Aalto University
School of Business

Gravity Model of Trade and Russian Exports

Economics
Master's thesis
Antti Weckström
2013

Department of Economics
Aalto University
School of Business

Aalto University
School of Business

GRAVITY MODEL OF TRADE AND RUSSIAN EXPORTS

Master's thesis
Antti Weckström
30.05.2013
Economics

Approved by the Head of the Economics Department __.__.2013 and awarded the grade

1. examiner 2.examiner

AALTO UNIVERSITY SCHOOL OF ECONOMICS
Department of Economics
Antti Weckström

ABSTRACT
May 30, 2013

GRAVITY MODEL OF TRADE AND RUSSIAN EXPORTS

PURPOSE OF THE STUDY
The purpose of this thesis is to utilize the Gravity Model of Trade in order to get an understanding of the reasons behind Russian export flows. The aim of this study is to find out if the most common gravity variables have a similar effect on Russian exports as they do for most of the advanced economies. As Russian exports consist mainly of raw materials, one could assume that they behave differently from the exports of western countries.

During the past two decades the Russian economy has gone through huge changes. The collapse of Soviet Union forced the country from a planned economy to a more western market economy in which the government still plays a major role. As a result of this, the trade flows from Russia have multiplied as the country has integrated to the Global markets.

DATA AND METHODOLOGY
The data includes Russia’s exports to its 31 most important trading partners from 1996 to 2010. The gravity variables such as country’s GDP and population were retrieved from OECD statistics database, national databases and Central Bank of Russia database. Distances between trading countries were self-calculated. The study was performed using the panel data method and by running separate regressions for Russian total exports, Russian oil and gas exports and Russian non-oil and gas exports.

RESULTS
While Russian population has on average been declining during the period studied, the exports have grown substantially, which causes the coefficient for population to be negative. At the same time the ruble has on average been appreciating and therefore the real exchange rate variable has a positive coefficient. This result differs from the majority of western countries, where real appreciation of a currency usually leads to declining exports. Distance between Russia and importing country has a negative coefficient as expected, but it’s not statistically significant.

KEYWORDS
Russia, gravity model, exports, trade

Table of Contents

List of tables and figures

1. Introduction

1.1. Motivation and background

While the western countries have been struggling with slow or negative economic growth, Russia has experienced very rapid growth on the 21st century. Relatively high prices of natural resources have accelerated Russia to become one of the world's leading economic great powers. Russia has also huge trade surplus, is practically debt free and has huge currency reserves. The recent economic growth in Russia has proven to be a great opportunity also for Finland, as numerous Finnish companies are now providing their goods and services for Russian consumers. Currently Russia is one of Finland's top trading partners both in exports as well as in imports.

The resource sector has been the greatest success story of Russian economy, even though Russia has lately put a lot of effort on making also the manufacturing sector internationally competitive. So far the success of these efforts has been relatively moderate, as the resource sector continues to be the driving factor of Russian economy. This high dependency on one sector differentiates Russia from most of the developed countries.

Currently the most popular theory to explain exports of countries is the Gravity Model of Trade. According to this theory the size of international trade flows can be explained by geographic, demographic and economic variables. The major advantage of this theory is that it fits very well together with the empiric observations. The aim of this thesis is to go through the theory behind gravity model and to study Russian exports with the help of this theory. As Russia has a very non-diversified export structure, one could assume that the variables explaining export will have a different influence on Russian exports than to the exports of industrialized countries.

The soviet heritage can still be seen in the Russian manufacturing sector as poor productivity, lack of competitive exporting sectors and high governmental influence. During the last 15 years Russia has also faced two very difficult financial crises, during which the Ruble devaluated and the whole economy faced serious difficulties. This is why I will also discuss in my thesis how Russian fiscal and monetary policies have affected the manufacturing and exporting sectors of Russia.

1.2. Research problem and method

My objective in this paper is to find out if the Russian export volumes can be explained by the Gravity Model of Trade. I will try to find out which effect the most common gravity variables have on Russian exports and whether these effects are statistically significant or not. Due to the high export share of oil and gas products, different calculations will be made for total exports, exports excluding oil and gas products and for oil and gas exports. Therefore the primary research question can be stated as follows:

"Which effect do the most common gravity model variables have on Russian exports?"

I will go through empirical literature regarding gravity model of trade, unravel the most significant gravity models and use them as a basis for my empirical study. The research question will be studied quantitatively using the panel data method. In the research I will try to explain Russian export volumes as a function of several variables, such as distance between trading countries and populations of trading countries.

1.3. Main results

After performing the panel data analysis for Russian exports in 1996-2010, several conclusions could be made. The total exports of Russia have increased rapidly during the last years, despite of ruble appreciating and the Russian population declining. This result is counterintuitive, as traditionally the appreciation of a currency has been believed to decrease international competitiveness and to decrease exports. Also declining population has been linked to decreasing production and export possibilities. This hasn't been the case with Russia's raw material intensive economy. Increased raw material prices boosted the value of Russian exports to record-breaking levels while the foreign currency flowing into the country supported the real appreciation of ruble. The high export revenues were also a driving factor in the rapid increase of the Russian GDP. For Russian total exports the distance between trading countries has a negative coefficient but doesn't play a statistically significant role.

The results from this study show, that Russian exports don’t behave the same way as exports of most advanced economies do. The main explanation for this could be the raw material intensive export structure of Russian economy, which explains why exports increased while ruble was appreciating. This could also be a partial explanation for distance between trading countries not playing such a significant role for Russian exports. Raw-material markets are global and Russian raw-materials are exported all over the world.

1.4. Structure of the study

This thesis begins in chapter 2 with a literature review of gravity model theories, starting with descriptions of the original one introduced by Tinbergen in 1962 and Krugman’s model from 1980. After those I will go thoroughly through the Anderson and van Wincoop model (2003), which is the backbone of my literature review.

Chapter 3 will include an overview of Russian economy and economic history, which will help in understanding the previous and current state of Russian economy and exports. Chapter 4 will describe how the empirical study of Russian exports was done and which results were found in this study. In the end of the chapter I will interpret the results and sum up the findings of this study. Chapter 5 will conclude the main finding of the whole thesis.

2. Gravity Model of Trade

Modeling and understanding international trade flows has been a key question in economics for decades. Nowadays there is more trade between countries than ever before, which is why economists have tried to come up with a theory which can give microeconomic foundations for this phenomena and which would also be consistent with the empirics of international trade. It is well known that international trade increases welfare and efficiency through increased competition, specialization and scale benefits (Wang, Wei, Liu 2010). Therefore, from an economic point of view, it's in the interest of the entire world to further increase international trade. So far the Gravity Model of Trade has had great empirical success in explaining international trade, which is the reason why I'm focusing more deeply in it.

2.1. Description of the Basic Model

Gravity model was first discovered in physics, when Newton found out, that the gravity between two objects is correlated with the masses of these objects and the distance between the objects. The same principle was first found to work also in international economics by Jan Tinbergen in 1962. He was interested in international trade flows that would prevail if no trade barriers were being used. He argued that in most cases free trade would yield the world's wellbeing-maximizing solution. He also wanted to compare the trade volumes that were actually taking place with the theoretical non-trade barrier volumes. According to Tinbergen, the four cases in which protecting domestic markets by tariffs or by means alike are:

1) There is no sufficient income equality between trading countries. Therefore for underdeveloped countries some protection could yield a better result.
2) It is otherwise difficult to support young industries, that haven't yet reached their optimum size. It should be in the general interest to support new industries that will later on become competitive.
3) It is difficult or impossible to otherwise support industries that are vital for the country (in some cases agriculture etc.).

4) It is otherwise impossible to support measures which enhance the mobility of capital and labor. Free trade doesn't necessarily always lead to an optimal allocation and adjustment of resources, so sometimes some other measures may be needed.

According to Tinbergen, in these cases it's justifiable to protect domestic industries, but in any other case countries would maximize their wellbeing by freeing trade. Tinbergen based his research on the earlier empirical studies, which concluded that the most significant determinants of optimum trade were the size of GNP of trading countries and the geographical distance of these countries. The size of GNP affects trade in two ways: firstly, it shows the general volume of demand in that country and secondly, it's a good proxy for the diversity of production in that country. A country with more diversified industry will need to import proportionally less than a country with less diversified one. On the other hand, a country with diversified production has capability to export a wide range of goods. The distance between countries is obviously expected to be negatively correlated with the exports, since longer distance should mean higher trading costs. For his study, Tinbergen used the distance between commercial centers of the trading countries.

Tinbergen began his analyses using only three explanatory variables: GNP of exporting country, GNP of importing country and the geographical distance between countries. The basic form of Tinbergen's Gravity Model ended up being:

$$LogE_{ij} = \alpha_0' + \alpha_1 LogY_i + \alpha_2 LogY_j + \alpha_3 LogD_{ij}$$

E_{ij} =*Exports from country i to country j*

Y_i = *GNP in country i*

Y_j = *GNP in country j*

D_{ij} = *Distance between countries i and j*

Tinbergen also tried to incorporate dummy variables for neighboring countries, trade between Benelux-countries and trade between countries of British Commonwealth. In the study all these dummy variables got positive values, but they were not statistically significant. The most important results he got from his studies were that the GNP size of a country is indeed proportional to the imports of that country. This result conflicts with

Tinbergen's intuition that a larger country would produce larger amount of goods thus reducing the need for imports. Another finding was, that the group of countries that deviated most from the theoretical trade values, were the large industrial countries. This could be caused by the restrictive practices the counties are using, but no certain conclusions could be made.

As one can see, the original gravity model of Tinbergen was very crude and lacked theoretical foundations, but it was still able to explain a large part of the world trade. Even though the simple model fits quite well with the empirics, it doesn't necessarily contain all the variables that in reality explain world trade. In other words it may suffer from omitted variable bias.

During the last 60 years, several researchers have come up with a large amount of studies which give more theoretical justification to the Gravity Model of Trade than Tinbergen's model did. According to Evenett and Keller (2002) the theoretical foundations of Gravity Model of Trade can be derived from models such as Ricardian models, Heckscher-Ohlin models and increasing returns to scale models. These three models differ in the way the economies have specialized: in the Ricardian model the technologies differ among countries, so that each country specializes in producing the goods it has comparative advantage in. In Heckscher-Ohlin model countries have variable factor proportions, so that developed countries have a high ratio of capital to labor in relation to developing countries and vice versa. This is just a different way of describing the comparative advantage of a nation. In increasing returns to scale models the product specialization happens on a firm level.

Evenett and Keller (2002) also found out, that only a small amount of production is perfectly specialized due to factor proportions differences, which is why according to them, the Hechscher-Ohlin model is not the best one to explain the empirical success of Gravity Model of Trade. Secondly, especially among industrialized countries the increasing returns are indeed a good explanation for perfect product specialization and the Gravity Model.

Even though a variety of theories ends up to the same conclusions with the Gravity Model of Trade, they will still end up with different parameter values depending on the conditions of market entry one has chosen (Feenstra, Markusen, Rose, 2001). Therefore one should be careful in the assumptions one makes for the Gravity Model in order to understand what it's actually explaining. Also the role of transaction costs, possibly different preferences between countries and trade barriers should be discussed, since in reality they have a huge effect on international trade, even though they can be often omitted in studies for simplicity.

2.2. Krugman's model

One of the earlier and more popular models was Paul Krugman's monopolistic competition framework that he introduced in 1980. I will now go through his model on the common level, without going too deep into the details. In his theory there are economies of scale in production and companies can differentiate their products without any additional costs. Also all individuals have the same utility function and the only factor of production is labor. In production will be a fixed cost and constant marginal cost for each additional good produced. This will lead to diminishing average costs as production increases. There is full employment and firms maximize profits, but due to free entry and exit of firms, the equilibrium profits will be zero. Since firms can differentiate their products without a cost and all products enter symmetrically into demand, each good is produced by only one firm. Price of a good will remain the same regardless of the production level, since there is a large number of goods and the pricing decision of a single firm has no real effect on the marginal utility of income. These assumptions are far from reality, but necessary for a simple enough model.

The countries will have same tastes and technologies, so due to increasing returns, each good is produced in only one country by only one firm. Consumers will now gain from the wider range of goods offered by the foreign companies and not from lower prices. This is also a rather strange result, but according to Krugman, to get also financial utility into this model will complicate the model unnecessarily much.

Krugman considers the transportation costs between countries to be in proportion to the amount of goods shipped, in other words when an amount of goods is shipped abroad, a fixed fraction of those goods vanishes or is broken during the shipment, so the price of remaining goods will be the fixed fraction higher. Therefore the costs of selling a certain good will be higher in the recipient country than in the producing country. Interestingly, elasticity of export demand equals the elasticity of domestic demand, so the transportation cost doesn't actually have an effect on the firms' pricing policy. The only way that transportation cost affects Krugman's model, is that the wages can now be different in the countries trading. In fact, he comes to a conclusion that according to this model, the wages should be higher in the larger country, since there the home market is bigger and the transportation costs are minimized by producing close to the majority of markets. For labor to be fully employed in both countries, there should be a wage differential. Krugman takes the study still further to discover what kind of an effect the structure of home markets has on country's exports and comes to the conclusion that a country begins to export goods which have had in the very beginning a strong domestic demand.

As Krugman's theory of trade patterns makes several very strong simplifications compared to the real world, it can't be directly applied to empirics as it is. But it gives us more theoretical backbone than Tinbergen's original work, when it comes to understanding international trade flows. One of the more recent contributors to the Gravity Model of Trade has been the study of Anderson and Van Wincoop (2003) which I will now go thoroughly through.

2.3. Gravity Model by Anderson and van Wincoop

In the famous article "Gravity with Gravitas: A Solution to the Border Puzzle" (2003) James Anderson and Eric van Wincoop (A & vW) used the gravity model to study the effect of a border between USA and Canada on each country's domestic trade. I will now describe the full model as it was described in the article. Their version of the model is a refined version of the McCallum Gravity Equation (McCallum, 1995). Even though these researches were conducted to study effects that a national border has on trade within a country, the principle of remoteness is also relevant in international trade.

Firstly, the basic model including remoteness is:

$$ln\ x_{ij} = \alpha_1 + \alpha_2 ln\ y_i + \alpha_3 ln\ y_j + \alpha_4 ln\ d_{ij} + \alpha_5 ln\ REM_i + \alpha_6 lnREM_j + \alpha_7 \delta_{ij} + \varepsilon_{ij}$$

Where remoteness of a region I is:

$$REM_i = \sum_{m \neq j} d_{im}/y_m$$

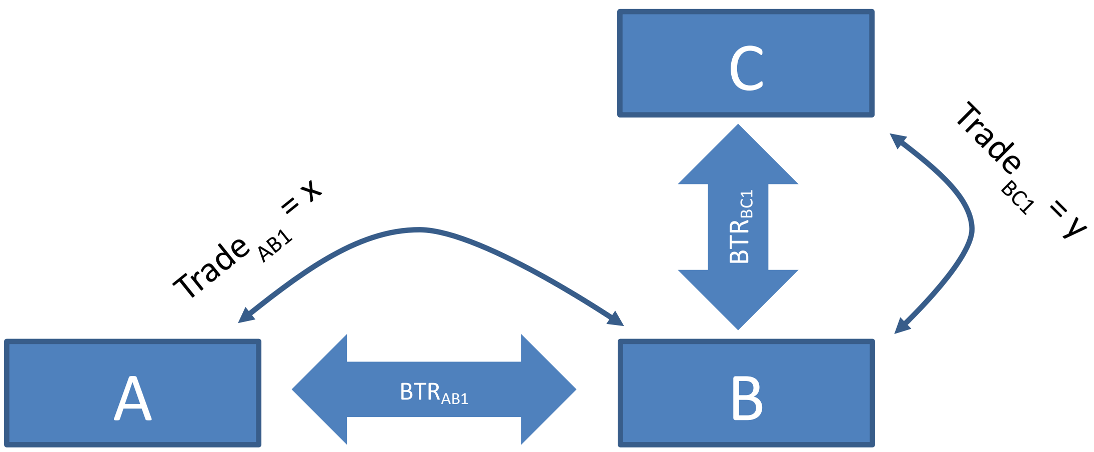
This is the average distance of region i from all trading partners except from j. This remoteness variable is very commonly used, although there is very little theoretical justification for such a variable. Also, using it doesn't increase the R^2 significantly.

δ_{ij} = a dummy variable for whether the trade is within the country or with another country

This was the starting point of Anderson and van Wincoop's work. They were dissatisfied with the current theoretical backing for the theory, even though it did match very well with the empirics. Especially in their interest was to further develop the term of trade resistance, they divided it into three components: 1) bilateral trade barrier between regions i and j, 2) i's resistance to trade with all regions and 3) j's resistance to trade with all regions.

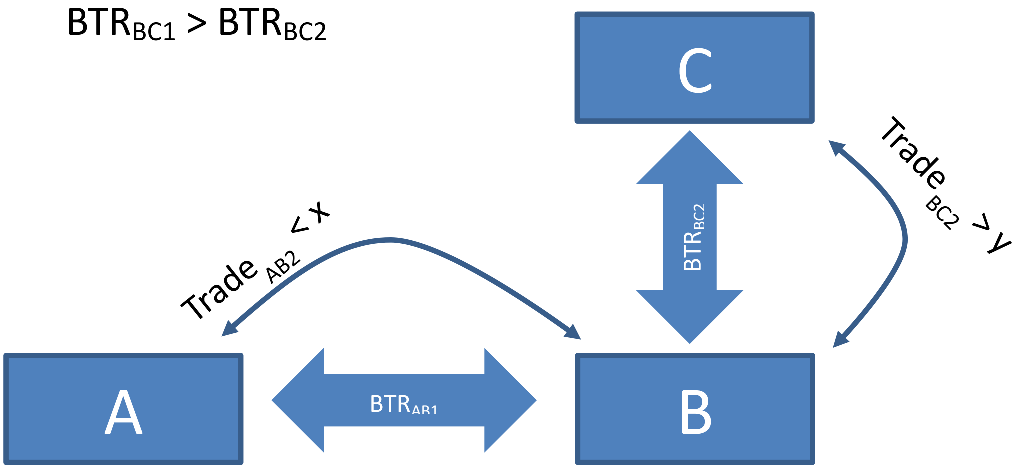
2.3.1. Multilateral Trade Resistance

The most significant contribution of Anderson and van Wincoop's article was the introduction of Multilateral Trade Resistance (MTR). Earlier studies had focused on trade obstacles on bilateral level, but Anderson and van Wincoop suggested also to consider the relative size of these bilateral trade resistances (BTR) to trade obstacles with all countries. The idea behind this was, that even when bilateral trade resistance between countries A and B remains the same, the reduction of trade barriers between B and C will also affect trade of A and B. In the beginning, both pairs of countries have their own Bilateral Trade Resistances and amounts x and y that they trade with each other.



Picture 1: Trade between countries before trade barriers change

In the beginning there are some bilateral trade resistances between countries A and B and countries B and C. In this case the corresponding bilateral trades have values x and y. In the next picture bilateral trade resistance between countries B and C decreases while the one between A and B remains the same.



Picture 2: Trade between countries before trade barriers change

Since trading between B and C has become relatively cheaper than between A and B, some of the previous trade between A and B is now redirected to take place between countries B and C. Costs of trading from B to C are now lower, so it's profitable to export more goods to that direction. Even though the bilateral trade resistance between countries A and B remains unchanged, it has still become relatively higher than between countries B and C, and the exports from B to A will diminish. In this example I had only a system of 3 countries, but the same principle can be also be used in a worldwide study, in which case the MTR would be calculated from trade resistances with the all the trading partners.

2.3.2. The Model

There are a few underlying assumptions in Anderson and van Wincoop's version of the Gravity Model. Firstly, all goods are differentiated by place of origin so that each region has specialized in producing only one good, which leads to monopolistic competition. Obviously such assumption is far from reality, but it makes the whole theory simpler to understand and to apply. Secondly, the preferences are homothetic and can be approximated by CES utility function. When c_{ij} is the amount of consumption of goods from region i by consumers from region j, the consumers from region j maximize

$$\left(\sum_i \beta_i^{(1-\sigma)/\sigma} c_{ij}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)} \qquad (1)$$

subject to budget constraint $\sum_i p_{ij} \ c_{ij}$= y_j (2)

Here σ is the elasticity of substitution between all goods, β_i is a positive distribution parameter, y_i is the nominal income of region j residents and p_{ij} is the price of region i good for consumers in region j. Gravity model of Anderson and van Wincoop doesn't provide a method to estimate σ, instead they settle for just assuming values for it. Later on Bergstrand, Egger and Larch (2013) provided several ways of estimating it.

As we have already noticed, for gravity model to work it's important that the prices differ between locations due to trade costs. They can be for example transportation costs, tariffs, information costs or costs due to non-trade barriers, but in any case these costs are not directly observable. Thereby the final price of a product in the importing country is exporters supply price p_i times the trade costs between the countries, denoted as t_{ij}. Therefore p_{ij} = $p_i t_{ij}$. In this point of view the exporter faces export costs of t_{ij} – 1 of his export goods. This is the same point of view that also Krugman used in 1980, the "iceberg melting" point of view, where a certain fraction t_{ij} of goods exported breaks or is lost during the transportation. Also in this case, the exporter passes these expenses on to the importer and the price for final customers becomes higher the higher the trade costs to that country are. In empirics Anderson and van Wincoop assume t_{ij} = $b_{ij}d_{ij}$, where d_{ij} is bilateral distance between regions and b_{ij} is a 1 if regions are located in the same country. In other cases "b_{ij} is equal to one plus the tariff-equivalent of the border barrier between the countries in which the regions are located".

The demand of region i goods in region j that satisfies the maximization subject to the constraint is

$$x_{ij} = (\frac{\beta_i p_i t_{ij}}{P_j})^{(1-\sigma)} y_j \qquad (3)$$

Here P_j is the consumer price index of country j. Later on the price indices are considered to be multilateral resistance variables, as they depend on all bilateral t_{ij}.

$$P_j = [\sum_i (\beta_i p_i t_{ij})^{1-\sigma}]^{\frac{1}{1-\sigma}} \qquad (4)$$

These two equations yield market clearance

$$y_i = \sum_j x_{ij} = (\beta_i p_i)^{1-\sigma} \sum_j (t_{ij}/P_j)^{1-\sigma} y_j \qquad (5)$$

Already James Anderson (1979) and Deardorff (1998) used the market clearance equation to solve the coefficients β_i. Anderson and van Wincoop developed this approach one step further and took the scaled prices $\beta_i p_i$ from market clearance to substitute them in the demand equation. When we name world nominal income y^W and income shares $\theta_j \equiv y_j/y^W$ we get

$$x_{ij} = \frac{y_i y_j}{y^W} (\frac{t_{ij}}{\Pi_i P_j})^{1-\sigma} \qquad (6)$$

in which

$$\Pi_i \equiv (\sum_j (t_{ij}/P_j)^{1-\sigma} \theta_j)^{\frac{1}{1-\sigma}} \qquad (7)$$

When equilibrium scaled prices are substituted to consumer price index, we obtain

$$P_j = (\sum_i (\frac{t_{ij}}{\Pi_i})^{1-\sigma} \theta_i)^{\frac{1}{1-\sigma}} \qquad (8)$$

Anderson and van Wincoop assumed that trade barriers are symmetric, so that $t_{ij} = t_{ji}$. While such symmetry holds, there exists an equilibrium of $\Pi_i = P_i$ with

$$P_j^{1-\sigma} = \sum_i P_i^{\sigma-1} \theta_i t_{ij}^{1-\sigma} \quad \text{for all } j \qquad (9)$$

From this one gets a solution for the price indices as a function of all bilateral trade barriers and income shares. From this follows, that the gravity equation becomes

$$x_{ij} = \frac{y_i y_j}{y^W} (\frac{t_{ij}}{P_i P_j})^{1-\sigma} \qquad (10)$$

And the gravity model is (10) subject to (9). For more practical representation one can take the logs of (10) and add notation of time to get the linear form of the model.

$$\ln x_{ijt} = \beta_0 + \ln y_{it} + \ln y_{jt} - lny_t^W + (1-\sigma) t_{ijt} - (1-\sigma) P_{it} - (1-\sigma) P_{jt} \qquad (11)$$

In which β_0 is a constant. For a still more practical representation coefficients can be applied for each variable.

$$\ln x_{ijt} = \beta_0 + \beta_1 \ln y_{it} + \beta_2 \ln y_{jt} + \beta_3 ln y_t^W + \beta_4 t_{ijt} + \beta_5 P_{it} + \beta_6 P_{jt} \quad (12)$$

This representation resembles significantly the older gravity models, with the exception of the two price index terms.

In this outcome Anderson and van Wincoop have given theoretic justification for including GDP sizes of both exporting and importing country, as well as for including the trade costs of exporting goods to another country. In empirical studies these costs are usually estimated by the distance between trading countries. Another significant result of this study is that an increase of trade barriers in all countries raises multilateral resistance more for a small country than it does for a large one. This is because the large country has also larger domestic markets which are not affected by trade barriers. Also the trade within a country increases, when the trade barriers increase. As increasing trade barriers have a bigger impact for small countries, also the trade within a country increases more in small countries than in large ones.

2.4. Further Development of Gravity model

By no means is this model perfect. In 2004 Anderson and van Wincoop discussed the problem of defining trade costs. Trade costs vary significantly between countries and product lines, therefore making too large simplifications of them can result in inaccurate estimations. De Benedictis and Taglioni (2011) criticize this study for the assumption that the trade costs are two-way symmetric across all pairs of countries. This assumption contradicts with reality for example in the case of preferential trade agreements. It is also assumed that the trade of each country is balanced, in other words that the size of exports of a country equal the size of that country's imports. Obviously this is almost never the case.

Westerlund and Wilhelmson (2011) pointed out that using the log-linear estimation will result in biased results due to the zero-trade observations, which have to be either discarded or given some arbitrary positive value. Instead they recommend using the fixed effects poisson maximum likelihood estimator, which should avoid the bias coming from zero-trade observations.

Also Helpman, Melitz and Rubinstein (2008) were dissatisfied with the assumption of symmetric trade and the way that zero-trade observations are taken into account. They committed their own study regarding the bilateral trade of 158 countries on a timespan of 27 years. They found out that although the overall volume of trade had increased significantly, the amount of country pairs trading had increased very modestly. Still in 1997 about half of the country pairs had no bilateral trade and some 10-15% of country pairs had trade in only one direction. They claimed, that by disregarding the zero-trade observations one will lose a significant amount of information of international trade flows. Next I will summarize the key points of their model.

The starting point of Helpman, Melitz and Rubinstein's model is very similar with the one of Anderson and van Wincoop. A product produced in one country is distinct from all the other products produced in the world. Elasticity of substitution across products is same in each country, $\varepsilon = 1/(1 - \theta)$, where θ is a parameter. A firm in country j produces an unit of output using a cost-minimizing combination of inputs α at the cost of $c_j\alpha$, where α is the amount of input bundles required for the production of one unit in that country. The cost, c_j is country specific, whereas α, the amount of bundles needed for production is firm specific, reflecting differences in productivity within a country. When a company wants to sell its product in the home market, it will only face the production cost $c_j\alpha$. When the company wants to export its good abroad, it faces also a fixed cost of serving importing country i, which equals c_jf_{ij}, $f_{ij} > 0$. In addition it has to pay a transportation cost t_{ij}, which is assumed to be an "iceberg melting" cost. It's notable that f_{ij} and t_{ij} depend on exporting and importing countries, but not on the exporting company. The delivered price in country i for product k is

$$pj(k) = t_{ij}\frac{c_j\alpha}{\theta}$$

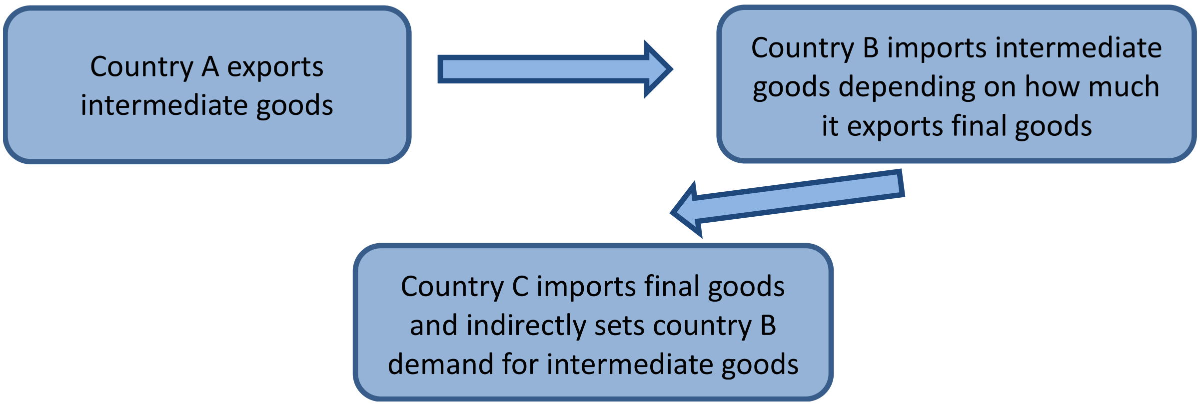
and the profit from sales to country i is

$$\pi_{ij}(\alpha) = (1 - \theta)\left(\frac{t_{ij}c_j\alpha}{\theta P_i}\right)^{1-\varepsilon} Y_i - c_jf_{ij}$$

Profits from selling to domestic market are always positive, since in that case $f_{jj} = 0$. On the other hand, the sales to foreign market i are profitable only if $\alpha \leq \alpha_{ij}$, where α_{ij} is defined by $\pi_{ij}(\alpha_{ij}) = 0$. Therefore only a fraction $G(\alpha_{ij})$ of a country j's companies export to country i. It's also possible that not a single company exports to country i, in which case the fraction will be zero. This fraction G(α) is a big difference to the Anderson and van Wincoop's model, as omitting it will change the nature of trade barrier's coefficient. For example the coefficient of distance can't be interpreted as the elasticity of the firm's trade with respect to distance, which is the way the coefficient is usually interpreted. By allowing zero trade flows one will get more accurate estimates for unobserved trade barriers, and by using unidirectional trade values one gets both importing and exporting country fixed effects. These asymmetries have a huge explanatory power on the predicted direction of trade and net value of bilateral trade. One more significant upside of the Helpman, Melitz and Rubinstein's model is that it can be applied on sectoral trade flows, where the fraction of zero-trade observations is obviously much larger.

In 2011 Anderson pointed out, that using the CES framework is unsuitable for describing small amounts of trade as well as it may not be the best one to represent the world economy. As a possible solution he suggests using translog cost function, which could also give better understanding for a large amount of zero-trade observations.

Lately researchers have criticized existing gravity models also for other reasons. They have pointed out, that GDP might not always be the most appropriate mass-variable for explaining bilateral trade flows. Baldwin and Taglioni (2011) showed that the structure of a trade flow plays a key role in determining a suitable mass-variable. If country's exports constitute mainly of final products, then the GDP of importing country is a good proxy for the import demand. Also, if the proportion of final and intermediate goods in country's exports remains stable, the GDP remains as a reasonable proxy. However, if a country's export structure changes into exporting more intermediate goods than before, then the GDP of importing country becomes less accurate in estimating the import demand. This is because the demand of these intermediate goods depends on the demand of the final products which are made of them, which might be consumed in a third country.



Picture 3: Third country sets demand for intermediate goods

Therefore, depending on a country, the more appropriate import demand proxy could be not the GDP of the country where intermediate goods are exported, but the GDP's of countries where the final goods are exported from the intermediate good importing country.

It's easy to understand the logic behind Gravity Model, but still none of the models previously mentioned is undisputedly correct. Instead they can be applied and further modified depending on the research question. Often when empiric studies are conducted using the Gravity Model of Trade, some variables are added to make the model fit better with the empiric results. Such variables can for example be real exchange rate changes between countries, whether countries are neighboring countries, if people speak same language in them, they belong to the same trade union and many other variables that could potentially affect the amount of trade between them. Including such variables usually yields good results, but don't necessarily give theoretic justification to the methods used.

2.5. Earlier empirical research

Gravity Model has been used in hundreds of studies to find out the driving forces of a country's trade. The main findings in these studies have been surprisingly consistent, even though the data and methods used have varied significantly between the studies. Disdier and Head (2008) gathered together a sample of 103 Gravity Model studies in which a coefficient for distance was estimated. In these studies altogether 1467 estimates were made. Of these estimates only one yielded a positive effect of distance on bilateral trade. All the others found a negative relation between distance and trade. Some researches show that the effect of distance has decreased over time (Yotov, 2012) whereas others claim that the importance of distance has actually increased during the last decades (Disdier, Head, 2008).

Several researchers have also tried to identify the mechanics through which the distance actually effects trade. The traditional point of view is that distance is a good approximation for transportation costs and time, which have a negative effect on trade. The problem is, that in the modern world a lot of goods are produced, which can be delivered either for free or at a very low cost (digital products etc.) and in which the high transportation costs don't explain the small amount of trade. In these cases the lack of trade is often caused by different technologies, cultures and legal and economic institutions (van Bergeijk, Brakman, 2010), which can be also somewhat correlated with geographical distance. This is why distance is not irrelevant in the trade of intangible products either.

The size of exporting country's GDP has been proven in many studies to be positively correlated with the amount of total exports from that country. This is quite logical, since usually countries with large GDP's have a larger total amount of companies as well as larger amount of exporting companies, which was shown by Lawless (2010). In several studies the coefficient for exporting country's GDP has been found to be around one. Nguyen (2009) found coefficients slightly over 1 for AFTA countries, the study of Lawless yielded a GDP coefficient of slightly below one for the exports of United States and Stack (2009) found coefficients between one and two for trade between several EU and OECD countries. Bogdan Lissovolik and Yaroslav Lissovolik conducted a study of Russian exports in 2006 using the gravity model framework. The coefficient for exporting country's (Russia's) GDP was slightly below one and the coefficient for distance was slightly over minus one. These results could give a benchmark on what kind of results my study could yield.

3. Russian Economy and Exports

3.1. Post-Soviet trade liberalization

Before using the gravity model to study the Russian exports, one should have sufficient background information of Russian economy and economic policies. Since the collapse of Soviet Union, the Russian economy has faced severe difficulties on the way to become the economic superpower it is today. During the years following the collapse of Soviet Union, the GDP decreased rapidly, while the inflation increased rapidly and unemployment rose dramatically. The shock from moving from a centrally governed system to almost a market economy was very hard. As price regulation and government subsidies were removed, the prices of some goods skyrocketed and the domestic demand declined drastically.

During the Soviet era the official international trade was strictly controlled by the state. The state decided what and how much was to be imported and exported. In addition to this official trade, there was also a lot of unofficial international trade, mainly imports, which was practiced by individuals. After the collapse of Soviet Union, the Russian companies got almost full freedom to import and export their products. During the Soviet era there was a lack of competition and incentives to become more efficient, so the productivity in most Russian companies was poor in the early 1990's. As foreign companies begun to operate in Russia, some sectors begun to face competition from international companies and were forced to become more efficient and productive. The liberalization of trade made also modern foreign components and production methods available for Russian producers, which allowed them to become more productive. However, this effect disappeared when ruble devaluated in 1998 and foreign components became relatively more expensive. (Bessonova, Kozlov, Yudaeva, 2003)

In the 1990's the prices of natural resources were on a rather low level, making the recovery of Russian economy even more difficult. Asian financial crisis hit hard on Russia in 1998 and the raw material prices sunk, which lead to increased budget deficit in Russia. This, combined with foreign investors fleeing from Russian markets led to Russia defaulting on its debt in 1998, which led to devaluation of Ruble and a momentarily high inflation.

As we can see from the chart, the Russian GDP declined significantly in 1993 and 1994 and it didn't increase until in 1997, only to face another shock in 1998.

Picture 4: Chart shows Russia's annual GDP (constant prices) growth according to the IMF

After the crisis of 1998 the domestic production recovered quickly especially on the domestically oriented non-resource sectors. This was due to the dramatically fallen wages and energy prices combined with rapidly increased prices of foreign goods. Such a rapid recovery wouldn't have been possible hadn't the economy been liberalized and privatized. Now there were private enterprises that could seize the opportunity provided by the devaluation of ruble. Later on the increasing prices of natural resources helped in the recovery, but were not the initial driver of it. Only in 2001 did the oil sector become the driving force of economic growth. (Ahrend, Tompson, 2005)

According to Ahrend (2006a) the common belief that property rights in Russia had become secure enough led to increased private investments in 2000 and 2001. This increase in mainly oil sector investments led to a significant increase in oil production and exports on the first years of the decade. At the same time the investments of state-controlled oil companies had stagnated. This implies that the privatization policy was an important factor in the growth of Russia's oil exports in early 2000's.

From 1999 to 2008 Russia experienced impressive growth figures, as the price of oil kept rising and as foreign investors regained their trust in Russia and begun to invest there again.

During this time also the average purchase power of Russians has increased significantly, due to which the domestic demand has also become an important growth driver.

As the post-crisis turmoil had settled in 2001 and the markets had gained back the trust in Russian state, also the foreign direct investments begun to rapidly grow. They nearly ten folded from 14 billion dollars in 2001 to 121 billion in 2007. During this time the state had put a lot of effort in making the country a better place for foreign investments. Among these measures were deregulation of business and improving taxation and customs policies. These foreign investments were one more of the factors which played an important role in improving the international competitiveness of the manufacturing sector. (Panibratov 2012)

Lately the country has tried to diversify its economy in order to reduce dependence on high raw material prices, but so far without being significantly successful. With some partner countries the raw materials still make up close to 90 % of the total exports. This proportion has remained relatively constant during the last 15 years, although the raw material prices have increased substantially during this time period. The other sectors have also managed to increase their exports, but the country is still very dependent on exporting raw materials.

Even though the Russian market has become more free during the past two decades, the government still plays a significant role in the economy. One of its tools is the Central Bank of Russia (CBR). As CBR plays an important role in Russian financial policy, I will next describe its backgrounds more thoroughly.

3.2. Ruble and Central Bank of Russia

The Central Bank of Russia is a legal entity that operates independently under the guidelines set by Bank of Russia Law, but it's still accountable to the State Duma of the Federal Assembly of the Russian Federation. CBR has many goals similar to the ones of central banks in western countries, such as setting rules for the retail banks, issuing cash and supervising actions of credit institutions and banking groups. In addition to these, it has among others, the following obligations related to foreign trade:

— It efficiently manages the CBR's international reserves;

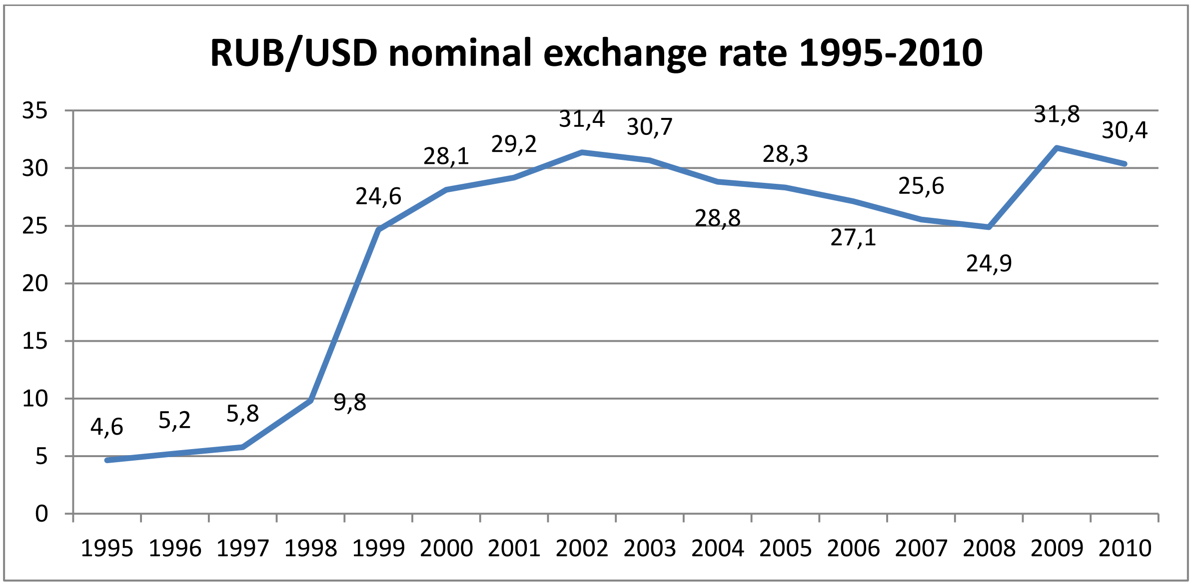
— It organizes and exercises foreign exchange regulation and control pursuant to federal legislation;

— It sets and publishes official exchange rates of foreign currencies against the ruble;

— It takes part in the compiling of Russia's balance of payments forecast and organizes the compiling of Russia's balance of payments;

— It sets the procedure for and conditions of foreign exchange purchases and sales by currency exchanges and issues, suspends and revokes permits for the currency exchanges to organize foreign exchange purchases and sales

What differs from for example the European Central Bank (ECB) is that nowhere is mentioned anything about inflation and trying to keep is stable, which is in fact the main task of ECB. Instead, the main purpose of CBR is to "protect the ruble and ensure its stability". This is a huge difference compared to the ECB and the Federal Reserve (Fed), since ensuring price stability and currency stability lead to very different policies from the central banks. Furthermore, these policies lead to different anticipations in the markets and cause aggregated level of economy to react differently and to have different future expectations. As it is clear that Russia's main interest is to stabilize the exchange rate, it is more difficult for public to predict the future inflation in Russia (Granville, Mallick 2006).



Picture 5: RUB/USD nominal exchange rates from 1995 to 2010, according to CBR. In order to make figures comparable, the redenomination of 1998 was taken into account.

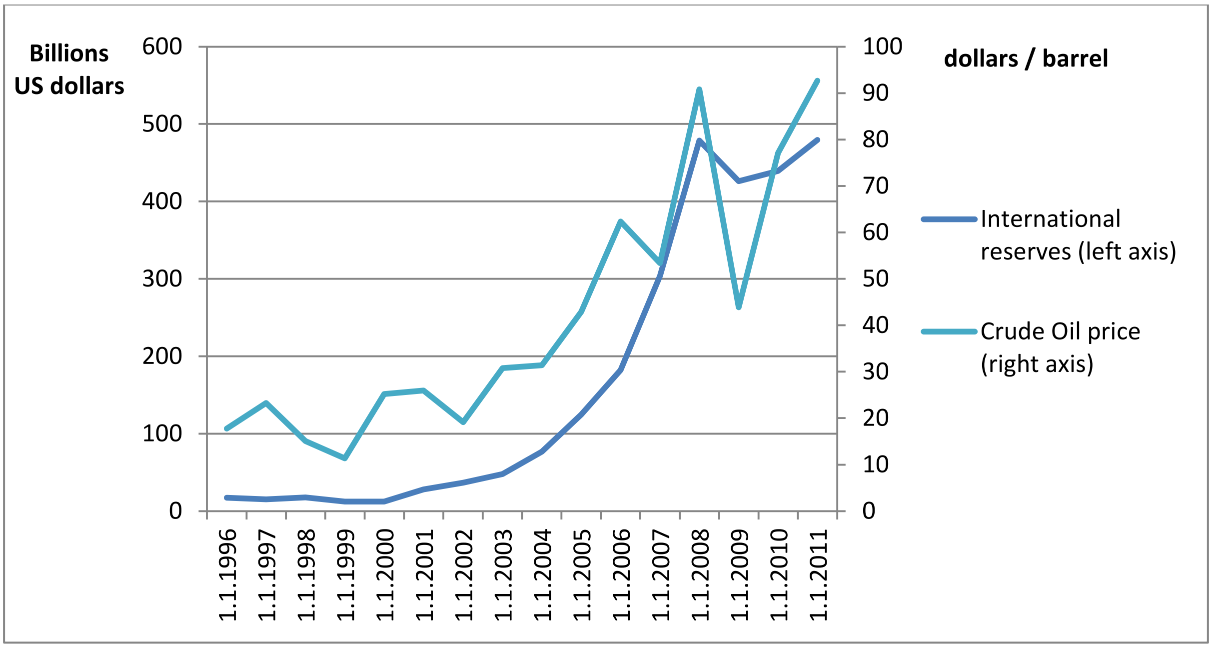
As we can see from the chart, except for the 1998 and 2009 crises, CBR has been relatively successful in keeping the nominal exchange rates stable. One major reason for this success has been the high price of oil that prevailed from 1999 to 2008. Especially in 2004 oil prices begun to increase significantly, which lead to a rapid increase in Russian tax revenues and exports. The increased export revenues caused more and more foreign currency to flow into country, which caused Central Bank of Russia's international reserves to grow exponentially during the first years of the millennia.

High raw material prices have caused Russia to have record trade surplus during the last decade. According to the Central Bank of Russian Federation (Bank of Russia, CBR), the trade surplus was about 150 billion US dollars in 2010, while in 2006 it was approximately 140 billion US dollars. These figures are much higher than in 2000, when the trade surplus was close to 60 billion US dollars.

In reality the Russian trade surplus might be slightly lower than what the official figures let believe. According to the study of Ollus & Simola (2007), the large grey sector in Russia and differences in trade accounting cause the reported imports to be slightly lower than what they are in reality. Grey imports are estimated to be significantly bigger than what the CBR estimates. If this is true, then according to this study the Russian imports are on average some 10% higher than what CBR announces.

These reserves gave an opportunity for the CBR to defend the ruble from rapidly devaluating during the latest financial crisis, as it could use its international reserves for buying rubles and thus create demand for them while the foreign investors were leaving Russia. When the demand of rubles was defended, the CBR could gradually devaluate ruble towards a more stable nominal value and thereby convince the markets that the situation was somewhat under control and there was no reason for panic.

Due to the long lasting significant trade surplus, Russia was able to increase its currency reserves from 20 billion US dollars in 2000 to its current reserve stock of more than 500 billion US dollars (CBR).



Picture 6: International reserves of Russia (according to CBR) and Crude Oil price (simple average of Brent, West Texas Intermediate and Dubai Fateh Spot prices) according to IMF.

From January 2000 till August 2008 CBR was able to constantly increase its international reserves. Only in September 2008 did ruble face such pressure to depreciate that the CBR decided to intervene and support the ruble while letting it devaluate slowly and intentionally. During the next 7 months CBR spent more than 200 billion dollars for defending the ruble, until there was no longer pressure for further devaluation.

Russia didn't spend excessively during the years of increasing raw material prices, even though the state budget had a significant surplus from 2001 all the way to 2009. Instead, it paid back the debts it had inherited from the Soviet Union and the ones that it had taken during the first decade of its independence. Also, a national stabilization fund was established in 2004 in which part of the oil revenues were channeled. The purpose of this fund was to save money for the common good of Russian people when the prices of natural resources are high and use the savings when these prices are low, thus evening out the macroeconomic fluctuations (Merlevede, Schoors, Aarle, 2009).

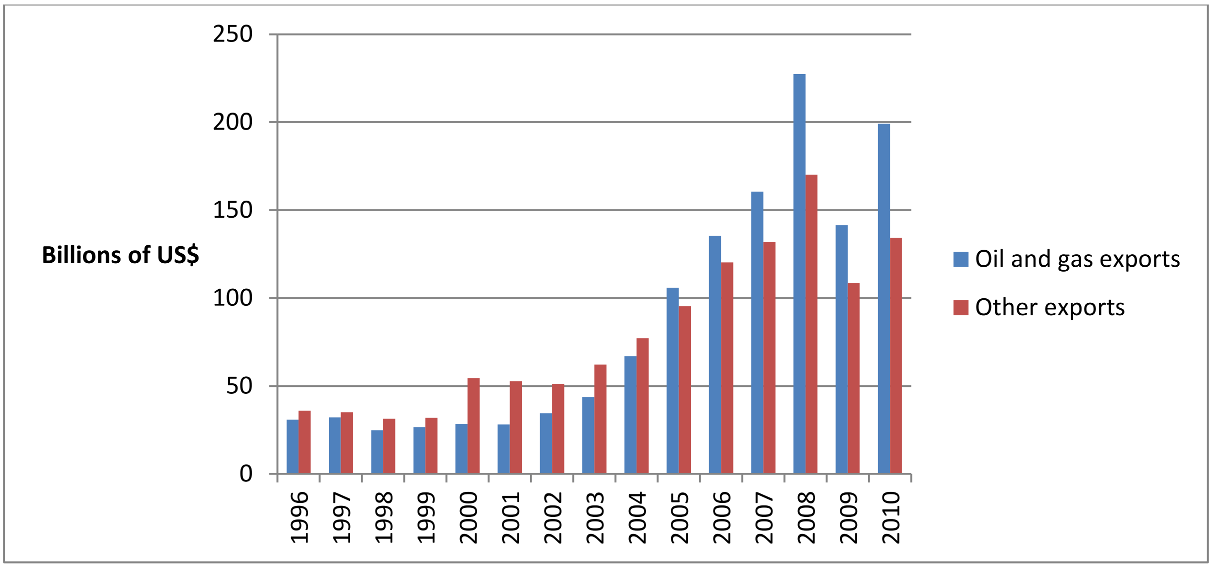
While operating under this policy, the Russian state also managed to partially avoid the "Dutch Disease", the case of country's own currency strongly appreciating as a result of sudden increase of foreign currency flooding to the country. This appreciation would deteriorate the global competitiveness of all the domestic non-booming export goods. Because of this, the whole domestic economy will face problems (Ebrahim-Zadeh, 2003).

Even though between 1996 and 2010 Russian ruble did on average appreciate in real terms, the amount wasn't fatal to the other exporting sectors. Regardless of the fact that Russia faced two serious economic crises during those 15 years, the value of exports excluding oil and gas increased on average by 12% per year. Most of this success comes from the increase of other raw material exports, but also the manufacturing sector increased its exports during the period.

Also one should keep in mind that a currency appreciating doesn't necessarily mean it's getting overvalued. As Drine and Vault found out in their study (2006): "the variations of the real exchange rate do not necessarily reflect a disequilibrium. Indeed, equilibrium adjustments related to fundamental variations can also generate real exchange rate movements". A currency can originally be undervalued, in which case appreciation will only bring it closer to what is commonly considered to be its equilibrium value. Also, the productivity of the whole economy can grow faster than that of its partner countries and the Harrod-Balassa-Samuelson effect (Tica, Družić 2006) can take place, in which case the appreciation can be justified by economic reasons. In his study Rudiger Ahrend (2006b) showed, that In Russia's case the labor productivity grew significantly between 1997 and 2004 on almost all major sectors. The study shows, that the sectors that were initially the least productive ones, had faster growth in productivity than the ones that were productive already to start with. It's also noticeable that the sectors where government played only an insignificant role were experiencing higher productivity growth than the ones where government was strongly involved in.

3.3. Russian Exports

How has the Russian economic growth and appreciation of ruble affected the exports of Russia? As we can see from the chart, the value of oil- and gas product exports has increased significantly due to the increased raw material prices. Also the value of other exports has increased rapidly, even though not quite as fast as the export of oil and gas products. The impact of the recent financial crisis on Russian exports is also evident. The resource prices plummeted in 2009 which also resulted in a significant reduction in all exports.



Picture 7: Value of Russian oil and gas exports and other exports to its 31 main trade partners (except for Belarus)

One reason for the good performance of non-oil and gas exports is the significant amount of other raw materials that Russia exports. Also a large amount of minerals, metals and precious stones are exported from Russia. During the resource boom also the prices of these resources went up. According to the Russian Federation Federal State Statistical Services, for the last 15 years approximately 80% of Russian exports have been raw-material related. This proportion has remained quite stable even though the raw material prices have been very volatile.

From the other large export sectors one could mention chemical products, machinery, vehicles, weapons and fertilizers. Already for quite a long time it has been a priority for Russian government to make Russian industrial production more versatile and internationally competitive. Intention has been to help for example nanotechnology, medicine, solar energy and mechanical engineering to become the new backbones of Russian economy. So far these intentions haven't been successful, as the country is still heavily dependent on raw materials. Actually, on the 21st century the raw materials' share of total exports has only increased.

4. Gravity Model Study of Russian Exports

In the empirical part of my thesis I will study the Russian exports to its 31 most important trading partners between 1996 and 2010 using the Gravity Model of Trade. As it is very hard to get trustworthy data from Belarus, I omitted it from the research even though it is a major trading partner of Russia. These 31 countries represent roughly 85-90% of Russia's total exports, so the study will cover the vast majority of Russian exports. Also, when choosing a sample of only large trading partners, I will avoid the problems occurring from large one-time export deals, such as weapons, ships or large machinery, which would cause high volatility to the annual export figures. Since a majority of Russian exports consists of gas and oil, I decided to study separately also the oil and gas exports as well as the non-oil and gas exports of Russia in order to see if the results will differ significantly.

4.1. Variables used

4.1.1. Exports

For overall annual export figures for each country I used the data collected from Russian Federations Federal State Statistics Service. For Russian exports of oil and gas I used the data found from United Nations Commodity Trade Statistics Database from where I used the Harmonized System (HS) category 27: mineral fuels, oils, distillation products, etc. This should fairly accurately show the extent of export of oil and gas products to different countries. For non-oil and gas exports I deducted each country's oil and gas exports from the corresponding total exports, therefore oil and gas exports + non-oil exports = total exports. There were 11 observations in which no oil or gas was exported, so this might result for some zero-observation bias in the regression for oil and gas exports.

4.1.2. GDP

Annual GDP values are time variant variables and they were found from OECD Factbook Statistics and national statistical databases. All the GDP values were gross values for the whole country and they were counted in US dollars, which made them easily comparable. GDP is a measure of the size of country's economy, so countries with high GDP values are assumed to trade more with each other than countries with low GDP values.

4.1.3. Population

Also the populations of all countries were found from OECD Factbook Statistics and national statistical databases. Population is another time variant variable that should be positively correlated with trade as larger markets should develop larger trade flows with each other. On the other hand, a large economy is able to produce a wider variety of goods, so in a simplistic world, such a nation should have less need for foreign imports.

4.1.4. Real Exchange Rate

In my study the real exchange rate (RER) is a time variant variable which I would assume to have a significant impact on Russian non-oil exports. As ruble appreciates, Russian goods become more expensive abroad and the demand for them should decline. In calculation of real exchange rate I needed the average annual nominal exchange rates for each currency against ruble and annual inflation rates in these countries. I calculated majority of the average annual currency rates by using the daily and monthly rates received from Foreign Currency Market Statistics of Central Bank of Russia. In the cases where information was not available from CBR, I used rates received from other central banks. Most of the annual inflation rates were found from OECD statistics database. In cases where necessary information was not available, it was searched from the corresponding country's national central bank or statistics database. In my study I calculated Ruble's appreciation against other currencies, so positive values indicate Ruble's RER appreciation and negative ones depreciation. The data set for RER is not complete, as I was unable to find trustworthy information for the exchange rate of Romanian Leu for 1995-1997, so I don't have the change of Ruble/Leu RER for 1996-1998. Otherwise the dataset is complete.

4.1.5. Distance

Distance is a time invariant variable, so it remains constant during the whole period I study. In Gravity Model of Trade distance is often used as a proxy for transaction costs for the trade between the two countries. Therefore a longer distance between two countries should reduce the amount of trade between them, as trade costs are assumed to rise. Recently it has been pointed out that a better approximation for the transportation costs could be received by applying also some infrastructure index, since a good infrastructure makes transportation cheaper and vice versa (Martinez-Zarzoso, Nowak-Lehmann, 2003). I will still use only simple geographical distance, which should give good enough estimations for this study.

It's not trivial which distance between countries should be used in empiric calculations. I calculated distances between countries by taking the distance between the two closest economically significant (with a population of approximately 300 000 or more) cities. This I did by taking the geographical coordinates of each city and calculating the distance between these coordinates. This renders the shortest distance between these cities. In reality, even a short distance can be hard to cover if the terrain is difficult, infrastructure is bad, or if one has to travel through several countries to get to the destination country. Still the shortest possible distance between two economically significant cities should give a good estimation of the transaction costs between trading partners.

If one would know for each destination country's exports the weighted average production location in Russia as well as the consumption location in destination country, one could calculate a very accurate average export distance for each country. This would probably be the ideal way of calculating the distance between the countries. Unfortunately such information would be extremely difficult to acquire. The distance calculation method that was chosen for this study will likely render shorter distances than what would be acquired in the ideal case, but still they should be closer to reality than the other commonly used ways of calculating the distance.

Other possible ways of measuring distance could've been for example the distance between capitals or the shortest possible distance between boarders. The former way is unsuitable for a country of the size of Russia, since the trading partners can actually be very close to each other even though their capitals are far away (for example Russia – China). The latter way of calculating the distance is also not so suitable, since countries can be neighboring even though their closest economic centers are hundreds of kilometers from each other. One more possibility, which is quite commonly used, is to take the population distribution weighed distance of countries. In my opinion this method is also not preferred in the case of Russia, since such a large quantity of Russian exports comes from the natural resources sector. For example the population distribution weighed distance between Japan and Russia is very high even though it is actually quite easy to export Siberian oil to Japan. Therefore, even though the distance used in this study might in some cases underestimate the real export distance, it's still closer to reality than the other commonly used distance measures. In the following table I have listed the distances from Russia to each country.

Country	Distances	Kilometres
Austria	Wien - Smolensk	1301
Belgium	Antwerpen - St Petersburg	1166
Bulgaria	Varna - Krasnodar	904
Hungary	Debrecen - Smolensk	1032
Germany	Berlin - Smolensk	1252
Greece	Thessalonika - Krasnodar	1395
Spain	Barcelona - Krasnodar	2983
Italy	Bari - Krasnodar	1841
Netherlands	Groningen - Smolensk	1666
Norway	Oslo - St Petersburg	1087
Poland	Warsaw - Smolensk	784
Romania	Lasi - Krasnodar	908
Slovakia	Kosice - Smolensk	1002
United Kingdom	London - Smolensk	2142
Finland	Helsinki - St Petersburg	300
France	Strasbourg - Smolensk	1801
Czech Republic	Ostrava - Smolensk	1083
Switzerland	Zurich - Smolensk	1836
Sweden	Stockholm - St Petersburg	691
India	Jalandhar - Omsk	2614
Iran	Tabriz - Sochi	826
China	Harbin - Vladivostok	471
Korean Republic	Seoul - Vladivostok	737
Turkey	Samsun - Sochi	377
Japan	Sapporo - Vladivostok	820
USA	Anchorage - Petropavlovsk Kamchatsky	3146
Lithuania	Vilnus - Smolensk	434
Latvia	Riga - St Peterburg	491
Estonia	Tallin - St Peterburg	317
Kazakhstan	Kostanay - Chelyabinsk	262
Ukraine	Donetsk - Rostov-on-Don	166

Table 1: Distances from Russia to its most important trading partners

4.1.6. Common Border Dummy Variable

I used a dummy variable (time invariant variable) for countries that share a common border with Russia. I assume that neighboring countries would trade more, as the transportations costs should be relative low.

4.1.7 Slavic Language Dummy Variable

Another dummy variable I used was one for countries, where the state language can be classified as “Slavic”. With such a variable I want to know if countries where a Russian-like language is widely spoken also trade more with Russia than what the other countries do.

4.1.8. Former Soviet Republic Dummy Variable

The third dummy variable I use is a dummy for countries that used to be part of Soviet Union. During the Soviet era many republics were quite specialized in producing certain kind of goods, which were then centrally directed to other regions where such a good was needed. I’m interested whether former Soviet republics still trade exceptionally much with Russia, or have they moved on and now trade equally with all countries.

4.1.9. Excluded variables

There are also many other variables that are commonly used in such studies, but which I chose not to use in this one. These could be for example some indices for socioeconomic development or trade freedom or dummy variables for a common currency union, island countries, landlocked countries, foreign trade agreements, common religion etc. I chose to exclude these variables from the study, as I believe them to have very marginal effects on Russian exports. Also some of these variables are not even possible to apply for Russia, since it’s not an island or landlocked country, it didn’t have comprehensive foreign trade agreements during the period studied and it wasn’t part of a common currency union.

4.2. Method of Study

I study Russian exports to its main trading partners using primarily the following function:

$$LnExport_{Rjt} = \alpha_0 + \alpha_1 LnGDP_{Rt} + \alpha_2 LnGDP_{jt} + \alpha_3 LnPOP_{Rt} + \alpha_4 LnPOP_{jt} + \alpha_5 LnDist_{Rj} + \mathrm{RER}_{\mathrm{Rj}} + \alpha_6 Boarderdum + \alpha_7 Slavicdum + \alpha_8 Sovietdum$$

$LnExport_{Rjt}$ = Logarithm of Russian exports to recipient country j at year t

$LnGDP_{Rt}$ = Logarithm of GDP of Russia at year t

$LnGDP_{jt}$ = Logarithm of GDP of recipient country j at year t

$LnPOP_{Rt}$ = Logarithm of Russian population at year t

$LnPOP_{jt}$ = Logarithm of population of recipient country at year t

$LnDist_{Rj}$ = Logarithm of distance between Russia and recipient country

RER_{Rj} = Annual changes in the real exchange rate between Russian ruble and the currency of recipient country

Boarderdum = Dummy variable for common boarder

Slavicdum = Dummy variable for countries where a Slavic language is spoken

Sovietdum = Dummy variable for former Soviet countries

α_{0-8} = Parameter values

This equation is somewhat different than the one suggested by Anderson and van Wincoop (2003). The most significant difference is the interpretation of multilateral trade resistance. Anderson and van Wincoop consider the MTR's to be price indices of trading countries, which are dependent on exporters' supply prices and trade cost factors between trading countries. Thereby high price index P_n reflects high MTR and high trade barriers. Instead of price indices, I will use the change in real exchange rates in somewhat similar way as Brun, Carrére, Guillaumont & De Melo (2005) used. According to them, using RER is preferred in the case of using panel data and when there is a large sample of countries for which representative price indices are not available. Also Anderson and van Wincoop pointed out, that it's not incorrect to replace multilateral resistance terms with country specific dummies. This estimation method is simpler, but at the same time it's also less efficient.

There are both advantages and disadvantages in the method I have chosen. Unlike in the A & vW model, this model doesn't take into account the tariff equivalent of the border barrier. I use only distance as a proxy of trade costs. Another possible disadvantage is that RER might not work as well as a MTR as the price indices do. We know that the RER of ruble is correlated with the price of oil, so that if oil prices go down, the export revenues decline, the ruble depreciates and vice versa. Another fact is that in advanced economies, oil price shocks pass through into inflation at least partially (Chen, 2009). This is due to the importance of energy prices in many large industries. Therefore there would be reason to believe that changes in RER of ruble and changes in the rest of the worlds' production costs are correlated at least to a certain degree.

A clear advantage of this model is the availability of data. The changes of Russian rubles real exchange rates against different currencies can be calculated quite easily. Also the interpretation of RER changes is often more intuitional. Still, this is not necessarily the case in Russia as the major Russian export commodities are not traded in rubles.

I use panel data method and perform the regressions with Stata-program. I apply both fixed effects (FE) and random effects (RE) techniques and I will study the suitability of these techniques for explaining the Russian exports. These two methods differ in the way how individual specific effects are treated. In FE model it is assumed that the individual specific effect is correlated with the individual variables. Therefore there is some variable that we haven't taken into account, but as it correlates with the ones that we do use, there won't be omitted variable bias. In RE model individual specific effect is not correlated with the individual variable so over time there are changes within one group which our variables can't explain. In a simple form both models are like:

$$Y_{it} = \beta_0 + X_{it}\beta + Z_i\Upsilon + \alpha_i + \varepsilon_{it}$$

β_0 = Constant term

$X_{it}\beta$ = Observed time-variant factors, can be estimated in both FE and RE models

$Z_i\Upsilon$ = Observed time-invariant factors, can be estimated in RE, but not FE models

α_i = Un-observed individual specific effect. In FE model is assumed to be correlated with one of the observed time-variant factors, thereby omitted. In RE model this is assumed to be uncorrelated with both time-variant- and time-invariant factors. Instead it's included in the residual term.

ε_{it} = Un-observed random error term, residual

Obviously, in addition to the variables used in this study, there are many other things that affect Russian exports, such as political relations and changes in trade partners' preferences. Unfortunately not all of them can be included in our model, both due to lack of such data and due to the model becoming overly complicated.

4.3. Total Exports

In the following table we can see the correlations between our main variables. We can see that exports without oil and total exports are correlated with the other variables in a similar way, whereas oil exports have very different correlation with population and GDP of recipient countries. Also Russian GDP and Russian population are very strongly negatively correlated. While Russian population declined on average in 1996-2010, the GDP rose at the same time significantly. Therefore we have reason to believe that the negative correlation is purely a coincidence. The economic growth hasn't been the reason for declining population and vice versa.

	lnexpl	lnexpn~l	lnoilexp	lnpop	lngdp	lndist	lnruspop	lnrusgdp	rercha~e
lnexpl	1.0000								
lnexpnooil	0.8905	1.0000							
lnoilexp	0.7580	0.4722	1.0000						
lnpop	0.3546	0.4756	-0.0191	1.0000					
lngdp	0.4534	0.5249	0.1236	0.8718	1.0000				
lndist	-0.0280	-0.0440	-0.1116	0.2981	0.5142	1.0000			
lnruspop	-0.5501	-0.4939	-0.4310	-0.0087	-0.1623	0.0001	1.0000		
lnrusgdp	0.5662	0.4841	0.4359	0.0097	0.1665	-0.0001	-0.9505	1.0000	
rerchange	-0.1156	-0.1039	-0.1175	-0.0031	-0.0200	0.0756	0.2725	-0.2205	1.0000

Table 2: Correlations between variables used in the study

Next I will perform a FE regression for Russia's exports to 31 countries. Even though FE method is used to only study the impact of time-variant variables and therefore it will not give results for time-invariant effects, it might still give some interesting results for the time-variant variables. When the fixed effects model is applied in our case, we assume that the individual specific effects are correlated with our observed variables and we get the following results. As already mentioned, the time-invariant variables (distance and three dummy variables) are omitted.

```
Fixed-effects (within) regression               Number of obs      =       462
Group variable: country                         Number of groups   =        31

R-sq:  within  = 0.8170                         Obs per group: min =        12
       between = 0.0482                                        avg =      14.9
       overall = 0.3577                                        max =        15

                                                F(5,426)           =    380.50
corr(u_i, Xb)  = 0.0174                         Prob > F           =    0.0000
```

lnexpl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpop	.1351789	.1334816	1.01	0.312	-.1271856	.3975433
lngdp	-.0903997	.1542485	-0.59	0.558	-.3935825	.2127831
lndist	(omitted)					
lnruspop	-12.53945	3.200843	-3.92	0.000	-18.83086	-6.24804
lnrusgdp	1.036065	.1205839	8.59	0.000	.7990516	1.273079
rerchange	.0980956	.0286009	3.43	0.001	.0418791	.1543121
commonborder	(omitted)					
slaviclang~e	(omitted)					
formersovi~y	(omitted)					
_cons	227.7807	61.71224	3.69	0.000	106.4823	349.0791
sigma_u	.84258974					
sigma_e	.31136463					
rho	.87985217	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(30, 426) =    67.54             Prob > F = 0.0000
```

Table 3: Results for the fixed effects regression for total exports of Russia

As we can see, the coefficients for RER change, Russian GDP and Russian population are significant on the 95% confidence interval. Intuitively these results are quite surprising. The coefficient for RER change is positive, so Russian exports increase on average when RER of ruble appreciates and exports decrease when RER depreciates. Also Russian population is strongly negatively correlated with Russian exports, as we discussed already earlier. The only significant result that goes in line with initial expectations is the positive correlation of Russian GDP and exports.

When a F-test is performed for the five variables included in this estimation, we receive a F-statistic of 381, which means that we can reject the null hypothesis with a less than 0,01% probability of being wrong. This means that fixed effects are present in our data.

When the corresponding estimations are done using the RE method, we get the following results for total exports. This time also the time-invariant factors are taken into account and they get coefficients.

```
Random-effects GLS regression                   Number of obs      =       462
Group variable: country                         Number of groups   =        31

R-sq:  within  = 0.8161                         Obs per group: min =        12
       between = 0.3101                                        avg =      14.9
       overall = 0.5133                                        max =        15

                                                Wald chi2(9)       =   1894.54
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

lnexp1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnpop	.167283	.0942209	1.78	0.076	-.0173866	.3519527
lngdp	.1378871	.1145222	1.20	0.229	-.0865724	.3623465
lndist	-.2170244	.2846509	-0.76	0.446	-.7749298	.340881
lnruspop	-11.49094	3.184116	-3.61	0.000	-17.73169	-5.25019
lnrusgdp	.9389638	.1116527	8.41	0.000	.7201286	1.157799
rerchange	.1029164	.028631	3.59	0.000	.0468007	.159032
commonborder	-.1470509	.4567065	-0.32	0.747	-1.042179	.7480774
slaviclang~e	.346268	.3623665	0.96	0.339	-.3639574	1.056493
formersovi~y	.2904988	.5559118	0.52	0.601	-.7990684	1.380066
_cons	207.3744	61.14527	3.39	0.001	87.53186	327.2169
sigma_u	.73770297					
sigma_e	.31136463					
rho	.84879141	(fraction of variance due to u_i)				

Table 4: Results for the random effects regression for total exports of Russia

The results gotten from the RE model are very similar to those gotten from FE model. Coefficients of Russian population, Russian GDP and RER change are all similar in both models. None of the time-invariant factors were significant on the 95% confidence interval. The coefficient of distance is negative, as one could assume it to be. Exports and distance between trading partners seem to be negatively correlated. With 90% confidence also population of recipient country is significant for Russian exports.

It's noticeable that the coefficient for bilateral distance is quite different than what one could have expected based on previous studies. Also the statistical significance of distance is very low. In 2006 Lissovolik and Lissovolik had gotten a distance coefficient of slightly below minus one for Russian exports, while in this study the coefficient was only minus 0,22 and not statistically significant.

One could also have assumed that the GDP of the importing country would have great explanatory power for Russian exports, but this turned out not to be the case. One reason for this could be that on the 21st century the raw-materials proportion of total exports has still increased. Baldwin and Taglioni (2011) suggest that for countries that export an increasing amount of intermediate goods, the importing country's GDP is a bad proxy for import demand. This could partially explain the poor explanatory power of importing country's GDP found in this study. On the other hand, the majority of Russian raw material exports comes from oil and gas, which are often imported to fulfill domestic energy demand and can therefore sometimes be considered to be final products. Timber and minerals on the other hand are more often further refined in the importing country and are therefore typically intermediate products.

When we conduct a Breuch-Pagan Lagrange Multiplier Test for Random Effects, we receive a $chibar^2$ value of 2083, so we can reject the null hypothesis at a probability of less than 0,01% of being wrong. Therefore it's evident that there are some random effects present. As we have now rejected null hypotheses in both F-test and Breuch-Pagan Lagrange Multiplier Test, it would be good to perform the Hausman Test in order to know which method would likely be more accurate. The null hypothesis in Hausman Test is that the random effect is not correlated with other regressors. The results of Hausman Test are following.

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnpop	.1351789	.167283	-.0321042	.0945502
lngdp	-.0903997	.1378871	-.2282868	.1033307
lnruspop	-12.53945	-11.49094	-1.048509	.3268083
lnrusgdp	1.036065	.9389638	.0971013	.045543
rerchange	.0980956	.1029164	-.0048208	.

```
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        7.09
                Prob>chi2 =      0.2138
                (V_b-V_B is not positive definite)
```

Table 5: Results for the Hausman test for the total exports of Russia

The resulting chi^2 figure of 7 is very low and we can't reject the null hypothesis on a sufficient confidence. Therefore in this case it seems like the Random Effects model would be more suitable.

4.4. Non-Oil and Gas Exports

Whereas the results of Russian total exports yielded some unexpected results, it'll be interesting to know whether non-oil and gas exports behave in the same way, or do they for example increase when RER of ruble depreciates. After conducting similar fixed-effects estimation as for total exports (appendices 1 and 2), the coefficients for all non-oil and gas export variables are quite similar as the ones for total exports. An interesting result is that the coefficient for RER is positive (being 0,14) and statistically significant on 1% confidence interval in both FE and RE regressions. Therefore, while ruble has appreciated, the exports on other sectors have increased. Traditionally the rise of RER has been expected to decrease exports. Still, in Russia's case the initial exports of other sectors were quite low and the productivity was not that high, so the rapid increase in labor productivity on almost all major sectors (Ahrend, 2006b) can be one explanation for this result.

The results give direction to how non-oil and gas sector is behaving, but one shouldn't forget that this export group still includes a large amount of other natural resources. Therefore one shouldn't mix these results to the exports of manufacturing sector. When keeping this in mind, these results seem to go hand in hand with the results for total exports. In order to get results for the manufacturing sector, the exports studied in the regression should've been stripped from all raw materials.

Also the other RE model results for non-oil and gas exports are very similar with the results for total exports, although the Russian population isn't significant at the 95% confidence level. It's also interesting that the negative coefficient for distance has increased, although it's still not statistically significant.

The chibar^2 value for Breuch-Pagan Lagrange Multiplier Test for Random Effects is 1617, which is again clearly large enough to reject the null hypothesis and therefore random effects exist also in non-oil exports. The F-statistic of this data is 202, which is also enough to reject the null hypothesis and therefore the fixed effects are evident also in non-oil and gas exports. When the Hausman test is done for the RE regression of non-oil and gas exports (appendix 3) the results are very much like the ones for total exports. Also the resulting chi squared value is relatively low, so we can't reject the null hypothesis, thus we can conclude that random effects model will likely give us better results also in this case.

4.5. Oil and Gas Exports

The coefficients for oil and gas exports are somewhat different than the ones for non-oil and gas exports. In the FE regression for oil and gas exports (appendix 4) the GDP of importing country has a positive coefficient which is significant on a 10% confidence interval. Also the Russian GDP has a positive coefficient which is equally significant. The reason for this might be that the oil and gas sectors are so dominant in Russia. The increase in oil and gas exports increases also directly the Russian GDP. Russian population seems to be negatively correlated with the exports whereas the RER change seems to be totally insignificant with a coefficient close to zero. For non-oil exports the RER had a positive coefficient which was significant at 1% confidence interval.

In the RE regression the results resemble the ones in non-oil and gas regression (appendix 5). The most significant difference also for RE regression is in the coefficients of RER. For oil and gas exports it seems to have no explanatory power. This could be explained by the nature of oil trade (oil is traded in US dollars) and by the relatively inelastic demand for oil products. Even when the oil prices go up, the demand doesn't really go down, and when the oil prices decline, the demand for oil doesn't skyrocket.

Both the Russian and the importing country's GDP have positive coefficients which are statistically significant. From the Russian GDP's part this isn't surprising, since a large part of Russian GDP comes from the oil and gas sector. From the importing country's part this is slightly surprising, since at least part of the oil exports are refined in the importing country and further exported to a third country. As mentioned earlier, if this would take place in large amounts, then importing country's GDP should have very little statistical significance. On the other hand one could assume that larger economies consume more gas and oil and thus often need to import it in large amounts to satisfy the domestic energy demand. Distance or the other dummy variables used don't seem to be significant in explaining Russian oil and gas exports. This is somewhat surprising. Even though the oil markets are global, one could still assume that it is bought from as close as possible in order to minimize the transportation costs. Regardless of this, oil and gas are being exported in large quantities to countries quite far away from Russia, such as Italy and USA. On the other hand, the state is in control of oil and gas exports and therefore the exports aren't only affected by economic reasons, but also political decisions (Bilgin, 2009).

4.6. Conclusions of Russian Exports

In both FE and RE regressions for Russian total exports, oil exports and non-oil exports the coefficient for Russian population is negative and significant on a 10% confidence interval. This is due to the steadily increased export volumes while the Russian population has been steadily declining. Therefore it would be wrong to assume that one has been the reason behind the other. For total and non-oil exports the coefficient for RER is positive and significant, so while Russian ruble has been appreciating in real terms, the total exports of Russia have increased. This is perhaps the most notable result of my study, as for most of the other countries real appreciation of domestic currency results in decreased competitiveness and decreasing exports.

Even though the total exports have increased while ruble has appreciated, it doesn't mean that Russia has come up with some astonishing new way to fight the resource curse. Instead, according to Benedictow, Fjærtoft and Løfsnæs (2013) the oil, natural gas and petrochemicals exports constitute such a huge part of Russian exports (65% in 2008), so that together with other natural resources they dominate the Russian exports. Even after deducting the oil and gas exports, the export share of manufacturing sector is so small, that the behavior of non-oil and gas exports doesn't reflect the behavior of manufacturing sectors' exports. For comparison, in industrialized countries the natural resources constitute usually only a small part of total exports.

Another interesting finding was that the coefficient for distance between Russia and importing country, although being negative as anticipated, was not a statistically significant variable. Slavic language, and former Soviet country –variables had positive coefficients, but none of the dummy variables used were statistically significant in any of the cases.

5. Conclusions

Gravity Model of Trade has already for decades been the most popular theory to explain trade flows between nations. The theory matched very well with the empiric observations, so it became a common tool among economists, even though it lacked thorough theoretical justification. On the 21st century researchers like Anderson & van Wincoop and Helpman, Melitz & Rubinstein have been able to provide us with solid theoretical backing for the Gravity Model of Trade. Regardless of all the existing and widely accepted modifications of the gravity model, one should always be careful in choosing a suitable version for his own study. Trade flows between different countries differ enormously and there isn't a single specific model that would be the best possible option for all countries in the world.

When Russia's exports to its main trading partners were studied, several conclusions could be made. First of all, the export structure of Russia differs a lot from that of an average industrialized country. Therefore also the results of this study differed from those that are usually gotten from gravity model studies of industrialized countries. Majority of Russian exports are raw materials, which are usually traded in US dollars. During the resource boom that prevailed on last decade, the resource prices increased drastically, which led to an inflow of foreign currency and to the appreciation of ruble. Therefore, the gross amount of exports increased steadily while the ruble was on average appreciating. This is possible because the appreciation of ruble doesn't decrease the international competitiveness of most of Russia's exports.

Secondly, the distance between Russia and its trading partners doesn't really affect the Russian exports, whereas for an average industrialized country a long distance to a trading partner tends to decrease trade significantly. A likely explanation for also this result could be the export structure of Russia. Raw material markets are global and some of them have to be exported very long distances, as they can be produced in only certain locations.

Also the population of the export market seems to be a bad variable to explain Russian exports. Once again, the demand for raw materials doesn't depend on the size of population, but it does seem to depend on the wealth of the nation. According to this study the wealth (GDP size) of a country seems to explain some of the demand for Russian exports and especially the demand for Russian oil and gas exports. This result matches with the intuition, as a wealthy country has typically higher need for raw materials, gasoline and energy than a less developed country has.

There is also a strong negative correlation between Russian population and Russian exports, but there is still no reason to believe that a decline in Russian population would cause increase in Russian exports. This relationship seems to be rather just a coincidence. Russian population declined on average during the period studied, while the resource boom caused Russian exports to increase rapidly.

This study shows once again how important the raw material sector still is for the Russian economy and exports. With the proper information and resources, this topic could be studied further in order to get even more accurate results. For example a separate study could be made of the non-resource exports of Russia. These exports cover only a very small amount of total exports, but would better represent the manufacturing sector of Russia. Also the variables used in the model could be calculated more thoroughly. The distance could possibly be calculated to represent the actual distance that goods on average travel from one country to another. Also the multilateral trade resistance could be calculated in the way Anderson and van Wincoop suggest. Finally, the whole model could be adjusted to fit better the export structure of a country that exports mainly raw-materials and intermediate goods, as the demand for these goods can behave differently from the demand of final goods.

Sources

Ahrend, R (2006a) “How to Sustain Growth in a Resource Based Economy? The Main Concepts and Their Application to the Russian Case”, OECD Economics Working Paper No. 478.

Ahrend, R (2006b) “Russian Industrial Restructuring: Trends in Productivity, Competitiveness and Comparative Advantage”, Post-Communist Economies, Vol. 18, No. 3 (September 2006)

Ahrend, R and Tompson, W (2005) “Fifteen Years of Economic Reform in Russia: What Has Been Achieved? What Remains to Be Done?” OECD Working Paper No. 430

Anderson, J. A (1979) “Theoretical Foundation for the Gravity Equation”, American Economic Review, March 1979, 69(1), pp. 106-116

Anderson, J and van Wincoop, E (2003) “Gravity with Gravitas: A Solution to the Border Puzzle”, The American Economic Review, Vol. 93, No. 1 (Mar., 2003), pp. 170-192

Anderson, J and van Wincoop, E (2004) “Trade Costs”, Journal of Economic Literature, Vol. 42, No. 3. (Sep., 2004)

Anderson, J (2011) “The Gravity Model”, Annual Review of Economics, Vol 3, pp. 133-160

Asseery, A and Peel, D. A (1991) “The effects of exchange rate volatility on exports”, Economic Letters 37

Baldwin, R and Taglioni, D (2011) “Gravity chains: estimating bilateral trade flows when parts and components trade is important” European Central Bank Working Paper Series NO 1401 (November 2011)

Benedictow, A, Fjærtoft, D and Løfsnæs, O (2013) “Oil dependency of the Russian economy: An econometric analysis”, Economic Modelling, Volume 32, May 2013, pages 400 - 428

van Bergeijk, P. A and Brakman, S (2010) “The gravity model in international trade: Advances and applications”, Cambridge University Press.

Bergstrand, J, Egger, P and Larch, M (2013) “Gravity Redux: Estimation of gravity-equation coefficients, elasticities of substitution, and general equilibrium comparative statics under asymmetric bilateral trade costs”, Journal of international Economics, Volume 89, Issue 1, pages 110-121 (January 2013)

Bessonova, E, Kozlov, K and Yudaeva, K (2003) “Trade Liberalization, Foreign Direct Investment, and Productivity of Russian Firms”, CEFIR Working paper No. 39, New Economic School, Moscow

Bilgin, M (2009) “Geopolitics of European natural gas demand: Supplies from Russia, Caspian and the Middle East”, Energy Policy, Volume 37, Issue 11, November 2009 pp. 4482-4492

Boug, P and Fagereng, A (2007) “Exchange rate volatility and export performance: A cointegrated VAR approach”, Statistics Norway, Research Department Discussion Papers No. 522 (November 2007)

Brun, J-F, Carrère, C, Guillaumont, P and De Melo, J (2005) “Has distance died? Evidence from a panel gravity model”, The World Bank Economic Review, 19(1), 99-120.

Chen, S-S (2009) “Oil price pass-through into inflation”, Energy Economics, Volume 31, Issue 1, January 2009, Pages 126-133

Deardorff, A (1998) “Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?”, National Bureau of Economic Research, The regionalization of World Economy, University of Chicago Press, 1998, pp. 7-22.

De Benedictis, L, Salvatici, L and Taglioni, D (2011) “The Gravity Model of International Trade” in: The Trade Impact of European Union Preferential Policies: An Analysis Through Gravity Models, Berlin/Heidelberg, Springer

Disdier, A-C and Head, K (2008) “The Puzzling Persistence of the Distance Effect on Bilateral Trade”, The Review of Economics and Statistics, February 2008, Vol. 90, No. 1, Pages 37-48

Drine, I and Rault, C (2006) "Learning about the Long-Run Determinants of Real Exchange Rates for Developing Countries: A Panel Data Investigation", in (ed.) Panel Data Econometrics Theoretical Contributions and Empirical Applications (Contributions to Economic Analysis, Volume 274), Emerald Group Publishing Limited, pp. 307 – 325

Ebrahim-Zadeh, C (2003) "Back to Basics – Too much wealth managed unwisely, Finance and Development", A quarterly magazine of the IMF, March 2003, Volume 40, Number 1

Evenett, S and Keller, W (2002) "On Theories Explaining The Success Of The Gravity Equation", Journal of Political Economy, v110, 281-316

Feenstra, R, Markusen, J and Rose, A (2001) "Using The Gravity Equation To Differentiate Among Alternative Theories Of Trade", The Canadian Journal of Economics, Vol. 34, No. 2. (May 2001), pp. 430-447.

Granville, M (2006) "Does inflation or currency depreciation drive monetary policy in Russia?" Research in International Business and Finance 20, 163-179

Granville, M (2010) "Monetary Policy in Russia: Identifying exchange rate shocks", Economic Modelling, Volume 27, Issue 1, 432-444

Helpman, E, Melitz, M and Rubinstein, Y (2008) "Estimating Trage Flows: Trading Partners and Trading Volumes", Quarterly Journal of Economics 123, 441-487

Krugman, P (1980) "Scale Economies, Product Differentation, and the Pattern of Trade", The American Economic Review, Volume 70, No. 5, Dec., 1980

Lawless, M (2010) "Deconstructing gravity: trade costs and extensive and intensive margins", Canadian Journal of Economics/Revue canadienne d'économique, 43, 1149–1172.

Lissovolik, B and LIssovolik, Y (2006) "Russia and the WTO: The "Gravity" of Outsider Status", IMF Staff Papers, Vol. 53, No. 1, 2006

Martinez-Zarzoso, I and Nowak-Lehmann, F (2003) "Augmented Gravity Model: an Empirical Application to Mercosur-European Union Trade Flows". Journal of Applied Economics 6, no. 2, 291–316.

McCallum, J (1995) "National Borders Matter: Canada-U.S. Regional Trade Patterns", The American Economic Review, Vol. 85, No. 3 (Jun., 1995), pp. 615-623

Mendoza, E. G (1995) "The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations", International Economic Review, Vol. 36, No. 1, (1995)

McKenzie, M (1999) "The Impact of Exchange Rate Volatility on International Trade Flows", Journal of economic surveys 13.1 (1999): 71-106

Merlevede, B, Schoors, K and Aarle, B (2009) "Russia from Bust to Boom and Back: Oil Price, Dutch Disease and Stabilization Fund", Comparative Economic Studies 51. 2 (Jun 2009)

Mussa, M (1986) "Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications", Carnegie-Rochester Conference Series on Public Policy 25, 117-214

Nguyen, T. K (2009) "Gravity Model by Panel Data Approach", ASEAN Economic Bulletin. Dec 2009, Vol. 26 Issue 3, p266-277.

Ollus, S-E and Simola, H (2007) "Russia's true imports", Bank of Finland, Institute for Economies in Transition. BOFIT Online, ISSN 1456-811X ; 1/2007

Panibratov, A (2012) "Russian multinationals: From regional supremacy to global lead", London, Routledge

Stack, M. M (2009) "Regional Integration and Trade: Controlling for Varying Degrees of Heterogeneity in the Gravity Model", World Economy, 32: 772–789.

Tica, J and Družić, I (2006) "The Harrod-Balassa-Samuelson Effect: A Survey of Empirical Evidence", University of Zagreb, Faculty of Economics and Business, EFZG Working Paper Series, Paper No. 06-07

Tinbergen, J (1962) "Shaping the World Economy: Suggestions for an International Economic Policy" New York, The Twentieth Century Fund

Wang, C, Wei, Y and Liu, X (2010) "Determinants of Bilateral Trade Flows in OECD Countries: Evidence from Gravity Panel Data Models" The World Economy 33 (7), 894-915.

Westerlund, J and Wilhelmsson, F (2011) “Estimating the Gravity Model Without Using Panel Data”, Applied Econometrics Vol. 43 Issue 6, p 641-649.

Yotov, Y (2012) A simple solution to the distance puzzle in international trade, Economic Letters, Volume 117, Issue 3, December 2012, Pages 794–798

Russian Federation Statistical Services (2012) http://www.gks.ru/ web page accessed 14.3.2012

The Central Bank of the Russian Federation - Bank of Russia (2012) http://www.cbr.ru/eng/today web page accessed 17.10.2012

UN COMTRADE, United Nations Commodity Trade Statistics Database (2012), http://comtrade.un.org web page accessed 8.5.2012

Appendices

Appendix 1

Results for fixed-effects regression for Russian non-oil and gas exports.

```
Fixed-effects (within) regression               Number of obs      =       462
Group variable: country                         Number of groups   =        31

R-sq:  within  = 0.7037                         Obs per group: min =        12
       between = 0.3194                                        avg =      14.9
       overall = 0.1154                                        max =        15

                                                F(5,426)           =    202.30
corr(u_i, Xb)  = -0.2167                        Prob > F           =    0.0000
```

lnexpnooil	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpop	.0374397	.1629455	0.23	0.818	-.2828375	.3577169
lngdp	-.1551327	.1882963	-0.82	0.410	-.5252382	.2149728
lndist	(omitted)					
lnruspop	-30.3973	3.907378	-7.78	0.000	-38.07744	-22.71716
lnrusgdp	.3437543	.1472009	2.34	0.020	.0544238	.6330847
rerchange	.1364206	.0349141	3.91	0.000	.0677952	.2050459
commonborder	(omitted)					
slaviclang~e	(omitted)					
formersovi~y	(omitted)					
_cons	574.9436	75.33422	7.63	0.000	426.8705	723.0167
sigma_u	1.017058					
sigma_e	.38009334					
rho	.87745046	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(30, 426) =    39.82             Prob > F = 0.0000
```

Appendix 2

Results for random-effects regression for Russian non-oil and gas exports

```
Random-effects GLS regression                   Number of obs      =       462
Group variable: country                         Number of groups   =        31

R-sq:  within  = 0.7002                         Obs per group: min =        12
       between = 0.4827                                        avg =      14.9
       overall = 0.5604                                        max =        15

                                                Wald chi2(9)       =   1014.94
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

lnexpnooil	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnpop	.1780957	.1038894	1.71	0.086	-.0255238	.3817153
lngdp	.2330177	.1274409	1.83	0.067	-.0167619	.4827973
lndist	-.3617266	.25677	-1.41	0.159	-.8649867	.1415334
lnruspop	-28.64377	3.892054	-7.36	0.000	-36.27206	-21.01548
lnrusgdp	.1745794	.1346131	1.30	0.195	-.0892575	.4384162
rerchange	.1444298	.0350569	4.12	0.000	.0757196	.2131399
commonborder	-.1763984	.4099237	-0.43	0.667	-.9798341	.6270372
slaviclang~e	.168953	.3267134	0.52	0.605	-.4713935	.8092996
formersovi~y	.4040274	.5031386	0.80	0.422	-.5821061	1.390161
_cons	539.4193	74.72083	7.22	0.000	392.9692	685.8694
sigma_u	.65600516					
sigma_e	.38009334					
rho	.74866475	(fraction of variance due to u_i)				

Appendix 3:

Hausman test results for Russian non-oil and gas exports

	Coefficients			
	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnpop	.0374397	.1780957	-.140656	.1255317
lngdp	-.1551327	.2330177	-.3881504	.1386157
lnruspop	-30.3973	-28.64377	-1.753527	.3457065
lnrusgdp	.3437543	.1745794	.1691749	.0595601
rerchange	.1364206	.1444298	-.0080092	.

```
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        8.00
                Prob>chi2 =      0.1560
                (V_b-V_B is not positive definite)
```

Appendix 4:

Results for fixed-effects regression for Russian oil and gas exports.

Fixed-effects (within) regression		Number of obs =	462
Group variable: country		Number of groups =	31
R-sq:	within = 0.4646	Obs per group: min =	12
	between = 0.0006	avg =	14.9
	overall = 0.0317	max =	15
		F(5,426) =	73.93
corr(u_i, Xb)	= -0.7711	Prob > F =	0.0000

lnoilexp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnpop	.5832495	.4320771	1.35	0.178	-.2660189	1.432518
lngdp	.9525262	.4992991	1.91	0.057	-.0288704	1.933923
lndist	(omitted)					
lnruspop	-19.6207	10.36106	-1.89	0.059	-39.98588	.7444711
lnrusgdp	.7523912	.3903277	1.93	0.055	-.0148168	1.519599
rerchange	.040348	.0925806	0.44	0.663	-.1416236	.2223197
commonborder	(omitted)					
slaviclang~e	(omitted)					
formersovi~y	(omitted)					
_cons	342.5774	199.7613	1.71	0.087	-50.063	735.2179
sigma_u	2.7921571					
sigma_e	1.007881					
rho	.88472219	(fraction of variance due to u_i)				

F test that all u_i=0: F(30, 426) = 27.32 Prob > F = 0.0000

Appendix 5

Results for random-effects regression for Russian oil and gas exports

Random-effects GLS regression		Number of obs =	462
Group variable: country		Number of groups =	31
R-sq: within	= 0.4590	Obs per group: min =	12
between	= 0.1840	avg =	14.9
overall	= 0.2990	max =	15
		Wald chi2(9) =	367.96
corr(u_i, X)	= 0 (assumed)	Prob > chi2 =	0.0000

lnoilexp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnpop	-.2939525	.2614052	-1.12	0.261	-.8062973	.2183923
lngdp	.6757518	.321582	2.10	0.036	.0454628	1.306041
lndist	-.4970342	.6013247	-0.83	0.408	-1.675609	.6815405
lnruspop	-20.46844	10.25988	-1.99	0.046	-40.57743	-.3594485
lnrusgdp	.9124161	.3529791	2.58	0.010	.2205899	1.604242
rerchange	.0323565	.0924816	0.35	0.726	-.148904	.213617
commonborder	-.2547499	.9578295	-0.27	0.790	-2.132061	1.622561
slaviclang~e	1.062826	.7649954	1.39	0.165	-.4365376	2.562189
formersovi~y	.8726194	1.179419	0.74	0.459	-1.438999	3.184238
_cons	377.8211	196.9729	1.92	0.055	-8.238803	763.881
sigma_u	1.5352833					
sigma_e	1.007881					
rho	.69882938	(fraction of variance due to u_i)				

.