TRADE POTENTIAL OF THE REPUBLIC OF BELARUS: GRAVITY MODEL APPROACH

by

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Abstract

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This study incorporates recent amendments and modifications to the gravity model of trade to assess the gap between the actual volume of exports trade flows and the volumes predicted by the model for the Republic of Belarus. The prediction is calculated by using out-of-sample prediction, applying the methodology developed by Helpman, Melitz, Rubenstein (2008). Two stages of estimation are performed to predict extensive and intensive margins of trade. The results demonstrate that the Republic of Belarus tends to concentrate its trade in the CIS region, while underperforming in trade with European Union and other developed countries.

To my grandmother, who loved me dearly and supported through life.

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Chapter 1

INTRODUCTION

At the beginning of the last decade of the twentieth century the USSR totally collapsed, which resulted in gaining independence by its former republics and so-called transition period from the command to market economy. This, in its turn, led to disintegration of the Council for Mutual Economic Assistance (CMEA), of the USSR customs union and to the need of changing the trade patterns of countries. A necessity to be engaged in free trade and globalization processesbecame apparent,as a way to ensure the country's growth and stable performance of the country's economy. New trade links had to be established and new integration blocks to be formed as a result of obliteration of previous trade policy.

The Republic of Belarus, being one of the former USSR countries, is a country with relatively small exports oriented open economy, still on its way from administrative economy to the market one. International trade policy is one of the main issues under consideration by the present Belarusian government. Belarusian authorities bring forward claims that increasing and diversifying exports and decreasing a flow of imports in the economy can and will ensure stable economic growth of the country and lead to an increase in "Trade across borders"ranking by international organizations[1].

International trade is of considerable importance for the economic and monetary stability of the Republic of Belarus. Manufacturing is mostly exports oriented,

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1 Ministry of the foreign affairs of the Republic of Belarus, International Rankings, http://www.mfa.gov.by/en/foreign_trade/ratings/

which signals about the dependence on the trade flow. While imports dependence is significant too as the country doesn't have any energy resources of its own and is reliant on the sufficient amount of imported raw materials. Exports of fuel amount to 37 percent of all merchandise exports, while exports of food and agricultural products are only 11 percent. According to World Bank current account balance amounts to a deficit of almost 6.4 billion dollars in 2009 while exports were more than 21 billion dollars.[2] These numbers indicate that the diversification of trade and change of the existing trade patterns might be beneficial to a current account balance and to the economy of Belarus in general. According to the Ministry of foreign affairs of the Republic of Belarus, the country's key export positions are potash and nitrogen fertilizers, oil products, rolled steel, trucks and tractors, wood products, clothing, dairy and meat products, sugar and others. Number of Belarusian trade partners is close to 180 countries worldwide.[3]

In this research I concentrate on trade flows of the Republic of Belarus with the world, and specifically, members of the Commonwealth of Independent States (CIS) and with the European Union. Multilateral and bilateral models of free trade have been under close consideration for a long time. Bilateral models of free trade have been studied since 1933 by Bertil Ohlin, who argued that "increasing returns might be a reason for trade between countries"(Ellsworth, 1933). Frankel and Romer (1999) also investigated the impact of international trade on income by using bilateral trade equation, which contained only geographical characteristics of countries, disregarding economic ones. The objective of this paper is to make inferences on whether Belarus is trading at its potential, to evaluate present diversification of trade partners, and to conclude whether trade policy of the Republic of Belarus is efficient in this diversification

[2] World Bank Indicators, http://data.worldbank.org/indicator/BN.CAB.XOKA.CD
[3] Ministry of Foreign Affairs, Foreign trade of Belarus, http:/www.mfa.gov.by/en/foreign_trade/

or if some measures have to be taken to increase its economic growth through improving international trade policy.

This research contributes to the studies of trade patterns of emerging countries, since, despite the importance of these countries for international economic development, Belarus in particular; empirical works estimating Belarusian trade potential are quite limited. The goal of this research is to assess the gap between the way Belarus trades now and how its economic growth could profit from diversifying its trade pattern in future.

This is to be done by using gravity model approach, which "has been long recognized for its consistent empirical success in explaining many different types of flows" (Bergstrand, 1985, p.2). Model specification is to be described with the latest renovations employed to control for selection, asymmetry and endogeneity biases. Firstly, gravity equation for the world is estimated. After that, following Batra (2004) method estimated coefficients are used specifically to analyze Belarusian trade patterns. This is to be done by using the method of out-of-sample predictions, which assumes excluding from the first gravity equation Belarus as a trade partner. According to McPherson and Trumbull (2008) "world" gravity equation should be estimated for the most developed countries so as to see the maximum potential of a country's trade. In a similar way, the "world" gravity equation is estimated here for the majority of countries of the world. Then these estimated values are compared with the actual volume of exports in Belarus and inferences are made whether the trade potential is achieved and whether the diversification of exports is sufficient.

The dependent variable in this analysis is multidirectional export trade flows for 10 aggregated industries for 174 exporting countries and 227 importing countriesin 1998-2008 for the "world" gravity equation. Gross domestic product is measured in US dollars and population, measured in millions, is obtained from World Development Indicators of the World Bank. Annual data on bilateral trade flows are obtained from the databases of UN COMTRADE and CEPII. Since this paper estimates trade potential at a disaggregated level, industry level trade flows are used. Export data are aggregated into ten sectors from the initial 42 GTAP sectors. Bilateral distance in kilometers is also obtained from CEPII. Country-specific variables are provided in CIA's World Factbook.

The remainder of the paper is organized as follows. Chapter 2 provides a brief literature review on applications of the gravity model to estimating trade potential in transition countries and on the estimation technique. Chapter 3 and Chapter 4 present the data and methodological foundations for the model. Chapter 5 discusses the results and possible future applications, as well as directions of further diversification of trade of the Republic of Belarus.

Chapter 2

LITERATURE REVIEW

This chapter investigates both the theoretical and empirical backgrounds of the popular gravity model of trade, while mentioning new amendments and critics to the model. It follows by discussing the application of the model to bilateral trade flows of the transition counties. Specific attention is drawn to the techniques for estimation of the trade potential of a country.

For more than five decades, since it was first thought of in 1961, the gravity model of trade has been called "workhorse for cross-country empirical analysis of international trade flows" (Baier and Bergstrand, 2006, p.1), "most empirically successful in economics" (Anderson and Wincoop, 2003, p.1) and has been further developed into a strong theoretical and empirical model. Nevertheless, modifications to the model do not cease, which signals about yet to be existing applications and amendments to both theoretical and empirical sides of gravity model of trade.

The gravity model was first developed following the physical gravity model derived by Newton in 1687 and was then used by economists in the 1960's - Linder (1961), Tinbergen (1962) and Linneman(1966). These were purely empirical papers, which is why they underwent serious criticism because of the absence of theoretical foundation. Anderson (1979) made the first attempt to prove that theoretical justification for the gravity model exists. Further the same assumption was used by Bergstrand in 1985, who aimed at "developing further the microeconomic foundations of the gravity equation". Helpman and Krugman (1985) used the same assumptions and the same constant elasticity of substitution

(CES) utility function to again prove that the gravity equation is consistent with theory of international trade. Deardoff (1995) derived the gravity equation from the well-known two-factor, two-commodity Heckscher-Ohlin model. All of that allowed economists to see that the gravity approach to estimating trade flows is not only a useful technique, but can also be transformed in many ways to analyze other issues of international trade.

Even so, nowadays, attention is drawn to the fact that aggregated data, used for purposes of research in the gravity model, aren't reliable as it assumes homogenous prices across all countries and the absence of zero trade flows. The fact that data were aggregated in the early works prompted a plenty of new theoretical papers to be written proving empirically that the gravity equation is still applicable if heterogeneity of firms is taken into consideration.

Once transportation costs, border barriers and barriers to entry are introduced to the model it causes "substantial asymmetries between trading partners and bias estimators of the coefficients of the gravity equation because of correlation of errors with explanatory variables" (Shepotylo, 2009, p.2). Feenstra et al. (2001) was one of the first to use disaggregated data and predicted that the volume of exports is proportional to GDP only in countries where there are no barriers to entry. Empirically that meant the appearance of a new explanatory variable in the gravity equation accounting for this "home-market effect". But Feenstra only accounted for disaggregation from one side, which was criticized by the following research that disaggregated data on both sides (Melitz, 2003).

Recently a simple model was developed to account for heterogeneity or disaggregation of the data. Helpman, Melitz and Rubinstein (further, HMR, 2008) derived a theoretical model to estimate probability of a firm to export. They suggested that firms in a country differ in their productivity and there is a selection mechanism for a firm into exporting. Additionally, their model allows considering trade flows at the extensive and intensive margins, which is to predict trade flows geographically as well as to evaluate the composition of exports. Another attractive feature of the model is that, even though it accounts for price heterogeneity and firm's selection process it does not require scarce firm-level data, allowing for "country level data, which predict the selection of heterogeneous firms into export markets and their associated aggregate trade volumes"(HMR, 2008, p.5).

This is particularly important in this research as firm-level data aren't available for the Republic of Belarus as well as some of the transition economies, which also allows to use the model described above in papers concerning trade potentials in emerging markets. As a result, the work by HMR (2008) provided the researchers with the invaluable theoretically based model that is able to control for asymmetry and selection biases, which are considered the main drawbacks of the gravity model.

The problem of zero trade flows has been under close consideration as well, since they can lead to biased estimates. This problem is especially closely examined in works concerning trade potentials since the method of prediction generates values that are incomparable with zero trade flows. Evenett and Venables (2002), Anderson and van Wincoop (2004) and HMR(2008) all argue that "disregarding countries that do not trade with each other" leads to asymmetric bias.

However, HMR "develop a theory that predicts positive as well as zero trade flows between countries and use the theory to derive estimation procedures that exploit the information contained in data sets of trading and nontrading countries alike" (HMR, 2008, p.2).Zero trade flows are specifically important in this research as Belarus doesn't trade with most of the countries of the world, which especially at the industry level, leads to the prevalence of zeros in data. This would lead to the biased prediction and will be addressed with a methodology proposed by HMR (2008).

The main assumption made by founders of the gravity model is that there is no so called "border puzzle". Trade is assumed to have no "frictions" (Helpman, 1987) and there are "melting iceberg" transport costs (Deardoff, 1995). Substantial number of works is dedicated to investigate and explain this border puzzle. When border effects, such as transport costs or tariff measures appear in the model one can't claim the presence of homogeneity of prices and a new approach should be developed. Some studies just introduced a dummy variable controlling for some border effect (Manchin and Pinna, 2003), which caused omitted variable bias. Feenstra (2004) thought of "assuming a specific utility function and adopting the CES specification". Border puzzle has become a burning issue since McCullum (1995) brought up the gravity model that compared trade between Canadian provinces and trade between Canada and the USA. In his model he introduced a bilateral distance between two provinces as an explanatory variable and included a variable for the common border, which was a breakthrough and is still used as one of the key explanatory variables for the gravity model of trade.

Anderson and van Wincoop (2003, p.3) derived a supplementary to McCallum's equation by adding what they called "multilateral resistance" that they refer to as "theoretically appropriate average trade barrier".This can easily be called a breakthrough in theoretical context of the gravity model. Since Anderson and van Wincoop (2003) systematic bias was recognized in the estimation of the gravity equation particularly from the omitting endogenous "multilateral resistance" (MR) term. While decomposing trade resistance into three components, they acknowledge that "trade costs are borne by the exporter". MR term is a measure of trade barriers between an exporter and its trading partners. Anderson and van Wincoop (2003, p.5) said that "MR variables bear some resemblance to remoteness indexes included in the gravity estimates subsequent to McCullum (1995)". The notion of geographic remoteness was entitled to "capture the effect on trade flows between some regions of average distance". That was a valuable extension to the gravity equation that allowed to calculae how distance affects trade flows.

While McCullum (1995), Anderson and van Wincoop (2003) suggested constructing a tedious system of nonlinear equations, empirical works found it hard to use any known estimation technique to obtain these parameters. Baier and Bergstand (2008) stated that "one needs to estimate these multilateral resistance terms for any two regions with and without a border, in a manner consistent with theory". Nevertheless, they thought of "using a simple first-order log-linear Taylor-series expansion of the multilateral prices", which helped them achieve at estimation of the gravity equation with OLS. The results obtained by Anderson and van Wincoop (2003)were analyzed by Ballisteri and Hillberry, Rutherford (2007) who concluded that McCullum's model didn't give full explanation to the border puzzle effect and pointed out the presence of structural bias.

Even though the fact that the issue with resistance terms was a cornerstone of the theoretical framework, Egger (2001) concentrated on econometric issues and, in its turn, looked for an unbiased estimator for the analysis of trade volumes. He pointed out three econometric problems that arise and arrived at the conclusion that "the consistent and most efficient model is a Hausman and Taylor AR(1) estimator"(Egger, 2001, p.12).His research was aimed at pointing out the best technique for calculating trade potential based on the famous gravity model. As a matter of fact, he professed that "large unused export potentials", calculated with the help of other procedures, rather than Hausman and Taylor, "reveal nothing other than inherent problems of misspecification in terms of consistency and efficiency of the estimators" (Egger, 2001, p.12).

Following Egger (2002) this research makes use of "out-of-sample" methodology to calculate projected trade volumes for Belarus as a constructed model proposes, while comparing them to the actual trade flows. Nowadays, it is very straightforward that one should use the gravity model to estimate trade potentials. With all the discussed shortcomings and weaknesses of the model, researches around the world use it to evaluate trade patterns of many emerging economies.

Brodzicki (2009) utilized the gravity model of trade to investigate bilateral trade flows of Poland with 181 trade partners. The author estimates two equations, the basic and the extended one to arrive at the conclusion that not only common independent variables affect trade volumes, but one should also consider including exchange rate volatility in the model for transition economies, if they are not a part of a currency union. The author, however, has doubts if such a measure is useful as volatility of a local currency should be then considered versus a basket of currencies, while for Poland it was useful to use euro. Egger (1999) estimated the potential for trade between Austria and five CEE countries (Hungary, Czech Republic, Slovak Republic, Poland and Slovenia). He used "fixed country effects" to estimate export potential in the framework of these countries accessing European Union. According to his results "CEEC's openness to EU exports would increase, without altering the bilateral degree of openness among other countries of the European Union" (Egger, 1999, p.59).

Maryanchyk (2005) applied the gravity theory of trade to estimate two specifications of the model for Ukraine and found that until 1999 actual trade flows exceeded those predicted by the model, while also stating that the country exhausted all potential of trade with European Union countries and should concentrate on "prospects of trade with smaller economies". Subsequently, he stated that Ukraine should engage in more trade with countries big in size and GDP, such as the USA, Japan and others. Shepotylo (2009, p.22) estimated trade potential of CIS countries based on disaggregated data while incorporating zero trade flows and heterogeneity of firms at the industry level. As a result, he found that "CIS countries are largely in line with what is expected from gravity model", "there are some distortions of export flows of CIS countries that indicate smaller degree of geographical and industrial diversification".

This thesis investigates the trade patterns of the Republic of Belarus with the help of the gravity model. It incorporates the results to compute the trade potential and to analyze the scope of trade diversification of the country to see whether the potential is explored or there are still some opportunities to ensure the surplus of the current account of the balance of payments by increasing the volume of exported goods.

As the above literature review showed, both empirical and theoretical works on the gravity model have come a long way over the last fifty years. The main shortcoming, as the history of research revealed, is the weak theoretical foundation of the model proposed by the founders, which was then established by the successors. Several theories were developed,whichhelped to provide researchers with a ground for the empirical analysis. The variety of macro- and microeconomic theories can be used to specify different gravity equations, whereas all of them could be aimed at explaining trade flows and trade potentials of the bilateral and multilateral trade between countries of the world. This paper estimates the potential of trade of the Republic of Belarus based on the given data to show that the country's exports are not diversified sufficiently and to demonstrate possible geographical and industrial diversification that can be achieved.

Chapter 3

METHODOLOGY

As was noted above, this research intends to study trade patterns of the Republic of Belarus by using the gravity model approach, which proved to be one of the best for analyzing and predicting trade flows among countries. A lot has been done to improve the specification of the gravity model as well as to solve the empirical puzzles discussed above. The methodology used in this paper tries to incorporate achievements of previous works to build yet another specification of the famous model, which then will be tested empirically to see if the specification is reasonable.

The main goal of this research is to make inferences whether Belarus trades at its potential. For this I apply the methodology introduced by Heplman, Melitz and Rubenstein (further HMR, 2008) where they proposed two stage estimation procedure, where at the first stage the probability of export from one country to another is estimated and at the second stage gravity equation itself is estimated and the results obtained are compared with actual trade flows. It is expected to see some substantial deviation from what will be predicted with the Probit equation and what will be estimated with the gravity equation.

Following the discussion of the empirical puzzles and possible problems the model presented below takes into account heterogeneity and disaggregation of the data by implementing the model of HMR (2008), the problem of zero trade flows is solved by the estimation of the probit model including time and country fixed effect, so-called the border puzzle is solved by including in the main equation multilateral resistance term, constructed following Baier and Bergstrand (2009), which serves as an indicator of the geographical remoteness.

The most commonly used gravity equation is derived from microeconomic foundations of utility maximization of a consumer (Anderson and van Wincoop, 2003) and has a form:

$$X_{ij} = \left(\frac{p_i t_{ij}}{P_j}\right)^{1-\sigma} Y_j \quad , \qquad (1)$$

where p_i is the exporter's price of region i's good, t_{ij} is the gross trade cost, Y_j is the GDP of country j and P_j is the CES price index of country j (Baier and Bergstrand, 2009). There is no need to prove the gravity model theoretically as it has been done by many researches before (Anderson and van Wincoop, 2003, HMR,2008, Feenstra, 2004). The specification of the model tested in this paper is the following:

$$lnX_{ij} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_{ij} + \beta_4 MRT_{ij} + \beta_5 lnV_{ij} + +\gamma A + \varepsilon_{ij} \quad , \qquad (2)$$

Where i, j = 1, 2, ..., N, lnX_{ij} is log of exports of country i to country j in a given year, $lnGDP_{it}$ and $lnGDP_{jt}$ - logs of GDP for trading countries i and j in a given year, $lnDIS_{ij}$ –log of distance between trading countries, MRT_{ij} - proxy for the remoteness variable, lnV_{ij} is polynomial of degree three of the latent variable estimated by the probit equation and will be explained later, A is a vector of control factors including country and time fixed effects, and ε_{ij} is the error term, which is assumed to be normally distributed with zero mean and constant variance.

Multilateral resistance terms, used to account for remoteness, are calculated following Baier and Bergstrand (2009) and are the logs of GDP of all other countries weighted by the distance of those countries, are calculated by using the following formula:

$$MRT_{ij} = \left[\left(\sum_{k=1}^{N} \theta_k lnDIS_{ik} \right) + \left(\sum_{m=1}^{N} \theta_m lnDIS_{mj} \right) - \left(\sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m lnDIS_{km} \right) \right], \quad (3)$$

where θ 's represent the share of country's GDP in the world GDP, and $lnDIS_{ij}$ is the log of distance between two countries trading partners.

The theory predicts that distance will have a negative influence on the amount of goods exported, the further the trade partner is more trade barriers and costs the exporting country faces and the less trade occurs. Size of the countries, proxied by GDP, is assumed to enhance trade if countries are similar in size. For instance, if a country is small and the volume of GDP is small it is unlikely to be a big exporter as there is not enough domestic production to satisfy the need to export. So, the sign of the coefficient for GDP is ambiguous and depends on the relative size of two countries – trade partners. Influence of the variables such as population and area of the country on the volume of exports are, similarly, imprecise. According to the developed methodology, used to calculate MRT, the coefficient should have the sign opposite to that of the distance. Dummy variables for the regional trade agreement in force, contiguity of two countries, and common colony should have a positive influence on trade. Countries tend to trade more, if they share the same border, have preferential trade settings, and were once a colony, since that provides superior conditions for theoccurrence of trade in both directions.

As mentioned above the estimation of the above gravity equation serves only as a tool to predict the trading potential of Belarus. This paper follows the two-step estimation procedure proposed by HMR (2008), who provided a "theoretical model that has firm heterogeneity, yet doesn't need firm-level data to estimate the gravity equation". In their model, operating profits from the sales of goods to country i from country j are:

$$p_{ij}(a) = (1-\alpha)\left(\frac{t_{ij}c_j a}{\alpha P_i}\right)^{1-\sigma} Y_i - c_j f_{ij}, \quad (4)$$

Profits of a firm that exports to country i from country j are explained by trade costs t_{ij}, input costs c_j, productivity of the firm a, income Y_i and price index P_i of the importing country, bilateral fixed costs f_{ij}. Under zero profit condition HMR define a latent variable z_{ij} that determines the selection of the firms into the exports market and shows if the countries export to one another. Even though it is unobserved, the data gives us the possibility to observe the presence of the trade flow. Hence, $z_{ij}>0$ when country j exports to i, and $z_{ij}=0$ when it doesn't. Introducing this unobservable latent variable allowed them to come up with a probit model that is able to predict the relative volume of exports, even though the data can reflect a zero trade flow in its place. This particular result is very important for this research as the obtained probabilities will be compared with the prediction estimated by the gravity equation. First – stage estimation equation is as follows:

$$\rho_{ij} = prob(Z_{ij} > 0 | observed\ variables) = \quad , \quad (5)$$

Probit regression includes fixed country and time variables such as variable for common religion (n_{ij}), common currency (t_{ij}), WTO memberships (d_{ij}), common language (x_{ij}) and common legislation (m_{ij}). At the second stage, applying HMR's (2008) approach lnV_{ij} is approximated by the polynomial of the degree three by including the estimated values of the latent variable ($\psi_{ij} = \Phi^{-1}(\rho_{ij})$) and its second and third powers into the main gravity equation. As HMR (2008, p.16) stated "there is a need to select valid excluded variables for the second stage to rely on the normality assumption for the unobserved trade costs", which will affect only the volume of trade but have no effect on fixed trade costs. However, variables for size of the country, distance, contiguity and colony are also considered important for this stage of estimation and are included to provide reliable predicted probabilities, obtained after probit procedure. Therefore, most of the variables used in the first stage will not enter the gravity equation leaving the dummies contiguity and common colony.

Gravity model generally assumes the absence of zero trade flows in both directions. Nevertheless, the data used in empirical testing of the model always contains a lot of zero or even missing values. However, Linders and Groot (2006), HMR (2008) along with many other trade economists claim that just omitting observations that are missing or equal to zero produces bias to the results, as ignoring these trade flows underestimates the effects of the corresponding countries on trade or "that we lose information on the causes of very low trade" (Linders and Groot, 2006, p.4). Hence, some kind of selection mechanism is needed to capture the information provided by zero trade flows and that is exactly why it is the first stage of estimation that is performed. The obtained predicted value of the latent variable in the form of polynomial of degree three is assumed to capture all of unobserved factors that influenced the decision to export.

Given the fact that the empirical estimation is going to be performed by using data on bilateral trade flows over a number of years, the data are pooled and corresponding estimation techniques should be applied. However, there was a long debate about the technique to be applied. It was Egger (2001, 2000) who argued that "cross-section approach is affected by a severe problem of misspecification" and "convenient OLS estimates are very likely to result in inconsistent estimates". Wooldridge (2001) points out four possible techniques, which are pooled OLS, fixed effects, random effects and a methodology proposed by Hausman and Taylor (1981). Traditionally researchers estimate gravity model of trade for just a single year or for two years separately, which leads them to a single cross section. In this case one may use the realization of Baier and Bergstrand (2009): simple OLS. However, it doesn't seem reasonable to predict the potential of trade for any country based on the results of single year regression. Therefore, this research is going to use the panel data.

Egger (2001) notes that there are two possible problems with applying typical estimation methods for the panel data. Firstly, random effects model provides inconsistent parameters "due to the correlation of the explanatory variables with the unobserved effects". Secondly, there seems to be serial correlation among the residuals. He came up with application of Hausman and Taylor AR(1) model for estimating gravity model of trade. Egger (2001) claimed that "this estimator eliminates the systematic difference between observed and predicted trade flows". Hence, the model should account not only for heterogeneity bias, time-invariant variables, but also tests should be performed for autocorrelation and heteroscedasticity of error terms, since we are particularly interested in using them for predicting the dependent variable. And since the model proposed here uses two stages of estimation omitted variable bias is not considered as an issue, as the probit equation and the gravity equation include control variables for almost all types of barriers to trade among countries.

Chapter 4

DATA DESCRIPTION

As was mentioned before, this research is aimed at estimating trade potential of the Republic of Belarus by taking into consideration several problems discussed by early researchers. This includes testing the gravity equation with the panel of disaggregated data of bilateral trade flows for the world.

In order to estimate the gravity equation this paper uses data of bilateral exports for 174 countries leaving Belarus out at this estimation stage and 227 destination countries for the period 1998-2006 for each of the 42 industries described in Table 1. Disaggregated annual data on exports trade flows, which is the dependent variable in the model, are in thousands of the US dollars for GTAP sectors under 1998 classification obtained by using World Integrated Trade Solution (WITS) software from UN COMTRADE database. The GTAP sectors are aggregated into 10 groups for the simplicity. As a result dataset contains over 5 million observations. However, 3.8 million observations for the value of export are missing and 47 thousand are reported as zero. This accounts to more than 60 percent of all observations. As was stated before, the model doesn't imply dropping the missing observations, because their presence just means that either the country did not report the data or did not export to the trade partner. Taking into account the missing observations is essential for understanding the existing trade patterns in the world during the given period of time. The dataset obtained from UN COMTRADE contains zero values of exports trade flows as well. These values are not changed, assuming that the trade is just absent in a given year for a given pair of countries. The value of export itself is reported in thousands of US dollars and reaches as much as 76 billion dollars, which represents a trade flow from China to the USA in 2006. All the discussed peculiarities of the dataset are controlled for the selection mechanism discussed above.

Data for Gross Domestic Product are in current US dollars, area is in sq. kilometers, population data were obtained from World Development Indicators (WDI), 2010. Country specific variables, such as dummies for common currency, common religion, common language, which enter the probit equation, are obtained from Centre D'EtudesProspectives et D'InformationsInternationales (CEPII), Paris. Common border dummy is constructed using CIA's World Factbook, 2010. Information on whether two trading partners are a part of GATT/WTO or are in regional trade agreement comes partially from WTO website and from CEPII. All of these variables take a value of one if the above statement is true and zero otherwise. Weighted distance and other geographical characteristics such as a measure for a total population and area are from CEPII. All variables, except binary, are transformed into logs as the theory suggests.

Binary variables described before are chosen because they are recognized to be influential when it comes for a decision to export by a manufacturer in a country. Contiguity dummy, dummy for a colonial relationships and dummy, controlling for the same border of the trading partners are assumed to reflect trade costs that occur irrespective of the distance between countries. Variables that enter the probit equation are chosen because they seem to influence the decision to export but not on the side of volume and variety of exported goods. These variables reflect whether there is a common language in the countries, same religion and common currency. While the former will influence the decision to export as it is, the latter is assumed to influence exports at another level. Descriptive statistics are presented in Table 3.

Chapter 5

EMPIRICAL RESULTS

The chapter below is divided into 4 subsections. The main goal of this section is to report and discuss the results obtained by two stage estimation procedure discussed above and to compute the value of trade potential of the Republic of Belarus with its main trading partners, while choosing alternative countries and making inferences on how Belarusian trade is diversified across intensive and extensive margins of trade.

As noted before the estimation procedure will consist of two stages. Selection equation that is meant to capture the heterogeneity of firms and the cost for them to export includes variables that are thought to influence the choice of the firm to export. These are binary variables for common language, WTO membership for two countries, common legislation, common currency and common religion. Columns of Table 4 present the results for the first stage probit regression for 10 industries of the model.

The rest of the variables that enter the second stage estimation are also important elements of the probability of positive exports. Countries are more likely to trade with each other when the distance between them is smaller, when their sizes, captured by their GDP, are similar. Sharing a border also increases probability of trade by 0,57 percent in food industry, by 0,79 percent in agriculture and forestry . To a lesser extent, presence of colonial relationships also increases the probability of trade. It should be noted, that a country being a WTO member, whether origin or destination, also significantly increases the probability of trade between the countries. Countries that are in WTO are 0,67 and 0,89 percent more likely to trade in food industry and gas manufacturing industry respectively, 0,60 percent more likely to trade in wood and paper products.

Additional variables, controlling for the size of the country and the distance between trade partners are also a significant factor of the probability of trade. Size of the country, captured by its GDP has a positive influence on the probability of export in all industries to a different extent. So, being similar in size increases the probabilities of trade by more than 0,55 percent in metallurgy and by 0,49 percent in wearing apparel. Distance has the opposite influence on the choice of the firm to export. The further away the potential trading partner is the smaller is the probability that they will engage in trade. For instance, distance decreases the probability of export in electricity and mineral commodities by more than 0,5 percent. Mostly all coefficients are significant at 1% level which signals about the importance of the included factors to the probability of a firm to decide to export.

Table 5shows the obtained coefficients for all variables selected to enter second stage estimation procedure and the gravity model was assessed with Hausman-Taylor methodology to control for unobservable individual fixed effects in the model that might correlate with the error term. To be able to apply this methodology endogenous variables were specified. These include dummy variable for RTA, contiguity and colony. As was discussed earlier, Hausman-Taylor method has proved to provide the best results when projecting the existing trade flows to a particular country in order to calculate its trade potential. The Republic of Belarus is not included in the estimation stage to correspond to the chosen method of prediction.

Majority of the obtained coefficients are of expected sign and, moreover, significant at 1% level. So, the sign of the coefficient for the measure of distance is negative across all industries, which only proves the theory. Countries that are far away from each other are less likely to engage in trade, than those that share the same border. In such a way, if a country is a neighboring for its possible trading partner, export increase by as much as 1,5 times in chemicals and crude materials, such as petroleum, for example. If a country is distant from each other, export in this sector drops by 1.35 times. As can be seen these two variable have the opposite effect on exports that is also in the same range for most industries.

It should also be noted that coefficients for MRT are all positive and significant and are of a different sign from log of distance, which is exactly what Baier and Bergstrand (2009) assumed in their work. The significance at 1% suggests that the inclusion of a measure of remoteness is critical to the gravity model of trade and should not be neglected because of systematic bias. So, remoteness of two countries that trade with each other, which ranges from 0,061 for electricity to 0,572 for textile and wearing apparel industry.

Variable ψ and its higher powers, which represent the obtained values from the selection equation and were included in the gravity equation to control for a big share of missing and zero values, are jointly significant in the all industries except the last two. This signals about the importance of both the first stage of estimation and the inclusion of the above variables in the main equation. The rejection of joint significance in the last two industries is mainly due to the substantial number of missing and zero observations in the data and, also, because of the specific nature of exported good (electricity and gas manufacturing export is limited to a number of countries).

As mentioned before, predicted values obtained in the second stage of estimation are used to analyze the degree of trade diversification and the use of the trade potential of the Republic of Belarus. The gravity model of trade allows projecting the results on Belarus along both industrial and geographical dimensions. The degree of deviation provides us with conclusions whether Belarus reached its potential in trade. Extensive margins analysis implies the examining the selection equation, comparing the existing number of trade flows with those predicted by the Probit equation. The results reported in tables6 and 7 are mean averaged across time probabilities of export, given geographical and economic characteristics of a country. The choice of countries in tables6 and 7 is dictated by the data on top ten trading partners of the Republic of Belarus provided by National Statistical committee of the Republic of Belarus for 2011[4]. The choice of countries in the subsequent table is a random choice based on the value of predicted probability of export by the Probit equation with a threshold of 75 percent.

As can be seen from the results Belarus trades with a vast majority of countries chosen in a particular industry. However, as a model suggests, Belarus tends to overtrade with countries that is in Commonwealth of Independent States (CIS) and in most cases trade under its potential with other countries. Accordingly, the selection equation shows that the probability of export to Russia, Ukraine and Azerbaijan is less than the actual share, which signals that Belarusian export is well diversified along CIS countries dimension. Predicted share of export with Russia is 70 percent on average, with Ukraine is 80 percent, while the actual number is 1 meaning that during the given period of time Belarus exported to those countries in each industry of the model.

[4] National Statistical Committee of the Republic of Belarus, Indicators of economic performance for January-March, 2011, http://belstat.gov.by/homep/ru/indicators/doclad/2011_3/8.pdf

Nevertheless, contemplating such countries as the United Kingdom, Austria and Venezuela, industrial diversification of exports in some specific industries is less that the predicted value. Export to Austria in wood and paper products industry is above its reasonable value as well as, for example, export to China of food product is under its predicted value. All together, the selection equation tends to predict the extensive margin rather well and it can be stated that Belarus diversifies its exports more than what is predicted by the model.

The predicted values of export for Belarus at the intensive margin are obtained by the method of out-of sample prediction applied after finding coefficients from the second stage of the estimation procedure. However, the values shouldn't be directly comparedbecause of the log transformation of the gravity equation. Silva and Tenreyro (2006) argued that due to Jensen's inequality one should not compare the log of expected value and expected value of the log, because of the unobserved value of variance, which appears from the assumption of log-normal distribution of the dependent variable. Therefore, it is common to compare the actual and predicted values of export by computing the ratio:

$$x_k^{tj} = X_k^{tj} / X^t * 100\% \, , \qquad (6)$$

where the denominator represents the total export of Belarus in a given year and the numerator is total export of Belarus to a specific country j in industry k. The predicted value is computed in similar way, with actual values replaced by those, predicted by the gravity equation. After the values are computed they are collapsed by destination country and by time to come up with a single number, representing the total actual and predicted volume of export of the Republic of Belarus to specific countries in percentage value, which become comparable and represent trade potential in a specific industry. All figures along geographical dimensions sum up to 100% due to construction.

According to the results, represented in table 8 and table 9 , Belarus overtrades with Russia in three industries. It is interesting to notice that, for instance, food industry exports are bigger than those predicted by the model for four percent.That signals about overconcentration of Belarusian export to Russia in this industry. That in turn leads to under-trade with Ukraine (model predicts food industry exports by 4 times bigger), Poland, Germany and the majority of the other mentioned countries. One should observe that the model predicts underperfomance with Estonia, Bulgaria and Azerbaijan in this particular sector. Agricultural and forestry industry is underperforming as well. The potential in this sector is not achieved along geographical dimension. Looking at the mean values for all industries one can see that Belarusian exports is concentrated in crude materials and textile industry. Exports of mineral commodities are almost 4 times bigger than the predicted one for the 14 top trade partners of the Republic of Belarus. This comes as no surprise, since the country is one of the largest among those that transit Russian oil and gas to Europe. It is difficult to judge about welfare gains that could be reached when exports in food, textile and agricultural industries will be diversified more, but it is clear that concentration of exports to particular trade partners is not beneficial to the economy of the country.

Such trends can be seen in most of model sectors, however it is of a big importance to see that Belarus under-trades not only with non-CIS countries, but with their closest trading partner as well. To increase export diversification and possibly reaching its trade potential the Republic of Belarus may perhaps engage in more intensive trade with European countries, exploiting the not only the fact that the countries share the same border but also the resemblances in size, area and population. In general, one can notice, that for the given period of time there are significant and consistent divergences of potential trade from the actual. Though under- or overperformance of some of the numbers can be explained with peculiarities of the country itself, most of it comes from the concentration of exports on the particular region. The potential to increase diversification and volume of exports is noticeable in agricultural, food, wood and paper and textile industries, while export in mineral commodities, chemicals and metallurgy is not likely to increase to the potential level due to the lack of the prerequisite materials in Belarus.

Chapter 6

CONCLUSIONS

This paper employed the gravity model of trade to find out whether the Republic of Belarus trade to its potential. The latest modifications and amendments to the gravity approach were used. In this way, the model of HMR (2008) was tested with including MRT term, discussed by Baier and Bergstrand (2009).

The gravity model of trade takes into account the presence of almost 60 percent of missing or zero observations in the data and heterogeneity of firms by estimating a selection equation, controlling for variables that can influence the decision of a firm to export, while saving predicted probabilities and incorporating them in the second stage, which is estimating the gravity model itself. Both of the above estimation procedures did not include Belarus in the sample in order to take advantage of the method of out-of-sample prediction that is believed to provide more consistent and reliable results than in-sample predictions. After two stages are performed the obtained predicted values are used to make projections for Belarus in order to compute the intensive and extensive margins of trade along geographical and industry dimensions.

As a result, outstanding distortions were found between actual volume of trade and the one predicted by the model. The Republic of Belarus tends to concentrate its trade in the CIS region, while underperforming in trade with European Union and other developed countries. The selection equation has predicted the extensive margins rather well and Belarus seems to overperform the predicted values. To increase export diversification and possibly reaching its trade potential the Republic of Belarus may perhaps engage in more intensive trade with European countries, exploiting the not only the fact that the countries share the same border but also the resemblances in size, area and population. The absence of diversification on intensive margins may not only point toward the possible welfare loss for Belarus, but also to the existence of external and internal trade barriers, which can be related to either economic, political or social preferences of the Republic.

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TABLES

Table 1: Description of GTAP sectors

Sectors of the model	GTAP Product code	GTAP product description
Agriculture and forestry	1	PDR - Paddy rice
	2	WHT - Wheat
	3	GRO - Cereal grains n.e.c.
	4	V_F - Vegetables, fruit, nuts
	5	OSD - Oil seeds
	6	C_B - Sugar cane, sugar beet
	7	PFB - Plant-based fibers
	8	OCR - Crops n.e.c.
	9	CTL - Bovine cattle, sheep and goats, horses
	10	OAP - Animal products n.e.c.
	12	WOL - Wool, silk-worm cocoons
	13	FRS - Forestry
	14	FSH - Fishing
Mineral Commodities	15	COA - Coal
	16	OIL - Oil
	17	GAS - Gas
	18	OMN - Minerals n.e.c.
Food industry	19	CMT - Bovine meat prods
	20	OMT - Meat products n.e.c.
	21	VOL - Vegetable oils and fats
	22	MIL - Dairy products
	23	PCR - Processed rice
	24	SGR - Sugar
	25	OFD - Food products n.e.c.
	26	B_T - Beverages and tobacco products
Textile	27	TEX - Textiles
	28	WAP - Wearing apparel
	29	LEA - Leather products
Wood, paper	30	LUM - Wood products
	31	PPP - Paper products, publishing
Chemicals	32	P_C - Petroleum, coal products
	33	CRP - Chemical, rubber, plastic products
	34	NMM - Mineral products n.e.c.
Metallurgy	35	I_S - Ferrous metals
	36	NFM - Metals n.e.c.
	37	FMP - Metal products
Motor vehicles, parts, equipment	38	MVH - Motor vehicules and parts
	39	OTN - Transport equipment n.e.c.
	40	ELE - Electronic equipment
	41	OME - Machinery and equipment n.e.c.
	42	OMF - Manufactures n.e.c.
Electricity	43	ELY - Electricity
Gas	44	GDT - Gas manufacture, distribution

Table 2: List of countries in the model.

REPORTER NAME		PARTNER NAME	
Albania	Norway	Afghanistan	Kyrgyz Republic
Algeria	Oman	Albania	Lao PDR
Andorra	Pakistan	Algeria	Latvia
Anguila	Panama	American Samoa	Lebanon
Antigua and Barbuda	Papua New Guinea	Andorra	Lesotho
Argentina	Peru	Angola	Liberia
Armenia	Philippines	Anguila	Libya
Aruba	Poland	Antarctica	Lithuania
Australia	Portugal	Antigua and Barbuda	Luxembourg
Austria	Qatar	Argentina	Macao
Azerbaijan	Romania	Armenia	Macedonia, FYR
Bahamas, The	Russian Federation	Aruba	Madagascar
Bahrain	Rwanda	Australia	Malawi
Bangladesh	Samoa	Austria	Malaysia
Barbados	Sao Tome and Principe	Azerbaijan	Maldives
Belgium	Saudi Arabia	Bahamas, The	Mali
Belgium-Luxembourg	Senegal	Bahrain	Malta
Belize	Seychelles	Bangladesh	Marshall Islands
Benin	Sierra Leone	Barbados	Mauritania
Bhutan	Singapore	Belarus	Mauritius
Bolivia	Slovak Republic	Belgium	Mayotte
Bosnia and Herzegovina	Slovenia	Belgium-Luxembourg	Mexico
Botswana	South Africa	Belize	Micronesia, Fed. Sts.
Brazil	Spain	Benin	Moldova
Brunei	Sri Lanka	Bermuda	Monaco
Bulgaria	St. Kitts and Nevis	Bhutan	Mongolia
Burkina Faso	St. Lucia	Bolivia	Montenegro
Burundi	St. Vincent and the Grenadines	Bosnia and Herzegovina	Montserrat
Canada	Sudan	Botswana	Morocco
Central African Republic	Suriname	Bouvet Island	Mozambique
Chile	Swaziland	Br. Antr. Terr	Myanmar
China	Sweden	Brazil	Namibia
Colombia	Switzerland	British Indian Ocean Ter.	Nauru
Comoros	Syrian Arab Republic	British Virgin Islands	Nepal
Cook Islands	Taiwan, China	Brunei	Netherlands
Costa Rica	Tanzania	Bulgaria	Netherlands Antilles
Cote d'Ivoire	Thailand	Bunkers	Neutral Zone
Croatia	Togo	Burkina Faso	New Caledonia
Cuba	Tonga	Burundi	New Zealand
Cyprus	Trinidad and Tobago	Cambodia	Nicaragua
Czech Republic	Tunisia	Cameroon	Niger
Denmark	Turkey	Canada	Nigeria
Dominica	Turkmenistan	Cape Verde	Niue
Dominican Republic	Turks and Caicos Isl.	Cayman Islands	Norfolk Island
East Timor	Tuvalu	Central African Republic	Northern Mariana Islands
Ecuador	Uganda	Chad	Norway

Table 2: List of countries in the model - Continued.

REPORTER NAME		PARTNER NAME	
Egypt, Arab Rep.	Ukraine	Chile	Occ.Pal.Terr
El Salvador	United Arab Emirates	China	Oman
Eritrea	United Kingdom	Christmas Island	Pakistan
Estonia	United States	Cocos (Keeling) Islands	Palau
Ethiopia(excludes Eritrea)	Uruguay	Colombia	Panama
European Union	Vanuatu	Comoros	Papua New Guinea
Faeroe Islands	Venezuela	Congo, Dem. Rep.	Paraguay
Fiji	Vietnam	Congo, Rep.	Peru
Finland	Yemen	Cook Islands	Philippines
France	Yugoslavia	Costa Rica	Pitcairn
French Polynesia	Zambia	Cote d'Ivoire	Poland
Gabon	Zimbabwe	Croatia	Portugal
Gambia, The		Cuba	Qatar
Georgia		Cyprus	Romania
Germany		Czech Republic	Russian Federation
Ghana		Denmark	Rwanda
Greece		Djibouti	Saint Helena
Greenland		Dominica	Saint Pierre and Miquelon
Grenada		Dominican Republic	Samoa
Guatemala		East Timor	San Marino
Guinea		Ecuador	Sao Tome and Principe
Guinea-Bissau		Egypt, Arab Rep.	Saudi Arabia
Guyana		El Salvador	Senegal
Honduras		Equatorial Guinea	Seychelles
Hong Kong, China		Eritrea	Sierra Leone
Hungary		Estonia	Singapore
Iceland		Ethiopia(excludes Eritrea)	Slovak Republic
India		European Union	Slovenia
Indonesia		Faeroe Islands	Solomon Islands
Iran, Islamic Rep.		Falkland Island	Somalia
Ireland		Fiji	South Africa
Israel		Finland	South Georgia and the South Sa
Jamaica		Fr. So. Ant. Tr	Spain
Japan		France	Special Categories
Jordan		Free Zones	Sri Lanka
Kazakhstan		French Polynesia	St. Kitts and Nevis
Kenya		Gabon	St. Lucia
Kiribati		Gambia, The	St. Vincent and the Grenadines
Korea, Rep.		Georgia	Sudan
Kuwait		Germany	Suriname
Kyrgyz Republic		Ghana	Swaziland
Latvia		Gibraltar	Sweden
Lebanon		Greece	Switzerland
Lesotho		Greenland	Syrian Arab Republic
Lithuania		Grenada	Taiwan, China
Luxembourg		Guam	Tajikistan
Macao		Guatemala	Tanzania

Table 2: List of countries in the model - Continued.

REPORTER NAME	PARTNER NAME	
Macedonia, FYR	Guinea	Thailand
Madagascar	Guinea-Bissau	Togo
Malawi	Guyana	Tokelau
Malaysia	Haiti	Tonga
Maldives	Heard Island and McDonald Isla	Trinidad and Tobago
Mali	Holy See	Tunisia
Malta	Honduras	Turkey
Mauritania	Hong Kong, China	Turkmenistan
Mauritius	Hungary	Turks and Caicos Isl.
Mayotte	Iceland	Tuvalu
Mexico	India	Uganda
Moldova	Indonesia	Ukraine
Mongolia	Iran, Islamic Rep.	United Arab Emirates
Montserrat	Iraq	United Kingdom
Morocco	Ireland	United States
Mozambique	Israel	United States Minor Outlying I
Namibia	Italy	Unspecified
Nepal	Jamaica	Uruguay
Netherlands	Japan	Us Msc.Pac.I
Netherlands Antilles	Jordan	Uzbekistan
New Caledonia	Kazakhstan	Vanuatu
New Zealand	Kenya	Venezuela
Nicaragua	Kiribati	Vietnam
Niger	Korea, Dem. Rep.	Wallis and Futura Isl.
Nigeria	Korea, Rep.	Western Sahara
	Kuwait	Yemen
	Zimbabwe	Yugoslavia
		Zambia

Table 3: Descriptive statistics of data.

Variable	Observations	Mean	Std. Dev.	Min	Max
Contiguity	5685335	0,024	0,153	0	1
Official common language	5685335	0,177	0,382	0	1
Colony	5685335	0,019	0,136	0	1
WTO membership, origin	5685335	0,684	0,465	0	1
WTO membership, destination	5685335	0,664	0,472	0	1
RTA	5665175	0,080	0,272	0	1
Common legislation	5645635	0,291	0,454	0	1
Common religion	4745786	0,176	0,253	0	1
Common currency	5685335	0,020	0,141	0	1
Log of GDP, origin	4843158	10,050	2,567	3,873	16,396
Log of GDP, destination	4787419	9,763	2,479	3,873	16,396
Log of distance	5685335	8,713	0,878	-0,005	9,898
MRT	5685335	0,127	0,379	0	5,349
Log of population, origin	5093086	1,940	2,111	-3,927	7,179
Log of population, destination	5066068	1,795	2,086	-3,927	7,179
Log of area, origin	5685335	10,987	3,126	1,946	16,653
Log of area, destination	5685335	10,877	3,133	1,946	16,653
Export	1911207	31319,76	426747,1	0	76100000
Log of exports	1863013	5,310	3,525	-6,908	18,148

Table 4: Selection equation – marginal effects.

VARIABLES	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products
Contiguity, yes=1	0.786***	0.817***	0.568***	0.531***	0.404***
	(0.015)	(0.020)	(0.016)	(0.018)	(0.019)
Common language, yes=1	0.405***	0.371***	0.408***	0.408***	0.505***
	(0.007)	(0.011)	(0.008)	(0.008)	(0.009)
Colony, yes=1	0.471***	0.403***	0.393***	0.234***	0.213***
	(0.019)	(0.024)	(0.020)	(0.023)	(0.025)
WTO member, origin, yes=1	0.458***	0.358***	0.661***	0.472***	0.602***
	(0.007)	(0.010)	(0.007)	(0.007)	(0.008)
WTO member, destin, yes=1	0.214***	0.286***	0.248***	0.313***	0.283***
	(0.006)	(0.009)	(0.006)	(0.007)	(0.007)
Common legislation, yes=1	0.178***	0.142***	0.122***	0.0521***	0.00485
	(0.006)	(0.008)	(0.006)	(0.006)	(0.007)
Common religion, yes=1	-0.132***	-0.285***	-0.144***	-0.236***	-0.162***
	(0.010)	(0.014)	(0.010)	(0.011)	(0.012)
Common currency, yes=1	-0.628***	-0.920***	-0.637***	-0.598***	-0.699***
	(0.018)	(0.025)	(0.017)	(0.020)	(0.021)
Log of distance	-0.476***	-0.555***	-0.506***	-0.429***	-0.472***
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
Log of GDP, origin	0.396***	0.413***	0.477***	0.491***	0.488***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Log of GDP, destination	0.318***	0.309***	0.212***	0.247***	0.231***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
R-squared	0.51	0.48	0.506	0.47	0.465
Chi-squared	344729	145767	341149	269919	225020
Observations	491,379	307,476	493,743	412,366	356,717

*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parentheses; the dependent variable is a binary variable indicating the presence of the trade flow from one country to another; marginal effects are reported.

Table 4: Selection equation – marginal effects – Continued.

VARIABLES	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment	Electricity	Gas manufacture and distribution
Contiguity, yes=1	0.446***	0.574***	0.493***	1.560***	0.659***
	(0.019)	(0.019)	(0.016)	(0.035)	(0.048)
Common language, yes=1	0.339***	0.444***	0.436***	-0.252***	0.576***
	(0.008)	(0.009)	(0.007)	(0.039)	(0.037)
Colony, yes=1	0.177***	0.282***	0.208***	0.368***	-0.127**
	(0.024)	(0.024)	(0.021)	(0.051)	(0.063)
WTO member, origin, yes=1	0.537***	0.494***	0.560***	0.130***	0.878***
	(0.007)	(0.008)	(0.006)	(0.040)	(0.106)
WTO member, destin, yes=1	0.295***	0.294***	0.264***	0.312***	0.208***
	(0.007)	(0.007)	(0.006)	(0.043)	(0.046)
Common legislation, yes=1	0.0212***	-0.0299***	-0.0619***	0.196***	0.106***
	(0.006)	(0.007)	(0.006)	(0.031)	(0.034)
Common religion, yes=1	-0.113***	-0.219***	-0.179***	-0.0584	-0.414***
	(0.011)	(0.012)	(0.009)	(0.048)	(0.060)
Common currency, yes=1	-0.715***	-0.686***	-0.497***	-0.524***	-0.679***
	(0.019)	(0.021)	(0.017)	(0.051)	(0.078)
Log of distance	-0.485***	-0.523***	-0.433***	-0.602***	-0.304***
	(0.004)	(0.004)	(0.003)	(0.015)	(0.016)
Log of GDP, origin	0.525***	0.552***	0.533***	0.194***	0.221***
	(0.002)	(0.002)	(0.001)	(0.007)	(0.007)
Log of GDP, destination	0.191***	0.235***	0.207***	0.209***	0.136***
	(0.001)	(0.001)	(0.001)	(0.007)	(0.007)
R-squared	0.49	0.52	0.49	0.56	0.31
Chi-squared	272371	286655	361776	12032	3594
Observations	400,682	396,029	559,807	292,783	292,758

*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parentheses; the dependent variable is a binary variable indicating the presence of the trade flow from one country to another; marginal effects are reported.

Table 5: Results of Hausman-Taylor estimation procedure of the gravity model of trade.

VARIABLES	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products
Log of distance	-0.884***	-0.724***	-0.972***	-1.255***	-1.416***
	(0.010)	(0.029)	(0.010)	(0.010)	(0.013)
Log of population, origin	-3.276***	-4.754***	-1.320***	-3.810***	-2.073***
	(0.205)	(0.512)	(0.213)	(0.223)	(0.242)
Log of population, dest.	0.226***	0.253***	0.0575***	-0.0541***	0.0213***
	(0.006)	(0.014)	(0.006)	(0.006)	(0.006)
MRT	0.198***	0.169***	0.311***	0.572***	0.483***
	(0.015)	(0.037)	(0.017)	(0.018)	(0.021)
Log of GDP, origin	0.0795***	-0.170***	0.240***	-0.471***	-0.268***
	(0.026)	(0.059)	(0.026)	(0.027)	(0.029)
Log of GDP, destination	0.576***	0.508***	0.388***	0.805***	0.621***
	(0.005)	(0.014)	(0.004)	(0.005)	(0.006)
Log of area, destination	-0.142***	-0.148***	-0.0450***	-0.0778***	-0.0711***
	(0.004)	(0.009)	(0.004)	(0.00367)	(0.004)
RTA, yes=1	0.0132	-0.0442	0.133***	0.788***	0.355***
	(0.018)	(0.0416)	(0.018)	(0.019)	(0.021)
Contiguity, yes=1	0.758***	0.0255	1.002***	1.124***	1.011***
	(0.023)	(0.058)	(0.025)	(0.029)	(0.034)
Colony, yes=1	0.545***	0.132**	0.810***	1.288***	1.302***
	(0.025)	(0.063)	(0.026)	(0.031)	(0.035)
Log of area, origin	2.609***	3.704***	1.147***	3.226***	2.041***
	(0.421)	(1.018)	(0.286)	(1.061)	(0.579)
ψ	50.07***	-50.23***	15.40**	-188.5***	-233.4***
	(7.039)	(12.67)	(7.474)	(6.952)	(7.249)
$\psi 2$	-31.64***	23.01***	-8.946*	117.0***	140.5***
	(4.643)	(8.102)	(4.955)	(4.567)	(4.735)
$\psi 3$	6.977***	-3.084*	2.023*	-23.47***	-27.55***
	(1.013)	(1.719)	(1.086)	(0.994)	(1.025)
χ^2:joint significance	1626,28	642,62	992,44	4409,01	5152,71
p-value	0.000	0.000	0.000	0.000	0.000
Observations	268,568	59,189	282,123	199,477	146,518

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Note: The dependent variable is the log of exports from the country of origin to the destination country. Time dummies and constant term are included but not reported.

Table 5: Results of Hausman-Taylor estimation procedure of the gravity model of trade – Continued.

VARIABLES	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment	Electricity	Gas manufacture and distribution
Log of distance	-1.350***	-1.366***	-1.230***	-1.574***	-0.402***
	(0.012)	(0.011)	(0.008)	(0.241)	(0.150)
Log of population, origin	-1.507***	-1.441***	-3.018***	-0.610	-4.267
	(0.235)	(0.234)	(0.173)	(0.907)	(2.751)
Log of population, dest.	0.118***	0.100***	-0.0117***	-0.111	0.0700
	(0.006)	(0.006)	(0.004)	(0.097)	(0.082)
MRT	0.415***	0.174***	0.393***	0.0613	0.448**
	(0.021)	(0.019)	(0.014)	(0.317)	(0.186)
Log of GDP, origin	0.323***	0.262***	0.511***	1.018***	-0.120
	(0.028)	(0.027)	(0.019)	(0.202)	(0.443)
Log of GDP, destination	0.551***	0.760***	0.769***	0.623***	-0.0349
	(0.005)	(0.005)	(0.003)	(0.079)	(0.068)
Log of area, destination	-0.0599***	-0.0846***	-0.0319***	-0.111*	0.0419
	(0.004)	(0.004)	(0.003)	(0.067)	(0.046)
RTA, yes=1	0.301***	0.321***	0.424***	-0.157	-0.223
	(0.021)	(0.019)	(0.015)	(0.184)	(0.243)
Contiguity, yes=1	1.506***	1.276***	1.235***	1.207***	-0.612**
	(0.032)	(0.029)	(0.023)	(0.442)	(0.307)
Colony, yes=1	0.954***	1.052***	1.319***	-0.214	-0.0605
	(0.034)	(0.031)	(0.024)	(0.234)	(0.343)
Log of area, origin	1.407***	1.466***	2.376***	0.431	2.817
	(0.384)	(0.407)	(0.622)	(0.715)	(2.643)
ψ	-128.2***	-156.6***	-126.9***	-34.21	137.2
	(8.193)	(7.116)	(6.958)	(74.40)	(234.5)
ψ2	77.42***	96.01***	81.92***	18.93	-79.78
	(5.402)	(4.673)	(4.658)	(45.93)	(135.9)
ψ3	-14.86***	-18.81***	-16.66***	-3.327	15.07
	(1.180)	(1.016)	(1.032)	(9.420)	(26.12)
χ^2:joint significance	3184,05	5086,82	7329,06	2,70	6,89
p-value	0.000	0.000	0.000	0.44	0.076
Observations	200,330	181,509	355,600	1,747	835

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Note: The dependent variable is the log of exports from the country of origin to the destination country. Time dummies and constant term are included but not reported.

Table 6: Extensive margins of trade to trade partners of the Republic of Belarus.

	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment	Electricity	Gas manufacture and distribution
Azerbaijan	0.55	0.78	1	1	1	1	1	1	0	0
	0.25	0.07	0.31	0.25	0.18	0.29	0.2	0.33	0.0003	0.00002
Brazil	0	0	0	1	0.22	1	0.22	1	0	0
	0.51	0.18	0.37	0.49	0.35	0.41	0.37	0.55	0.0003	0.00005
China	0.56	0	0.22	0.94	1	1	1	1	0	0
	0.72	0.37	0.54	0.66	0.48	0.53	0.53	0.63	0.003	0.0002
France	1	0.44	1	1	1	1	1	1	0	0
	0.89	0.61	0.75	0.81	0.73	0.77	0.78	0.84	0.013	0.0006
Germany	1	1	1	1	1	1	1	1	0	0
	0.92	0.75	0.84	0.87	0.81	0.84	0.85	0.81	0.03	0.001
Italy	1	1	1	1	1	1	1	1	1	1
	0.87	0.62	0.78	0.81	0.73	0.77	0.78	0.84	0.015	0.006
Kazakhstan	0	0	0	0	0	0	0	0	0	0
	0.35	0.11	0.32	0.3	0.23	0.31	0.25	0.37	0.004	0.00003
Latvia	1	1	1	1	1	1	1	1	0.78	0
	0.85	0.68	0.84	0.78	0.69	0.81	0.79	0.83	0.25	0.003
Lithuania	1	1	1	1	1	1	1	1	0.11	0
	0.9	0.74	0.88	0.81	0.73	0.84	0.83	0.86	0.31	0.004
Netherlands	1	1	1	1	1	1	1	1	0	0
	0.79	0.55	0.71	0.74	0.67	0.73	0.73	0.8	0.01	0.0004
Poland	1	1	1	1	1	1	1	1	0.67	0
	0.97	0.88	0.93	0.92	0.85	0.91	0.91	0.92	0.42	0.007
Russian Federation	1	1	1	1	1	1	1	1	0.22	0
	0.97	0.84	0.91	0.87	0.77	0.82	0.86	0.88	0.3	0.002
Ukraine	1	1	1	1	1	1	1	1	0.89	0
	0.89	0.68	0.81	0.77	0.66	0.77	0.76	0.81	0.19	0.002
United Kingdom	1	0.33	0.83	1	1	1	1	1	0	0
	0.86	0.62	0.74	0.82	0.73	0.77	0.77	0.84	0.01	0.0006
Venezuela	0	0	0	0	0.11	1	0.22	0.67	0	0
	0.32	0.08	0.26	0.33	0.23	0.32	0.25	0.41	0.0001	0.00002

Note: The number on top is the actual number of existing trade flows averaged over time and industries and the number at the bottom is the probability predicted by the selection equation.

Table 7: Extensive margins of trade to alternative trade partners.

	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment	Electricity	Gas manufacture and distribution
Austria	0.11	0	0.3	0.64	0.82	1	0.7	1	0	0
	0.42	0.13	0.31	0.42	0.27	0.34	0.3	0.47	0.0001	0.00003
Belgium	0.94	0.56	0.91	0.95	0.94	0.96	0.96	0.97	0	0
	0.74	0.44	0.65	0.71	0.62	0.68	0.67	0.77	0.007	0.003
Bulgaria	0.44	1	0.86	1	1	1	1	1	0	0
	0.53	0.25	0.53	0.54	0.42	0.57	0.46	0.58	0.004	0.0002
Switzerland	1	0.33	1	0.91	1	1	0.85	1	0	0
	0.73	0.45	0.67	0.69	0.62	0.69	0.69	0.76	0.007	0.0003
Czech Republic	1	1	1	1	1	1	1	1	0	0
	0.74	0.47	0.69	0.69	0.6	0.7	0.65	0.73	0.01	0.0004
Estonia	1	1	1	1	1	1	1	1	0	0
	0.53	0.29	0.6	0.53	0.46	0.6	0.54	0.62	0.007	0.0002
Finland	1	0	0.11	1	1	1	1	1	0	0
	0.77	0.51	0.72	0.74	0.67	0.75	0.72	0.81	0.013	0.0005
Greece	0.89	1	0.7	1	1	1	1	1	0	0
	0.7	0.37	0.62	0.64	0.57	0.64	0.62	0.72	0.005	0.0002
Japan	0.55	0	0.67	0.73	0.9	1	0.92	1	0	0
	0.77	0.43	0.57	0.7	0.58	0.6	0.63	0.74	0.002	0.0002
Norway	0.8	0	0.2	0.89	0.97	1	0.97	1	0	0
	0.73	0.45	0.68	0.74	0.63	0.7	0.69	0.77	0.008	0.0004
Sweden	1	0.78	0.91	1	1	1	1	1	0	0
	0.8	0.56	0.74	0.77	0.71	0.77	0.76	0.83	0.016	0.0006
Turkey	0.33	1	0.33	1	0.93	1	1	1	0	0
	0.72	0.42	0.65	0.72	0.6	0.69	0.66	0.75	0.006	0.003
United States	0.94	0.56	1	1	1	1	1	1	0	0
	0.86	0.53	0.65	0.77	0.64	0.65	0.67	0.77	0.004	0.0003

Note: The number on top is the actual number of existing trade flows averaged over time and industries and the number at the bottom is the probability predicted by the selection equation.

Table 8: Intensive margins of trade to selected trade partners of the Republic of Belarus.

	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment
Azerbaijan	0.16	0.11	3.12	4.14	26.17	14.11	5.33	46.85
	2.28	1.15	16.52	6.92	8.16	19.73	21.37	23.87
Brazil				0.29	0.001	99.5	0.04	0.18
				11.53	1.91	49.1	6.43	31.04
China	0.02		0.003	2.45	0.2	79.25	5.81	12.27
	5.38		1.99	5.04	3.72	25.82	28.65	29.39
Germany	1.59	24.7	3.59	17.1	17.7	7.76	13.09	14.5
	9.45	3.44	8.17	9.77	9.93	17.26	24.5	17.5
France	1.88	0.01	2.7	7.22	14.3	51.8	10.3	11.9
	8.95	1.07	8.2	10.3	8.6	18.9	23.8	20.1
United Kingdom	0.03	0	0.002	2.82	0.45	93.7	2.5	0.393
	6.27	0.87	3.81	10.62	10.1	23.4	23.4	21.56
Italy	7.65	0.07	0.39	45.05	5.64	6.53	28.33	6.34
	10.32	2.51	5.29	9.69	8.69	19.92	25.12	18.45
Lithuania	2.86	6.41	3.16	9.05	6.88	53.46	5.8	12.36
	5.13	0.94	16.25	4.45	9.26	33.66	16.42	10.74
Latvia	1.65	1.35	0.89	1.98	4.39	77.38	7.32	5.05
	4.47	0.64	19.68	3.92	7.27	31.02	13.61	10.27
Netherlands	0.13	2.69	0.25	3.45	1.07	90.82	1.25	0.35
	12.17	3	10.08	7.03	7.79	20.13	20.9	18.81
Poland	2.95	10.12	4.69	3.48	2.99	62.34	6.17	5.29
	5.80	1.69	9.42	5.85	9.63	29.06	22.42	12.14
Russian Federation	1.54	0.40	14.59	11.383	6.85	16.65	8.18	40.39
	5.02	0.65	10.46	10	7.97	22.81	21	21.85
Ukraine	0.34	0.09	3.79	7.15	4.36	47.81	4.55	31.9
	4.91	0.56	14.25	6.05	6.11	32.59	18.45	14
Venezuela					0.05	95.88	0.18	3.9
					1.42	56.3	8.81	33.46
Mean	1.73	4.18	3.10	8.89	6.50	56.93	7.06	13.69
	6.68	1.50	10.34	7.78	7.18	28.55	19.63	20.23

Notes: The number on top is the share of actual export to the total export of Belarus in a particular year and the number on the bottom is the one predicted by the gravity equation. Tenth industry is omitted due to the absence of data for this particular sector on actual trade flows. Missing cells indicate that Belarus either does not export to this particular country in this particular sector, or data is missing on this level of disaggregation. Intensive margins for Kazakhstan are omitted because of the same issue.

Table 9: Intensive margins of trade to alternative trade partners.

	Agriculture and forestry	Mineral commodities	Food industry	Textile, wearing apparel and leather industry	Wood and paper products	Crude materials and chemicals	Metallurgy	Motor vehicles and parts, equipment
Belgium	0.79	0.01	0.53	4.02	22.59	62.03	9.2	0.83
	9.55	1.36	7.7	8.15	7.98	21.92	25.09	18.25
Bulgaria	0.05	1.58	0.61	7.50	1.99	20.72	1.73	65.82
	2.88	2.43	18.22	2.73	8.86	27.5	17.08	20.3
Switzerland	0.6	0.06	12.75	10.72	7.37	59.98	0.29	8.24
	8.4	0.85	14.77	5.06	12.17	25.03	15.9	17.81
Czech Republic	1.14	0.47	0.6	25.33	7.67	18.96	21.85	23.99
	10.73	2.09	9.9	6.85	8.67	26.48	19.23	16.06
Spain	2.53	0.2	0.24	7.47	6.78	27.3	46.42	9.05
	8.38	3.13	6.69	9.27	7.16	21.08	19.11	25.19
Estonia	0.94	1.59	1.27	1.73	3.98	79.38	3.85	7.27
	8.81	1.18	26.82	4.74	7.55	23.43	12.52	14.95
Finland	17.94		0.04	6.07	0.37	34.09	34.94	6.56
	7.61		0.92	7.05	10.92	31.38	20.09	22.02
Greece	9.99	0.81	2.08	12.85	3.86	44.17	11.39	14.84
	12.51	2.94	8.38	7.31	7.84	23.48	14.62	22.93
Japan	0.01		5.07	0.89	0.13	58.97	3.27	31.67
	4.6		8.9	6.63	4.98	20.74	19.81	34.35
Norway	0.37		0.84	0.04	0.3	85.26	11.41	1.77
	3.45		1.3	8.44	13.13	30.36	24.63	18.69
Sweden	2.57	2.33	0.29	3.05	1.37	85.14	4.42	0.83
	5.56	1.69	5.8	9.39	11.22	27.38	18.97	19.98
Turkey	0.03	0.06	0.07	54.92	0.56	17.9	0.37	26.1
	2.32	3.82	3.65	5.62	7.26	32.74	19.79	24.82
United States	0.21	0.004	1.06	23.77	2.43	57.06	10.92	4.55
	2.42	0.67	9.17	16.45	6.17	17.02	16.56	31.54
Mean	2.86	0.55	1.96	12.18	4.57	50.07	12.31	15.50
	6.71	1.55	9.40	7.52	8.76	25.27	18.72	22.07

Notes: The number on top is the share of actual export to the total export of Belarus in a particular year in percent and the number on the bottom is the one predicted by the gravity equation in percent. Industry 9 and 10 is omitted due to either zero export or the absence of data for this particular sector on actual trade flows. Missing cells indicate that Belarus either does not export to this particular country in this particular sector, or data is missing on this level of disaggregation.