Wageningen University

Department of Agricultural Economics and Rural Policy

ANALYSING GLOBAL WHEAT TRADE USING A GRAVITY MODEL

M.Sc. Thesis

By

Anastasios Chasimidis

Supervisor:

Dr.ir. Koos Gardebroek

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Abstract

International wheat trade remains a complex concept determined by the combination of economic, social and political factors. These factors can either enhance or restrict wheat trade from one country or region to another. In this thesis a gravity model is developed to study the effects of economic and other factors, on the traded quantity of wheat. All the variables are incorporated in a panel data set. Income, domestic price and distance are the basic economic determinants for this analysis. Those determinants are combined with a set of qualitative variables like common language, WTO membership for importers, trade creation and trade diversion and used to estimate the gravity model for the trade flows of wheat. Wheat trade flows between seventeen countries, that are considered among the major exporting and importing countries around the world, are included in this research for the years 2000-2011. The random effects regression for our model highlights that income constitutes a crucial aspect, indicating that economic power stimulates wheat trade in the international markets. Furthermore, domestic prices for exporters (negative effect) and importers (positive effect) respectively, form an important factor for determining the trade flows of wheat as well. Lastly, costs of transport (proxied by distance) are found to deteriorate the trade flow of wheat. Moreover, language and trade creation have a positive effect on the traded quantities, while WTO membership and trade diversion exhibit a negative coefficient. All in all, gravity model is found to form a fruitful tool for analysing trade as it captures both quantitative and qualitative variables effects. However further analysis on econometric techniques and enrichment of the model could provide an interesting aspect for future research on international trade.

Keywords: wheat trade, gravity model, panel data analysis

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Lastly and most importantly I would to like to devote this thesis to my family and especially to my parents. Πολυαγαπημένοι μου γονείς αυτή η μεταπτυχιακή διατριβή είναι αφιερωμένη σε σας. Δεν έχω λόγια να σας ευχαριστήσω για ότι έχετε κάνει για μένα. Γνωρίζοντας ότι με αυτό το σύντομο αλλά μεγάλης σημασίας κείμενο θα σας δώσω έστω και ελάχιστη χαρά με κάνει να γεμίζω από υπερηφάνεια και κουράγιο να αντιμετωπίζω τις προκλήσεις που ακολουθούν. Επίσης, θα ήθελα να αναφέρω ιδιαίτερα τα αδέλφια και ανίψια μου Πάνο, Θεώνη, Τάσο, Σοφία και Νίκο οι οποίοι αποτελούνε κάτι ξεχωριστό για εμένα. Σας ευχαριστώ και σας αγαπώ με όλη μου την καρδιά.

Chapter 1 – Introduction

1.1 Background

Global trade can in general be explained by the simple principle of buying or producing a product at a lower cost and then transporting and selling it at another location, where prices are higher. Consumers can buy imported products, which have a high cost of production domestically, whereas producers can promote their domestically cheaper products abroad. Global trade is in fact more complicated as it involves economic, political and social factors, which affect the flow of products from one place to another. As Linders (2006) indicated, there are often undetermined coefficients which usually constitute significant barriers for nations to exchange their products or services. In case of a single commodity, like wheat, trade flows are determined by several factors. Analysing trade relationships between a set of major exporting and importing countries theoretically and empirically can help to identify and explain these factors. Gravity models have been used extensively as a tool to estimate and explain trade relationships between countries over the past 25 years (Bergstrand, 1985, 1989; Koo and Karemera, 1991; Van Koop and Anderson, 2003). They use trade data and econometric techniques, more specifically panel data techniques, as they have been proven to be fruitful in trade analyses (Koo and Karemera, 1991; Egger and Pfaffermayr, 2003).

Wheat is one of the primary food ingredients consumed by humans around the world. It is the main component for making flour (bread), pasta, noodles and pastry. A quite important feature of this commodity is the variety of different kinds of wheat with varying protein levels. Apart from human nutrition wheat is used in livestock production as compound feed and in making alcoholic beverages. In 2001 almost 1/5 of wheat’s production worldwide was traded at an international scale, mainly from the major exporters such as USA, Canada, Australia and EU towards developing countries in order to meet the increasing demand from the local consumers. This makes wheat one of the most traded commodities (Gómez-Plana and Devadoss, 2004). Moreover, wheat’s durability allows for storage under the proper conditions and producers can sell it in another period of time, when a production shortfall takes place. This storage capability constitutes an additional reason for trading it even among countries with a large distance from each other. However this storage capability poses additional risks because of the potential for speculative behaviour which may affect significantly the prices. Several studies have been conducted about the market structure of wheat. However, researchers have faced limitations in their studies due to data availability constraints (Sekhar, 2010).

Despite the case studies that have been carried out on the international wheat market, still wheat trade at a global scale remains a complicated concept because of the interaction between various factors. These factors include price, national income, exchange rates and transportation costs. Moreover, population and inflation rates may also significantly affect trade flows. In addition, in the literature it is pointed out that qualitative indicators can play a role in the determination of wheat trade. Common language is a typical example of such an indicator (Koo and Karemera, 1991; Grant and Lambert, 2005).

Cultural discrepancies coupled with differences between domestic markets constitute additional reasons for making international wheat trade a complex concept. Government interventions together with the importance of wheat for nutrition have attracted the attention of many economists lately. Summing up the mentioned arguments afore, it is obvious that the global wheat market is an interesting agricultural commodity market to analyse.

The USA, Canada, Australia, the EU–27 and Argentina dominate supply on the world wheat market, as they account for almost 90% of the total exports (USDA, 2013). Those nations have dominated the global wheat market for more than half a century. However, during recent years a gradual and increasing interference of other countries such as Russia and Ukraine is observed on the world market. Ukraine and Russia imposed export bans for wheat in 2007 and 2010 respectively because of unpredictable and extended droughts in those countries and so as to prevent a deficit in wheat supply for the local consumers. More specifically, in Russia in 2010 one of the worst droughts ever took place and destroyed almost 20% of the total domestic wheat production. Given that Russia counted for about 8% of the total wheat crop globally, this loss drove a 1.6% decrease of the world's wheat supply. Despite the fact that wheat prices faced significant upward changes within 2010, they still remained within a reasonable range. This implied that other major exporting countries like USA, Canada and Australia were able to cover this deficit of wheat for the world market because of their surplus (mainly towards Middle East and North Africa where Russia used to export wheat). Moreover, countries like China and India which are among the biggest producers of wheat worldwide are not classified among the major wheat exporting nations. Potential reason for the absence of those nations from the top list of the exporting countries is the increasing demand by the local people. This is confirmed by the increased wheat production in China compared to other countries during 2010 (Hernandez et al., 2010).

Another element which makes wheat one of the most crucial agricultural commodities for an economist to deal with is the food crisis during 2007–2008. Between 2005 and 2010 there was a gradual increase in food prices internationally that peaked in the middle of 2008. This price spike raised food security concerns worldwide, and enforced the governments to adjust their policies in order to respond to price volatility. In addition, the global increasing demand by the consumer's side led to lower stored quantities putting additional pressure on world market prices.

Weather conditions combined with government interventions can either enhance or deter the traded quantities of wheat between countries over time. Governments could reform their intervention in the world market, concerning what has been preceded in the relevant research. In addition, Koo and Karemera (1991) and Grant and Lambert (2005) found that bilateral trade flows can be examined by using a gravity model mainly because this kind of model can capture the effects of the quantitative and qualitative factors that are explicitly involved in the trade pattern of wheat. It is important to quantify the factors that determine global wheat trade in order to assist specialists who deal with the implementation of policies and measures in the wheat market. Moreover, trade gravity models can evaluate the trade flows among pairs of countries. The main advantage of the analysis of trade flows with a gravity model compared to spatial equilibrium models that researchers used in the past is that spatial equilibrium models are found to perform poorly with regard to the explanation of agricultural commodities' trade, since trade flows are distorted by specific export promotion or import restriction programmes (Koo and Karemera, 1991).

1.2 Research objectives

This study aims to examine some main global wheat trade patterns within the period of 2000–2011. Furthermore, it identifies factors that affect the trade of wheat and their significance. In detail, the study addresses the following questions:

- Which factors are relevant in explaining wheat trade according to the literature?
- How is wheat trade explained by a gravity model?
- What is the effect of indicators included on wheat trade?

The analysis is carried out in three main steps:

- Literature review concerning global wheat trade
- Estimation of a gravity model in order to identify which factors affect wheat trade
- Quantification of the impacts of the factors identified in step two on wheat trade flows

The results of this analysis point out which aspects play an important role in the relationship between the major importing and exporting countries for wheat trade. Then, based on the estimation results this thesis provides relevant information with regard to economic and other significant determinants for the trade of agricultural commodities around the globe. Figure 1 below shows the selected countries for this study.

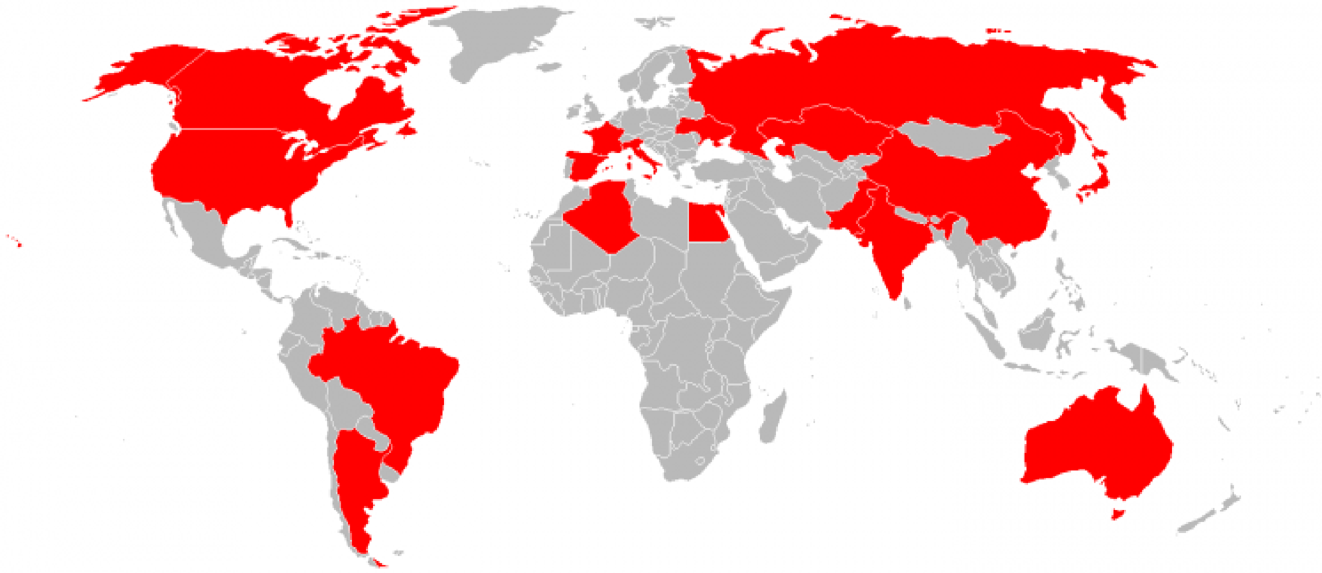

Figure 1: Map of selected countries for wheat trade analysis

1.3 Thesis methodology

The increased availability of data lately and the capture of qualitative variables effects led researchers to develop different types of gravity models for studying international trade patterns (Koo and Karemera, 1991). The basis for this study is the initial gravity equation where the gross domestic product of the involved countries and the distance between those countries together with a constant influence the volume of trade. According to the existent literature, a gravity model seems to be the most feasible way to evaluate the determining factors for the wheat trade flows. Several data sources are used for obtaining the necessary data for this project. Seventeen countries are examined, which are the major exporting and importing nations in the global wheat trade flows, as indicated by FAO (2013). Nations from all the continents are chosen. The independent variables which are used in this study are the Gross Domestic Product (approximating the national income), transportation costs (use of distance as proxy variable for the transportation costs between countries) and domestic price. For the traded values and quantities, the six digits Harmonized System (HS – 110100) is chosen for the inclusion of wheat without separating it into categories. Trade agreements implemented by the governments can also affect the trade volume so they are incorporated in the model, together with other qualitative variables such as common language and WTO participation. The parameters of the resulting gravity model are estimated using econometric methods in order to quantify the effects of the included variables on wheat trade.

1.4 Structure of the thesis

The rest of the thesis is organised as follows. Chapter 2 reviews literature on wheat trade and frames the methodology used in the thesis. Chapter 3 describes the gravity model whereas chapter 4 presents the data used to estimate the model. Chapter 5 discusses the results and chapter 6 concludes.

Chapter 2 – Literature Review

This chapter reviews studies on gravity trade models. In addition, apart from the general specifications of gravity models, the second part of this chapter extends the review of gravity models used for the estimation of wheat trade flows.

2.1 Research on gravity trade models

The comprehension of the theory behind the gravity model and the application of it constitute potentially a contribution for the further understanding of the international market for wheat. In this section the theoretical background and application of the gravity model are reviewed.

Newton for the first time used a gravity equation in physics, inspiring later other researchers for the construction of the gravity model for the analysis of spatial flows. As Bergstrand (1985) stated, tourism, commodity shipping, immigration and commuting constitute typical examples of those spatial flows. The gravity equation was a useful tool for explaining these kinds of flows in a consistent way. For the explanation of bilateral trade flows, the gravity model started being used since the beginning of 1960's. The first who tried to analyse spatial flows with a gravity model were Tinbergen (1962), Poyhonen (1963) and Linneman (1966). The original idea for using a gravity model was that trade between two countries depends proportionally on the economic mass of those countries and inversely on the distance between the involved countries. So, initially it was presented in a simple form consisting of two variables. However there are examples like Tinbergen (1962) who tried to involve more variables in his analysis for world trade flows. Among others he used income, adjacency, distance and a qualitative variable for expressing a preferential trade agreement. Finally, he concluded that national income was the most effective factor for the trade volume. Tinbergen and his colleagues proved the empirical attribution of the model. Over time economists enriched this model with more variables in order to give a more analytical and accurate quotation of the factors which affect either positively or negatively the traded volume (e.g. prices, exchanges rates, population). Besides, several qualitative variables have been used (e.g. subsidies, tariffs), which are normally expressed using dummy variables (Yeboah et al., 2007).

Although in the early 1960's economists already implemented gravity models for international trade (e.g. Tinbergen, 1962), these models lacked a rigorous theoretical background. Anderson (1979) further developed the theoretical framework for using gravity equations in trade analysis by using the properties of constant elasticity of substitution (CES) functions. By using the properties of an expenditure system, Anderson made two basic assumptions: i) preferences among consumers from different regions are identical, ii) differentiation of goods by place of origin. Moreover, through the use of CES system Anderson (1979) extended properly the Cobb–Douglas system by including non–unity income elasticity in an unrestricted gravity equation and separating the goods into traded and non–traded. However, there was lack of empirical evidence in this gravity equation.

Up to 1980's most of the spatial trade research focused on spatial equilibrium models by using a mathematical algorithm. Since then, researchers started indicating that spatial equilibrium models resulted in a poor explanation of the trade patterns for agricultural commodities. This conclusion drove them to use the gravity model, as it was derived theoretically by Anderson (1979) and Bergstrand (1985, 1989). Bergstrand (1985) extended Anderson's work by defining the basic assumptions for a general equilibrium framework. Among the most highlighted assumptions are the substitutability of goods across countries, the adoption of zero tariffs, zero transportation costs and the importance of price variables. He acknowledged those basic assumptions and despite the lack of theoretical background he named this equation as generalized gravity equation, similar to the basic gravity model, proper for analysing international trade. This lack of theoretical background was the main reason for aborting its use for future predictions in spite of the fact that it had high statistical power. According to Bergstrand (1985), the generalized gravity equation performs in a similar way to a basic gravity model, something which was approved by the signs of the coefficients. More specifically, for importers' income, adjacency and preferential trade agreements he found positive effects, whereas for distance a negative one. Furthermore, Bergstrand (1989) expanded the microeconomic theoretical foundations of his work in 1985 by adding factor endowment and taste variables. Moreover he took into consideration supply and demand functions. Income for consumers plays a significant role according to his research, combined with a number of constraints. He substituted national income with GDP, an example which was followed later in other studies. Bergstrand (1989) also categorized goods into luxurious and necessary goods. He claimed that luxurious (in consumption) goods are capital intensive (in production), so their elasticity of substitution exceeds unity and the coefficients of income and income per capita are positive for exporters and importers. As wheat is considered as a necessity good, an increase in income for exporting and importing nations will result in a theoretically relative decrease on the traded quantity, though still remains positive in absolute terms.

McCallum (1995) investigated the trade patterns between Canada and USA using a gravity equation, aiming at the determination of the regional trade patterns. However, Van Wincoop and Anderson (2003) concluded that McCallum's study lacked a theoretical foundation in the gravity equation.

Van Wincoop and Anderson (2003) investigated potential impediments which are considered as the main trade barriers. Those are: 1) bilateral trade barriers, 2) exporters resistance to trade with all regions, and 3) importers resistance to trade with all regions. They modified the CES expenditure function as Anderson (1979) did in order to obtain a simpler version of the gravity model. A crucial difference between their analysis and McCallum's (1995) analysis was that they found a substantial reduction (44 percent) of trade among USA and Canada because of the border effects between the United States and Canada, instead of 19 percent change of the McCallum's findings (1995). So, trade barriers established on the borders seemed to diminish the trade flow between United States and Canada.

Martinez-Zarzoso and Nowak–Lehmann (2003) used the gravity model to explore the determinants of the trade flows among Mercosur and European Union countries. Their aim was to evaluate the role of the regional trade agreements which were established between the two trade blocs. They found that variables such as infrastructure and income differences played a significant role on the international trade flows.

Despite the fact that initially gravity equations seemed to be a useful tool for the analysis of international trade, criticism on the weak theoretical basis of this model appeared. Anderson was followed by other researchers and a lot of emphasis increasingly has been given to theoretical developments in support of the gravity model (Martinez-Zarzoso and Nowak–Lehmann, 2003). Within the last twenty years, economists started using panel data methodology to estimate gravity models, whereas before it was more common to use cross-sectional data. The reason behind this choice is mainly the gradual increase in data availability and the improvement of econometric techniques. However, three studies that deal with time-series econometrics discussed the additional problem of non-stationarity of variables (Coccari, 1978; Dale and Bailey, 1982; Shapiro, 1999). In case of non–stationarity of data the assumptions of the Ordinary Least Squares Estimator (OLS) can be violated, as it will result in biased results. Another possible bias is the phenomenon of heteroskedasticity or significant correlation in the residuals (Zwinkels and Beugelsdijk, 2010). Yeboah et al. (2007) refer to Mátyás' (1997) paper on the choice of a proper econometric framework.

The main advantage of the gravity model is that it allows incorporating the effects of policies in the estimation of trade flows. The three main components of the gravity equation are the economic coefficients, which affect the traded volume in exporting countries, importing ones and other determinants, either quantitative or qualitative (Koo and Karemera, 1991). Koo and Karemera (1991) revised the conventional gravity model and applied it to wheat markets to determine the factors which affect the trade flows of wheat. The main variables involved in their work, concerning multilateral wheat trade flows, were national income, prices, inflation rates, exchange rates and costs of transportation. The coefficients for GDP were expected to have a positive effect in both exporting and importing countries. This is because in exporting countries higher levels of GDP imply that there is more space for promoting exports. In addition, for the importers higher income means more economic power for importing wheat. On the opposite, distance is expected to affect negatively the traded volume as it is going to be a proxy variable for the costs of transportation. Subsidies are expected to encourage exporters for supplying certain quantities of wheat abroad. Exchange rate appreciation in importing countries is assumed to have also a positive effect. On the other hand tariffs are probably going to restrict the imported quantity (Martínez-Zarzoso and Nowak–Lehmann, 2003). A potential increase in the exporting nation's domestic price can decrease the exported quantity whereas a price increase in the importing country can drive up the demanded quantity from the world market. Finally, inflation is hypothesised to affect negatively the exporting nation and positively the importing one, for the same reasons as domestic prices do (Koo and Karemera, 1991).

Many trade economists, including Koo and Karemera (1991), use dummy variables in their gravity model specification, in order to measure the effects of different policy frameworks. Besides, Koo and Karemera (1991) examined several programmes that trading countries imposed in order to either restrict or enhance trade flows. One typical example is the long term agreements that Canada and Australia implemented aiming at the promotion of the wheat surplus in the world market. Except for Canada and Australia, the European Community initially (afterwards renamed to European Union) and United States of America used different policies for expanding their shares in the global wheat market. On the other hand, traditionally importing countries used typical barriers like tariffs or quotas to protect their domestic market.

Except for the quantitative indicators, qualitative traits (e.g. customs union, common language) can also affect trade flows, but to a lower extent. Dummies have been again used to capture the potential effects from factors like cultural distance, common language and regional integration (Yeboah et al, 2007).

Van Wincoop and Anderson (2003) showed that the gravity equation can be simplified into a model based on specific theoretical assumptions. They stated that trade depends partly on three crucial aspects: Firstly on bilateral trade barriers, secondly on the exporting nations negation to exchange goods or services with the other countries and thirdly on the importing nations negation to import goods or services from abroad. The authors concluded that a partial equilibrium model consisting of four equations can lead to a more simplified gravity equation.

De Benedictis and Taglioni (2011) studied the role of the gravity model in international trade and noted that there is an observed causality relationship between income and distance to trade. They further stated that using panel data techniques is more preferable compared to cross–sectional econometrics. They criticised the power of distance as a proxy for trade costs and the coefficient of adjacency, indicating that cross–section series can capture distance and sizes effects but they do not count for omitted variables bias. Additionally, they claimed that panels are better in identifying policy measures and trade agreements effects. In short the use of gravity models is becoming more valuable for firm data analyses. They ended with the remark that a re–evaluation of gravity specifications needs to be made due to the gradual changes of the trade relationships.

2.2 Applications of gravity trade models in agricultural commodity markets

In this section a review of gravity models for wheat trade and agricultural commodities is presented. As mentioned above, Koo and Karemera (1991) studied the factors that determine trade flows in the wheat market. They focus mainly on the several policy measures that governments have implemented over time. The construction of a single–commodity gravity model for wheat was the main tool for their analysis. As indicated in the literature the gravity model is a reduced form of a general equilibrium model, consisting of supply and demand functions. Following the example of Linneman (1966) initially and Bergstrand (1985, 1989) later on, Koo and Karemera (1991) stated that the demand model is derived by the maximization of a constant elasticity substitution (CES) utility function with respect to income constraints. On the other hand a supply model is derived using a constant elasticity of transformation technology with regard to the profit maximization of a firm. The main independent variables contained in the model were income (approximated by GDP), price, exchange rate, inflation, population and costs of transport (use as a proxy for the variable distance). Government interventions (mainly for the importing countries) were captured by the tariffs for the importing countries. Similarly, export promotion policies and additional import restriction measures were expressed through the use of several variables. For example, Australia and Canada, as major exporting countries used long term agreements (LTA) to ensure that a certain amount of the locally produced wheat would be exported abroad. In the paper it is also indicated that income represents the agricultural production capacity for the exporters whereas in importing countries income represents the purchasing power of the consumers.

However, it is noticeable that through their analysis Koo and Karemera (1991) concluded that the wheat traded quantities do not depend on the production capacity for the exporters nor on the importers' disposable income. Subsequently world trade patterns for wheat do not depend on the distance among the trading nations mainly because of the non-homogeneity of the different types of wheat produced in the exporting countries. This study showed that export promotion programmes had a significant positive effect on the quantities traded among the involved countries, whereas import restriction policies led to reduced wheat imports. More specifically, LTAs were proven to be more effective compared to credit sales (CS) programmes which were basically used by the US, France, Canada and Australia as well. Moreover, some importing countries used support price programmes in order to increase the price of wheat in the importers for the protection of the agricultural sector. The papers of Koo and Karemera (1991) and Grant and Lambert (2005) constitute the basis for the empirical framework of this thesis.

Grant and Lambert (2005) used an extended gravity model to assess the effects of regional trade agreements (RTAs) on agricultural trade, including wheat trade. Among the involved agricultural commodities they studied wheat and durum wheat using the classification of the two-digit Harmonized System (HS) level for the identification of the products. Their study had two major aims: 1) to investigate the potential changes in welfare among trade partners (trade creation) because of the RTAs, 2) to address the changes in merchandise trade (trade diversion). An RTA is considered as trade creating when it displaces high cost exports with lower cost exports from a country–member. In addition, an RTA is trade diverting when higher cost imports are replaced by lower cost foreign supplies from a bloc member. Grant and Lambert (2005) used a variable for trade creation and a separate one for trade diversion. To note, Koo and Karemera (1991) had done the same[1] in their study for the determinants of wheat trade, for the effect of the trade agreement between Economic Community countries. Both trade creation and trade diversion variables were qualitative. The trade creation variable takes the value of 1 when the year is larger or equal to when the agreement was signed. The trade diversion variable takes the value of 1 when there is trade between two countries (one agreement member and the other non–agreement member) and the year is larger or equal to the year the agreement was signed.

Grant and Lambert (2005) concluded that income elasticity was positive and significant for almost all products. In the same way distance affected negatively more than half of the agricultural commodities. Similarly, qualitative variables such as common language and contiguity had the expected significant effects. They further discussed that the North American Free Trade Agreement (NAFTA), Asian Pacific Economic Cooperation (APEC) and Africa Trade Agreements had all positive and significant effects in the trade creation. This implied that they enhanced the trade flow among the agreement member–nations. On the contrary, the trade diversion coefficient had no statistical significance for products like wheat and durum wheat. This enforced member countries to move towards other member countries rather than countries which are more efficient in the production for the exchange of the commodities.

[1] They include qualitative variables to measure the effect on trade flows.

To sum up, Koo and Karemera (1991) and Grant and Lambert (2005) incorporated variables such as trade creation and trade diversion. Thus, it is possible to capture the potential policy trends by the use of the trade agreements[2].

Consequently, Yeboah et al. (2007) analysed the trade effects of the Central American Free Trade Agreement (CAFTA). As they pointed out, CAFTA aimed at removing the barriers of trade in most of the commodities and liberalizing intellectual properties, investments and services. They used a restricted version of a gravity model for a bilateral trade flow including the variables of income, relative size, factor endowment, distance and exchange rates.

Yeboah et al. (2007) found that the coefficients of income, factor endowment and exchange rates had significantly positive effects (at 1% significance level), whereas distance appeared to have a negative sign only at the 10% significance level. This study suggested that all the involved countries are trade creators with Nicaragua being the largest one and Costa Rica being excepted. To note, those nations were net importers but can become net exporters if the level of investment and technological support is improved in the future.

Jayasinghe and Sarker (2008) performed an analysis for identifying trade creation and trade diversion effects of the North American Free Trade Agreement. They estimated an extended gravity model using pooled cross-sectional time-series regression for several commodities including wheat. Their analysis (six agrifood products from 1985-2000) showed that the share of intraregional trade is growing within NAFTA and also that NAFTA displaced trade with the rest of the world. In the case of grains the income coefficient was found to be positive for both exporters and importers while income per capita was positive for exporters and negative for importers. Distance showed a negative effect on the trade flow whereas openness to trade affected also significantly the trade volume (negatively). Moreover, they included a dummy variable NAFTA in order to examine the effects of NAFTA formation on the trade relationships. The coefficient of this variable had a negative value for the first two sub-periods and positive for the rest of the years.

Analogous to the previous studies, Vollrath, Gehlhar and Hallahan (2009) used the generalised gravity framework to analyse the role of the factors for agricultural protection in the bilateral trade relationships for agricultural products, including wheat. Inspired from Bergstrand's (1989) capital/labour factor endowment, they incorporated the land/labour ration, focusing on the physical land size. One of their main results is the significance of the relative factor endowments, the negligible effect of the border protection on agricultural trade and the variance of the effects for importer's income, income differences, exchange rates and colonial relations by year. Cultural ties and financial linkages constitute typical examples of those factors.

Summing up, it is obvious that gravity models have been widely used for the identification of the determinants of good flows and the intervention of trade policies. Baier and Bergstrand (2007) analysed trade agreements using a gravity model while Van Wincoop and Anderson (2003) evaluated national borders as a restricting aspect for international trade with the use of a gravity model. This study emphasizes the recent findings of Grant and Lambert (2005) and Koo and Karemera (1991) punctuating the determinants for the trade flows of wheat.

[2] In some cases found either as regional or as free trade agreements in the literature.

Based on the previous findings, in the next chapter a conceptual gravity model of wheat trade is developed, which is estimated using panel data techniques.

Chapter 3 – Methodology

3.1 Basic Framework

This study develops a gravity model in order to estimate the factors affecting wheat trade flows among seventeen countries around the world. The above mentioned literature serves as a basis for the explanation and interpretation of the parameters within the gravity model. This chapter builds on the reviewed studies in order to identify the regression performed for this thesis.

The gravity model in its basic form, for a bilateral trade relationship, consists of the traded volume of the commodity, the economic mass (measured by GDP) of the two included countries and the distance between those countries (Krugman et al., 2012). This relationship is denoted as:

$$T_{ij} = A \times \frac{Y_i Y_j}{D_{ij}} \quad (1)$$

where:

i : exporting country (or region)

j : importing country (or region)

T_{ij} : volume of trade between countries (or regions) i and j

A : constant

Y_i : GDP of the exporting country (or region) i

Y_j : GDP of the importing country (or region) j

D_{ij} : distance between countries (or regions) i and j

By transforming the basic form of the gravity model, the logarithm of the volume of trade (T_{ij}) between exporting and importing countries i and j, is regressed on the logarithm of the economic size of the exporting country (or region) i (Y_i), the logarithm of the economic size of the importing country (or region; both represented by GDP) j (Y_j) and the logarithm of the distance between them (D_{ij}):

$$\ln \mathrm{T}_{ij} = \ln A + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{ij} + \varepsilon_{ij} \quad (2)$$

where D_{ij} is expected to show a negative sign since trade depends inversely on this variable.

3.2 Conceptual model

Koo and Karemera (1991) denoted that the gravity model for a specific commodity is specified under the market equilibrium condition, where demand equals supply of the commodity, following Linneman (1966) and more recently Bergstrand (1985, 1989). As a result, they extended the basic framework of the gravity equation with the additions of tariffs, prices, exchange rates and inflation for the involved countries. Nevertheless, empirical research has generated a number of alternative specifications for the gravity model.

As a result, for the more accurate interpretation of the included dummy variables, this thesis will use the non-linear transformation established by Grant and Lambert (2005). Hence, in this study the model (equation 1), with the use of the semi-logarithmic transformation, is extended as follows:

$$\begin{aligned} \ln Q_{ij} &= \ln \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln P_i + \beta_5 \ln P_j + \\ &+ \beta_6 COMLANG + \beta_7 WTOIM + \sum_{l=1}^{26} \alpha_l CTRADE + \sum_{m=1}^{26} \gamma_m DTRADE + \\ &+ \varepsilon_{ij} \end{aligned} \tag{3}$$

where β_0 is the constant A in equation (1), β_n are the parameters to be estimated and ε_{ij} is the error term. Equation (3) is estimated using panel data regression in this study.

Exporter income (Y_i) as mentioned above expresses the country's production capacity whereas importer income (Y_j) is the purchasing power of the country (Koo and Karemera, 1991,). Moreover, the coefficients of Y_i and Y_j are expected to be positive and statistically significant due to the fact that larger exporting nations intend to trade more while at the same time importing countries' larger income implies higher demand (Grant and Lambert, 2005). Additionally, distance (D_{ij}) is expected to affect negatively the trade flow. P_i reflects the exporting price which is the domestic price in exporting country and P_j is the importing price of wheat. According to trade theory, an increase in P_i will decrease the traded volume and an increase in P_j will increase the trade flow.

Furthermore, some qualitative measures are used in this study to examine the effect of the respective factors on the trade relationships. Common language ($COMLANG$) is perceived to allow for better communication among nations and account for potential cultural similarities. In addition, being a member of the World Trade Organization ($WTOIM$) may imply a further considerable explanation for the trade flows. Moreover, as mentioned in the literature, trade creation ($CTRADE$) is a variable whose direction and magnitude are of great interest and as a result are part of this study. More specifically, the coefficient of this dummy variable indicates that a regional trade agreement (RTA) enhances or depresses intra-regional trade of an agricultural commodity (Grant and Lambert, 2005).

As trade diversion ($DTRADE$) has been found to fully capture the impacts of the trade agreements on the market, it is the last variable embodied in our model to quantify the effect of trade agreements. The trade diversion dummy variable is designed to estimate whether the volume of the increase (in case of actual increase) in trade creation was a result of trade diversion of non-members (Grant and Lambert, 2005).

Thereupon the coefficient of a continuous variable is the elasticity of $\ln Q$ for a small change in the explanatory variable X_i. However, a dummy variable is a discontinuous variable and the derivative of $\ln Q$ with respect to a small change in the set of dummy variables does not exist. On the contrary, according to Grant and Lambert (2005), the percentage change in $\ln Q$ going from $\ln Q_0$ to $\ln Q_1$ for a discrete change in the set of dummy variables, is calculated as:

$$\left[\frac{\ln Q_0 - \ln Q_1}{\ln Q_1}\right]*100 = \left[\frac{\exp\left(\alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln P_i + \beta_5 \ln P_j + \delta * 1 + \varepsilon_i\right)}{\exp\left(\alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln P_i + \beta_5 \ln P_j + \delta * 0 + \varepsilon_i\right)}\right]*100 -$$

$$-\left[\frac{\exp\left(\alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln P_i + \beta_5 \ln P_j + \delta * 0 + \varepsilon_i\right)}{\exp\left(\alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln P_i + \beta_5 \ln P_j + \delta * 0 + \varepsilon_i\right)}\right]*100 = \left(\exp(\delta) - 1\right)*100 \quad (4)$$

where δ is the sum of the coefficients of dummy variables.

As Rahman (2007) indicated, the gravity model in the classical theory uses cross-section data to estimate trade relationships and trade effects for a particular period of time. However, in fact cross-section data observed over several periods of time (panel data), provides more useful information.

The thesis builds upon panel data methodology inspired from the recent literature where it is pointed out that the scope of panel data methods is highly appreciated (Carrere, 2006; Rahman, 2007). The use of panel data methodology relies upon two major advantages:

1. Panels can effectively capture the relevant relationships among variables over time
2. Panels can monitor the unobservable individual effects between trading partners

More particularly, a random-effects regression is used in order to test the influence of the parameters. The reason behind the choice of this specification is mainly that in our model we use time-invariant variables (i.e. distance as a proxy for transportation costs) and by using a random-effects regression, the model can be properly estimated, since with fixed-effects specification these variables would be differenced out.

Following the conceptualisation of the empirical model, the next chapter describes the data used for this study.

Chapter 4 – Data

4.1 Introduction

This chapter describes the variables used in the regression. The data used are annual data from 2000–2011, including 1,010 observations. The export quantities were found in the United Nations Commodity Trade Statistics Database (UN comtrade). However for the chosen countries there are some limitations since not all the quantities are publically available for common use. So, taking into consideration the availability of the data, it is considered that there are missing values in the data set for the export quantities. This number of observations results in the final data set representing the international wheat trade relationships for the chosen countries. The choice of the countries for this study relies upon the rankings of the FAOSTAT concerning the major exporting and importing countries for the year 2011 worldwide. The 8 major exporting countries included in the analysis belong in the list with the top exporting countries for 2011. The other 9 countries included are considered as major importers in the global wheat market (FAOSTAT, 2013). It is also important to distinguish China, India and Pakistan because of their huge populations and the role in the wheat market as well as their potential demand fluctuations on the consumer side. Figure 2 below and figure 3 on the next page show the production of wheat in those countries.

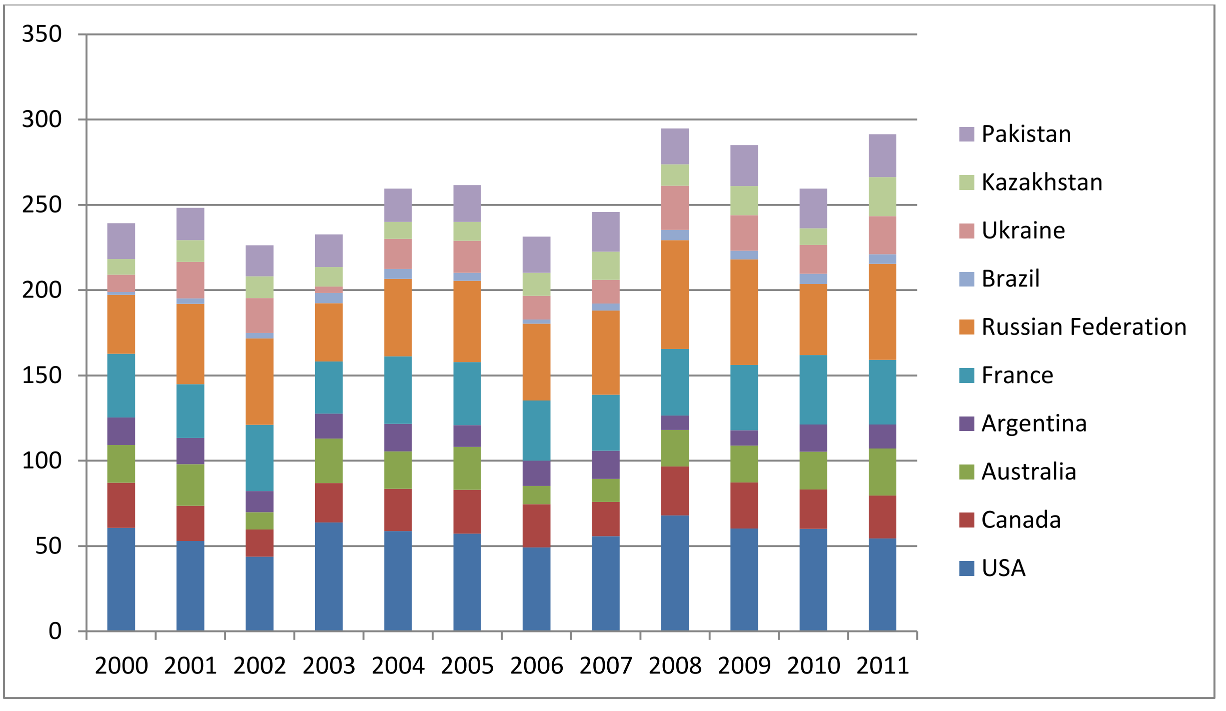

Figure 2: Production of wheat for major exporters (million tonnes)

Source: FAOSTAT

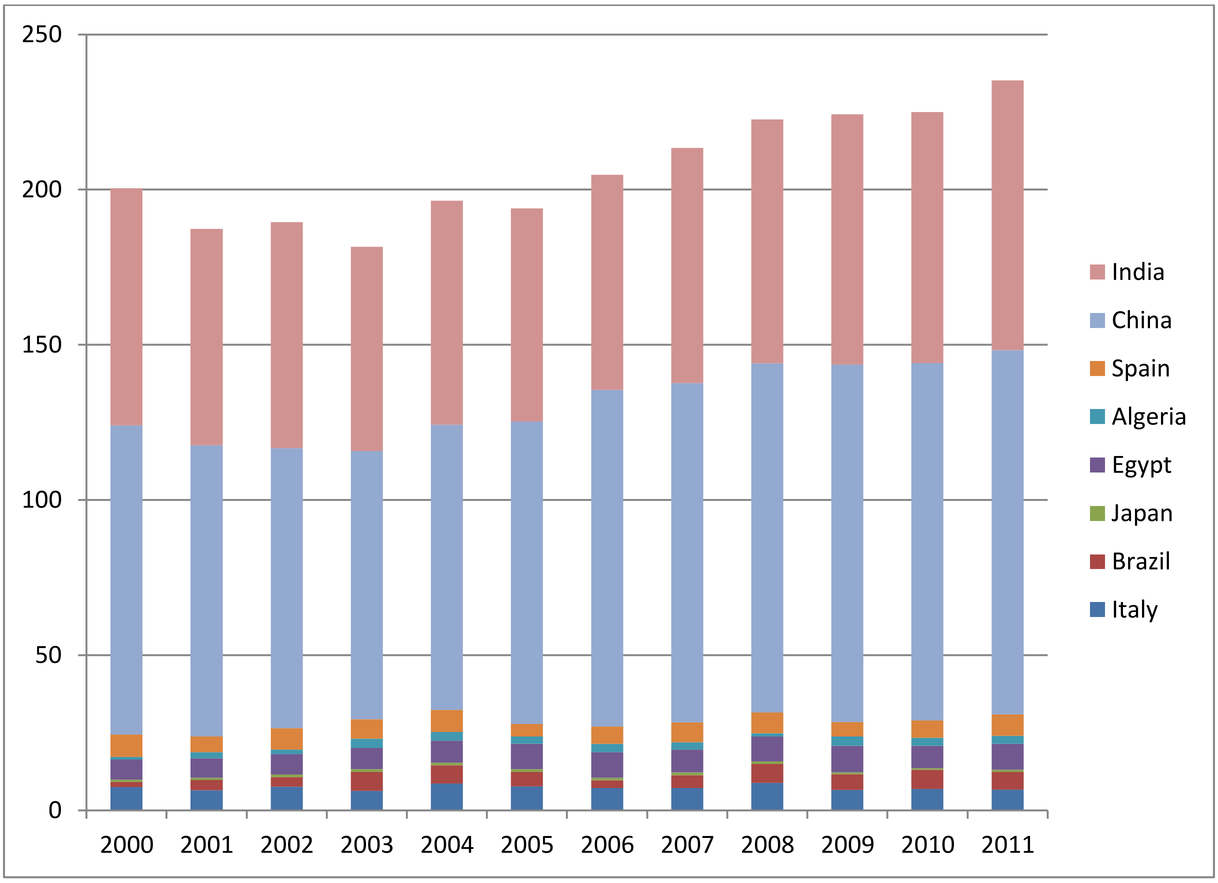

Figure 3: Production of wheat for major importers (including China and India, million tonnes)

Source: FAOSTAT

Several other data sources were used for the data collection for the included variables. The United States Department of Agriculture (USDA) and more specifically the Economic Research Service Department (USDA/ERS) were used for a number of quantitative variables data such as incomes. Apart from the previous sources, the CEPII, FAOSTAT and WTO official websites were used for the extraction of data. Further explanations are provided in section 4.2.

4.2 Data description

Table 1 provides the descriptive statistics for each variable included in the model. In addition, Table A1 in the Appendix gives the definition and the source of all the variables.

Table 1: Summary Statistics for Wheat Specific Gravity Model

Variable	**Units**	***Mean***	***Std. Dev.***	***Min***	***Max***
Q_{ij}	tonnes	8,495.336	48,668.04	0.1	653,607.6
Y_i	billions of 2005 US dollars	2,923.513	3,876.539	34.88	13,299.1
Y_j	billions of 2005 US dollars	3,120.139	4,049.094	34.88	13,299.1
D_{ij}	km	7,108.397	4,355.274	683.37	19,297.47
P_i	USD/TON	244.237	252.314	55.9	1,552.8
P_j	USD/TON	269.658	296.859	55.9	1,552.8
COMLANG	1	0.201	0.401	0	1
WTOIM	1	0.838	0.368	0	1
CTRADE	1	0.174	0.379	0	1
DTRADE	1	0.092	0.289	0	1

Quantity

The wheat trade variable (Q_{ij}) is defined as the exported quantity of wheat in tonnes. The traded quantities were classified under the code HS 110100. A list of all the countries included in this analysis and the number of observations for each nation can be found in the next page[3]. These data were taken from the United Nations Commodity Trade Statistics Database (UN comtrade). Among the chosen countries there are missing observations since those countries do not trade (or do not report trade) wheat in some cases. Those missing observations are reported as missing values in the data set. Figure 4 in the next page presents the total exports of each country to other countries included in the analysis.

[3] All the countries can be either exporters or importers for the analysis.

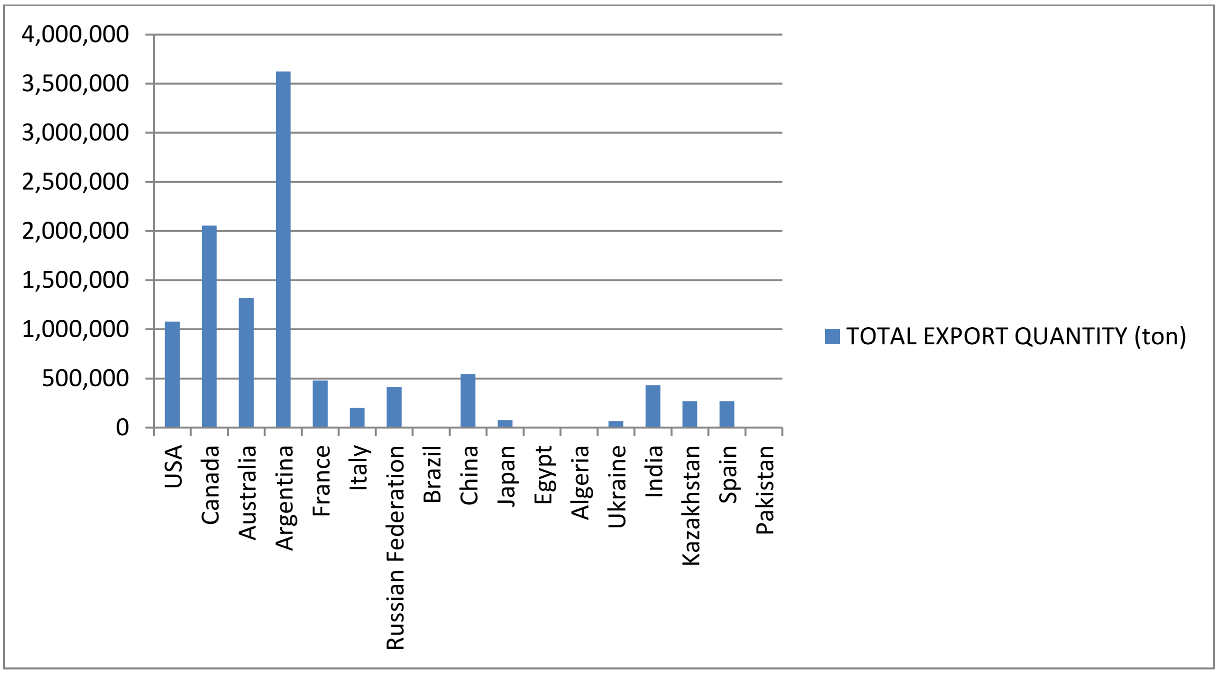

Figure 4: Total cumulative exports for all the countries included in the analysis (million tonnes)

Source: FAOSTAT

From the above figure it is obvious that Argentina is the major exporter from 2000-2011 (concerning the traded quantities between the countries of the analysis) in the world wheat market and Algeria is the minor one[4]. Table 2 presents the list of exporting and importing countries and the number of observations per country.

[4] Although USA is the major exporter globally it typically exports to many other countries which are not included in the analysis.

Table 2: List of exporters and importers and numbers of observations

Exporter	*Number of observations*	*Importer*	*Number of observations*
USA	134	USA	147
Canada	67	Canada	87
Australia	65	Australia	67
Argentina	55	Argentina	16
France	114	France	88
Italy	137	Italy	62
Russian Federation	60	Russian Federation	75
Brazil	31	Brazil	55
Egypt	7	Egypt	26
China	49	China	95
Japan	73	Japan	83
Algeria	5	Algeria	35
Ukraine	33	Ukraine	45
India	88	India	36
Kazakhstan	24	Kazakhstan	21
Spain	57	Spain	60
Pakistan	11	Pakistan	12

Italy exhibits the largest number of observations as an exporter whereas United States of America as an importer. However, it is interesting that even though USA and Canada belong to the group of major exporters in terms of global wheat trade, within the selected countries for this analysis the number of observations in case of imports is larger to the respective one in case of exports. This may imply that within the selected countries in this analysis they act more like importers rather exporters. Italy constitutes an exactly opposite example.

Income

National income is approximated by GDP, provided by the United States Department of Agriculture and more specifically by the Economic Research Service (ERS), in 2005 United States billion dollars (USD). GDP values are deflated by the GDP deflators (2005 = 100), which are obtained by USDA/ERS as well. According to Koo and Karemera (1991), exporting country's income is interpreted as the production capacity of the nation. On the other hand, importer's income is the country's purchasing power. Furthermore, income is expected to relate positively with the trade flows for both exporters and importers. From the summary statistics in table 1 it is obvious that there are differences in the income levels between exporters and importers.

Transportation Costs

There are several variables available for denoting the trade barriers. In case of transportation costs distance is used as a proxy variable[5]. The distance dataset used for this analysis was provided by a French international economics research centre, CEPII (Mayer and Zignago, 2006). This dataset contains four variables for bilateral distances which are used as an approximation for transportation costs. Those variables are separated into weighted and non-

[5] Linneman (1966), Bergstrand (1985, 1989) and Koo and Karemera (1991) used distance as a proxy for transportation costs.

weighted distances. In this study a non-weighted distance variable between the capital cities (since capitals are considered as the commercial centres for the transactions) is used. Distance is assumed to correlate negatively with the trade flow because as distance increases the quantity of the traded commodity is expected to decrease.

Domestic price

Prices were obtained from the United Nations Food and Agriculture Organization (UN/FAO). For both exporters and importers domestic prices in dollars/ton are used. Domestic prices, denoted as P_i for the exporting countries and P_j for the importing ones, are considered as exogenous to the model and the centrepiece of traditional trade theory. According to the trade theory exporters' price is expected to have a negative sign, whilst as the importers' price increases the flow of the wheat traded among the countries is enhanced.

Language

Mayer and Zignago (2006) provided two dummy variables for the term of common language. The official common language shared between two countries and a common language spoken by more than 9 percent of the people in those nations. However, due to strong correlation between these variables only the official common language was included. All in all, it is hypothesized that, because of better communication between nations, language is more likely to promote trade.

WTO membership

This is a qualitative variable that provides information with respect to WTO membership for an importing country. This dummy variable takes the value of 1 when the year is greater or equal than the year of importer's entry into the World Trade Organisation. Table 3 shows which countries are members of WTO and the year that they entered the organisation.

Table 3: List of countries-members of WTO

Country	**WTO membership**
USA	Member of WTO on 1 January 1995
Canada	Member of WTO on 1 January 1995
Australia	Member of WTO on 1 January 1995
Argentina	Member of WTO on 1 January 1995
France	Member of WTO on 1 January 1995
Italy	Member of WTO on 1 January 1995
Russian Federation	Member of WTO on 22 August 2012
Brazil	Member of WTO on 1 January 1995
Egypt	Member of WTO on 30 June 1995
China	Member of WTO on 11 December 2001
Japan	Member of WTO on 1 January 1995
Algeria	Not a member
Ukraine	Member of WTO on 16 May 2008
India	Member of WTO on 1 January 1995
Kazakhstan	Not a member
Spain	Member of WTO on 1 January 1995
Pakistan	Member of WTO on 1 January 1995

Source: WTO

Trade Creation

Twenty-six trade agreements have been considered to measure qualitatively the welfare effects of a trade agreement for the partners involved in the agreement. Trade creation variables were developed for every agreement reported to the WTO. CTRADE variables take the value of one when the year is equal or greater than the year that the agreement was signed. Table A2 provides a list of all agreements, countries involved and year of application. If the coefficient of this qualitative variable is positive, then the agreement has a positive effect on the trade flow. Otherwise, the influence is negative. Nevertheless, according to the previous research it is expected that trade agreements in general affect positively the trade relationships among nations.

Trade Diversion

A trade diversion dummy variable was included in the analysis for each of the 26 applicable agreements as reported to WTO in order to quantify the effects of the agreements concerning the countries which have not been included. These qualitative variables take the value of 1 when there is observed a trade relationship between an agreement member and a non-agreement member and the year is greater than or equal to the year of the agreement imposition. The coefficient for DTRADE variable can be either positive or negative. It is expected that the trade between a country-member of an agreement and a non-member will be reduced compared with the case of trade relationship between two countries-members. This means that trade agreements diminish trade costs.

In the regression performed for this study, there are 10 variables in the model. In this regression there is a combination of continuous and dummy variables. In the following chapter the results and the interpretation of the coefficients are discussed.

Chapter 5 – Regression Results

5.1 Introduction

This chapter presents the regression results, which quantify the determinants of wheat trade flow across international borders. The gravity model is estimated in a semi-logarithmic form in order to interpret the coefficients in a straightforward way. Section 5.2 presents the results for the continuous variables in the regression performed while section 5.3 discusses the interpretation of the qualitative variables included in this analysis. Table 4 reports the results.

Table 4: Regression results for wheat specific gravity model

Variable	Coef.	Std. Err.	P>|z|
$\ln Y_i$	0.566	0.127	0.000
$\ln Y_j$	0.333	0.128	0.009
$\ln D_{ij}$	-1.228	0.280	0.000
$\ln P_i$	-0.308	0.183	0.092
$\ln P_j$	0.650	0.179	0.000
$COMLANG$	2.040	0.511	0.000
$WTOIM$	-0.935	0.373	0.012
$CTRADE$	1.031	0.545	0.059
$DTRADE$	-1.632	0.369	0.000
$\_cons$	17.827	2.496	0.000
R-sq: within = 0.032 between = 0.275 overall = 0.297			

5.2 Economic Variable Results

This sub-chapter will review the regression results of the continuous variables in the regression as mentioned above. To note, for the quantitative variables the estimated coefficients represent elasticities.

Initially, exporter's income ($\ln Y_i$) deflated in the model shows a positive coefficient of 0.566 which is significant at the 1% level[6]. This means that as exporter's income increases by 1%, the exports will rise by 0.566%. Exporters hence gain more incentives due to more production capacity according to the theory, to export wheat to the other countries. Furthermore, it is observed that the coefficient is smaller than 1.0, which indicates that wheat quantities for exporting countries are income inelastic. This may be attributed to the excess production capacity and domestic farm support programmes (Koo and Karemera, 1991).

[6] The 3 corresponding levels for this analysis are the 1%, 5% and 10%.

The coefficient of importers' income ($\ln Y_j$) is 0.333 and is significant at the 1% level for the regression. This implies that by increasing the importers' income by 1%, the imported quantity of wheat goes up by 0.333%. In other words, a higher income drives up the demand for imports for basic agricultural commodities such as wheat. Similarly, wheat quantities do seem to be income inelastic. Koo and Karemera (1991) and Grant and Lambert (2005) argued that this can be explained from the fact that wheat is a necessity.

On the contrary, the distance as an approximation for transportation costs ($\ln D_{ij}$) presents a negative and significant coefficient of -1.228 at the 1% level for the regression. In this case an increase of 1% of the distance between the capitals of the trading countries reduces the trade flow by 1.228%. The result verifies that as distance becomes larger, countries are less likely to trade since bigger distance necessitates higher costs of shipping. The results are not in line in terms of significance with the findings of Koo and Karemera (1991) and Grant and Lambert (2005), who found insignificant outcomes.

The exporters' price for wheat ($\ln P_i$) shows a significant effect on the trade flow at the 10% level. In addition, it is noticeable that the coefficient is -0.308, which implies that when the price of the good increases domestically, then exports will be affected negatively. A 1% increase in the exporting price implies a 0.308% decrease in the quantity of wheat traded. Other empirical studies do not agree with this result (for example Koo and Karemera, 1991). This is, however, because of different sources used and differences in the number of variables included in the model. Nevertheless, governments could potentially balance this difference by providing export subsidies to the producers in such a way that the price received by the producers for supplying their wheat abroad to be higher compared to the price that they would receive in case of selling their commodity in the domestic market.

In contrast, importer's price ($\ln P_j$) coefficient is 0.650 and significant at the 1% level. A 1% increase in the importing nation's price enhances the traded quantities by 0.650%. An increase in the domestic price for importers encourages consumers to demand wheat coming from the international market. Comparing with the results for this variable with other studies, we see a difference among the coefficients as in the price for exporters potentially for the same reasons as mentioned before. In case of imports if governments intend to support the domestic production, they could impose import taxes in such a way that the monetary value of imported wheat will be higher and consumers will be enforced to buy the domestically produced commodity.

5.3 Qualitative Variables

In this section, the estimation results for the qualitative variables used in the analysis are reviewed. Together with the quantitative variables, the results are given in Table 2. To repeat, the coefficients of those variables represent the semi-elasticities.

The first dummy variable studied in this thesis is the common language. Its parameter is significant at the 1% level with a rate of 2.04, showing the highest coefficient value in the analysis. It is possible that when a country involved in trade agreement exports wheat to a third country, cultural characteristics, approximated by the language, facilitate the trade flow among them. Although, the results are somewhat different from the literature, this can be because less variables or different sources of data are used in this study. In the previous analyses the coefficients were found between 0.3 and 0.5. One could argue, however, that when countries are not participating in a trade agreement where other aspects like tariffs can be handled within the agreement, cultural similarities may facilitate trade negotiations. Briefly, the coefficient of 2.04 evinces that by having a common language, the traded quantity will be augmented by 2.04%.

The WTO membership variable is significant at the 5 and 10% levels respectively. Its coefficient of -0.935 means that when the importing country is a member of the World Trade Organization, the trade flow from the exporter to the importer is restricted by 0.935%. Multinational negotiations for agricultural products have not developed the reduction of trade barriers extensively and as a result this lack of trade liberalization may be due to WTO strategies. Nevertheless, another potential reason for this negative sign could be the individual traits of the selected countries.

Literature suggests that taking into consideration trade agreements between countries or regions can significantly influence the characteristics of a trade relationship. In addition, among others Martinez and Lehmann (2003), and Yeboah et al. (2007) studied the effects of trade agreements in potentials for trade relationships. Pllaha (2012) analysed the effect of free trade agreements in South-Eastern European countries with gravity estimations. In this study, the variable CTRADE expresses the effect of trade agreements, testing the significance of this effect as well. Table 2 shows the scores for this dummy. The results verify that CTRADE is significant at the 10% level with a value of 1.031, showing that a change of one unit of CTRADE variable causes an upward variation of quantity of about 1.031%. The results collide favourably with the empirical findings of the above mentioned studies.

The trade diversion variable is the last variable studied in this thesis. The results show that its estimated effect follows the economic theory of the restriction of trade for agricultural commodities. The volume of this variable is -1.632 and significant at the 1% level. By having trade restrictions, wheat traded quantity is limited by 1.632%. It is obvious that trade diversion causes a relatively larger change with respect to the magnitude of CTRADE coefficient and as expected of the opposite sign.

Trade diversion is the last variable analysed in this thesis. In conclusion, from table 4 seems that the within variation explains 3.2% of the model, the between variation explains 27.5%, while the overall variation interprets 29.7% of the model. The random effects model takes into account both within and between variations. Besides, the data set of this analysis is unbalanced, as there are missing observations, so the between variance is calculated using the mean of the panel means, whereas the overall mean is calculated as a weighted mean of the panel means. However, the mean of the panel means is unweighted.

Chapter 6 - Conclusions and implications

In this thesis, we assumed that the trade flows of wheat among different countries depend on several quantitative and qualitative factors. Based on the literature review conducted, such quantitative factors are the costs of transportation, income, domestic prices and population. Besides, coupled with the economic parameters, recent studies have pointed out the significance of qualitative aspects such as the formulation of regional trade agreements, cultural characteristics (e.g. common language and colonization) and contiguity.

In the empirical application, most of the above-mentioned variables were included in order to shed light on their effect on the trade of wheat. A weakness of this study was the sensitivity of the model concerning the inclusion of the population variable. The discrepancy of the population volumes among all different countries resulted in this variable being far not normally distributed resulting to unusual signs for many other parameters. Hence, population was excluded from the specification of the gravity model. A potential inclusion of countries with less variation in population volumes could solve this issue.

Moving to the defense of the technique used in this thesis, the gravity model was used as it can form a valuable tool for analysing international wheat trade. Its major advantage concerning the study of agricultural commodities trade, such as wheat trade, has to do with the fact that, except for primary economic variable effects, it can take into account the influence of trade policies on the trade flow. The choice of this kind of model relies upon the fact that spatial equilibrium models, that initially constituted the main tool for spatial trade, proved to perform poorly on the explanation of trade patterns of agricultural goods. Moreover, the combination of time series and cross-section techniques (panel data methodology) has been proven to result in a more accurate estimation than cross-section alone. Capture of relationships among variables over time and monitoring of unobservable individual effects between trading partner pairs set up two basic advantages of this method.

Concerning the answers to the research questions of this thesis, income, distance and domestic prices are proven to determine the flow of wheat traded among the countries. Additionally, common language between countries and formulation of trade agreements seem to facilitate wheat trade. Last but not least, multinational negotiations and trade diversion effects can deteriorate wheat trade. On the whole, distance, exporter’s price and participation in WTO for importers are together with trade diversion the negative influencing aspects for trade among countries in case of a staple agricultural good like wheat. In contrast, income and importer’s price coupled with language (denoting contiguous cultural characteristics) can step up the traded quantities. Above all, distance, common language and trade diversion show the largest coefficients in the analysis.

The results from this thesis are in line with the reviewed empirical studies which analysed the factors influencing agricultural trade with a gravity model, by implementing panel data techniques. Countries participating in trade agreements are more likely to see higher gains from trade with their partner. Hence, this thesis suggests that trade liberalization could potentially be a starting point for governments in order to improve the conditions for further development of agricultural trade.

Taking wheat trade analysis into account, studies for trade of other agricultural commodities as well could enrich the evidence with respect to agricultural supply and demand. Marketing strategies can try to explore cultural similarities among countries. The results confirm that common language and trade agreements help to expand trade as these not only favour consumer preferences but can also enhance trade negotiations.

However, the increasing role of food standards in international trade is well recognized in the literature. Standards introduce an interesting case for trade analysis since they may facilitate or impede the trade of agricultural commodities. For instance, strict standards may restrict dramatically the trade prospects for developing countries. Consequently, there is space for further improvement in order to estimate trade flows with the use of a gravity model more accurately in the future, as currently the inclusion of food standards in the model is limited and econometric techniques can be meliorated.

References

Anderson, J. E. (1979). "A theoretical foundation for the gravity equation." The American Economic Review: 106-116.

Baier, S. L. and J. H. Bergstrand (2007). "Do free trade agreements actually increase members' international trade?" Journal of international Economics 71(1): 72-95.

Bergstrand, J. H. (1985). "The gravity equation in international trade: some microeconomic foundations and empirical evidence." The review of economics and statistics: 474-481.

Bergstrand, J. H. (1989). "The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade." The review of economics and statistics: 143-153.

Carrere, C. (2006). Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model. European Economic Review, 50(2), 223-247.

Coccari, R. L. (1978). Alternative models for forecasting U.S. Exports. Journal of International Business Studies, 9, 73-84.

Dale, C., and Bailey, V. B. (1982). A Box-Jenkins model for forecasting U.S. merchandise exports. Journal of International Business Studies, 13, 101-108.

De Benedictis, L. and D. Taglioni (2011). "The gravity model in international trade."

Egger, P. and M. Pfaffermayr (2003). "The proper panel econometric specification of the gravity equation: A three-way model with bilateral interaction effects." Empirical Economics 28(3): 571-580.

FAOSTAT (2013), http://faostat.fao.org/site/342/default.aspx (Accessed April 15, 2013).

Globerman, S., and Shapiro, D. M. (1999). The impact of government policies on foreign direct investment: The Canadian experience. Journal of International Business Studies, 30, 513-532.

Gómez-Plana, A. G. and S. Devadoss (2004). "A spatial equilibrium analysis of trade policy reforms on the world wheat market." Applied Economics 36(15): 1643-1648.

Grant, Jason H., and Dayton M. Lambert (2005). "Regionalism in world agricultural trade: Lessons from gravity model estimation." Proceeding of the American Agricultural Economics Association Annual Meeting, July, 2005.

Hernandez, M. A., M. Robles, et al. (2010). "Fires in Russia, Wheat Production, and Volatile Markets, Reasons to Panic." IFPRI, August 6.

Jayasinghe, S., and Sarker, R. (2008). Effects of regional trade agreements on trade in agrifood products: evidence from gravity modelling using disaggregated data. Applied Economic Perspectives and Policy, 30(1), 61-81.

Koo, W. W. and D. Karemera (1991). "Determinants of world wheat trade flows and policy analysis. "Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie 39(3): 439-455.

Krugman, P., M. Obstfeld, et al. (2012). "International Economics: Theory and Policy, Global Edition." Essex: Pearson Education Limited ".

Linders, G.J. M. (2006). "Intangible barriers to trade: the impact of institutions, culture and distance on patterns of trade".

Linnemann, H. (1966). An econometric study of international trade flows, North-Holland Publishing Company Amsterdam.

Martínez-Zarzoso, I. and F. Nowak-Lehmann (2003). "Augmented gravity model: An empirical application to Mercosur-European Union trade flows." Journal of applied economics." 6(2): 291-316.

Mátyás, L. (1997). "Proper econometric specification of the gravity model." The World Economy, 20(3), 363-368.

Mayer, T. and S. Zignago. CEPII Distances Database. May 3, 2006. http://www.cepii.fr/distance/noticedist_en.pdf (Accessed May 11, 2013).

McCallum, J. (1995). "National borders matter: Canada-US regional trade patterns. The American Economic Review 85(3): 615-623.

Pöyhönen, P. (1963). "A tentative model for the volume of trade between countries." Weltwirtschaftliches Archiv: 93-100.

Rahman, M. M. (2007). The causative factors of Bangladesh's exports: evidence from the Gravity Model Analysis. Proceedings of the 48th Annual Conference of the New Zealand Association of Economists, New Zealand Association of Economists.

Sekhar, C. (2010). "Structure of the World Wheat Market: Some Implications for Strategic Trade Policy?" Journal of Quantitative Economics 8(2): 142-158.

Tinbergen, J. (1962). "Shaping the world economy; suggestions for an international economic policy."

United Nations Statistics Division (2013). http://unstats.un.org/unsd/default.htm (Accessed April 15, 2013).

United States Department of Agriculture. Economic Research Service (USDA/ERS) (2013). http://www.ers.usda.gov (Accessed May 3, 2013).

Van Wincoop, E. and J. E. Anderson (2003). "Gravity with gravitas: a solution to the border puzzle." American Economic Review 93(1): 170-192.

Vollrath, T. L., M. J. Gehlhar, et al. (2009). "Bilateral Import Protection, Free Trade Agreements, and Other Factors Influencing Trade Flows in Agriculture and Clothing." Journal of Agricultural Economics 60(2): 298-317.

World Trade Organization (2013). http://www.wto.org/index.htm (Accessed June 10, 2013).

Yeboah, O. A., Shaik, S., Allen, A., Ofori-Boadu, V. (2007). Trade Effects of the Central American Free Trade Agreement. 2007 Annual Meeting, July 29-August 1, 2007, Portland, Oregon TN, American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Zwinkels, R. C. J. and S. Beugelsdijk (2010). "Gravity equations: Workhorse or Trojan horse in explaining trade and FDI patterns across time and space?" International Business Review 19(1): 102-115.

Appendix

Table A1: Definitions of variables included in the gravity model for wheat trade

Variable	**Definition**	**Source**
Q_{ij}	Wheat quantity trade between i and j in year t	UN comtrade
$Y_i\,(Y_j)$	Gross Domestic Product	USDA/ERS
D_{ij}	Distance between capitals of countries	CEPII
$P_i\,(P_j)$	Domestic prices	FAOSTAT
$COMLANG$	Common official language	CEPII
WTOIM	Member of WTO for importers	World Trade Organization
$CTRADE$	Trade agreement	World Trade Organization
$DTRADE$	Trade among trade agreement partner and non-trade agreement partner	World Trade Organization

Table A2: List of trade agreements according to WTO

Trade Agreement	Date of entry into force	Countries included in agreement and Analysis
USA – Australia	01-Jan-2005	USA and Australia
North American Free Trade Agreement (NAFTA)	01-Jan-1994	Canada and USA
ASEAN – Australia – New Zealand	01-Jan-2010	Australia
Global System of Trade Preferences among Developing Countries (GSTP)	19-Apr-1989	Algeria, Argentina, Brazil, Egypt, India, Indonesia and Pakistan
Latin American Integration Association (LAIA)	12-Mar-1981	Argentina and Brazil
MERCOSUR - India	01-Jun-2009	Argentina, Brazil and India
Southern Common Market (MERCOSUR)	29-Nov-1991	Argentina and Brazil
EU – Algeria	01-Sep-2005	Algeria, France, Italy and Spain
EU – Egypt	01-Jun-2004	France, Italy, Spain and Egypt
Common Economic Zone (CEZ)	20-May-2004	Russian Federation, Ukraine and Kazakhstan
Russian Federation – Kazakhstan	07-Jun-1993	Russian Federation and Kazakhstan
Ukraine - Russian Federation	21-Feb-1994	Ukraine and Russian Federation
Protocol on Trade Negotiations (PTN)	11-Feb-1973	Brazil, Egypt and Pakistan
ASEAN - China	01-Jan-2005	China
Asia Pacific Trade Agreement (APTA) – Accession of China	01-Jan-2002	China and India
Pakistan - China	01-Jul-2007	Pakistan and China
ASEAN - Japan	01-Dec-2008	Indonesia and Japan
India - Japan	01-Aug-2011	India and Japan
Ukraine - Kazakhstan	19-Oct-1998	Kazakhstan and Ukraine
South Asian Preferential Trade Arrangement (SAPTA)	07-Dec-1995	India and Pakistan
South Asian Free Trade Agreement (SAFTA)	01-Jan-2006	India and Pakistan
ASEAN - India	01-Jan-2010	India
Eurasian Economic Community (EAEC)	08-Oct-1997	Kazakhstan and Russian Federation
Russian Federation – Belarus – Kazakhstan	03-Dec-1997	Kazakhstan and Russian Federation
Economic Cooperation Organization (ECO)	17-Feb-1992	Kazakhstan and Pakistan
EC Treaty	01-Jan-1958	France, Italy and Spain

Stata commands

```
clear

set memory 150m

cd "C:\TASOS\

insheet using "final_2.txt"

des

sum

//rename//

rename year YEAR

rename exporter i

rename importer j

//how to drop//

encode i, generate(i2)

describe

encode j, generate(j2)

describe

gen yi_def = yi/ydefl_i

gen yj_def = yj/ydefl_j

xtset id YEAR

gen qij_log = log(qij)

gen yi_log = log(yi)

gen yj_log = log(yj)

gen cij_cap_log = log(cij_cap)

gen pi_log = log(pi)

gen pj_log = log(pj)

gen yi_def_log = log(yi_def)

gen yj_def_log = log(yj_def)

xtreg qij_log yi_def_log yj_def_log cij_cap_log pi_log pj_log comlang wtoim ctrade dtrade, re
```