (firm level)	Because structural capital is largely enhanced by other IC components, managers should have a clear idea of the type of innovation they want to create and the firm's technology level Regarding internal relational capital, managers should avoid taking for granted that as long as employees have trusting relationships and share useful knowledge Promotion of external relationships is highly dependent on the industry to which the company belongs
Buenechea-Elberdin et al (2017)	Structural equation modelling and a multigroup analysis	1289 Spanish firms with 100 employees or more (firm level)	Promoting an entrepreneurial attitude among employees, enhancing learning and updating the knowledge base are crucial for innovation in high-tech companies. In low-tech firms, the capacity to learn and acquire new knowledge and skills is pivotal for boosting innovation. In both types of company, a qualified and motivated workforce and investment in upgrading employees' knowledge and skills is critical for the enhancement of both entrepreneurial and renewable capital
Panchenko and Voychak (2016)	Comparative analysis	High-tech exports of Ukraine (country study)	The development of the world economy is accompanied by a rapid growth not only in international trade volumes in general, but especially in high-tech exports characterized by a great value added share The analysis of high-tech export changes and

			trends in the world in 2004-2015 revealed, on the one hand, a stable consolidation of China's position in this market, which became a leader in 2006, the stable positions of the US, EU and Japan In the current conditions, the leading countries in the market of high-tech export accumulated a considerable and diverse experience of regulation and support of high-tech export. In order to strengthen the positions of Ukrainian high-tech companies in the world markets, it is feasible to implement a system of immediate action in two areas: macroeconomic and sectoral
Gylfason et al (2015)	Gravity model	Bilateral exports for 60 exporters and 150 importers from the period 1995 to 2012 (country study)	The Eastern Partnership countries gain significantly from free trade agreements with the EU but little if anything from free trade agreements with Russia, and that improvements in the quality of institutions in Eastern Partnership countries have played an important role in fostering exports.
Petrov et al. (2015)	Case study	EU-Ukraine Association Agreement (country study)	It is a truly innovative legal instrument in the EU's external relations practice based on comprehensiveness, complexity and conditionality. The EU-Ukraine Association Agreement does not go as far as the EEA Agreement, which extends the entire EU Internal Market *acquis* to the participating EFTA States on the basis of homogeneity
Burger et al. (2009)	Gravity model, Poisson fixed-effects estimation	Set of 138 countries in the period 1996-2000 (country study)	The Poisson and modified Poisson (negative binomial, zero-inflated) modelling techniques applied may provide a viable alternative to the lognormal specification of the gravity trade model
Qineti et al. (2009)	Competitiveness and comparative advantage	Slovak and the EU-27 agro-trade with Ukraine and Russia (country study)	Based on the regression analysis of the Balassa Indexes, the degree of specialization in the agro-trade between Slovakia and the EU-27 in one hand, and Ukraine in the other had different developments In the case of Slovakia, the number of commodity groups with comparative advantage has been increasing, while for the EU 27, they have been decreasing. The preliminary conclusion is that the competitiveness of the Slovak agri-food commodities in the Ukrainian market has been slightly increasing since the accession, while, on the contrary, the EU-27 shows the tendencies

2.4 Specification of the empirical model

Estimate Augmented Gravity Model

As it was mentioned before, in this research we will estimate bilateral foreign trade between Ukraine and countries of the European Union (EU-28) with Augmented Gravity model, which includes more variables than just GDPs of trading countries and the distance between them. For comparison, we will present the basic Gravity model and the Augmented gravity model in their linear forms.

Basic Gravity model:

$$lnX_{ij} = c + b_1 lnGDP_i + b_2 lnGDP_j + b_3 lnDIST_{ji} + e_{ij} \quad (2.3)$$

where X_{ij} shows exports from country i to country j, GDP is each country's gross domestic product, $DIST_{ji}$ represents costs of trade between the two countries, distance is the geographical distance between them – as an observable proxy for trade costs – and e_{ij} is a random error term.

However, in this research, apart from GDPs and distance, we will use the following variables (which we will describe in the following subsection): value of differential GDP per capita; real effective exchange rate index; tariff rate implied on manufactured products in %; absolute value of bilateral exports flows; absolute value of bilateral imports flows; and, dummy variables for common border, former colony and landlock. And the linear form of Augmented Gravity model (2.4) has the following look:

$$\begin{aligned} lnTT_{ij} = c + b_1 lnGDP_i + b_2 lnGDP_j + b_3 lnDIST_{ji} + b_4 lnDIFF_{ij} + \\ + b_5 lnTARIFF_{ij} + b_6 lnREER_{ij} + CONT + LAND + COL + e_{ij} \end{aligned} \quad (2.4)$$

where ln means natural logarithm, TT shows the total trade (exports + imports), $DIFF_{ij}$ is a value of differential GDP per capita, TARIFF represents the tariff rate on manufactured products, REER is real effective exchange rate index (2010 = 100), and CONT, LAND and COL are dummy variables for common border, landlocked and common colony respectively. It is

necessary to add, that this model is not the only one, as the given model has variations with different dependent variables. Apart from TT (total trade), there are models with regressors for exports X (2.5) and imports M (2.6):

$$lnX_{ij} = c + b_1 lnGDP_i + b_2 lnGDP_j + b_3 lnDIST_{ji} + b_4 lnDIFF_{ij} + b_5 lnTARIFF_{ij} + b_6 lnREER_{ij} + CONT + LAND + COL + e_{ij} \quad (2.5)$$

$$lnM_{ij} = c + b_1 lnGDP_i + b_2 lnGDP_j + b_3 lnDIST_{ji} + b_4 lnDIFF_{ij} + b_5 lnTARIFF_{ij} + b_6 lnREER_{ij} + CONT + LAND + COL + e_{ij} \quad (2.6)$$

As we can see, the Augmented Gravity model contains in itself more variables than basic model, and the further aim is to analyse to what extent each of the variables has one or another impact on foreign trade (in our case) between Ukraine and the EU-28.

2.4.1 Description of variables

According to the theoretical model, which was reviewed in this work, three series of explanatory variables were adopted to the Augmented Gravity model as Ukraine's bilateral exports (X), bilateral imports (M) and total trade (TT). This group of dependent variables accounts accounts as the estimators for measuring the amount of foreign trade between Ukraine and European Union as the whole. The first three variables, which are included in the model, are basically the variables from the basic Gravity model, which was presented in the previous section. They are gross domestic product of one party (Ukraine, GDPi), gross domestic product of the partner (each country of EU-28 partners, GDPj) and, basically the distance between the trading partner (by the distance we mean the geographical distance between the economic centres – capital cities, DIST). After this, the following variables (including the variables of basic Gravity model) represent the Augmented Gravity model itself: absolute value of differential GDP per capita between Ukraine and its trading partners (own calculations were provided, DIFF); tariff rate, applied, simple mean, manufactured products (%); real effective exchange rate (2010 = 100, REER). The last group of variables is illustrated by dummy variables, such as common border (CONT), former colony (meaning the independent nations

which were under the protectorate of the same or different states, COL) and landlock i.e. whether or not the nation has the access to the sea or ocean (1 for countries without access to sea, LAND).

It is necessary to add, that due to Ukraine's vector towards European Union, the Ukraine-EU Deep and Comprehensive Free Trade Area provisionally entered into force on 1 January 2016. In our opinion, it could be a good dummy variable, which would show the impact of this agreement on the bilateral foreign trade, however, only 3 years have passed since that moment and there are risks, it is still impossible to see the vivid relation between the agreement and international trade, especially on macro level. Nonetheless it could be possible to analyse this on micro level in future researches.

Below we present a description of the variables, which are used in this work.

Bilateral exports (X), Imports (M) and Total Trade (TT): Bilateral exports are measured as the total value of all goods in U.S. dollars flowing out from Ukraine to its partner. Bilateral imports are measured as the total value of all goods in U.S. dollars flowing in from given partner to Ukraine. Total trade is the arithmetic sum of bilateral exports and bilateral imports. Data on bilateral exports and imports were obtained from UN Comtrade: International Trade Statistics.

Income (GDP): Income is measured by Gross domestic product that is the monetary measure of the market value of all the final goods produced in a period of time. It is measured in absolute value (current U.S. dollars). We use Ukraine's GDP that is the importer country (GDPM) and the exporters GDP's which are the EU partners (GDPM). Data was obtained from the World Bank, World Development Indicators online database.

Distance (DIST): This is the geographical distance between the economic centers (capital cities) in Ukraine and its trading partners, measured in kilometers (km). Data on distance is sourced from an online distance calculator website ("Website," n.d.-a).

Income per capita differential (DIFF): this variable is defined as the difference between the per capita GDP of the partner countries, introduced to identify a possible Linder effect. According to Linder's hypothesis, bilateral trade will be greater when the per capita GDPs of the

trading countries are more similar. DIFF is computed as the absolute value of the difference between Ukraine's GDP per capita and that of its partners; where GDP per capita was sourced from the World Bank, World Development Indicators online database. The use of nominal GDP (instead of real GDP) is theoretically more suitable.

Tariff rate (TARIFF): this variable is the simple mean of tariffs, manufactured products (%), World Bank staff estimates using the World Integrated Trade Solution system, based on data from UNCTAD's Trade Analysis and Information System (TRAINS) database and the WTO Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database.

Real effective exchange rate (REER): Real effective exchange rate index (2010 = 100). Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs, International Monetary Fund, International Financial Statistics.

Common border (CONT): The given dummy variable shows if any of the European country has a common border with Ukraine (1, if there is a common border and 0 – if countries are not neighbouring). This dummy is closely related with the variable of distance which, in turn implies that neighbouring countries will trade between each other more.

Lanlock (LAND): It is a dummy variable, which indicates if any of the country has access to the sea or not. 1 is for the country which does not have open access to the sea, and 0 – for economies with marine access respectively. The information was obtained from the World Population Review online webpage.

Former colony (COL): This refers to the countries which were under the patronage of one country during the last century. It is constructed in such way that, COL is equal to 1 if the country was a part of the same state in the past, and COL is equal to 0 if it was not under control of another country.

2.4.2 Data

To analyse Ukraine's bilateral trade flows in manufactured goods with the European Union within the framework of gravity model, this work implies a panel dataset of annual observations on a cross-section of 28 European countries and Ukraine itself, over a period of 23 years between 1995 and 2017 collated from different secondary sources. The choice of the sample period and countries in the cross-section in this research is influenced by the availability of data on all the variables (and countries) used in the research. It is necessary to note, that the initial period of time was planned to be from 1991 to 2017 (since Ukraine got its independence), but during collecting the data over that period, one issue occured due to the absence of data for a few countries of former Yugoslavia i.e. data for period from 1991 to 1994 (for example, data for Slovenia and Croatia was completely missing for that period) and due to those circumstances we were forced to revise the period of study.

Table 2: List of dependent and explanatory variables

Variable	Definition of variable	Data source
X	Absolute value of bilateral exports flows	United Nations COMTRADE
M	Absolute value of bilateral imports flows	
TT	Absolute value of total bilateral trade flows computed as the sum of exports and imports	Own calculations with data from United Nations COMTRADE
GDPX	Absolute value of income of EU partners (exporters), where GDP is the gross domestic product (current 2000 US dollars)	Data on GDP was sourced from the World Bank, World Development Indicators online database
GDPM	Absolute value of income of Ukraine (importer), where GDP is the gross domestic product (current 2000 US dollars)	
DIST	Geographical distance between economic center (capital) of Ukraine and its trading partners	French Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
DIFF	Absolute value of differential income per capita between Ukraine and its trading partners to identify a potential Linder effect, where GDP per capita is the gross domestic product (constant 2000 US dollars) divided by total population	Own calculations with data sourced from the World Bank, World Development Indicators online database

REER	Real effective exchange rate index (2010 = 100), Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs	International Monetary Fund, International Financial Statistics
TARIFF	Tariff rate, applied, simple mean, manufactured products (%)	World Bank staff estimates using the World Integrated Trade Solution system, based on data from UNCTAD's Trade Analysis and Information System (TRAINS) database and the WTO Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database
CONT	Common border or border trade that refers to the flow of goods across the international borders between close countries	French Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
COL	Post-Soviet states, also collectively known as the former Soviet Union or former Soviet Republics	French Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
LAND	Landlocked country is a sovereign state entirely enclosed by land, or whose only coastlines lie on closed seas	French Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)

2.5 Estimation methods

This section will take a review on techniques, which will be used to estimate empirically trade relations between Ukraine and countries of the European Union. To estimate Augmented Gravity model, Robust Ordinary Least Squares (OLS) and Poisson Pseudo-Maximum Likelihood estimators, with and without fixed effects, will be used. All following calculations and estimations will be provided with Stata software.

2.5.1 Ordinary Least Squares (OLS) estimator

Ordinary least squares (OLS) is a method for estimating the unknown parameters in a linear regression model. OLS chooses the parameters of a linear function of a set of explanatory variables by the principle of least squares: minimising the sum of the squares of the differences

between the observed dependent variable (values of the variable being predicted) in the given dataset and those predicted by the linear function.

From the point of Stata software, OLS is implemented in the *regress* command. It takes the following format:

regress dependent_variable independent_variable1 independent_variable2 … [if…], [options]

The *if* statement can be used to limit the estimation sample to a particular set of observations, If no *if* command is specified, then the entire sample is used for estimation. Stata automatically handles issues such as missing observations of either the dependent or independent variables – they are dropped from the sample – so there is no need to drop those observations from the dataset prior to estimation.

Among the various options that can be specified with *regress* command, two of them are of a big interest in the gravity context. The first is *robust*, which produces standard errors that are robust to arbitrary patterns of heteroskedasticity in the data. The *robust* option is therefore a simple and effective way of fixing violations of the second OLS assumption. The second option that is commonly used by gravity modelers is *cluster(variable)*, which allows for correlation of the error terms within groups defined by *variable*. Failure to account for clustering in data with multiple levels of aggregation can result in greatly understated standard errors. For example, errors are likely to be correlated by country pair in the gravity model context, so it is important to allow for clustering by country pair. To do this, it is necessary to specify a clustering variable that separately identifies each country pair independently of the direction of trade. An example is distance, which is unique to each country pair but is identical for both directions of trade. A common option specification is therefore *cluster(distance).*

By interpreting the coefficient t-statistics, we use the model to test a number of simple hypotheses. We can also use it to conduct tests of compound hypotheses. For example, GDP coefficients in the goods trade literature are frequently found to be close to unity – and some theories suggest they should be exactly unity – so we can test whether that is in fact the case in our services data. Using the same approach, we can test the compound hypothesis that historical and cultural links do not matter for trade in services, i.e. that the coefficients on all such variables are jointly equal to zero (Shepherd 2016).

2.5.2 Poisson Pseudo-Maximum Likelihood (PPML) estimator

The Poisson pseudo-maximum likelihood estimator provides consistent estimates of the original nonlinear model. An important point to stress, since it is often missed in the applied

literature, is that since dealing with a pseudo-maximum likelihood estimator, it is not necessary that the data be in fact distributed as Poisson. So although Poisson is more commonly used as an estimator for count data models, it is appropriate to apply it far more generally to nonlinear models such as gravity.

The Poisson estimator has a number of desirable properties for applied policy researches using gravity models. First, it is consistent in the presence of fixed effects, which can be entered as dummy variables as in simple OLS. The point is a particular important one for gravity modeling because most theory-consistent models require the inclusion of fixed effects by exporters and by importer.

Second,the Poisson estimator naturally includes observations for which the observed trade value is zero. Such observations are dropped from the OLS model because the logarithm of zero is undefined. However, they are relatively common in the trade matrix, since not all countries trade all products with all partners (Haveman & Hummels, 2004). Although the issue has mainly arisen to date in the context of good trade, it is also relevant for services trade. Dropping zero observations in the way that OLS does potentially leads to sample selection bias, which has become an important issue in recent empirical work. Thus the ability of Poisson to include zero observations naturally and without any additions to the basic model is highly desirable.

Third, interpretation of the coefficients from the Poisson model is straightforward and follows exactly the same pattern as under OLS. Although the dependent variable for the Poisson regression is specified as exports in levels rather than in logarithms, the coefficients of any independent variables entered in logarithms can still be interpreted as simple elasticities. The coefficients of independent variables entered in levels are interpreted as semi-elasticities, as under OLS.

Taking all of these points together, there is a strong argument for using Poisson as the workhorse gravity models estimator. From an applied policy research point of view, the desirable properties of Poisson suggest that estimates of policy impacts should generally be based on Poisson results rather than OLS (Silva, Santos, & Tenreyro, 2006).

An additional advantage of Poisson is that it lends itself naturally to counterfactual simulations that respect certain important empirical constraints. First, (Arvis & Shepherd, 2013) show that Poisson estimates of the gravity model have the remarkable property that although

actual and estimated bilateral trade flows are different, actual and estimated total trade flows (e.g., total exports or imports by country) are exactly identical. (Fally, 2015) extends that result and shows more broadly that Poisson estimates satisfy a variety of constraints on structural gravity models, and in particular when fixed effects are included, they are consistent with the multilateral resistance terms of the (Anderson & van Wincoop, 2003) model. In fact, this methodology offers a practical and robust approach for undertaking counterfactual simulations based on the structural model (Shepherd 2016).

Charbonneau (2012) claimed that "a Poisson model with two fixed effects does suffer from the incidental parameter problem", and this claim has recently been echoed by other researches. However, Charbonneau's claim is based on an example with N=T=2, which cannot be informative about the existence of an incidental parameter problem because this problem is asymptotic in nature. In contrast, (Fernandez-Val & Weidner, 2014) have proved that a Poisson model with two fixed effects does not suffer from the incidental parameter problem as long as the regressors are strictly exogenous (a requirement that is also needed for the consistency of the fixed effects estimator in linear models). Therefore, under very general conditions, inference based on the estimation by PPML of Gravity equations including both importer and exporter fixed effects will not be affected by an incidental parameter problem (Silva et al., 2006).

The choice between OLS and Poisson is an empirical one. (Silva et al., 2006) present test for determining whether the OLS estimator is appropriate, and another for determining whether Poisson or another pseudo-maximum likelihood estimator is likely to be efficient.

2.6 Presentation of results

The main aim of this section is to present and analyze the estimated results of the gravity models of bilateral trade flows. In the next section we will discuss the estimated results among the variables entering gravity models of bilateral foreign trade between Ukraine and countries of EU-28. The estimations will be provided for bilateral exports, imports and total trade, results of which will be presented in the following table. And the following estimations will be provided in forms of Robust OLS estimations for the augmented gravity model and PPML estimations for augmented gravity model with and without fixed effects.

Our panel data comprises 644 observations from 1995 to 2017. Table 3 presents descriptive statistics of the variables used in the gravity models. The correlation matrix is presented in Table 4.

Table 3: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
lnTT	644	19.71242	1.469692	14.89265	22.92023
lnX	644	18.79586	1.641225	13.25213	21.83497
lnM	644	18.93193	1.716623	11.20081	22.69187
lnGDPX	644	25.70147	1.713139	21.95872	28.98959
lnGDPM	644	25.10517	.5883186	24.16565	25.93444
lnDIST	644	7.188844	0.414365	6.380215	8.117211
lnDIFF	644	-2.256019	0.7174994	-3.941483	-.6632714
lnTARIFF	639	.7172411	0.3132703	.3920421	1.442202
lnREER	644	4.553215	.1376795	3.826471	4.843494

Table 4: Correlation matrix

	lnTT	lnX	lnM	lnGDPX	lnGDPM	lnDIST	lnDIFF	lnTARIFF	lnREER
lnTT	1								
lnX	0.9146	1							
lnM	0.9310	0.7409	1						
lnGDPX	0.6350	0.4882	0.6884	1					
lnGDPM	0.4058	0.3121	0.4054	0.2260	1				
lnDIST	-0.3314	-0.2894	-0.3395	0.2298	0.0007	1			
lnDIFF	0.1806	0.3272	0.0375	-0.4564	0.1440	-0.5421	1		
lnTARIFF	-0.2669	-0.1992	-0.2429	-0.1410	-0.6068	0.0105	-0.0862	1	
lnREER	0.1006	0.0017	0.1566	0.3122	0.3625	0.0934	-0.2980	-0.2887	1

Robust OLS estimations.

Considering the origin of dataset employed in this study, it is compulsory that we select an appropriate estimation method which accounts for the heterogeneity in the gravity models resulting from the presence of individual and time effects in the panel data. The exploratory results of these estimations are presented in Table 5 below.

Table 5: Robust OLS Estimates of the Augmented Gravity Models between Ukraine and EU-28, Total Trade, Exports and Imports, 1995-2017

	Dependent variable		
	lnTT	lnX	lnM
Explanatory variable			
lnGDPX	0.792	0.859	0.901
	(7.61)**	(5.59)**	(10.15)**
lnGDPM	0.445	0.134	0.720
	(3.99)**	(0.85)	(5.59)**
lnDIST	-0.861	-0.035	-1.579
	(2.88)**	(0.09)	(5.03)**
lnDIFF	0.647	1.341	0.207
	(2.55)*	(4.19)**	(1.00)
lnTARIFF	-0.157	-0.079	0.032
	(1.52)	(0.53)	(0.24)
lnREER	-1.363	-1.048	-1.806
	(2.73)*	(1.93)	(2.60)*
CONT	0.234	0.354	0.131
	(0.72)	(1.00)	(0.41)
LAND	0.361	0.722	0.399

	(1.44)	(2.01)	(1.59)
COL	0.859	1.227	1.031
	(2.01)	(2.31)*	(2.20)*
constant	1.960	1.155	-2.470
	(0.65)	(0.34)	(0.68)
R^2	0.80	0.69	0.83
N	639	639	639
** p<0.05; ** p<0.01*			

Let's begin from results of total trade. To interpret the model results further, look more closely at the estimated coefficients and their corresponding t-tests. Taking GDP terms first, we see that exporter and importer GDP are both positively associated with trade, as we would expect: a 1% increase in exporter's GDP tends to increase services trade by about 0.79%, and importer GDP tends to increase by about 0.45% and this effect is statistically significant at the 1% level. It means that there is a difference in total gains for each economy, however, both of them have positive consequences. The coefficient on distance, on the other hand, is negative and 1% statistically significant: a 1% increase in distance tends to reduce trade by about 0.86%. The fact, that distance significantly affects trade suggests that the world is still far from "flat" in the sense that goods do not move costlessly across borders. Differential GDP per capita proves Linder's hypothesis, which states that more similar economies tend to trade more. In our case it has value is about 0.65, which means that if economies will become more similar by 1%, the trade between them will increase by approximately 0.65%. Real effective exchange rate, as suggested, has a negative sign, and it is significant at 5% level. As expected, appreciation or depreciation of the currency will lead to increase or decrease (respectively) – increasing of exchange rate by 1% will lead to decrease of total trade between Ukraine and European by more than 1.3%, which, in turn, is quite a serious factor, which influence on foreign trade. The tariff rate for manufactured products has negative sign, as expected, however it does not matter because the p-value is much higher than 0.05, thereby it is impossible to comment this variable's result.

Of the remaining geographical and historical variables, all dummies have the positively signed coefficients, however, all of them are insignificant. This could happen due to the insufficient amount of dataset.

Bilateral exports results. Looking at the GDP terms first, we see that exporter and importer GDP are both positively associated with trade but only GDP of exporter is statistically significantly, while GDP of the EU countries does not have a significant value. So, in this case 1% of increasing GDP of Ukraine will lead to respective increase in exports by 0.86%. The coefficient on distance, on the other hand, is negative but it is statistically insignificant. Differential GDP per capita has value about 1.34, which means that if economies will become more similar by 1%, the trade between them will increase by approximately 1.34%. Other results have insignificant results, which makes it difficult to make any conclusions. The reason, why it happened, will be discussed later. Talking about dummy variables results, it is useful to note that countries from the former Soviet Union have, on average, bilateral exports more by 139% than those who were not (exp[1.22] - 1 = 2.39) i.e. there closer ties between the countries of former USSR.

Bilateral imports results. The results are slightly better than for bilateral exports. Taking into account the GDP terms first, we see that exporter and importer GDP are both positively associated with trade: a 1% increase in exporter's GDP tends to increase services trade by about 0.9%, and importer GDP tends to increase by about 0.72% and this effect is statistically significant at the 1% level. The coefficient on distance, on the other hand, is negative and 1% statistically significant: a 1% increase in distance tends to reduce trade by about 1.58%.

Talking about dummy variables results, it is useful to note that countries from the former Soviet Union have, on average, bilateral imports more by 80% than those who were not (exp[1.03] - 1 = 1.80) i.e. there closer ties between the countries of former USSR.

The R-squared on average is 0.8, which means that we can trust the obtained results at 80%.

By interpreting the coefficient t-statistics, we used the model to test a number of simple hypotheses. We can also use it to conduct tests of compound hypotheses. For example, GDP

coefficients in the goods trade literature are frequently found to be close to unity – and some theories suggest they should be exactly unity – so it is possible to test whether that is in fact case. Table 6 contains results. It shows that the null hypothesis of equality is strongly rejected by the data: the p-value of the F-statistics is less than 0.01, which means that we can reject the hypothesis at the 1% level, as for total trade. It is the same about bilateral exports. For bilateral imports we also reject the null hypothesis at 5% level.

Table 6: Tests of the hypotheses that both GDP coefficients are equal to unity (2nd row) and that all historical and cultural coefficients are equal to zero (3rd row)

lnTT	lnX	lnM
(1) lnGDPX - lnGDPM = 0 (2) lnGDPX = 1 F(2, 26) = 23.83 Prob > F = 0.0000	(1) lnGDPX - lnGDPM = 0 (2) lnGDPX = 1 F(2, 26) = 32.92 Prob > F = 0.0000	(1) lnGDPX - lnGDPM = 0 (2) lnGDPX = 1 F(2, 26) = 3.43 Prob > F = 0.0478
(1) CONT - LAND = 0 (2) CONT - COL = 0 (3) CONT = 0 F(3, 26) = 1.55 Prob > F = 0.2254	(1) CONT - LAND = 0 (2) CONT - COL = 0 (3) CONT = 0 F(3, 26) = 2.18 Prob > F = 0.1145	(1) CONT - LAND = 0 (2) CONT - COL = 0 (3) CONT = 0 F(3, 26) = 1.99 Prob > F = 0.1408

Using the same approach, we can test the compound hypothesis that historical and geographical links do not matter for trade, i.e. that the coefficients on all such variables are jointly equal to zero. The third row of Table 6 presents respective results. In this case we failed to reject the null hypothesis: the p-values associated with the F-test are higher than 0.05, which means we are not able to reject null hypothesis even at 5% level. Based on these results, we conclude that historical and geographical links are not important determinants of trade.

Poisson Pseudo-Maximum Likelihood Estimator (PPML).

A few words before the analysing of results. Firstly, we rescaled the dependent variables to avoid estimations problems variables, and so they were rescaled in millions of U.S. dollars. Secondly, we did not use logarithms of dependent variables due to literature review on PPML,

which claimed that we don't need to bring dependent variables to logarithm as they can be included naturally by Poisson.

Table 7: PPML results of the Augmented Gravity Models between Ukraine and EU-28, Total Trade, Exports and Imports, 1995-2017

	Dependent variable		
	TT_resize	X_resize	M_resize
Explanatory variable			
lnGDPX	0.875	0.826	0.924
	(7.89)**	(5.54)**	(7.62)**
lnGDPM	0.561	0.292	0.775
	(5.90)**	(1.89)	(8.41)**
lnDIST	-0.610	-0.004	-1.087
	(1.84)	(0.01)	(2.71)**
lnDIFF	0.653	1.109	0.221
	(3.18)**	(3.36)**	(1.25)
lnTARIFF	0.063	0.125	0.013
	(0.89)	(1.47)	(0.18)
lnREER	-1.687	-0.943	-2.255
	(3.65)**	(2.43)*	(3.69)**
CONT	0.398	0.380	0.543
	(2.14)*	(1.59)	(1.77)
LAND	0.570	0.690	0.502
	(3.71)**	(3.10)**	(2.66)**
COL	1.041	0.993	1.219

	(3.34)**	(2.40)*	(2.88)**
constant	-17.363	-16.827	-19.683
	(5.66)**	(5.13)**	(5.87)**
R^2	0.78	0.65	0.77
N	639	639	639

* p<0.05; ** p<0.01

Table 7 presents results for a gravity model estimated using Poisson Pseudo-Maximum Likelihood estimator.

Total trade. Firstly, let's take a look at the results for total trade. Looking at GDPs, we see that exporter and importer GDP are both positively associated with trade: a 1% increase in exporter's GDP tends to increase services trade by about 0.88%, and importer GDP tends to increase by about 0.56% and this effect is statistically significant at the 1% level. It means that there is a difference in total gains for each economy, however, both of them have positive consequences. The coefficient on distance, on the other hand, is negative and 1% but it is not statistically significant. Differential GDP per capita proves Linder's hypothesis, which states that more similar economies tend to trade more. In this case it has value is about 0.65, which means that if economies will become more similar by 1%, the trade between them will increase by approximately 0.65%. Real effective exchange rate, as suggested, has a negative sign, and it is significant at 1% level. As expected, appreciation or depreciation of the currency will lead to increase or decrease (respectively) – increasing of exchange rate by 1% will lead to decrease of total trade between Ukraine and European by more than 1.68%, which, in turn, is quite a serious factor, which influence on foreign trade. The tariff rate for manufactured products has a positive sign, however, it does not matter because the p-value is much higher than 0.05, thereby, we reject this result.

Bilateral exports. Looking at the results of GDPs, we can see the same behaviour, as from the Robust OLS estimations. There are significant results for the GDP of exporter but insignificant result for its partner. So if exporter GDP increases by 1%, it will lead to the increase of exports by 0.83%. The results for distance still have negative sign but it remains insignificant,

so we neglect the given result. Looking at Linder's hypothesis, if states' economies become more alike by 1%, exports will increase by about 1.11%. Tariff rate results remain insignificant, thereby it is impossible to say something about this. Real effective exchange rate has the negative sign and is significant at 5% level: appreciation or depreciation of the currency will lead to increase or decrease (respectively) – increasing of exchange rate by 1% will lead to decrease of total trade between Ukraine and European by more than 0.94%

Bilateral imports. Taking into account the GDP terms first, we see that exporter and importer GDP are both positively associated with trade and both are significant at 1% level: a 1% increase in exporter's GDP tends to increase services trade by about 0.9%, and importer GDP tends to increase by about 0.72% and this effect is statistically significant at the 1% level. The coefficient on distance, on the other hand, is negative and 1% statistically significant: a 1% increase in distance tends to reduce trade by about 1.58%.

Talking about dummies, in all 3 cases for total trade, exports and imports, two of three dummy variables are statistically significant (i.e., LAND and COL, which refer to landlocked countries and countries from former Soviet Union respectively).

Poisson Pseudo-Maximum Likelihood (PPML) Estimator with Fixed Effects.

Here are presented the results of PPML fixed effects for the augmented gravity model for total trade, bilateral exports and bilateral imports in the Table 8.

Table 8: PPML with Fixed Effects results of the Augmented Gravity Models between Ukraine and EU-28, Total Trade, Exports and Imports, 1995-2017

	Dependent variable		
	TT_resize	X_resize	M_resize
Explanatory variable			
lnGDPX	0.917	1.145	0.769

	(5.48)**	(4.84)**	(4.69)**
lnGDPM	0.464	0.055	0.746
	(5.58)**	(0.36)	(9.34)**
lnDIST	-0.755	-0.189	-1.309
	(13.03)**	(3.08)**	(25.15)**
lnDIFF	0.682	1.170	0.326
	(2.21)*	(2.30)*	(1.71)
lnTARIFF	0.044	0.089	0.025
	(0.78)	(1.16)	(0.46)
lnREER	-0.816	-0.637	-0.722
	(3.19)**	(1.57)	(2.77)**
CONT	0.554	0.757	0.380
	(1.24)	(1.20)	(1.28)
LAND	0.525	1.141	0.102
	(2.11)*	(3.02)**	(0.39)
COL	1.183	1.900	0.631
	(1.49)	(1.75)	(0.97)
Partner_2	0.431	0.630	0.389
	(2.15)*	(2.01)*	(1.86)
Partner_3	0.788	1.553	-0.066
	(0.93)	(1.32)	(0.11)
Partner_4	1.737	3.195	0.197
	(2.47)*	(3.26)**	(0.29)
Partner_5	0.309	0.030	0.567
	(1.03)	(0.07)	(3.02)**
Partner_6	0.344	-0.164	0.597

	(2.25)*	(0.74)	(5.09)**
Partner_7	-0.014	0.518	-0.343
	(0.05)	(1.09)	(1.13)
Partner_9	0.124	0.488	-0.136
	(0.95)	(2.37)*	(1.06)
Partner_10	0.143	-0.451	0.107
	(0.45)	(0.95)	(0.32)
Partner_11	-0.340	-0.915	0.107
	(2.53)*	(4.75)**	(1.10)
Partner_12	-1.133	-1.134	-1.176
	(15.27)**	(10.78)**	(20.56)**
Partner_13	-0.392	0.147	-0.756
	(1.26)	(0.35)	(2.65)**
Partner_14	-0.932	-0.214	-1.437
	(1.39)	(0.24)	(2.59)**
Partner_15	0.134	-0.054	0.272
	(1.94)	(0.47)	(3.85)**
Partner_16	-0.167	0.007	-0.140
	(0.54)	(0.01)	(0.44)
Partner_17	0.388	0.607	0.188
	(5.91)**	(6.08)**	(3.89)**
Partner_19	-0.513	-0.445	-0.573
	(1.36)	(0.72)	(1.53)
Partner_20	-0.305	0.236	-0.910
	(7.52)**	(4.33)**	(21.15)**

Partner_21	0.675	2.026	-0.585
	(0.77)	(1.67)	(0.71)
Partner_22	0.653	1.081	0.395
	(4.21)**	(4.07)**	(2.77)**
Partner_24	-0.314	0.042	-0.861
	(0.97)	(0.09)	(3.05)**
Partner_25	-0.550	-0.289	-0.756
	(2.49)*	(0.94)	(4.50)**
Partner_27	0.554	-0.264	0.614
	(0.91)	(0.32)	(1.08)
Partner_28	-0.159	-0.951	-0.072
	(0.71)	(2.65)**	(0.31)
constant	-18.971	-19.592	-19.905
	(4.24)**	(3.41)**	(5.46)**
R^2	0.97	0.92	0.98
N	639	639	639

* $p<0.05$; ** $p<0.01$

Total trade results. According to the PPML with Fixed Effects results, the trade elasticities of all the current gravity variables – export GDP and import GDP, and geographical distance – have their theoretically designated signs and are highly statistically significant at 1% error level. That is, increasing GDP of Ukraine and GDP of EU partners by 1% will get the raise in trade by 0.92% and 0.46% respectively. That is, economic growth for Ukraine is much more important for foreign trade than for its EU partner. As it was just mentioned, distance is statistically significant and has a negative sign, which confirm the hypothesis that countries with longer distance will suffer more transportation costs. Taking a look at other variables of augmented gravity model we can exclude from conclusion variables: tariff rate for manufactured goods, and also dummies for countries of former Soviet Union and for common borders.

Anyway, the remaining variables are statistically significant. Here the Linder's hypothesis is confirmed again, where if two economies become more similar at 1%, then the trade between them will increase at the level of 0.68%. Real effective exchange rate, as expected, has a negative sign and is statistically significant. And we can declare that appreciation or depreciation of the local currency by 1% will lead to cutting the trade by 0.82%

Bilateral exports results. For the results of bilateral exports, the situation is slightly different. Despite that GDP of Ukraine and distance variables are significant, we have gotten insignificant result for GDP of EU partners again, similarly as in the previous estimations. From this result we can conclude that growing Ukraine's economy by 1% will lead to increase of exports by 1.14%. Distance expectedly has negative sign, and is statistically significant. Differential GDP per capita between Ukraine and its European partners has a negative sign and is significant at 5% error term. That is, convergence of economies by 1% will lead to accelerating of trade turnour between them by about 1.17%, which also is a good explanatory variable. It means that Ukraine must level its economy with economies of European Union to be able to trade more with them. And real exchange rate has a negative sign, which is that if real exchange rate raises by 1%, it will lead to cut-off the exports by 0.64%.

Bilateral imports results. For the results of bilateral imports, the situation is better with the situation of bilateral exports. Both GDP of Ukraine and its EU partners, and also distance variables are significant at the 1% level. From this result we can conclude that growing Ukraine's economy and EU's economy by 1% will lead to increase of imports by 0.77% and 0.75%. These results are quite similar, which, in turn, makes it at the same value for both Ukraine and countries of the European Union. Distance expectedly has negative sign, and is statistically significant. And still distance plays a vital role in foreign trade (in imports in the given case). The increase in distance by 1% will lead to reduce of imports by 1.31%. Differential GDP per capita between Ukraine and its European partners becomes insignificant in this case so we neglect its results. Tariff rate for manufactured goods remains insignificant. And real exchange rate has a negative sign, which is that if real exchange rate raises by 1%, it will lead to cut-off the exports by 0.72%.

To conclude. One of the main difference, which can be observed, is the number of R-squared. In the Robust OLS regression results for total trade the R-squared number lies at the level of 80%. For the PPML this number is a little bit smaller – 78%. The most interesting thing is that the R-squared for PPML with Fixed effects is 97%, which means that we can trust the obtained results at the level of 97%. And, of course, the last tool is the most suitable for the augmented gravity estimations at the macro level.

2.7 Discussion of research findings

This research is presented to analyse the motives of bilateral foreign trade using gravity model of trade with panel data, involving a cross-section of 28 European countries and Ukraine for the period of 1995-2017. Proceeding from standard theoretical and empirical literature on international trade, the study measures an augmented version of Tinbergen (1962) and Poyhonen (1963) gravity model of trade. All Augmentent gravity models are estimated with robust Ordinary Least Squares (OLS) and Poisson pseudo-maximum likelihood (PPML) estimators. For PPML, we use both PPML estimator with fixed effects and without fixed effects, and compare estimation results..

Hereafter, we present the main conclusions of the study:

1) The empirical outcomes define that the gravity model is quite important in explaining the pattern of bilateral foreign trade between Ukraine and EU-28. This is because of the coefficients (known as trade elasticities) of the variables in the gravity models. Income of Ukraine and income of EU partners and distance appeared to be robustly consistent with the predictions of trade theory and the gravity model.

2) Among the trade determinants, we used income differential to test the Linder's hypothesis. This finding is based on the fact that the coefficient per capita income differential robustly showed up to be positive and statistically significant in all the estimated trade models. This finding suggests that the more Ukraine's income will be close to the income of the European economy, the more bilateral trade flows will be performed.

3) In all estimations the tariff for manufactured goods coefficient is insignificant and this is a topic to be discussed. This result is surprising. Hence, we might ask the question what is the reason of this result? One reason for such a result could be the sample size. Anyway, the result indicate that this specific variable does not play an important role in determining international trade flows between Ukraine and EU-28.

4) The real effective exchange rate appears to have a negative impact on trade flows and it is a significant determinant of Ukraine's bilateral trade flows. An increase of the exchange rate will negatively influence Ukraine's foreign trade, which in turn, will impact the absolute volume of Ukraine's trade flows with the EU. An appreciation means an increase in the value of Ukraine's currency. It means Ukraine's currency is worth more in terms of foreign currency. Exports become therefore more expensive and we would expect to see a fall in exports. Moreover, imports become cheaper for consumers. Therefore, with cheaper imports, we would expect an increase in imports.

5) Overall, the dummy variables, as statistical F-tests showed, are only statistically significant depending on the trade model and estimation method used. In most cases they are not significant. Hence, we cannot conclude that they play an important role in determining bilateral trade flows between Ukraine and EU-28 trading partners.

In conclusion, the major share of results converges with other studies, applied for other countries. It concerns such variables, as income – nations tend to trade more if they have higher level of income(Awokuse, 2018), the Linder hypothesis – similar economies tend to trade more between each other, distance – countries will suffer higher transportation costs if they locate farer from each other (Anderson & van Wincoop, 2003), exchange rate – appreciation of exchange rate will lead to reduce of bilateral imports (Sarantis, 1999). However, we can not check for convergence with the other economical literature about tariffs for manufactured rate and it is hard to follow the results for dummy variables due to their inconsistency.

3. CONCLUSIONS, RECOMMENDATIONS AND RESEARCH LIMITATIONS

3.1 Conclusion

The aims of this research were:

i) Modelling and analysing trade relations between Ukraine and the EU-28 member states;

ii) Performing a cross-country analysis on the main determinants of international trade flows in goods between Ukraine and EU-28 member states;

iii) Applying the gravity model of trade to get a deeper understanding and importance of the main determinants of trade between Ukraine and the EU-28 member states by applying the gravity model for international trade for total trade and its decomposition into exports and imports;

iv) Estimating trade elasticities for total trade, exports and imports functions;

v) Using the regression results to recommend trade policy makers on the implementation of the EU Association Free-Trade Agreement with Ukraine.

And what was done eventually in this research:

i) We modelled and analysed trade relations between Ukraine and countries of the EU-28 with augmented gravity model for international trade;

ii) We performed a cross-country analysis on the main determinants of international trade flow in goods;

iii) We applied a specification of gravity model (the Augmented Gravity model) and got a deeper understanding and importance of main determinants of foreign trade between Ukraine and the EU-28 member states by applying this mode and we confirmed, that indeed, the basic gravity model still works unquestionably, and while analysing augmented gravity model we also confirmed the Linder's hypothesis that similar economies tend to trade more between each other. Also, from the augmented gravity model it is clear that real effective exchange rate plays a vital role in forming the amount of trade turnover between Ukraine and the member states of European Union;

iv) Estimated trade elasticities for total trade, exports and imports functions;

v) Prepared recommendations about trade policy makers on the implementation of the EU Association Free Trade Agreement with Ukraine.

As a result, the main objectives were reached and the results explain the behaviour of pattern of bilateral trade between Ukraine and EU-28 member states. We estimated augmented gravity models to understand what are the main determinants of bilateral trade flows between Ukraine and EU-28. The result of the Linder's hypothesis indicates that Ukraine must not hesitate in upgrading its economic growth and keep going on developing to get more gains from international trade. Also, the exchange rate is, so called, "a dark horse" in this situation as foreign trade and other economic relations between Ukraine and European Union depend on the strength and reliability of currency systems of both subjects.

Also, there is another side of the medal. The estimations, in turn, were not as expected. Some of the variables turned out to be insignificant, which implied some limitation on the model. In our opinion, the main reason of this may lie in the use of a small sample size and/or the variety of independent variables, which were taken for estimations.

However, the study is quite interesting, and this work can be a fundament for further researches in the similar studies which investigate relations of trade between Ukraine and the European Union. But nevertheless, it is quite important to hold a hand on the pulse of the current events. Because the events are changing fast, they are not easy to predict. Also, one must not forget that Russian Federation brings instability in the region by occupying the Crimea peninsula and the Eastern part of Donbas region. And this is sort of a threat for the economic safety as well as for national safety.

In conclusion, in identifying the factors that determine trade flows in the case of Ukraine and European Union, the research found out that there is evidence that the augmented gravity model explains, mostly, a growing amount of trade flows in goods between Ukraine and the members of the European Union.

3.2 Policy recommendations

Summarizing the findings above, we can conclude and state some of the recommendations for elaboration of foreign bilateral trade between Ukraine and European Union

but first of all they relate to Ukraine, using the European Union as a guide for achieving economic and prosperity goals.

Firstly, there is the legislation system. Despite the fact that Ukraine has already signed Association Agreement and Free-Trade agreement with European Union, which demands from Ukraine to improve laws and legislation, there are still fallacies in the legislation, which are the pretexts for corruption schemes. The government supply-side policies (for example, government subsidies) are also recommended.

Secondly, there is the investment climate. This point arrives from the previous one. Due to imperfect legislation, the investments (especially foreign investments) are not quite defende by the law, which creates barriers for investors and hence, for capital income which would promote economic growth and, finally, foreign trade for Ukraine. So, improving consumer and investor confidence in the economy and maintaining Ukraine's external competitiveness is highly recommended. This will improve the productivity of the economy in the long run, which in turn, finally will reduce the pressure on domestic currency from depreciation.

Thirdly, the state must guarantee the stability of local currency (i.e., Ukrainian hryvnia) from its depreciation not by wasting foreign-exchange reserves, as it was being done 5-8 years ago, but by adopting the appropriate blend of fiscal and monetary policies to achieve stability in the foreign value of the Ukrainian hryvnia. We admit that the National Bank of Ukraine is doing a good job on keeping the currency at the current level but for increasing foreign trade the local currency should appreciate, which in turn, demands the economy to develop.

Fourthly, Ukraine should continue productive partnership with the European Union and keep on working on the reforms and not curtail them. Of course, current trade agreement between Ukraine and European Union have a purpose to develop foreign trade between each other. However, this process is not short and the effects are not visible within one year. The only way to keep Ukraine's economy grow is to follow European vector of development, improve quality of institutions in Ukraine which will lead to more efficient functioning of economy and international trade.

3.3 Limitations and suggestion for further research

There are some of limitations of the Poisson pseudo-maximum likelihood estimator. The model does not pass the RESET test because we reject the null of correct specification.The p-value suggests the above specification is not in correct functional form.The problem is not that PPML is not the right estimator for the model but that the model is not right for the data. In this case the model specification needs to be improved.

However, PPML is quite robust when using clustered standard errors. The main reason to prefer PPML is not the zeros but the heteroskedasticity of trade data. So, even without zeros, PPML is generally preferable.

Models often fail the RESET when the sample focus on a particular group of countries. For example, when modeling only the exports of one country to the rest of the world, or modeling trade just between a small group of countries. Maybe future researches could add other important regressors. Or maybe include interactions (or cross-products) of the regressors that you already have. Finally, note that our sample is quite small.

Next, we did not review the effects of Ukraine-European Union Association Agreement and EU-Ukraine Deep and Comprehensive Free Trade Area as there is a quite short period of time since these events till nowadays, and it is quite complicated to estimate the effects of the counted above agreements on foreign bilateral trade between Ukraine and European Union on annual basis. Probably it will be advisable to analyse trade relations at level of the firms taking monthly data. However, it will be possible to study this issue deeply and comprehensively in a few years (at least 5 years after the events) and, apparently, it will be possible to get sufficient results and make additional conclusions and recommendations.

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APPENDICES

Stata do-file

```
Robust OLS Estimator
--------------------
Robust OLS results of the augmented gravity model for total trade
------------------------------------------------------------------
. regress lnTT lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)

test (lnGDPX = lnGDPM = 1)
test (CONT = LAND = COL = 0)

Robust OLS results of the augmented gravity model for imports
-------------------------------------------------------------
. regress lnX lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)

. test (lnGDPX = lnGDPM = 1)
. test (CONT = LAND = COL = 0)


Robust OLS results of the augmented gravity model for imports
-------------------------------------------------------------


. regress lnM lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)

. test (lnGDPX = lnGDPM = 1)
. test (CONT = LAND = COL = 0)

Summarize regression tables
---------------------------


. ssc instal outreg

. regress lnTT lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)
. outreg using gravity.doc, replace
. regress lnX lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)
. outreg using gravity.doc, merge
. regress lnM lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL, robust
cluster(DIST)
. outreg using gravity.doc, merge
```

```
Poisson Pseudo-Maximum Likelihood Estimator

------------------------------------------

To avoid estimations problems variables are rescaled in millions of US dollars
------------------------------------------------------------------------------
. generate TT_resize = TT/1000000

. generate X_resize = X/1000000

. generate M_resize = M/1000000
------------------------------------------------------------------------------


PPML results for the augmented gravity model for total trade
------------------------------------------------------------
. ppml TT_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)

PPML results for the augmented gravity model for exports
--------------------------------------------------------

. ppml X_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)

PPML results for the augmented gravity model for imports
--------------------------------------------------------

. ppml M_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)


Summarize regression tables
---------------------------
Use outreg command to create a single table that will summarize the estimation results
side by side

. ppml TT_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)
. outreg using gravity.doc, replace
. ppml X_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)
. outreg using gravity.doc, merge
. ppml M_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL,
cluster(DIST)
outreg using gravity.doc, merge
```

```
PPML Fixed-Effects Estimator

----------------------------

PPML fixed-effects results for the augmented gravity model for total trade
------------------------------------------------------------------------------

. xi: ppml TT_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL
i.Partner, cluster(DIST)

PPML fixed-effects results for the augmented gravity model for exports
------------------------------------------------------------------------------

. xi: ppml X_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL
i.Partner, cluster(DIST)

PPML fixed-effects results for the augmented gravity model for imports
------------------------------------------------------------------------------

. xi: ppml M_resize lnGDPX lnGDPM lnDIST lnDIFF lnTARIFF lnREER CONT LAND COL
i.Partner, cluster(DIST)
```

Stata regression outputs

```
Robust OLS Estimator
--------------------

Robust OLS results of the augmented gravity model for total trade
------------------------------------------------------------------------------

Linear regression                                      Number of obs =     639
                                                       F(  9,    26) =   44.56
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.8043
                                                       Root MSE      =  .65679

                                 (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
         lnTT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnGDPX |   .7920416   .1040723     7.61   0.000     .5781178    1.005965
       lnGDPM |   .4451517   .1114852     3.99   0.000     .2159907    .6743128
       lnDIST |  -.8614225   .2987546    -2.88   0.008    -1.475521   -.2473236
       lnDIFF |   .6474529   .2536555     2.55   0.017     .1260565    1.168849
     lnTARIFF |  -.1573249   .1032226    -1.52   0.140    -.3695021    .0548522
       lnREER |  -1.362569   .4998776    -2.73   0.011    -2.390082   -.3350555
         CONT |   .2341678    .325951     0.72   0.479    -.4358341    .9041697
         LAND |   .3606184   .2502735     1.44   0.162    -.1538262     .875063
          COL |   .8590277   .4284409     2.01   0.055    -.0216451    1.739701
        _cons |   1.959686    2.99407     0.65   0.519    -4.194713    8.114085
------------------------------------------------------------------------------

Test if the hypothesis that both GDP coefficients are equal to unity
--------------------------------------------------------------------

 test (lnGDPX = lnGDPM = 1)

 ( 1)  lnGDPX - lnGDPM = 0
 ( 2)  lnGDPX = 1

       F(  2,    26) =   23.83
            Prob > F =    0.0000

Test of the hypothesis that all dummy coefficients are equal to zero
--------------------------------------------------------------------
test (CONT = LAND = COL = 0)

 ( 1)  CONT - LAND = 0
 ( 2)  CONT - COL = 0
 ( 3)  CONT = 0

       F(  3,    26) =    1.55
            Prob > F =    0.2254
```

Robust OLS results of the augmented gravity model for exports

```
Linear regression                                      Number of obs =     639
                                                       F(  9,    26) =   30.73
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.6866
                                                       Root MSE      =  .92735

                                    (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
         lnX |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .8591307   .1537629     5.59   0.000     .5430665    1.175195
      lnGDPM |   .1336821    .156828     0.85   0.402    -.1886825    .4560466
      lnDIST |  -.0351628   .4023824    -0.09   0.931    -.8622717     .791946
      lnDIFF |    1.34105   .3203633     4.19   0.000     .6825333    1.999566
    lnTARIFF |  -.0794105   .1486235    -0.53   0.598    -.3849105    .2260896
      lnREER |  -1.048395   .5425466    -1.93   0.064    -2.163615    .0668256
        CONT |   .3540366    .355189     1.00   0.328    -.3760648    1.084138
        LAND |   .7221541   .3590512     2.01   0.055    -.0158862    1.460194
         COL |   1.226675   .5315775     2.31   0.029     .1340022    2.319349
       _cons |   1.154861   3.406132     0.34   0.737    -5.846543    8.156266
------------------------------------------------------------------------------

Test if the hypothesis that both GDP coefficients are equal to unity
------------------------------------------------------------------------
test (lnGDPX = lnGDPM = 1)

 ( 1)  lnGDPX - lnGDPM = 0
 ( 2)  lnGDPX = 1

       F(  2,    26) =   32.92
            Prob > F =    0.0000

Test of the hypothesis that all dummy coefficients are equal to zero
------------------------------------------------------------------------
test (CONT = LAND = COL = 0)

 ( 1)  CONT - LAND = 0
 ( 2)  CONT - COL = 0
 ( 3)  CONT = 0

       F(  3,    26) =    2.18
            Prob > F =    0.1145
```

Robust OLS results of the augmented gravity model for imports

```
Linear regression                                      Number of obs =     639
                                                       F(  9,    26) =   32.13
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.8287
                                                       Root MSE      =  .71782

                                    (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
         lnM |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .9007878   .0887808    10.15   0.000     .7182962    1.083279
      lnGDPM |   .7195386   .1287539     5.59   0.000     .4548812    .9841961
      lnDIST |  -1.578639   .3140105    -5.03   0.000    -2.224097   -.9331808
      lnDIFF |   .2074984    .208143     1.00   0.328    -.2203457    .6353425
    lnTARIFF |    .031932   .1334465     0.24   0.813    -.2423712    .3062352
      lnREER |  -1.805552   .6946883    -2.60   0.015    -3.233504   -.3775998
        CONT |   .1305639   .3206661     0.41   0.687    -.5285746    .7897024
        LAND |   .3988754   .2511398     1.59   0.124    -.1173498    .9151006
         COL |   1.031375   .4697354     2.20   0.037     .0658195     1.99693
       _cons |  -2.470049    3.61778    -0.68   0.501    -9.906501    4.966404
------------------------------------------------------------------------------

Test if the hypothesis that both GDP coefficients are equal to unity
------------------------------------------------------------------------
test (lnGDPX = lnGDPM = 1)

 ( 1)  lnGDPX - lnGDPM = 0
 ( 2)  lnGDPX = 1

       F(  2,    26) =    3.43
            Prob > F =    0.0478

Test of the hypothesis that all dummy coefficients are equal to zero
------------------------------------------------------------------------
test (CONT = LAND = COL = 0)

 ( 1)  CONT - LAND = 0
 ( 2)  CONT - COL = 0
 ( 3)  CONT = 0

       F(  3,    26) =    1.99
            Prob > F =    0.1408
```

Poisson Pseudo-Maximum Likelihood Estimator

PPML results for the augmented gravity model for total trade

```
note: checking the existence of the estimates
Number of regressors excluded to ensure that the estimates exist: 0
Number of observations excluded: 0
note: starting ppml estimation
note: TT_resize has noninteger values
Iteration 1:   deviance =  168916.2
Iteration 2:   deviance =  125717.4
Iteration 3:   deviance =  123161.8
Iteration 4:   deviance =  123147.1
Iteration 5:   deviance =  123147.1
Iteration 6:   deviance =  123147.1
Number of parameters: 10
Number of observations: 639
Pseudo log-likelihood: -64044.945
R-squared: .77897435
```

(Std. Err. adjusted for 27 clusters in DIST)

TT_resize	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPX	.8751695	.1109625	7.89	0.000	.6576869	1.092652
lnGDPM	.5606814	.094963	5.90	0.000	.3745573	.7468055
lnDIST	-.6095199	.3321552	-1.84	0.066	-1.260532	.0414922
lnDIFF	.6526365	.2050562	3.18	0.001	.2507336	1.054539
lnTARIFF	.062802	.0704128	0.89	0.372	-.0752046	.2008087
lnREER	-1.687322	.462258	-3.65	0.000	-2.593331	-.7813127
CONT	.3978493	.1860014	2.14	0.032	.0332933	.7624054
LAND	.5696836	.1534728	3.71	0.000	.2688825	.8704848
COL	1.040636	.3115257	3.34	0.001	.4300574	1.651216
_cons	-17.36298	3.068791	-5.66	0.000	-23.3777	-11.34826

PPML results for the augmented gravity model for exports

```
note: checking the existence of the estimates
Number of regressors excluded to ensure that the estimates exist: 0
Number of observations excluded: 0
note: starting ppml estimation
note: X_resize has noninteger values
Iteration 1:   deviance =  104856.1
Iteration 2:   deviance =  90173.97
Iteration 3:   deviance =  89406.57
Iteration 4:   deviance =  89402.94
Iteration 5:   deviance =  89402.94
Iteration 6:   deviance =  89402.94
Number of parameters: 10
Number of observations: 639
Pseudo log-likelihood: -46881.589
R-squared: .65393081
Option strict is: off
                                (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
    X_resize |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .8262709   .1490576     5.54   0.000     .5341233    1.118419
      lnGDPM |   .2919019    .154122     1.89   0.058    -.0101716    .5939755
      lnDIST |  -.0037027   .2731402    -0.01   0.989    -.5390477    .5316422
      lnDIFF |   1.108909   .3300238     3.36   0.001     .4620739    1.755743
    lnTARIFF |     .12548   .0853199     1.47   0.141     -.041744     .292704
      lnREER |  -.9434023   .3882088    -2.43   0.015    -1.704278   -.1825269
        CONT |   .3796774   .2383135     1.59   0.111    -.0874086    .8467633
        LAND |   .6896544   .2221785     3.10   0.002     .2541925    1.125116
         COL |   .9927921   .4139372     2.40   0.016     .1814901    1.804094
       _cons |  -16.82696   3.280633    -5.13   0.000    -23.25688   -10.39704
------------------------------------------------------------------------------
```

PPML results for the augmented gravity model for imports

```
note: checking the existence of the estimates
Number of regressors excluded to ensure that the estimates exist: 0
Number of observations excluded: 0
note: starting ppml estimation
note: M_resize has noninteger values
Iteration 1:   deviance =  111417.2
Iteration 2:   deviance =  77450.89
Iteration 3:   deviance =  74880.48
Iteration 4:   deviance =  74856.07
Iteration 5:   deviance =  74856.06
Iteration 6:   deviance =  74856.06
Number of parameters: 10
Number of observations: 639
Pseudo log-likelihood: -39652.501
R-squared: .76649304
Option strict is: off
                                (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
    M_resize |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .9238484   .1213038     7.62   0.000     .6860973      1.1616
      lnGDPM |   .7745086   .0921356     8.41   0.000     .5939261    .9550912
      lnDIST |   -1.08661   .4014961    -2.71   0.007    -1.873528   -.2996918
      lnDIFF |   .2212886   .1766965     1.25   0.210    -.1250301    .5676074
    lnTARIFF |   .0130531   .0728907     0.18   0.858      -.12981    .1559163
      lnREER |  -2.254801   .6106867    -3.69   0.000    -3.451725   -1.057877
        CONT |   .5429938   .3064276     1.77   0.076    -.0575934    1.143581
        LAND |   .5020336   .1889896     2.66   0.008     .1316207    .8724465
         COL |    1.21921   .4230435     2.88   0.004     .3900602     2.04836
       _cons |  -19.68281   3.352604    -5.87   0.000    -26.25379   -13.11183
------------------------------------------------------------------------------
```

PPML fixed-effects results for the augmented gravity model for total trade

```
i.Partner, cluster(DIST)
i.Partner          _IPartner_1-28      (naturally coded; _IPartner_1 omitted)
note: checking the existence of the estimates
WARNING: lnGDPX has very large values, consider rescaling  or recentering
WARNING: lnGDPM has very large values, consider rescaling  or recentering
Number of regressors excluded to ensure that the estimates exist: 4
Excluded regressors:  _IPartner_8 _IPartner_18 _IPartner_23 _IPartner_26
Number of observations excluded: 0
note: starting ppml estimation
note: TT_resize has noninteger values
Iteration 1:   deviance =   65294.9
Iteration 2:   deviance =  30354.88
Iteration 3:   deviance =  26881.28
Iteration 4:   deviance =  26604.24
Iteration 5:   deviance =  26596.84
Iteration 6:   deviance =  26596.83
Iteration 7:   deviance =  26596.83
Number of parameters: 33
Number of observations: 639
Pseudo log-likelihood: -15769.807
R-squared: .97371492
Option strict is: off
                                (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
   TT_resize |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .9166355   .1672954     5.48   0.000     .5887425    1.244529
      lnGDPM |   .4635873   .0830092     5.58   0.000     .3008923    .6262823
      lnDIST |  -.7551444   .0579437   -13.03   0.000     -.868712   -.6415768
      lnDIFF |   .6819446   .3088669     2.21   0.027     .0765766    1.287313
    lnTARIFF |   .0443947   .0569241     0.78   0.435    -.0671746    .1559639
      lnREER |   -.816264   .2558102    -3.19   0.001    -1.317643   -.3148853
        CONT |   .5535364   .4457798     1.24   0.214    -.3201759    1.427249
        LAND |   .5252802   .2494689     2.11   0.035     .0363302     1.01423
         COL |   1.182606    .793977     1.49   0.136    -.3735599    2.738773
 _IPartner_2 |   .4308064   .2003581     2.15   0.032     .0381118    .8235011
 _IPartner_3 |    .787692   .8494028     0.93   0.354    -.8771069    2.452491
 _IPartner_4 |   1.736677   .7019943     2.47   0.013     .3607931     3.11256
 _IPartner_5 |   .3088542   .3004819     1.03   0.304    -.2800795    .8977878
 _IPartner_6 |   .3438358   .1529952     2.25   0.025     .0439707    .6437009
 _IPartner_7 |  -.0138074   .2945392    -0.05   0.963    -.5910936    .5634787
 _IPartner_9 |   .1235487   .1304794     0.95   0.344    -.1321861    .3792836
_IPartner_10 |    .143368    .319768     0.45   0.654    -.4833657    .7701018
_IPartner_11 |  -.3396639   .1343184    -2.53   0.011    -.6029231   -.0764048
_IPartner_12 |  -1.133208   .0742163   -15.27   0.000    -1.278669   -.9877464
_IPartner_13 |  -.3923129   .3121141    -1.26   0.209    -1.004045    .2194196
_IPartner_14 |  -.9319451   .6706077    -1.39   0.165    -2.246312    .3824218
_IPartner_15 |   .1338605   .0691333     1.94   0.053    -.0016382    .2693593
_IPartner_16 |  -.1670014   .3091649    -0.54   0.589    -.7729533    .4389506
_IPartner_17 |   .3879278    .065668     5.91   0.000     .2592209    .5166347
_IPartner_19 |    -.51313   .3778602    -1.36   0.174    -1.253722    .2274624
_IPartner_20 |  -.3048418   .0405229    -7.52   0.000    -.3842652   -.2254184
_IPartner_21 |   .6752617   .8753873     0.77   0.440    -1.040466    2.390989
_IPartner_22 |   .6530419   .1550941     4.21   0.000     .3490631    .9570206
_IPartner_24 |  -.3138998   .3245208    -0.97   0.333    -.9499489    .3221492
_IPartner_25 |  -.5501313   .2213226    -2.49   0.013    -.9839156   -.1163469
_IPartner_27 |   .5539845   .6090092     0.91   0.363    -.6396515    1.747621
_IPartner_28 |  -.1586957   .2246662    -0.71   0.480    -.5990334    .2816421
       _cons |  -18.97068   4.470147    -4.24   0.000    -27.73201   -10.20935
------------------------------------------------------------------------------
```

PPML fixed-effects results for fixed-effects estimates for the augmented gravity model for exports

```
i.Partner         _IPartner_1-28      (naturally coded; _IPartner_1 omitted)
note: checking the existence of the estimates
WARNING: lnGDPX has very large values, consider rescaling  or recentering
WARNING: lnGDPM has very large values, consider rescaling  or recentering
Number of regressors excluded to ensure that the estimates exist: 4
Excluded regressors:  _IPartner_8 _IPartner_18 _IPartner_23 _IPartner_26
Number of observations excluded: 0
note: starting ppml estimation
note: X_resize has noninteger values
Iteration 1:   deviance =  42859.35
Iteration 2:   deviance =     27838
Iteration 3:   deviance =   26106.1
Iteration 4:   deviance =  25943.26
Iteration 5:   deviance =  25934.56
Iteration 6:   deviance =  25934.48
Iteration 7:   deviance =  25934.48
Iteration 8:   deviance =  25934.48
Number of parameters: 33
Number of observations: 639
Pseudo log-likelihood: -15147.361
R-squared: .91845789
Option strict is: off
                                (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
    X_resize |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   1.144526   .2362718     4.84   0.000     .6814419     1.60761
      lnGDPM |   .0551866   .1524246     0.36   0.717    -.2435601    .3539334
      lnDIST |  -.1891041   .0614097    -3.08   0.002    -.3094649   -.0687433
      lnDIFF |   1.170383   .5080886     2.30   0.021     .1745479    2.166219
    lnTARIFF |   .0894919   .0772476     1.16   0.247    -.0619107    .2408945
      lnREER |  -.6371201   .4063231    -1.57   0.117    -1.433499    .1592585
        CONT |   .7574763   .6307153     1.20   0.230    -.4787031    1.993656
        LAND |   1.140798   .3781178     3.02   0.003     .3997008    1.881895
         COL |   1.900379   1.085028     1.75   0.080    -.2262374    4.026995
 _IPartner_2 |   .6298011   .3131191     2.01   0.044     .0160989    1.243503
 _IPartner_3 |   1.553327   1.173417     1.32   0.186    -.7465278    3.853182
 _IPartner_4 |   3.194501   .9788644     3.26   0.001     1.275962     5.11304
 _IPartner_5 |   .0301213   .4451308     0.07   0.946     -.842319    .9025615
 _IPartner_6 |   -.164108   .2217188    -0.74   0.459    -.5986688    .2704527
 _IPartner_7 |   .5182274   .4746449     1.09   0.275    -.4120594    1.448514
 _IPartner_9 |   .4880546   .2060917     2.37   0.018     .0841223    .8919869
_IPartner_10 |  -.4508512   .4739649    -0.95   0.341    -1.379805    .4781029
_IPartner_11 |   -.914989   .1926268    -4.75   0.000    -1.292531   -.5374474
_IPartner_12 |  -1.134424   .1052442   -10.78   0.000    -1.340699   -.9281495
_IPartner_13 |   .1469593   .4166926     0.35   0.724    -.6697432    .9636618
_IPartner_14 |   -.213885   .9097841    -0.24   0.814    -1.997029    1.569259
_IPartner_15 |  -.0542365   .1158992    -0.47   0.640    -.2813948    .1729218
_IPartner_16 |   .0069803   .4880786     0.01   0.989    -.9496361    .9635968
_IPartner_17 |   .6067579   .0997985     6.08   0.000     .4111563    .8023594
_IPartner_19 |   -.445455   .6206495    -0.72   0.473    -1.661906    .7709956
_IPartner_20 |   .2361196   .0544907     4.33   0.000     .1293198    .3429195
_IPartner_21 |   2.026048   1.210446     1.67   0.094    -.3463829    4.398478
_IPartner_22 |    1.08124    .265401     4.07   0.000     .5610631    1.601416
_IPartner_24 |   .0419603   .4501395     0.09   0.926    -.8402969    .9242176
_IPartner_25 |  -.2894676   .3067357    -0.94   0.345    -.8906584    .3117233
_IPartner_27 |  -.2644889   .8286073    -0.32   0.750    -1.888529    1.359552
_IPartner_28 |  -.9505686   .3593467    -2.65   0.008    -1.654875    -.246262
       _cons |  -19.59182   5.749016    -3.41   0.001    -30.85968   -8.323951
```

PPML fixed-effects results for the augmented gravity model for imports

```
i.Partner         _IPartner_1-28      (naturally coded; _IPartner_1 omitted)
note: checking the existence of the estimates
WARNING: lnGDPX has very large values, consider rescaling  or recentering
WARNING: lnGDPM has very large values, consider rescaling  or recentering
Number of regressors excluded to ensure that the estimates exist: 4
Excluded regressors:  _IPartner_8 _IPartner_18 _IPartner_23 _IPartner_26
Number of observations excluded: 0
note: starting ppml estimation
note: M_resize has noninteger values
Iteration 1:   deviance =  42546.35
Iteration 2:   deviance =  16534.61
Iteration 3:   deviance =  13448.89
Iteration 4:   deviance =  13140.95
Iteration 5:   deviance =  13116.93
Iteration 6:   deviance =  13116.39
Iteration 7:   deviance =  13116.39
Iteration 8:   deviance =  13116.39
Number of parameters: 33
Number of observations: 639
Pseudo log-likelihood: -8782.6653
R-squared: .98232621
Option strict is: off
                                (Std. Err. adjusted for 27 clusters in DIST)
------------------------------------------------------------------------------
             |               Robust
    M_resize |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lnGDPX |   .7692709   .1638579     4.69   0.000     .4481153    1.090427
      lnGDPM |   .7459943   .0799018     9.34   0.000     .5893896    .9025991
      lnDIST |  -1.308577   .0520357   -25.15   0.000    -1.410565   -1.206588
      lnDIFF |   .3261877   .1905997     1.71   0.087     -.047381    .6997563
    lnTARIFF |   .0254567   .0553313     0.46   0.645    -.0829906    .1339041
      lnREER |  -.7216892   .2603761    -2.77   0.006    -1.232017   -.2113614
        CONT |   .3800777   .2980488     1.28   0.202    -.2040872    .9642426
        LAND |   .1017854   .2631113     0.39   0.699    -.4139033    .6174741
         COL |    .630597   .6527672     0.97   0.334    -.6488032    1.909997
 _IPartner_2 |   .3887287    .208985     1.86   0.063    -.0208744    .7983318
 _IPartner_3 |  -.0659573   .6237496    -0.11   0.916    -1.288484     1.15657
 _IPartner_4 |   .1967836   .6836194     0.29   0.773    -1.143086    1.536653
 _IPartner_5 |   .5674965   .1880606     3.02   0.003     .1989045    .9360885
 _IPartner_6 |   .5965812   .1172761     5.09   0.000     .3667242    .8264382
 _IPartner_7 |  -.3431836   .3047056    -1.13   0.260    -.9403956    .2540284
 _IPartner_9 |  -.1363105   .1285473    -1.06   0.289    -.3882585    .1156375
_IPartner_10 |   .1069383   .3335548     0.32   0.749     -.546817    .7606936
_IPartner_11 |   .1065869   .0966737     1.10   0.270    -.0828901    .2960639
_IPartner_12 |  -1.175952   .0572008   -20.56   0.000    -1.288063    -1.06384
_IPartner_13 |  -.7561049   .2857911    -2.65   0.008    -1.316245   -.1959646
_IPartner_14 |  -1.436816   .5548276    -2.59   0.010    -2.524258   -.3493741
_IPartner_15 |   .2715375   .0705255     3.85   0.000       .13331    .4097651
_IPartner_16 |  -.1395067   .3194884    -0.44   0.662    -.7656925     .486679
_IPartner_17 |   .1876536   .0481987     3.89   0.000      .093186    .2821213
_IPartner_19 |  -.5729878   .3740021    -1.53   0.126    -1.306018    .1600428
_IPartner_20 |  -.9100548   .0430302   -21.15   0.000    -.9943924   -.8257171
_IPartner_21 |  -.5852484   .8228312    -0.71   0.477    -2.197968    1.027471
_IPartner_22 |   .3953687   .1426524     2.77   0.006     .1157751    .6749623
_IPartner_24 |  -.8608002   .2823249    -3.05   0.002    -1.414147   -.3074535
_IPartner_25 |  -.7561688   .1681828    -4.50   0.000    -1.085801   -.4265366
_IPartner_27 |   .6138828   .5681462     1.08   0.280    -.4996632    1.727429
_IPartner_28 |  -.0723049   .2323607    -0.31   0.756    -.5277235    .3831137
       _cons |  -19.90468   3.645834    -5.46   0.000    -27.05038   -12.75897
```

LIST OF COUNTRIES

Number of the country	Name of the country	Number of the country	Name of the country
1	Ukraine	24	Romania
2	Austria	25	Slovakia
3	Belgium	26	Slovenia
4	Bulgaria	27	Spain
5	Croatia	28	Sweden
6	Republic of Cyprus	29	United Kingdom
7	Czech Republic		
8	Denmark		
9	Estonia		
10	Finland		
11	France		
12	Germany		
13	Greece		
14	Hungary		
15	Ireland		
16	Italy		
17	Latvia		
18	Lithuania		
19	Luxembourg		
20	Malta		
21	Netherlands		
22	Poland		
23	Portugal		

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