The Asian Journal of Shipping and Logistics ● Volume 28 Number 3 December 2012 pp. 369-390 ●

Seaborne Trade between Developed and Developing Countries*

Tsz Leung YIP **

Contents

Ⅰ. Introduction
Ⅱ. Literature Review
Ⅲ. Grain Trade Flow Models
Ⅳ. Results and Discussion
Ⅴ. Conclusion

Abstract

This paper analyses the international grain trade flow by using the gravity equation of trade. On the basis of microeconomic theory and the new trade theory, the gravity equation of trade is used to examine grain exports and imports between pairs of countries. One of the main purposes of this paper is to examine how the grain trade is affected by economic factors, population, and country development. By using data of 41 major trading countries over 14 years (1996-2009), the gravity equation of two different specifications are deployed for the investigation. The analysis differentiates between developed and developing countries and identifies the differences between different pairing. Importer's GDP lead to grain trade growing much faster than exporter's GDP. Developing countries tend to import less grain but developed countries import more, if the population is higher. The paper provides a new insight about the grain trade flow between developed and developing countries.

Key words : Grain trade, Bulk shipping, Cereal, Gravity model, International business

* This paper is revised version of an earlier paper presented at ICASL 2012, Yeosu, Korea, on 9-10 July, 2012. The authors greatly appreciated anonymous reviewers for their helpful comments.

** Assistant Professor of The Hong Kong Polytechnic University, Hong Kong, Email : lgttly@polyu.edu.hk

I. Introduction

Grain is a basic commodity and is used as both human food and animal feed in the production of meat. As the world population is increasing steadily and continuously in recent decades, grain trade has become indispensable to the world food consumption. Under current technical situation, it is still a crucial condition of the quantity one country can produce. It is important for a country to decide whether it can afford the domestic demand for grains by itself; otherwise it has to import from other countries. Meanwhile, if a country has abundant earth to grow crops and the produced grains cannot be consumed inside the country, it is possible to export the overstock.

Table 1 shows that USA is the dominant exporter of grain.[1)] Production of grain for export is concentrated naturally enough in the fertile agriculture areas of the world, such as Canadian and North America "grain belt", Argentina, Uruguay, and Brazil in South America, Australia, New Zealand, and Thailand in the Far East. As shown in Table 2, 39.1% of all grain was shipped from USA in 2007. With South America and Canada, North and South Americas counted for (39.1%+34.3%+6.1%=) 79.5% of all grain carried by sea. The most important flow of grain is to the Far East (Japan + other Far East), which make up (8.5%+25.3%=) 33.8% of all grain transported by sea. Africa is a very important customer, counting for 14.6% of the total grain sold and transported by ship in 2007.

Many trade studies have been limited to manufactured products. Studies on agricultural trade are relatively fewer. Cereal grain (or simply cereal) trade is examined in the study because of its extensive globalization of production and distribution. Following the definition of UN Comtrade database, cereals are including the commodity of 1) wheat and meslin, 2) rye, 3) barley, 4) oats, 5) maize (corn), 6) rice, 7) grain sorghum and 8) buckwheat, millet and canary seed, other cereals. More importantly, the cereal trade (or grain trade as a whole) has satisfied the world food demand and need for many countries, regardless of developed or developing countries. Therefore, the patterns of grain trade deserve further and more comprehensive investigation.

Due to insufficient food production in many countries to cater for domestic food needs, developed and developing countries compete food in the

1) Fearnleys (2008), p.52.

international market. Nonetheless, developed and developing countries tend to experience different types of grain trade, which is attributed to different purchasing power and demand for food. In general, the grain production is less evolved in the developing world. Developing countries may face substantial challenges in readily conveying agricultural product quality. This paper explicitly analyses the trade dissimilarity between developed and developing countries.

As one of the outcomes of current economic recession, the transport cost and economic friction increases with respect to the depreciation of US dollars and such increase of transport cost may lead to lower trade volume and higher shortage of food import. Therefore, it is important to study the dynamics of international trade of grain, and this will provide valuable insight for future policy initiatives of food shipping and logistics to resolve the geographical mismatch of food production.

This paper is divided into five sections. Section 2 reviews the relevant literature on international trade. It is then followed by a discussion of the model deployed in this study in Section 3, in which presents the methodologies and data sources. Section 4 presents the findings, and Section 5 discusses the policy implications and concludes the study.

II. Literature Review

Theories of trade have been developed to explain essential features of international trade.[2] These theories include Adam Smith's theory of absolute advantage, Richardo's theory of comparative advantage, and Heckscher-Ohlin's factor production theory. All these classical theories have provided some insights to explain the direction of trade flow and the pattern of international trade. But these theories contribute very little to the determination of the flow of grain trade. Further proliferation of theories purporting to explain the forces behind the international trade flows necessarily requires empirical studies.

Carey[3] first introduced the gravity concept into human interaction and

2) Pugel (2008), pp.1-142.
3) Carey (1858), pp.42, 88-90, 371-373, 465.

suggested "*gravitation is here (social phenomena), as everywhere else in the material world, in the direct ration of the mass and in the inverse one of the distance*", the gravity model has been testified adoptable in other areas. For instance, the gravity models have applications in transport studies. The initial attempt in transport was a study on movements of the Austrian state railways,[4] whose result was then taken over by highway engineers to forecast road traffic. Apart from road transport, the aviation is also involved. The first record was evaluation of the air traffic flow between two communities.[5] And this model is more valuable than other econometric model approach that it is able to forecast demand even on new routes.[6] Compared with other forecasting techniques, the gravity model as one of causal techniques will provide better and more accurate forecasts when using to forecast airline passengers.

More popularly, the gravity models were applied in international trades. Based on the economic sizes of and the distance between two countries, the model was able to predict the bilateral trade flows.[7] Other studies adopted gravity models to evaluate the influences of mutual trade agreements on international trade. The international lending's effect of bilateral international trades was also testified by the models with inducing the real lending value as dependent variable, and GDP, population, trading value, area and other factors as explanatory variables.[8] Following that, the causal gravity model assessed the policy of free trade agreement between Switzerland and US impacting on economic structure and multilateral trade patterns. And the result was that "*bilateral trade is positively related to the joint GDP of the partner countries and negatively related to the distance between them*".[9]

However, most of the existing gravity model literature on international trade have focused on all traded commodities as a whole, rather than agricultural products, even in many cases, agricultural trade has been excluded from the analysis. There are several exceptions.[10] A gravity model analyzed oil seeds, wheat and durum versus GDP, GDP per capita, distance, contiguity, landlocked and common language as explanatory variables, evaluated how

4) Lill (1889).
5) Harvey (1951).
6) Doganis (2002), pp.230-231.
7) Isard (1954).
8) Rose and Spiegel(2002).
9) deRosa and Gilbert (2006), pp.229.
10) Schluter (2005); Grant and Lambert (2005).

effective the regional trade agreements promote multilateral free trade.[11] Moreover, the impacts of technical regulations on agricultural trade were also determined by the gravity equation of trade.

The gravity equation has demonstrated a strong statistical explanatory power in determining trade flows of total exports and total imports between paired countries.[12] However, the gravity equation is mainly used to study economic observations and trade policy, e.g. quotas,[13] agreements.[14] On the track of grain shipping, the time series analysis is mainly applied and the topics focus on grain finance[15] and freight forecasting.[16] Those findings provide little understanding on the international grain trade and its shipping.

This paper aims to fill the knowledge gap and to offer valuable insights into the cereal trade (or grain trade as a whole). This study will provide empirical evidence to explain the rationale behind the trade of developed and developing countries.

III. Grain Trade Flow Models

This study investigates the characteristics of the grain trade flows and the gravity equation of trade is used in the following analysis. In the literature, there are two common functional specifications based on either the microeconomic theory or the new trade theory, and the fitness of these two specifications will be tested with the data empirically.

1. Traditional gravity model

The gravity trade model, in its basic form, posits that trade between two countries is positively influenced by the economic size of the trading partners and negatively affected by distance.[17] Economic size is usually captured by Gross Domestic Product (GDP) and GDP per capita (GDPPC), with the latter also reflecting a country's level of development. The basic gravity equation

11) Grant and Lambert(2005).
12) Evenett and Keller(2002).
13) Baleix(2005).
14) Peridy(2005); Antonucci and Manzocchi (2006).
15) Haigh and Holt(2000); Haigh and Bryant(2001); Jonnala, Fuller and Bessler(2002); Haigh and Holt(2002).
16) Hsu and Goodwin(1995); Babcock and Lu(2002); Thoma and Wilson(2007); deVuyst, Wilson and Dahl(2009).
17) Anderson(1979); Bergstrand(1985, 1989); Evenett and Keller(2002).

is often augmented with a number of other country-specific variables that affect trade, such as physical area, indicators of cultural affinity, colonial relationship and various geographic characteristics. The gravity trade model thus identifies three fundamental determinants of bilateral trade volumes: (1) export supply, captured by income and income per capita of the exporting country, (2) import demand, captured by income and income per capita of the importing country, and (3) economic friction, captured by geographical distance and variables representing policy and cultural barriers to trade.[18)]

$$\begin{aligned}\ln TRADE_{ijt} = \alpha &+ \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln GDPPC_{it} + \beta_4 \ln GDPPC_{jt} \\ &+ \beta_5 \ln POP_{it} + \beta_6 \ln POP_{jt} + \beta_7 \ln EXCH_{it} + \beta_8 \ln EXCH_{jt} \\ &+ \beta_9 \ln AREA_i + \beta_{10} \ln AREA_j + \beta_{11} \ln DIST_{ij} + \varepsilon_{ijt}\end{aligned} \quad (1)$$

where

i the exporter index

j the importer index;

t the year index, representing the time when trading transactions take placed;

Y_{ijt} the value of cereal trade flow from i-th exporter to j-th importer in year t;

α the constant, unobserved or fixed effects which do not change over time across locations;

β the coefficients to be estimated;

GDP the real Gross Domestic Product (GDP) of countries indicating the economic sizes in millions of US dollars;

GDPPC the GDP per capita in millions of US dollars;

POP the population size;

EXCH the real exchange rate to US dollars;

AREA the area of the countries;

DIST the great-circle distance between paired countries; and

ε the error term.

Gross Domestic Product (GDP) is the production value assessed by the resident institutional units of the country in monetary term. As to the whole country, it is the measure of national income and output of the country's

18) Egger(2011).

economy. GDP is proxied to indicate the country's wealth and how rich the country is, which cursorily reflects the international purchase power of the country as a whole. Here, as a good measure of a country's income levels, GDP is introduced to assess the relationship between income of the country and how many cereals the given country wants to purchase. So the country with a higher GDP is expected to import more cereals from foreign countries.

The microeconomic theory suggests that the demand for commodities will be affected by the level of importer's personal income, proxied by GDPPC. GDP per capita (GDPPC) is a similar concept with GDP which also indicates the income level. However, the different aspect is that the GDPPC is the production value of the country (GDP) allocated to every resident. It can be seemed as the judgment of individual wealth of the country. For some countries, the countries with a high GDP have a low GDPPC. Since GDPPC has similar but different function with GDP, this study still involves this factor.

Cereal grains are the consumptive commodities which provide human beings with energy and nutrition. Human beings as the major part consuming cereal grains bring the primary demand for cereal grain. Population sizes of the importers have a direct relationship with the consumption of agricultural commodities. On one hand, the population size of an importer will affect the cereal consumption. On the other hand, the population of exporter can represent the productive forces as Heckscher-Ohlin suggested exporters will tend to have a comparative advantage in labour intensive goods production. Therefore the production labour force is proxied by the population of exporter, and consumer population by population of importer.

Exchange rate (EXCH) is the worth of one currency specified by another one. Usually, it reflects the country's transaction demand for money and is highly correlated to the level of business activity and GDP of the country. And it also captures the price effects of commodities. Generally speaking, settlement by US dollars is the international trade practice, so the exchange rate here means the currencies' value per US dollar.

Distance (DIST) is the basic variable participating in gravity models of trade which usually represents the transport costs and other economic friction.

It shall be grouped as the impedance variable and will be, to some extent, an obstacle to trade between two countries. So it is expected that the longer distance between two countries, the less trade flowing between them.

2. Gravity model of New Trade Theory

The alternative specification of gravity equation is based on the new trade theory, characterised by Krugman, Helpman and Krugman and Helpman.[19] As an extension from Egger's gravity equation of trade for analyzing bilateral trade,[20] we propose a generic gravity equation of grain trade after incorporating additional factors (such as population, exchange rate) that are related to the grain trade:

$$\begin{aligned}\ln TRADE_{ijt} = \alpha' + \beta_1' \ln GDPT_{ijt} + \beta_2' \ln SIMR_{ijt} + \beta_3' FRAC_{ijt} \\ + \beta_5 \ln POP_{it} + \beta_6 \ln POP_{jt} + \beta_7 \ln EXCH_{it} + \beta_8 \ln EXCH_{jt} \\ + \beta_9 \ln AREA_i + \beta_{10} \ln AREA_j + \beta_{11} \ln DIST_{ij} + \varepsilon_{ijt}'\end{aligned} \quad (2)$$

where

$$GDPT_{ijt} = GDP_{it} + GDP_{jt}$$

$$SIMR_{ijt} = 1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)$$

$$RFAC_{ijt} = \left|\ln GDPPC_{it} - \ln GDPPC_{jt}\right|$$

The new trade theory (NTT) assumes the increasing returns to scale. GDPT is the sum of real GDPs of trading partners and denotes the overall economy size.[21] SIMR is a similarity index of two trading partners and indicates the relative economy size of two trading partners.[22] Given economic size, bilateral trade will be higher between countries of similar sizes, implying the coefficient of the similarity SIMR positive. As international trade is increasingly liberalised, comparative advantages are expected to expand. Linder and Bergstand hypothesized that the trade between countries is negatively related to the difference in relative factor endowments, which

19) Krugman(1980); Helpman and Krugman(1985); Helpman(1987).
20) Eggar(2000).
21) Helpman and Krugman(1985); Helpman(1987).
22) Helpman and Krugman(1985); Helpman(1987).

is commonly understood as the amount of land, labour, capital and entrepreneurship.[23] RFAC is the absolute difference in GDPPC as a measure of relative factor endowments between two trading countries.

3. Data

In order to test the fitness of the gravity equation of cereal grain trade, a large quantity of the cereal trade data have to be collected first. This study will take a 14-year-period data (1996-2009) as a sample so that it ensures the data scale as abundant as possible, and further make sure that the model result is robust. In sum, we come up with an unbalanced panel of 9,124 observations. Table 3 reports the summary of data and statistics.

The countries chosen are the major exporters and importers, including United States, United Kingdom, Australia, Canada, Brazil, China, Finland, France, Germany, South Korea Japan, Russia and South Africa. Forty-one counties out of two hundred countries are selected to make sure the representative and consistency of the analysis. According to Equation (1) and (2), the cereal trade value *TRADE*, the GDP of the countries, the distance DIST between two countries and other data are collected and organized. The cereal trade data in US dollars are collected from the Comtrade database of the UN Comtrade website.[24] Based on the website of UN Comtrade database, cereals are including the commodity of 1) wheat and meslin, 2) rye, 3) barley, 4) oats, 5) maize (corn), 6) rice, 7) grain sorghum and 8) buckwheat, millet and canary seed, other cereals. As the data from different reporting countries may have different definition and measurement, it is rare that import and export values from different countries match each other. Therefore, this study use export (free-on-board or FOB) value of cereals reported by each country in this study to avoid the inconsistence of import and export trade value.

When the trade flow happens between *i*-th country and *j*-th country, it is very rare to find that the import value reported by *j*-th importer equals exactly to export value provided by *i*-th exporter. Usually, it is caused by the different parties of reporting for different purpose or the difference of reporting periods in different countries. The distance (DIST), an explanatory variable of the gravity model, is taken from the *Centre d'Etudes Prospectives et*

23) Linder(1961); Bergstand(1990).
24) United Nations Commodity Trade Statistics Database, http://comtrade.un.org

d'Informations Internationales (CEPII). The distance is calculated following the great circle formula which uses latitudes and longitudes of its official capital. Other factors, such as exchange rate, population of the countries, are collected from *the World Bank*.

However, the original data of these variables are measured by different levels of units. The value of *GDP* is measured in billion of US dollars; however the *GDPPC* and the cereal grain trade are measured in US dollars. In order to facilitate the following calculation, all the units of data are transformed to the same level, US dollars. Besides, the unit of population is also changed from thousand persons to persons. Then, according to the specifications of Equation (1) and (2), all these data shall be changed into natural logarithmic scale for further analysis. After that, the software of EViews has been used to analyze these data again.

The trade patterns of cereal grains between developed and developing countries are also a focus of this study. We differentiate between four types of trade flows: (1) from developing to developing or L2L, (2) from developing to developed or L2D, (3) from developed to developed or D2D, and (4) from developed to developing or D2L, while developing countries are also known as less developed countries. The 20 developed countries in our dateset are (in the alphabetical order): Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK and the US, and the rest 21 countries are regarded as developing countries.

IV. Results and Discussion

In this study, the traditional and new trade theory models are firstly compared. Table 4 shows the case summary which is analyzed by EViews. The values of "*Adjusted R squared*" are 0.740 for both functional specifications and the overall fitness of gravity equations are acceptable. Generally speaking, the higher "*Adjusted R Squared*", the closer the estimated regression equation fits the sample data.[25] According to previous studies on gravity equation of international trades between countries, the results of "*R*

25) Studenmund(2006).

Squared" is ranged from 0.39 to 0.59[26] which is acceptable. Now in current situation, an "*Adjusted R Squared*" of 0.740 might be considered as a good fit. The two functional specifications on the basis of the microeconomic theory and the new trade theory are similarly good.

As equation (1) and (2) are in logarithms, we can interpret the coefficients as elasticities. By comparing the column 2 and 3 of Table 4, we can find that the two functional specifications agree with each in general, except for the coefficients of population (POP). It is because that the GDPPC is related to GDP and population. Having different expressions of GDP and GDPPC in the traditional model and new trade theory model, the estimates will inevitably produce different coefficients of population.

Based on the new trade theory, we add three variables to replace GDP and GDPPC, as shown in the column 3 of Table 4, in order to test the influences of economies of scale, similarity and relative factor endowments. The coefficient signs of GDPT, SIMR and RFAC agree with the new trade theory. Along this sense, cereal (or grains) is an intermediate goods and its trade can be simply explained by theories of absolute advantage and comparative advantages. Moreover, countries prefer to trade with similar countries, implying that developed countries and developing countries have a prospective separation of cereal trade.

As this gravity model of cereal trade fits the sample data satisfactorily, the following part of this paper will focus on identifying the variables that have significant impact on the cereal trade. And the cereal trade can be estimated by the expected fluctuation of some economic indicators and other indices, namely, GDP, GDPPC, exchange rate, and population. By overall consideration of these various factors, the cereal trade amount can be estimated.

The traditional gravity equation is selected for the heterogeneous effects of country-pairs. Table 5 shows that the gravity models are different across different types of paired countries. We distinguish between four types of paired countries: developing to developing (L2L), developing to developed (L2D), developed to developing (D2L) and developed to developed (D2D). Overall, L2L and D2L estimates are similar, as the importers (buyers) show similar behaviours when they import cereal either developing or developed countries. L2D estimates are like a mirror image of L2L and D2L. D2D estimates show

26) Debaere(2002), referring to Appendix 7.

unique patterns such that the trade value depends mainly on its lagged value.

In the traditional model as shown in Table 4, the coefficient of lnGDP of exporters and lnGDPPC of importers are negative but lnGDP of importers and lnGDPPC of exporters show positive. The negative signs disagree the theoretical expectation assumes a higher GDP creates a stronger demand for imported food and also a larger supply for exports. From Table 4, we find that the economic forces work asymmetrically in the cereal trade. GDP pushes exports negatively but pull imports positively. The estimates show the decline in imports of developing countries is mainly due to the reduction of GDPPC, a proxy of individual salary. As shown in Table 5, the stronger pull effect on imports is especially observed in the developing importers.

It is interesting to find from Table 4 that the coefficient of importer's population (POP) is negative, which can be interpreted that: with the same supply level, importers of higher population tend to import less cereal. Table 5 shows the picture clearer. Developing countries of higher population tend to farm themselves and meet their food demand domestically. Developing countries naturally prefer to consume their domestic cereals. On the contrary, the import trade value is not statistically significant with the population of developed countries.

The distance (DIST), as a proxy of transport cost and hidden trade barriers, is negative and statistically significant for all types of paired countries. It was found that the negative effect of distance is the strongest from developed to developing countries (D2L). It is understood that the transport cost has a higher impacts on the import price of goods. Therefore, developing countries feel at risk of being in global grain trade market. We find empirical evidence of the transport cost more pronounced in developing importers. Therefore, developing importers will be affected more by the increase of ship fuel price.

The distance has a moderate effect on trade value, and economic factors and populations are the most important determinants of trade value in the macro perspective. It reflects the high degree of internationalisation of the cereal trade and relative low of transport cost. The trade from a developing country to another country means that the international food policy should be made to encourage developing countries to develop agriculture industry. The development of a developing country's economy will encourage more exports

of cereal, as shown in Table 5.

From both Table 4 and 5, the area of countries has relatively weak influence on the trade value of cereal. Exchange rates are not very critical to the trade value, as their coefficients are very small compared with other variables.

V. Conclusion

Grain (or cereal grain) trade is examined in the study because of its extensive globalization of production and distribution. More importantly, the cereal trade (or grain trade as a whole) has satisfied the world food demand and need for many countries, regardless of developed or developing countries. Therefore, the patterns of grain trade deserve further and more comprehensive investigation.

The GDP, population, exchange rate and area of cereal exporters and importers as explanatory variables are incorporated in this model. Besides, the distance between exporters and importers is a crucial explanatory variable which represents the transport cost and economic friction. And the cereal grain trade value between two countries is the dependent variable. The overall fitness of gravity equations is comparatively good. The distance lays a significant impact on cereal trade. The farther the distance between the two countries, the less the cereal they trade. More influential variables are GDP, GDPPC and population. It means that the economic level and population are important factors affecting the cereal trades. The richer countries will import more cereal and the countries with a large population will import less cereal. And the exchange rates have little influence on cereal trades.

We apply the panel data analysis to analyse the cereal trade. This study offers the literature a new and deeper insight of grain trade and food issues and provides policy makers a statistical evidence to derive the economy policy of food supply. In particular, from our analysis on cereal trade, clear distinctions have been observed between developed and developing countries. It is necessary to establish collaboration and communication between developed and developing countries.

There are still several questions for future research on the gravity model of international trade and its explaining power to some phenomena. Standard

analysis of gravity equations uses the monetary value as dependent variable, but other quantities of trade flow, e.g. tonnage, adopted in the gravity equation specifications may reveal new insights. A possible extension can be undertaken and address how the global logistics performance affects the supply of agriculture products, in particular to poor countries which are living in poverty and need timely help. Also, how changes of country logistics performance bring dynamics to the ongoing structuring of global food supply chains.*

Acknowledgements

This study was partially supported by the Hong Kong Polytechnic University under the research grant A-PL05. I thank Miss Xiao Xue Shirley Zhao and Miss Mei Chi Wong for their excellent assistance to data collection.

* Date of Contribution ; July 20, 2012
Date of Acceptance ; November 15, 2012

References

ANDERSON, J. E. (1979), "A theoretical foundation for the gravity equation," *The American Economic Review*, Vol.69, No.1, pp.106-116.

ANTONUCCI, D. and MANZOCCHI, S. (2006), "Does Turkey have a special trade relation with the EU? A gravity model approach," *Economic Systems*, Vol.30, No.2, pp. 157-169.

BABCOCK, M. W., LU, X. (2002), "Forecasting inland waterway grain traffic," *Transportation Research Part E*, Vol.38, No.1, pp.65-74.

BALEIX, J. M. (2005), "Quotas on clothing imports: Impact and determinants of EU trade policy," *Review of International Economics*, Vol.13, No.3, pp.445-460.

BERGSTRAND, J.H. and EGGER, P. (2011), "Gravity equations and economic frictions in the world economy," In: D. Bernhofen, R. Falvey, D. Greenaway, and U. Kreichkemeier (eds.), *Palgrave Handbook of International Trade*, Chapter 17, pp. 532-570.

CALDERON, C., CHONG, A. and STEIN, E.(2007), "Trade intensity and business cycle synchronization: Are developing countries are different?," *Journal of International Economics*, Vol.71, No.1, pp.2-21.

CAREY, H. C. (1858), *The Principles of Social Science,* Augustus Kelly, New York.

DEBAERE, P. (2005), "Monopolistic competition and trade, revisited: Testing the model without testing for gravity," *Journal of International Economics*, Vol.66, No.1, pp.249-266.

DEROSA, D. A. and GILBERT, J. (2006), "Estimates from gravity and CGE models," In: Hufbauer, G. C. & Baldwin, R. E. (2006), *The Shape of a Swiss-US Free Trade Agreement*, Washington, DC: Institute for International Economics, Chapter 8, pp.225-234.

DEVUYST, E., WILSON, W.W. and DAHL, B. (2009), "Longer-term forecasting and risks in spatial optimization models: The world grain trade," *Transportation Research Part E*, Vol.45, No.3, pp.472-485.

DOGANIS, R. (2002), *Flying Off Course: The Economics of International Airlines* (3rd ed.), Routledge, London.

EGGER, P. (2000), "A note of the proper econometric specification of the gravity equation," *Economics Letter*, Vol.66, No.1, pp.25-31.

EVENETT, S. and KELLER, W. (2002), "On theories explaining the success of the

gravity equation," *Journal of Political Economy*, Vol.110, No.2, pp.281-316.

GRANT, J. H. and LAMBERT, D. M. (2005), *Regionalism in world agricultural trade: Lessons from gravity model estimation,* American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005, pp. 1-31.

HAIGH, M. S. and BRYANT, H. L. (2001), "The effect of barge and ocean freight price volatility in international grain markets," *Agriculture Economics*, Vol.25, No.1, pp.41-58.

HAIGH, M. S. and HOLT, M. T. (2000), "Hedging multiple price uncertainty in international grain trade," *American Journal of Agricultural Economics*, Vol.82, No.4, pp.881-896.

HAIGH, M. S. and HOLT, M. T. (2002), "Hedging foreign currency, freight, and commodity futures portfolios – A note," *Journal of Futures Markets*, Vol.22, No.12, pp.1205-1221.

HARVEY, D. A. (1951), "Airline passenger traffic pattern within the United States," *Journal of Air Law and commerce*, Vol.18, pp.157-165.

HSU, J. L. and GOODWIN, B. K. (1995), "Dynamic relationships in the market for ocean grain freighting services," *Canadian Journal of Agricultural Economics*, Vol.43, No.2, pp.271-284.

ISARD, W. (1954), "Location theory and trade theory: Short-run analysis," *Quarterly Journal of Economics*, Vol.68, No.2, pp.305-322.

JONNALA, S., FULLER, S. and BESSLER, D. (2002), "A GARCH approach to modeling ocean grain freight rates," *International Journal of Maritime Economics*, Vol.4, No.2, pp.103-125.

LILL, E. (1889), "Die Grundgesetze des Personenverkehrs," *Zeitschrift für Eisenbahnen und Dampfschiffahrt der Öterreichisch-Ungarischen Monarchie*, Vol.35, pp.697-706.

PERIDY, N. (2005), "The trade effects of the Euro-Mediterranean partnership: What are the lessons for ASEAN countries?," *Journal of Asian Economics*, Vol.16, No.1, pp.125-139.

PUGEL, T. A. (2009), *International Economics* (14th ed.), Boston: McGraw-Hill Irwin.

ROSE, A. K. and SPIEGEL, M. M. (2002), "A gravity model of sovereign lending: Trade, default, and credit," *NBER Working Paper*, No. 9285.

SCHLÜTER, S. W. (2005), *Impacts of Technical Regulations on Agricultural Trade – A Gravity Model Approach*, Ph.D. Bonn: Universität, Bonn.

THOMA, M. A. and WILSON, W. W. (2007), "Market adjustment over transportation networks: A time series analysis of grain movements on the Mississippi inland waterway system," *Journal of Transport Economics and Policy*, Vol.41, No.2, pp.149-171.

<Table 1> Transport flow of grain by sea transport (1,000 tonnes)

From: To:	USA	Canada	South America	Australia	Others	Total 2007	Total 2006
UK/Continent	3,864	1,583	22,326	8	184	27,964	22,669
Mediterranean	4,763	925	18,446	28	4,941	29,103	21,814
East Europe	166	28	3,020	-	7,382	10,596	10,532
Other Europe	750	152	4,601	2	958	6,463	4,287
Africa	17,966	2,786	10,071	806	18,080	49,709	44,827
Americas	39,923	6,274	15,147	2	1,127	62,473	60,995
Near East	4,206	48	1,294	-	3,611	9,160	8,456
Indian Ocean	5,059	3,786	7,632	1,791	10,959	29,226	33,361
Japan	22,773	1,610	1,456	1,499	1,735	29,073	30,021
Oth. Far East	33,823	3,615	32,738	4,057	11,947	86,180	87,167
Oth.&Unspec.	85	8	27	514	140	775	655
Total 2007	133,377	20,818	116,757	8,707	61,063	340,722	
Total 2006	122,996	21,879	97,701	20,117	62,092		324,785

Source : Fearnleys 2008

<Table 2 > Transport flow of grain by sea transport (% distribution)

From: To:	USA	Canada	South America	Australia	Others	Total 2007
UK/Continent	1.1%	0.5%	6.6%	0.0%	0.1%	8.2%
Mediterranean	1.4%	0.3%	5.4%	0.0%	1.5%	8.5%
East Europe	0.0%	0.0%	0.9%	0.0%	2.2%	3.1%
Other Europe	0.2%	0.0%	1.4%	0.0%	0.3%	1.9%
Africa	5.3%	0.8%	3.0%	0.2%	5.3%	14.6%
Americas	11.7%	1.8%	4.4%	0.0%	0.3%	18.3%
Near East	1.2%	0.0%	0.4%	0.0%	1.1%	2.7%
Indian Ocean	1.5%	1.1%	2.2%	0.5%	3.2%	8.6%
Japan	6.7%	0.5%	0.4%	0.4%	0.5%	8.5%
Other Far East	9.9%	1.1%	9.6%	1.2%	3.5%	25.3%
Others & Unspecified	0.0%	0.0%	0.0%	0.2%	0.0%	0.2%
Total 2007	39.1%	6.1%	34.3%	2.6%	17.9%	100.0%

Calculated by author

<Table 3 > Summary of data

Variable	Description	Mean	Std. Dev.
Dependent variable			
$TRADE_{ijt}$	Trade value	27,896,267	161,000,000
Explanatory variables			
GDP_{it}	Gross domestic product of exporter	1,244	2,277
GDP_{jt}	Gross domestic product of importer	1,499	2,521
$GDPPC_{it}$	GDP per capita of exporter	24,638	11,483
$GDPPC_{jt}$	GDP per capita of importer	24,037	10,978
$EXCH_{it}$	Exchange rate of exporter	143	960
$EXCH_{jt}$	Exchange rate of importer	130	920
$AREA_{it}$	Area of exporter	1,845,267	3,835,372
$AREA_{jt}$	Area of importer	2,395,771	4,163,085
POP_{it}	Population of exporter	84,958	214,211
POP_{jt}	Population of exporter	100,868	242,520
$DIST_{ij}$	Great circle distance	5,004	4,788
YEAR	Year	2002	4
	Number of Observations 9,124		

Data sources and remarks:

Trade value ($TRADE_{ijt}$) is sourced from the Comtrade database of the UN Comtrade website (http://comtrade.un.org). In the Comtrade database, cereals include the commodity of (1) wheat and meslin, (2) rye, (3) barley, (4) oats, (5) maize (corn), (6) rice, (7) grain sorghum and (8) buckwheat, millet and canary seed, other cereals.

The data of distance ($DIST_{ij}$) between countries which is taken from the website of Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) (http://www.cepii.fr/anglaisgraph/bdd/distances.htm). The distance is calculated following the great circle formula which uses latitudes and longitudes of its official capital.

The rest of data is taken from open database published by the World Bank (http://data.worldbank.org/) which provides comprehensive dataset of most global countries.

<Table 4 > Gravity Equation for Different Specifications

Variable	Traditional Model	New Trade Theory
$lnTrade_{t-1}$	0.77*** (102.24)	0.77*** (103.22)
$lnGDP_i$	-3.33** (-2.01)	
$lnGDP_j$	6.93*** (3.74)	
$lnGDPPC_i$	3.57** (2.14)	
$lnGDPPC_j$	-6.66*** (-3.57)	
lnGDPT		0.53*** (8.38)
lnSIMR		0.28*** (6.6)
RFAC		-0.05* (-1.9)
$EXCH_i$	0.0001*** (2.68)	0.0001** (2.54)
$EXCH_j$	-0.0001*** (-3.24)	-0.0001*** (-2.73)
$lnAREA_i$	-0.04** (-2.44)	-0.04** (-2.2)
$lnAREA_j$	0.18*** (9.48)	0.18*** (9.38)
$lnPOP_i$	3.52** (2.12)	-0.09*** (-2.61)
$lnPOP_j$	-6.79*** (-3.67)	-0.12*** (-3.74)
lnDIST	-0.42*** (-14.79)	-0.42*** (-14.61)
Constant	46.25 (1.31)	3.37*** (13.17)
R^2	0.741	0.740
Adj R^2	0.740	0.740
F-statistic	908.812***	947.105***
Observations	7,331	7,331

Note s: Year dummies are not reported in the Table.
*** Significant with p-value <0.01
** Significant with p-value <0.05
* Significant with p-value <0.10

<Table 5 > Gravity Equation for Different Types of Paired Countries

Variable	L2L	L2D	D2D	D2L
$lnTrade_{t-1}$	0.69*** (26.68)	0.75*** (46.84)	0.79*** (71.56)	0.66*** (37.61)
$lnGDP_i$	3.06 (0.56)	-7.82*** (-2.59)	-0.83 (-0.31)	-5.71 (-1.1)
$lnGDP_j$	18.11** (2.44)	-1.63 (-0.35)	0.27 (0.09)	11.60*** (3.15)
$lnGDPPC_i$	-2.40 (-0.44)	8.30*** (2.78)	0.30 (0.11)	4.78 (0.93)
$lnGDPPC_j$	-17.89** (-2.41)	1.42 (0.31)	-0.58 (-0.19)	-10.96*** (-2.97)
$EXCH_i$	0.0002*** (2.81)	0.0001*** (4.14)	0.0019* (1.88)	-0.0024 (-1.09)
$EXCH_j$	-0.0001 (-1.31)	-0.0091*** (-3.55)	-0.0049*** (-3.57)	-0.0001 (-1.51)
$lnAREA_i$	0.16* (1.77)	0.09* (1.86)	0.01 (0.61)	-0.08* (-1.91)
$lnAREA_j$	0.15 (1.47)	0.29*** (7.57)	0.15*** (6.82)	0.27*** (3.67)
$lnPOP_i$	-3.06 (-0.56)	8.00*** (2.65)	0.96 (0.36)	6.04 (1.16)
$lnPOP_j$	-17.97** (-2.42)	1.81 (0.39)	0.00 (0.00)	-11.41*** (-3.1)
lnDIST	-0.46*** (-4.56)	-0.51*** (-8.4)	-0.45*** (-11.47)	-0.62*** (-8.03)
Constant	286.37** (2.19)	-133.53* (-1.75)	1.58 (0.03)	86.78 (0.98)
R^2	0.576	0.741	0.830	0.588
Adj R^2	0.565	0.738	0.829	0.583
F-statistic	54.297***	234.192***	659.892***	123.602***
Observations	943	1,902	3,126	2,019

Notes : Year dummies are not reported in the Table.
*** Significant with p-value <0.01
** Significant with p-value <0.05
* Significant with p-value <0.10