SCHOOL OF GRADUATE STUDIES

EXPLAINING ETHIOPIA'S FOREIGN TRADE POTENTIAL: A DYNAMIC GRAVITY APPROACH

BY

GEBREYESSUS GEBREHIWOT

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G/Yesus G/Hiwot

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

COMESA	Common Market for Eastern and Southern Africa
COMTRADE	Commodity Trade
ECA	Economic Commission for Africa
ERCA	Ethiopian Revenues and Customs Authority
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IMF	International Monetary Fund
LSDV	Least Squares Dummy Variable
MOFA	Ministry Of Foreign Affairs
NBE	National Bank of Ethiopia
SADC	Southern African Development Community
TradeSim	Trade Simulation
UN	United Nations
USD	United States' Dollar
WTO	World Trade Organization

Abstract

Towards improvement of Ethiopia's poor performance in the global trading system, the main objective of this paper is to estimate trade potential of the country with major trade partners around the world. The gravity model of trade has been duly employed for the purpose. For the sake of plausible results, recent innovations of the gravity model are incorporated as well. Specifically, a dynamic gravity approach based on a panel dataset of sample countries was estimated by System GMM estimators to first analyze the pattern of (basic vs export) trade flows. The coefficients obtained are then used to predict the basic trade and export trade potentials for Ethiopia.

As a result, we found that the dynamic gravity model fits the data well, indicating the presence of hysteresis in trade. Besides, the traditional gravity variables are all significant with anticipated signs. The last major finding of the study is that considerable part of the country's potential trade has remained unrealized. The magnitude of trade potential was found the highest with Asian, European and then African countries as a continent. The study recommends that export diversification which advances the narrow export dependency, improvement of infrastructure which reduces transaction costs, and bilateral trade negotiations stepping up the current status of the external sector are the necessary steps to exploit Ethiopia's untapped trade potential.

Key Words: Dynamic Gravity Approach, Ethiopia, Trade Potential.

1. INTRODUCTION

Foreign trade has increasingly become a keystone of economic prosperity in many countries of the world. In principle, both export and import trades are equally important. A country must import the required inputs, capital items and appropriate technologies to broaden its production base and foster export growth. Imports of consumer goods are also essential to meet the growing demand at home. Export trade, on the other hand, is crucial to fill the foreign exchange gap of a country and hence to increase import capacity and reduce dependence on foreign aid. For that reason, increased participation in world trade is considered as the single most important tool of rapid economic growth and development (Rahman, 2009).

Among other measures, the level of trade relative to GDP will show the degree to which an economy is integrated to the rest of the world (Getnet, 2010). Accordingly, we observe that the Ethiopian economy is fairly open, with trade to GDP ratio consistently increased from 19% in the 1980s to 27% in the 1990s and 46% in the late 2000s, on the average (World Bank, 2010). In absolute terms, the value of trade has grown from USD 1.6 billion (1985) to USD 2.6 billion (1997), USD 6.2 billion (2005) and further to USD 10.8 billion (2009) at current prices (Ibid). About 67% of this growth has been attributed to imports and nearly 33% to exports (IMF, 2010). Nevertheless, the external sector of Ethiopia (basically the export part) is characterized by high degree of concentration both in structure and partner countries, which probably makes Ethiopian trade more vulnerable to external shocks. That is, a negative shock in a major destination country or major export item may put a severe impact on the export performance of Ethiopia. Following the global economic recession of 2007/08, for instance, openness of the country has declined considerably (Getnet, 2010).

Needless to say, the sector has again been suffering from deficit throughout its history. Based on figures of the World Development Indicators (World Bank, 2010), trade deficit of the country was USD 312.5 million (1981), USD 593.7 million (1987) and USD 755.4 million (1993). Even worse, its trend was fast growing in the recent years—USD 963.7 million (1999), USD 1.68 billion (2004) and USD 5.2 billion (2009). In the last five years, where export proceeds have grown drastically[1], export earnings financed only 30% of imports (Alemayehu et al, 2010). In other words, the share of export earnings to the value of total trade has declined overtime—from 39% in 1981 to 33% in 1994 and 26% in 2009 (IMF, 2010). Furthermore, Ethiopia's share in world trade is extremely low and looks unimpressive as compared to even other African countries. In 2008, the country's share in world trade was merely 0.027% (World Bank, 2010). From the same source, these figures were 0.052% for Kenya, 0.065% for Sudan, 0.29% for Egypt, 0.050% for Cote d'Ivoire, 0.049% for Ghana and 0.51% for South Africa.

Clearly, for the sake of healthy economy, the country needs to improve its trade status with the rest of the world. In doing so, investigation of Ethiopia's potential for trade expansion will play a major role. The implication of explaining trade potential ranges from the need for country specific export promotion and bilateral integration activities to the anticipation of major distributional changes caused by the expansion of trade in the near future (Batra, 2004). Down the line, the country has a scanty of literature in this regard. From such angles, our study—analysis of the pattern as well as potential of Ethiopian trade—would be crucial and

[1] Despite a general agreement on that consistent growth, there are some discrepancies on the rate of growth among sources, ranging from 21% (World Bank) to 27% (National Bank of Ethiopia).

justified. Hopefully, findings of the study will serve as a standpoint for other studies such as investigation of mechanisms through which potential trades could be realized, which is beyond the scope of this study. Our project, which employs a dynamic gravity approach for the purpose, raises two research questions:

- *Does a dynamic gravity model of trade explain the pattern of Ethiopia's basic trade and export trade well?*
- *To what extent has Ethiopia realized its trade potential with the major trading partners around the world?*

The remainder of the paper proceeds as follows: In the next section, an overview of Ethiopia's trade is presented. Then, section three provides theoretical and empirical review of the literature, while section four describes the data, methodology and estimation issues of the study. In section five, analysis and discussion of the estimation results is made. Finally, section six concludes.

2. ETHIOPIA'S TRADE OVERVIEW

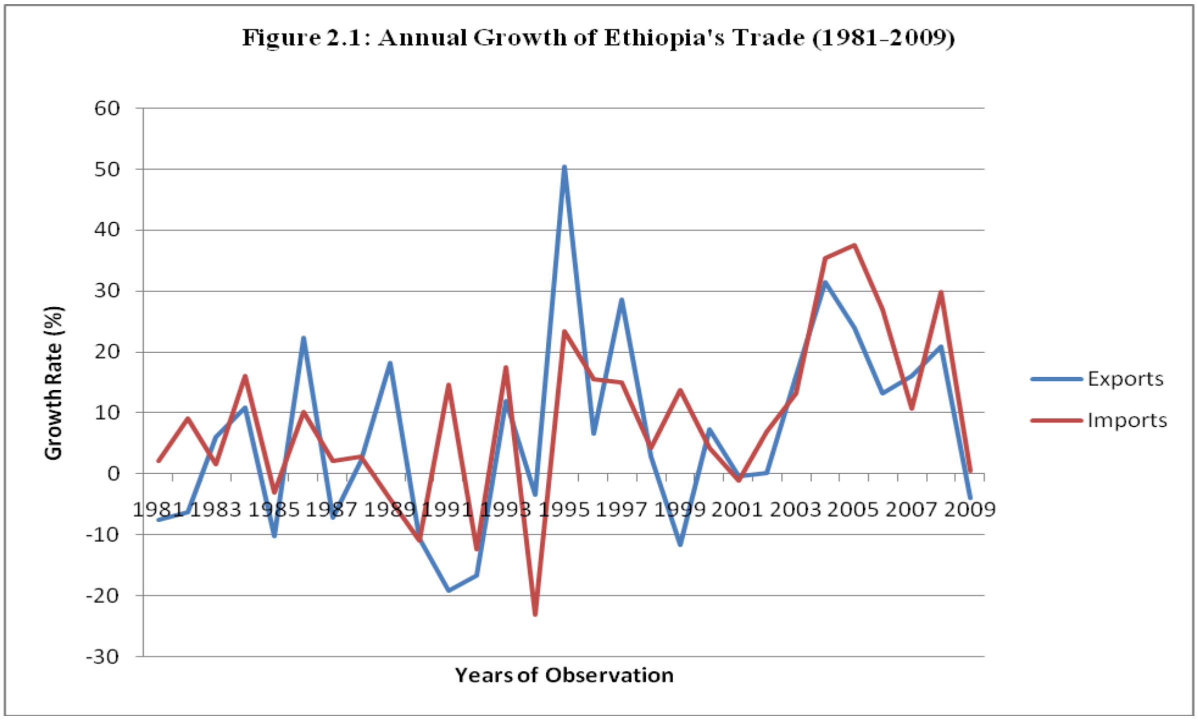
The Ethiopian economy is currently among the top performing economies in Africa. Indeed, the economy continues to register high growth rates. For more than half a decade, real GDP has grown significantly on annual average of over 11 percent (NBE, 2009/10). In this regard, we suspect that the contribution of trade was considerable. Surprisingly, trade was about 50% of GDP in the years 2005 and 2006 (see table 2.1). Its share however seems unstable and fluctuating overtime. In a broader sense, this fluctuation might be due to the smallness (price taking nature) of the country at the international market emanating from supply rigidity, less variety and vulnerability (to external shocks) of export products.

Table 2.1: Trends of Ethiopia's Trade in Goods and Services (1995-2009).

Year	Value of Trade (USD Millions)			Growth of Trade (%)		Trade in GDP (%)
	Exports	Imports	Total	Exports	Imports	
1995	736.92	1196.07	1932.99	--	--	25.42
1996	785.86	1380.89	2166.75	6.64	15.45	25.54
1997	1010.47	1588.49	2598.96	28.58	15.03	29.23
1998	1038.49	1654.92	2693.41	2.77	4.18	33.38
1999	917.87	1881.57	2799.44	-11.61	13.70	35.77
2000	984.27	1960.73	2945.00	7.23	4.21	36.00
2001	980.17	1938.02	2918.19	-0.42	-1.16	35.72
2002	981.82	2072.37	3054.19	0.17	6.93	39.21
2003	1139.43	2345.63	3485.06	16.05	13.19	40.73
2004	1497.96	3174.43	4672.39	31.47	35.33	46.48
2005	1857.98	4365.68	6223.66	24.03	37.53	50.58
2006	2104.89	5547.32	7652.21	13.29	27.07	50.47
2007	2441.56	6143.38	8584.94	15.99	10.75	47.75
2008	2949.98	7976.29	10926.27	20.82	29.84	42.19
2009	2832.97	8013.79	10846.76	-3.97	0.47	38.01

Source: Compiled from World Bank (2010) Database.

Likewise, trends in the growth of trade (both exports and imports) were so variable in the last 30 years (see figure 2.1). Over the period 1980-2009, growth rate of exports varied between -19.2 percent and 50.5 percent. Likewise, imports varied between -23.2 percent and 37.5 percent over the same period (IMF and World Bank Databases).



Source: Computations based on IMF (2010) and World Bank (2010) Databases.

2.1. Structure of Trade

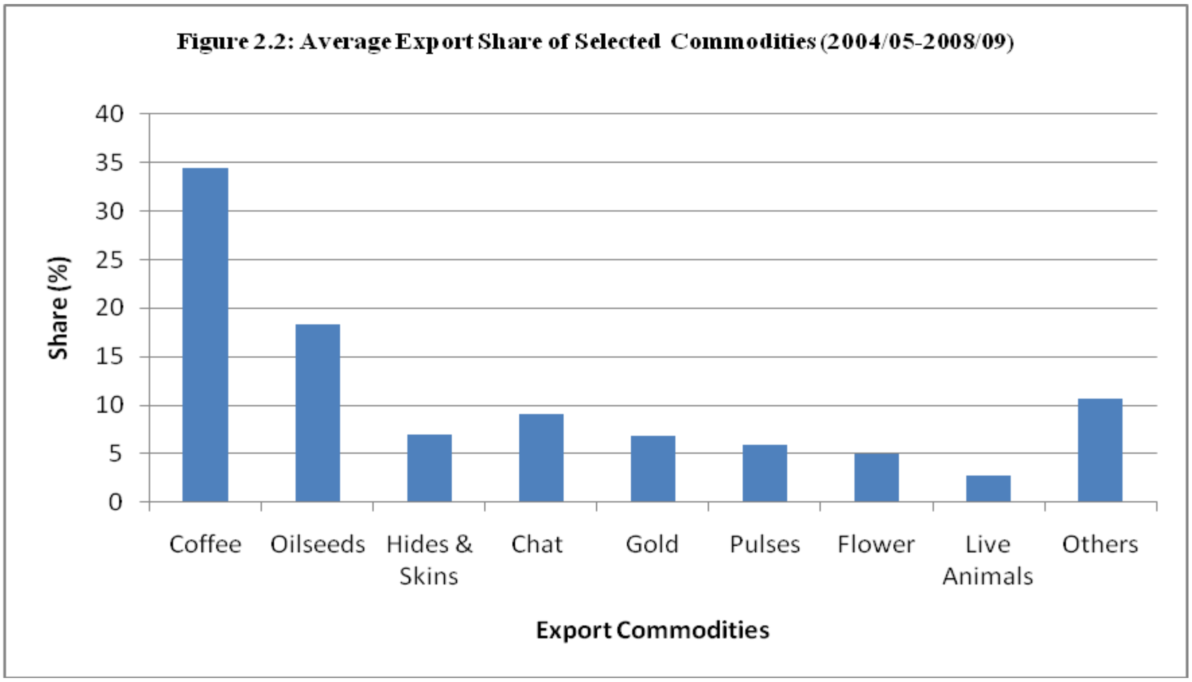
Notwithstanding the role of foreign trade to Ethiopia's economic growth, exports of the country are not diversified but dominated by few products including coffee, hides and skins, oilseeds, chat and gold (ERCA, Trade Statistics). According to annual report 2009/10 of the National Bank of Ethiopia, these five export items jointly generated around 78% of the total export proceeds over the period 2000/01−2008/09. Moreover, coffee and oilseeds alone contributed more than half of the total earnings in the last three years (see table 2.2). From this trend, one can easily observe that the export trade is highly dependent on a limited variety of agricultural commodities. Overtime, there seems to be slight improvements in the degree of diversification as some other products like flower, live animals and pulses become significant export items (ERCA, Trade Statistics). In addition, the share of coffee—almost the sole export item over history—has declined continuously.

Table 2.2: Values (ETB Billions) and Shares (%) of Major Export Commodities.

Commodity	2004/05		2005/06		2006/07		2007/08		2008/09	
	Value	%	Value	%	Value	%	Value	%	Value	%
Coffee	2.90	39.6	3.08	35.4	3.74	35.8	4.90	35.9	3.93	25.8
Oilseeds	1.08	14.7	1.84	21.2	1.65	15.8	2.04	15.0	3.82	25.1
Hides and skins	0.59	8.0	0.65	7.5	0.79	7.6	0.92	6.7	0.76	5.0
Pulses	0.31	4.2	0.32	3.7	0.62	5.9	1.33	9.8	0.95	6.2
Meat Products	0.13	1.8	0.16	1.8	0.14	1.3	0.19	1.4	0.27	1.8
Fruits and Veg.	0.14	1.9	0.12	1.4	0.14	1.3	0.12	0.9	0.12	0.8
Flower	0.07	1.0	0.19	2.2	0.56	5.4	1.04	7.6	1.37	9.0
Live Animals	0.11	1.5	0.24	2.8	0.32	3.1	0.38	2.8	0.54	3.5
Chat	0.87	11.9	0.77	8.9	0.82	7.8	1.00	7.3	1.45	9.5
Gold	0.51	7.0	0.56	6.4	0.86	8.2	0.74	5.4	1.03	6.8
Others	0.62	8.5	0.76	8.7	0.82	7.8	0.98	7.2	0.98	6.4
Total	**7.33**	**100**	**8.69**	**100**	**10.46**	**100**	**13.64**	**100**	**15.22**	**100**

Source: National Bank of Ethiopia (2009/10).

On the import side, the dominant product categories constitute capital goods, consumer goods, fuel (petroleum), intermediate items and raw materials which shared on average 97% of the total import bills over the period 2000/01−2008/09 (NBE, 2009/10). During 2008/09, these items individually accounted for 29.1%, 27.8%, 20.7%, 14.2% and 4.3% of total imports respectively (see table 2.3). As one can observe from figure 2.3, this share was maintained for the last five years.



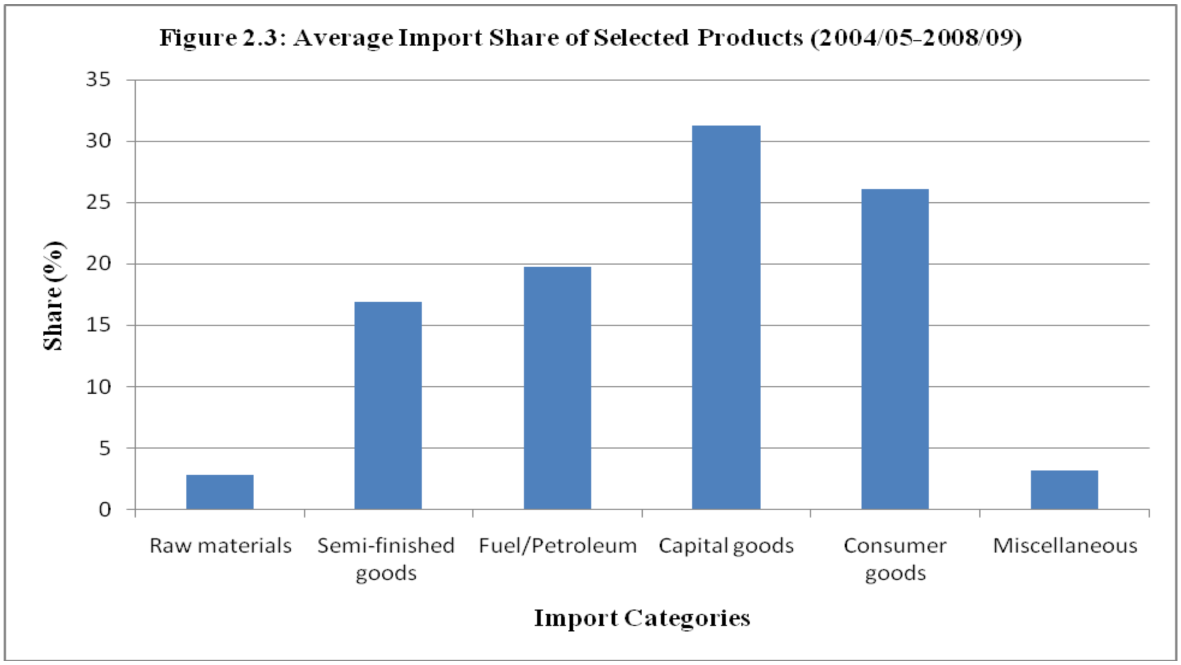
Source: Computations based on NBE (2009/10) data.

Table 2.3: Values (ETB Billions) and Shares (%) of Major Import Categories.

Category	2004/05		2005/06		2006/07		2007/08		2008/09	
	Value	%	Value	%	Value	%	Value	%	Value	%
Raw materials	0.43	1.4	0.67	1.7	1.31	2.9	2.39	3.8	3.65	4.3
Semi-finished goods	5.75	18.3	7.13	17.9	7.06	15.6	11.68	18.5	11.99	14.2
Fuel/Petroleum	5.79	18.4	7.47	18.7	7.69	17.0	15.08	23.9	17.56	20.7
Capital goods	10.38	33.0	12.61	31.6	16.45	36.5	16.42	26.0	24.60	29.1
Consumer goods	8.53	27.1	11.13	27.9	11.59	25.7	14.04	22.2	23.53	27.8
Miscellaneous	0.57	1.8	0.86	2.2	1.03	2.3	3.55	5.6	3.35	4.0
Total	**31.43**	**100**	**39.87**	**100**	**45.13**	**100**	**63.15**	**100**	**84.68**	**100**

Source: National Bank of Ethiopia (2009/10).

In the case of imports, one should underline that absence of diversification is not a real problem as for exports. Unless the country faces reserve constraints (due to low export earnings), the international market is full of supply. In fact, the aforementioned product categories are so broad that various goods are suppressed in each category. Capital goods, for example, incorporate a variety of machineries, vehicles, aircrafts, computers and so forth.

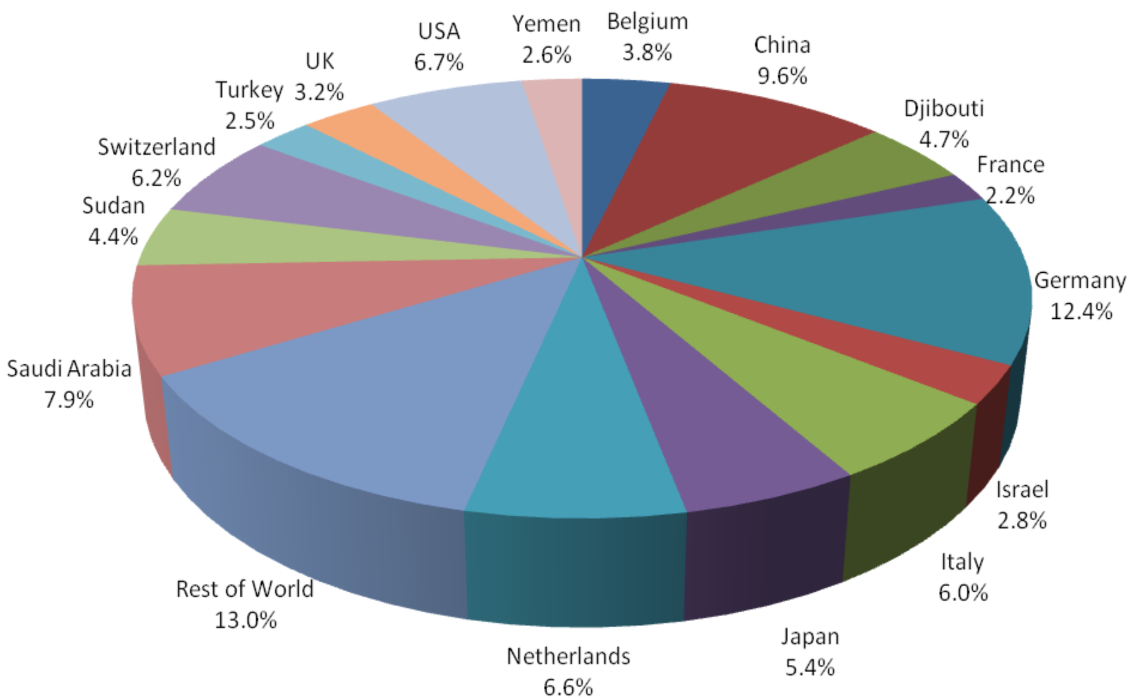


Source: Computations based on NBE (2009/10) data.

2.2. Direction of Trade

As far as Ethiopia's geographical distribution of trade is concerned, Europe and Asia followed by Africa remained the largest markets for Ethiopian exports accounting for 41.7%, 35.6% and 16.6% respectively of total exports in 2008/09 (NBE, 2009/10). Only 6% of the total exports were destined to the Americas and Oceania. Over the last three years, Germany (11.7%), China (10.8%), Saudi Arabia (9.5%), Netherlands (7.6%), United States (7.1%), Switzerland (6.7%), Italy (6%) and Sudan (4.9%) were the biggest destinations for Ethiopian exports (IMF, 2010). Therefore, as the case for their structure, the country's exports have some degree of concentration among limited number of destinations (see figure 2.4).

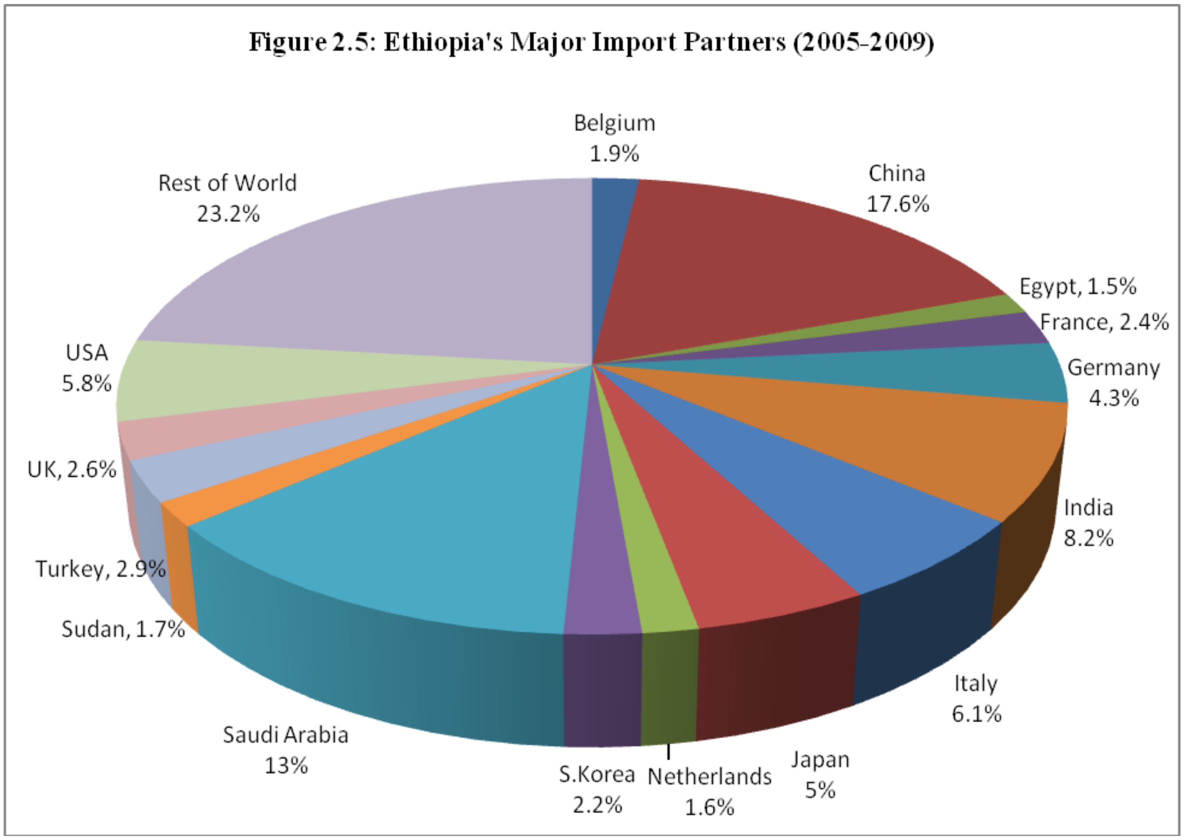
Figure 2.4: Ethiopia's Major Export Destinations (2005-2009)



Source: Computations based on IMF (2010) data.

Meanwhile, Asia remained the dominant supplier of Ethiopian imports with a share of about 64.7% followed by Europe (24.8%) and the Americas (6.5%); whereas Africa and Oceania shared the remaining 4% of total imports (NBE, 2009/10). Of the total imports from Asia, around 71% originated from four countries: China (26.2%), Saudi Arabia (25%), India (10.8%) and United Arab Emirates (9%). Regarding imports from Europe, Italy accounted for 24.5%, Russia 9.3% and Turkey 8.9%. At the same time, Egypt (29.2%), Sudan (28.1%) and South Africa (19.5%) constituted about 76.8% of imports from Africa countries, whereas the United States, Brazil and Canada accounted for 97.5% of imports from the Americas (Ibid). In aggregate terms, China (17.2%), Saudi Arabia (11%), India (7.7%), Italy (6.3%), United

States (5.1%), Japan (4.5%), Germany (3.2%) and Turkey (3%) were the largest import partners of Ethiopia over the last three years (IMF, 2010).



Source: Computations based on IMF (2010) data.

The highest share of 'rest of the world' in the above figure (23.2%) indicates that the sources of Ethiopia's imports were relatively diversified as compared to those of export destinations. In the case of exports, this figure was only 13%, not significantly higher than the share of some individual countries (see figure 2.4). This is one indication of the country's poor involvement in the export trade.

3. LITERATURE REVIEW

3.1. Theoretical Literature

3.1.1. Theories of Trade

There exists no single theory that can alone describe the pattern of international trade. Several theories have been developed overtime to explain the diverse ideas of the exchange of goods and services across global boundaries. Thus, one can argue that all traditional theories (in a perfect competition setting) along with contemporary ones (of market imperfection) have contributed a lot to support the concept of globalization and allow people look international trade with different viewpoints. Among the different international trade theories, the Ricardian Model, the Heckscher-Ohlin (HO) Model and the New Trade Theories are worth mentioning.

The Ricardian Model (1817) was devised to respond to the Mercantilist idea that trade was a zero-sum-game. Mercantilists (17^{th} − 18^{th} c.) strongly believed that exporting was good because it generated gold and silver for the national treasury, while importing was bad as it drained these precious metals from the national treasury. To ensure that a country exported a lot and imported only a little, they were in favor of high import restrictions. As opposed to this, the classic Ricardian Model states that every nation, which engages in international trade, could be benefited without requiring exports to be higher than imports. Clearly, Ricardo showed that both parties are better off under free trade than they were in autarky, and the reason why do nations trade is differences in production technology (Dunn and Mutti, 2004; Bjørnskov, 2005; Feenstra and Taylor, 2008).

Likewise, the HO model (1919-1924) was proposed as an alternative to the Ricardian model of basic comparative advantage. Despite its greater complexity, the model did not prove much more accurate in its predictions. But, from a theoretical point of view, it did provide a stylish explanation by incorporating the neo-classical price mechanism in to international trade theory (Feenstra, 2002). Based on this classical theory, technologies are the same across countries and the pattern of trade is solely determined by differences in factor endowments. It predicts that countries will export those goods that make intensive use of locally abundant factors and will import products that make intensive use of factors that are locally scarce (Markusen et al, 1995; Dunn and Mutti, 2004; Feenstra and Taylor, 2008).

The New Trade Theories, on the other hand, are often based on assumptions like monopolistic competition and increasing returns to scale. If markets are characterized by less than perfect competition, firms and countries can experience competitive advantages (Bjørnskov, 2005). One potential source of such advantages could be economies of scale. The more of one good a country produces, the lower will be its cost of production on average terms. Similarly, as we know just from walking down the aisles in a storehouse, most goods are differentiated. This disparity leads to (comes from) differences in tastes and preferences or love for variety of consumers around the world. Therefore, with product differentiation and scale economies, trade can arise between two countries having the same resource endowments, or between two economies for which there exists no pattern of comparative advantage (Markusen et al, 1995). Proximity is another factor that may cause similar countries to trade, while remoteness deters such type of trade because transportation cost is high. Obviously, residents of a nation situated far-from its trade partners tend to tolerate taste differentials and purchase similar items. Technological changes, regional trading blocs (trade creation or diversion), per capita incomes (Linder hypothesis) and product outsourcings are also among the new explanations that determine the pattern of trade (Markusen et al, 1995; Bjørnskov, 2005; Feenstra and Taylor, 2008).

By and large, all traditional and modern theories of international trade demonstrate that trade is generally beneficial, though uneven, for all trading partners. Unfortunately, none of them are as such successful empirically.[2] Trade theories just elucidate why nations trade in different products but do not explain why some nations' trade links are stronger than others and why the echelon of trade between countries tend to increase or decrease over time (Rahman, 2009).

3.1.2. Measures of Trade Potential

The term 'trade potential' can simply be defined as the maximum possible trade that can occur between economies with open and frictionless trade possible, given the current level of trade, transport and institutional technologies (Kalirajan, 1999; Miankhel et al, 2009; De, 2009). To explain the presence or absence of trade potential among economies, the most commonly used approaches in the literature are a set of trade indices and gravity models. A brief discussion of each approach follows.

As noted by Mikic and Gilbert (2007), trade indices are statistical ratios that can be used to describe and assess the state of trade flows and trade patterns of a particular economy (various economies) and then to monitor these flows and patterns over time or across economies. Such indices which are sometimes used as lagging indicators to describe what has happened in the past or leading indicators to predict about the future can provide huge information on the

[2] The basic problems in this regard include reliance of comparative advantage theories on unobservable autarky situations; numerous simplifying assumptions that cannot be true under all realistic circumstances; failure of trade theories to explain the extent of trade other than the pattern; competing hypotheses of theories instead of cooperative, etc. (Markusen et al, 1995).

significance of international trade relative to the whole economy (trade dependence, import penetration, export propensity, etc.), the trade performance of an economy (growth rate of trade, normalized trade balance, export/import coverage, etc.), the level of and changes in the regional pattern or direction of trade flows (trade shares, regional market share, trade intensity, trade entropy, etc.), the sectoral structure of trade (export diversification/similarity, trade complementarity, trade overlap, sectoral or aggregate intra industry trade, etc) and so forth. Because it is difficult here to present these numerous trade indices, concentration is given to those indicators which are of particular interest—trade overlap index, complementarity index and aggregate intra-industry trade index. In any case, these indicators are necessary conditions for trade potential to exist.

Trade overlap index is one that shows the overall significance of intra-industry trade as compared to inter-industry trade in the trade profile of an economy at a given point in time. This index ranges from zero to one. The higher is the value, the more important is intra-industry trade and the opposite side signifies the relative importance of inter-industry trade. Trade complementarity index is again a type of overlap index that measures the degree to which the export pattern of one country matches the import pattern of another. A higher value of this index (close to 100) is assumed to indicate higher trade potential, while the reverse is true if it is close to zero. Similarly, the index of aggregate intra-industry trade, defined as a weighted average of sectoral intra industry trade indices[3], is an alternative index to the above two indices. Higher ratios (close to one) suggest that the economies of scale and other sources

[3] A sectoral intra-industry trade index measures the degree to which trade in a particular sector represents intra industry trade (based on scale economies and/or market structures). Mikic and Gilbert (2007) details the mathematical expression of several trade indices.

of gain from intra-industry trade are being exploited, indicating low potential (Mikic and Gilbert, 2007).

Notwithstanding their importance to explain the state of trade flows, trade indices do not enable researchers quantify the amount of trade potential among nations. They only provide the insights for the (in)existence of potentials. These indicators can also suffer from other problems like sensitivity to the level of aggregation, inappropriate measurement of changes in intra-industry trade, ignorance of the level of trade (consider the structure only), inability to show dynamic effects and to examine the impact of policy shocks, etc. This situation has led Mikic and Gilbert (2007) to perceive trade indices as the "*2nd best* as compared to the *1st best* modeling tools."

Gravity models, on the other hand, are econometric models that many economists often use for ex-post analyses[4] of international trade flows. If after estimation the model is used for simulations, it can also predict future values (Piermartini and Teh, 2005). The gravity model of trade is based on the idea that overall trade volumes between two nations depend on the size of the two nations and the distance they are apart (Armstrong, 2007). Unlike trade indices, the gravity model of trade is one of the most empirically successful approaches in economics, both to explain the state of trade flows and estimate trade potentials (Helmers and Pasteels, 2005). It is also widely used as a baseline model for estimating the impact of a variety of policy issues (Baldwin and Taglioni, 2006). We can generally say that the estimation of trade

[4] Ex-post analysis is a study that uses historical data to explain the behavior of economic variables. On the contrary, ex-ante (simulation) analysis can be undertaken to answer 'what if' questions. The most commonly encountered models in this regard are computable general equilibrium models. Nonetheless, their application is complex and assumption sensitive (Piermartini & Teh, 2005).

potentials within the gravity framework is a line of research that has been studied extensively (Helmers and Pasteels, 2006). There are a couple of reasons for the central role played by the gravity model in such empirical works (Piermartini and Teh, 2005). The first has to do with the high explanatory power of the model in explaining bilateral trade flows. The second reason is that it provides an easy method to test the role that other variables play in affecting trade. Besides, the model can overcome the basic limitations of trade indices. For instance, it can incorporate dynamic effects (Bun and Klaassen, 2002), measure the impact of policy shocks or trade agreements (Piermartini and Teh, 2005) and capture the level as well as structure of trade (Alemayehu et al, 2010). It should be noted, however, that in analyzing trade between two countries, say X and Y, the model makes no provision for third party effects (Batra, 2004). That is, the model does not capture the conditions and opportunities that prevail between X and Z as well as Y and Z.

Within the gravity framework, there are two commonly used strategies in the literature to examine the flow of trade and predict trade potential among economies. One is the out-of-sample projection approach, which estimates the parameters of a gravity equation for highly integrated (liberal) countries and then the same coefficients are used to predict the natural trade relations between the benchmark countries and those starting to integrate (Egger, 2002; Benedictis and Vicarelli, 2005). Then, the difference between predicted and observed trade flows represents the yet unexploited trade potential. The second and most recently used strategy is called the in-sample approach (Ibid). In the latter case, all integrated and integrating countries are directly included in the regression analysis and then residuals of the estimated equation represent the difference between estimated and actual trade relations. The basic advantage of such approaches over trade indices is that they are capable of quantifying trade potentials.

Nevertheless, both in-sample and out-of-sample strategies are not without drawbacks. Egger (2002) has severely criticized the in-sample approach for being misleading because any large systematic difference between the in-sample projection and the actual trade flows only indicates problems of misspecification in the econometric model. Besides, from a consistent and efficient estimator, one should expect white noise residuals which do not have any more systematic variation. Therefore, Egger (2002) proposed the use of either out-of-sample approach or autoregressive model of order one. For the latter case, Egger (2002) argued that the application of an AR(1) model yields consistent and efficient estimator, which eliminates the systematic difference between observed and in-sample predicted values.

But, if models are not properly specified from the very beginning, the problems noted by Egger (2002) could prevail in the out-of-sample approach as well. Benedictis and Vicarelli (2005) stated that if the estimate of bilateral trade flows between the groups of countries taken as benchmark is misspecified, the bias is transmitted to the projection of the natural bilateral trade flows of the targeted countries. In addition, having benchmark and target countries with the same socio-economic characteristics to apply out-of-sample approach is not an easy task (Simwaka, 2010). Therefore, neither of the two strategies used to quantify trade potentials can be considered immune from the eventuality of serious bias if the equation regressed is not properly specified (Benedictis and Vicarelli, 2005).

In spite of which estimation strategy is used, there is a widespread tendency to draw strong conclusions from the sign of the difference between potential and effective trade flows (Benedictis and Vicarelli, 2005). The implication of a positive difference (untapped trade potential) between the two ranges from the need for country specific export promotion and broader bilateral integration to the need to anticipate major distribution changes caused by the expansion of bilateral trade flows in the near future (Batra, 2004). A negative sign in the difference between potential and effective trade (successful partnership), on the contrary, indicates that actual trade has reached its potential level and no social cost can be expected from future integration (Ibid).

From the previous discussion, we observe that gravity models outperform trade indices, particularly to achieve more specific targets. In our case, there are two basic advantages that gravity models can offer, while trade indices cannot. The model enables us to (i) incorporate dynamic effects in our analysis and (ii) quantify trade potential among economies. This circumstance makes the gravity model more appropriate for our study. Having preferred the gravity approach for our study, it is crucial to look at and choose among recent innovations of the gravity framework as well. In what follows, the general approach we are interested in will be discussed in detail. The origin and theoretical foundations of the gravity model are presented first, with the main objective of justifying the gravity model's consistency with economic theory. Secondly, the recent econometric developments in the gravity framework are discussed. This task will be helpful to make a final choice of appropriate model specification that improves the precision of our estimates.

3.2. The Gravity Model

According to Head (2003), the use of the gravity model in international trade is analogous to the Newton's Law of Universal Gravitation (1687). The law of gravity in physics held that the attractive force between two objects is positively related to the product of their mass and inversely related to the square of the distance between them. From this benchmark, Tinbergen (1962) was probably the first economist to propose the gravity equation's applicability to international trade flows (Head, 2003; Yihong and Weiwei, 2006; Rahman, 2009). Tinbergen's work, similarly, explains the flow of trade between a pair of countries as being proportional to their economic mass (GDP) and inversely proportional to the distance between them. This expression can mathematically be written as (Head, 2003 and WTO, 2008):

$$F_{ij} = k.\frac{M_i^a M_j^b}{D_{ij}^c} \quad ------------------------------(1)$$

Where $\boldsymbol{F_{ij}}$ is the flow of trade from origin i to destination j, the $\boldsymbol{M_i}$ **(**$\boldsymbol{M_j}$**)** is economic size of country i (j), $\boldsymbol{k}$ is constant of proportionality and ***a, b, c*** are response parameters. For ease of exposition, equation (1) could be transformed to a log linear (natural logarithm) form as follows:

$$\ln F_{ij} = k^* + a\ln M_i + b\ln M_j - c\ln D_{ij} + u_{ij} \quad --------------(2)$$

The $\boldsymbol{u_{ij}}$ is a log-normally distributed error term that captures the effect of all omitted and unobservable factors, while $\boldsymbol{k^*}$ equals the ***ln*** of $\boldsymbol{k}$.

Although the basic gravity model has later been augmented with many choice variables (just because there exists huge amount of variation in trade that cannot be explained by the traditional variables), the model is generally assumed to comprise supply and demand factors (GDPs, populations), as well as trade resistance (geographical distance, absence of common border) and trade preference (trade agreements, currency unions, historical links, etc.) factors (Eichengreen and Irwin, 1996; Benedictis and Vicarelli, 2005). However, one should still underline that gravity equations perform a pretty well job at explaining trade with just the size of economies and their distances (Head, 2003). Since the works of Tinbergen (1962), Pöyhonen (1963) and Linnemann (1966), gravity models are widely applied in the area of international trade, foreign investment and migration (Bergstrand, 1985; Deardorff, 1995 and Head, 2003).

3.2.1. Theoretical foundations

In spite of its empirical success, lack of theoretical backing has long been the major challenge of the gravity model (Bergstrand, 1985). We can observe from the literature that the model is simply an empirical device stemmed from none of the theories in economics. Obviously, the formal resemblance between the Newtonian gravity equation and the one used in economics is not an adequate explanation of why gravity models have become such popular tools for trade modeling (Földvari, 2006). As Anderson (1979) noted, all explanations based on physics have little interest for economics. Therefore, one can observe that the early applications of the gravity model have preceded the formal theoretical justifications.[5]

Unlike the absence of close correspondence between economic theory and the gravity model, trade theorists have recently found the latter to be consistent with the leading theories of

[5] Tinbergen (1962) and Pöyhonen (1963) give only an intuitive explanation for the model (Deardorff, 1995), while Linnemann (1966) made an attempt to provide some justifications in light of a partial equilibrium model that comprises export supply and import demand, but criticized as being *'loose'* (Bergstrand, 1985) for ignoring the multiplicative form.

international trade and justify the inclusion of core variables—income and distance (Eichengreen and Irwin, 1996; Batra, 2004; Rahman, 2009). Anderson (1979) was the first theorist who tried to equip the gravity equation with a formal theoretical foundation (Deardorff, 1995; Baldwin and Taglioni, 2006; Armstrong, 2007). Anderson (1979) employs the properties of expenditure systems with a maintained hypothesis of identical homothetic preferences across nations; while products were assumed to be differentiated by place of origin according to what is commonly called Armington assumption. From such setting, Anderson (1979) derived the gravity model and explained the presence of income variables as well as their multiplicative (log-linear) from. Latter in his analysis, the author incorporated the role for a transit cost factor including all border adjustments and transport costs. Anderson and van Wincoop (2003) also developed an operational gravity equation as a function of national income and trade costs from a constant elasticity of substitution expenditure system.

While Anderson's (1979) analysis was at macro level, Bergstrand (1985, 1989) develops a micro-economic foundation of the model. Bergstrand (1985) presents a general equilibrium framework of world trade based on utility and profit maximizing behavior of economic agents and then demonstrates that a generalized gravity equation[6] can be explicitly derived from this system by making certain simplifying assumptions: perfect substitutability of goods across countries, small open economies, and identical utility and production functions across countries to mention a few. Bergstrand (1985), however, noticed that if trade flows are differentiated by origin, the typical gravity equation is misspecified omitting certain price variables. For that matter, the author has undertaken an empirical test, whose result supports

[6] It is a form of gravity equation that treats income and certain price terms as exogenous instead of substituting out all endogenous variables in the system (Rahman, 2009).

the notion that gravity equation is a reduced form of a partial equilibrium sub system with nationally differentiated products (Ibid). In his later work (1989), Bergstrand extends the micro-economic foundations of the generalized gravity equation based on models of imperfect competition (Bergstrand, 1989). This study incorporates factor endowment variables in the spirit of Heckscher-Ohlin theory and preference indicators in line with Linder's hypothesis. Bergstrand (1989) further assumed the presence of product differentiation (across firms), monopolistic competition and shipping costs to illustrate how the gravity equation, including exporter and importer populations as well as incomes, coincide with the traditional theories of inter-industry trade and the modern theories of intra-industry trade.

Later, Deardorff (1995, 1998) has drawn it from two extreme cases of the classical framework of HO model. One is the case of frictionless trade, where the absence of trade barriers and the presence of homogenous products lead firms and households to be indifferent about to (from) whom they should sell (buy), because trade is just as cheap and therefore no less likely than domestic transactions. The second is the case of distinct products with complete specialization, in which positive impediments to trade are assumed to exist (Deardorff, 1995 and 1998). Here, the expressions for bilateral trade are devised with Cobb-Douglas and then Constant Elasticity of Substitution preferences. Unlike income variables, which are considered in both cases, distance is included in the latter case alone. In a broader sense, Deardorff (1995) notes:

> *It is certainly no longer true that the gravity equation is without theoretical basis, since several of the same authors who noted its absence went on to provide one. ……… I suspect that just about any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life (Deardorff, 1995: pp.1-9)!*

Besides, the gravity equation has been derived from a Ricardian framework (Eaton and Kortum, 2002), where technological heterogeneity dominates the pattern of trade. Eaton and Kortum (2002) have incorporated the role for geographical[7] features as well in their derivations. More recently, Helpman et al (2008) derives a gravity equation from a heterogeneous firms' model of trade. This derivation has addressed three basic issues that previous ones could not explain: zero trade observations, asymmetric trade flows and extensive margin of trade.

In any case, although the specific theoretical model that best describes the empirical success of the gravity equation is a matter of contention (Batra, 2004), it seems possible to derive the gravity model of trade from a variety of leading theories. For that reason, the model is said to have sufficient theoretical justifications for its usage in international economics. Our review was thus not to demand a new trade theory that best fits the gravity model, but instead to demonstrate the presence of a general consensus that our empirical approach is theoretically founded.

3.2.2. Recent Improvements

We saw that the gravity model is equipped with ample conceptual supports. As Batra (2004) claimed, the model has gone from "an amazing poverty of theoretical foundations to an embarrassment of riches!" Even so, various attempts are still underway to improve econometric specification of the model. One of the recent econometric developments is to extend the gravity model to a panel data setting and then take in to account the existence of

[7] Geographical factors are likely to include distance, topography and border effects of partners.

dynamic effects (Nguyen, 2010; Benedictis and Vicarelli, 2005; Bun and Klaassen, 2002; Harris and Mátyás, 1998; Eichengreen and Irwin, 1996). Previously, we find that the model used cross section data for several years (Bergstrand, 1985 and 1989; Oramah and Abou-Lehaf, 1998; Batra, 2004; Ram and Prasad, 2007). However, the traditional cross-section approach is probably affected by severe problems of misspecification (Mátyás, 1997 and Egger, 2002). Panels have the advantages in terms of being able to capture the relevant relationships overtime and monitor unobservable country-pairs specific effects (Batra, 2004). Further, existing gravity models which often use static panels could be improved by introducing dynamic panels (Nguyen, 2010).

With regards to dynamics, Eichengreen and Irwin (1996) stated that current trade flows of a country are affected by previous trade patterns. For countries that traded a lot in the past, it seems more likely that firms have set up distribution and service networks in the partner country which has lead to entrance and exit barriers due to sunk costs. Passing historical events that allow costs to be sunk can in turn be associated with persistent increases in the level of trade (Ibid). Besides, customers have grown habit formation (brand loyalty) for products of the partner country (Nguyen, 2010). For such historical reasons, the existence of economies of scale and scope in the production of goods and services can cause trade to flow in particular geographical channels (Eichengreen and Irwin, 1996). In addition, Harris and Mátyás (1998), Bun and Klaassen (2002) as well as Benedictis and Vicarelli (2005) demonstrated that trade is a dynamic process. Therefore, they suggested an extension to the basic gravity model, which accounts for the fact that contemporaneous trade flows are likely to be strongly related to the previous ones. According to Bun and Klaassen (2002), the estimate for lagged trade represents not only dynamic effects, but also the impact of unobserved pair-specific factors which are invariant overtime. Benedictis and Vicarelli (2005) noted that the existence of sunk costs borne by exporters to set up distribution and service networks in the partner country may generate inertia in bilateral trade flows, and countries trading with each other at time ***t*** will tend to trade more at time ***t+1*** too. Incorporating dynamics, the standard gravity model of trade can be written as follows:

$$\ln F_{ijt} = \beta_0 + \beta_1 \ln F_{ijt-1} + \beta_2 \ln M_{it} + \beta_3 \ln M_{jt} - \beta_4 \ln D_{ij} + u_{ij} \text{ -----------(3)}$$

Where $\boldsymbol{F_{ijt-1}}$ is the flow of trade from origin i to destination j at the previous year, while other variables are as defined earlier at the current year.

The second recent innovation of the gravity framework draws on procedures developed for estimating stochastic frontier production functions (Kang and Fratianni, 2006; Armstrong, 2007; Armstrong et al, 2008; Miankhel et al, 2009). Stochastic frontier function is an economic modeling developed by Aigner, Lovell and Others in the late 1970s to measure production efficiency (Armstrong, 2007). The basic idea of the function lies in the introduction of an additive error term consisting of a noise and an inefficiency term (Kang and Fratianni, 2006). The former is a more conventional symmetric error term which captures random disturbances, while the latter is a non-negative term that captures production inefficiencies. The ability to split the disturbance terms allows that a farmer who experiences drought is unlucky, but not inefficient (Armstrong, 2007).

According to Miankhel et al (2009), the stochastic frontier analytical framework can be used to model and explain trade potential among different geographical entities; and has the advantage of identifying (i) biasness from behind the border measures that traditional gravity model does not address, (ii) the potential trade and technical efficiency by each sector for each of a country's trading partners and (iii) the potential trade achievable from regional trading agreements. Mathematically, Kang and Fratianni (2006) write the stochastic frontier gravity equation as:

$$Y_{ijt} = f(X_{ijt}) + V_{ijt} - U_{ijt} ---------------------(4)$$

Where $\boldsymbol{Y_{ijt}}$ is the actual value of bilateral trade, $\boldsymbol{X_{ijt}}$ is a vector of explanatory variables including income, distance and other factors aiding or resisting trade, $\boldsymbol{f(X_{ijt})}$ is the value of predicted bilateral trade, $\boldsymbol{V_{ijt}}$ is a noise term assumed to have normal distribution and $\boldsymbol{U_{ijt}}$ is a trade inefficiency term having non-negative half normal distribution. Trade inefficiency, in this regard, is a measure of the difference between observed and predicted trade values.

The major problem of applying stochastic frontier to the gravity equation is that it requires a leap of faith in assuming that all trade restrictions are captured in the *inefficiency* term (Armstrong, 2007). In reality, one can hardly believe that this severe restriction will hold, as a result of which estimates may be misleading. In addition, existing specifications of the stochastic frontier approach accounts for only contemporaneous effects of regressors on trade. It ignores the role for hysteresis (lagged effect) in the flow of trade, which is the main consideration of our study.

Yet another innovation, the International Trade Centre has recently developed a gravity model known as *TradeSim*. This model, having three consecutive versions, was devised with the main objective of estimating bilateral trade flows and trade potentials between transition economies and their partner countries (Helmers and Pasteels, 2005). The sample of countries, the level of data aggregation and the range of explanatory variables considered are the major differences among these versions. But, the main concept is that the gravity equation, explaining observed bilateral exports within a sample of countries chosen, is used to obtain potential bilateral trade flows between any pair of countries within the sample. Such simulated bilateral exports are compared with observed ones in order to infer bilateral export potentials (Helmers and Pasteels, 2006).

According to Helmers and Pasteels (2005), the third version of the so called *TradeSim* uses (2002−2003) average trade data and estimates trade potentials for 19 sectors. Its econometric specification (Helmers and Pasteels, 2005) looks like equation (5). The authors noted that this latest version has made a major progress in terms of model specification and estimation robustness.

$$\ln X_{ijk} = \alpha_{ik} + \alpha_{jk} + \beta_{1k} \ln Dist_{ij} + \beta_{2k} \ln Tarf_{ijk} + \beta_{3k} Bord_{ij} + \beta_{4k} Lang_{ij} + \beta_{5k} \ln Conf_{ij} + \beta_{6k} Geog_{ij} + \varepsilon_{ijk} \text{ --------------------------------- } (5)$$

Where $\boldsymbol{X_{ijk}}$ represents the flow of trade from country *i* to country *j* in sector k; $\boldsymbol{Dist_{ij}}$ indicates distance between countries; $\boldsymbol{Tarf_{ijk}}$ bilateral market access measure; $\boldsymbol{Bord_{ij}}$ a dummy variable for common border; $\boldsymbol{Lang_{ij}}$ bilateral measure of common language; $\boldsymbol{Conf_{ij}}$ bilateral measure of conflict; $\boldsymbol{Geog_{ij}}$ bilateral measure of geographical location; $\boldsymbol{\alpha_{ik}}$ and $\boldsymbol{\alpha_{jk}}$ are multilateral resistance terms; while $\boldsymbol{\varepsilon_{ijk}}$ is a random error term.

Leaving alone its specification, *TradeSim* is a type of gravity model that is often static, which employs cross section data. Thus, it cannot escape from all the critics against traditional gravity models (Egger, 2002), making the strategy less important for our study. We do not also think that making traditional variables of the gravity model out of specification (as *TradeSim* did) will be worthwhile. The *TradeSim*, which simply captures income variables with multilateral resistance terms, may lack theoretical consistency.

3.3. Empirical Literature

Of the many empirical studies used the gravity framework, a high percentage shares the research task of predicting trade potentials. Because the area has very huge literature that cannot all be reviewed in this particular project, we will concentrate on the case of developing countries. Subsequently, empirical studies undertaken in the African and then Ethiopian context followed suit.

Employing an augmented gravity approach, Batra (2004) has estimated India's trade potential around the world. With the use of ordinary least squares estimation technique on a cross-section data of the year 2000, she first analyzed the flow of trade between India and its partners. The coefficients obtained were then used to predict trade potential for the country. The natural logarithm of total merchandise trade being the dependent variable, estimation results indicate that the gravity model works well, explaining about 69% of the variation in bilateral trade with all variables of interest (income, distance, common border and preferential trade agreements) found statistically significant. From an in-sample estimation strategy, Batra (2004) indicated that India has huge potential trade. Among countries that showed high potential for trade expansion with India include China, United Kingdom, Italy, France, Georgia and Uzbekistan.

In the same fashion, Ram and Prasad (2007) examined the global trade potential of Fiji. An augmented gravity model was estimated with ordinary least squares based on a cross-section data of the year 2005. Accordingly, the model has delivered plausible income and distance elasticities (about 0.85% and -1.1% respectively). Having estimated trade potentials with an in-sample strategy, Ram and Prasad (2007) found that countries like Australia, New Zealand and Thailand revealed maximum potential for trade expansion with Fiji. Another way round, Yihong and Weiwei (2006) employed a pooled dataset (1993−2003) to analyze China's export potential to the ASEAN market. After an export similarity index has given inconclusive outcomes, the study tended to apply a gravity method. Estimation results of the latter pointed out that China-ASEAN trade was higher in the study period. But, it was demonstrated that transactions could still increase, as the China-ASEAN free trade agreement showed a strong trade creating effect within that free trade area.

One step further, Rahman and Ara (2010) employed a dynamic gravity approach to estimate foreign trade potential for Bangladesh. The study was conducted based on bilateral trade flows between Bangladesh and its eighty major trading partners. For the purpose of estimating the gravity model, a static panel dataset (1995–2007) with random effects was used. Estimation results reveal that economic size, distance, regional trade agreement and adjacency are among significant variables of the model. Having predicted the natural trade flows with an in-sample strategy, Rahman and Ara (2010) have identified partners with which Bangladesh has unexploited trade potential. The magnitude of Bangladesh trade potential was found very high with China, Japan, India, United States, Germany and Russia respectively.

In the African context, Oramah and Abou-Lehaf (1998) have examined the potentials for increased intra-African trade. A gravity equation was estimated including two different measures of trade correspondence, namely Cosine of the angle between the vector of country i′s export and the vector of country j′s imports (COS) and Export-Import Similarity (EIS) index, as explanatory variables. The study was conducted using 1993 commodity composition of intra-Africa trade. Based on results obtained, a trade potential indicator (TPI) was estimated showing the relative capacity of each African country in exporting to other members of the continent. Accordingly, a number of African economies were found to have export structures which do not match up to 40% of the import structure of other African economies. Countries that would stand to gain from greater efforts to improve intra-Africa trade were Comoros, South Africa, Egypt, Sudan, Congo, Cote d’Ivoire, Gabon, Algeria and Cameroon. Those which may not gain as much were Burundi, Namibia, Guinea and Ethiopia.

Likewise, Alemayehu (2009) examined the nature of the potential for intra-Africa trade and hence the prospects for advancing regional economic integration. A variety of methods, including the popular gravity approach, were deployed for the purpose. The gravity model was estimated using a panel data of African countries and their major trade partners around the world (2000− 2006). The estimated coefficients of the model were afterwards used to simulate the potential for intra-Africa trade. Consequently, end results notified the existence of a potential for intra-Africa trade (about 63% weighted average for Central and Western Africa region, and some 60% for Eastern and Southern Africa region). In spite of that fact, Alemayehu (2009) perceived that realizing the potential and efforts to advance regional integration through intra-Africa trade was challenged by highly limited diversification of products and the relative competitive position of African suppliers.

Simwaka (2010) estimated the trade potential expected from the SADC free trade area. The average of the data which spans from 1998–2000 and 2003–2007 has been estimated with maximum likelihood method to show pre-integration and post-integration results respectively. Estimates of a Tobit gravity equation indicate that income variables, transportation costs, common official languages and regional groupings seem to basically determine the flow of exports in both periods, while population variables were significant in the post-integration period only. Finally, it was shown that SADC has the impact of creating trade for its members, so that untapped trade potential exists in the sub-region.

More recently, Africa-China trade potential was assessed by Matias (2010), by applying a combination of methodologies—stochastic frontier gravity approach and trade complementarity index. For the former case, the study utilized a panel data of Chinese exports to the African countries over the period 2001–2008. The latter case deserves no attention in this review. Matias (2010) estimates an in-sample stochastic gravity model, incorporating random disturbance and inefficiency terms. The estimated model was then used to calculate trade efficiency and potential of China with 52 African countries. Accordingly, China has realized on average only 13% of its export potential with African countries. Seychelles, Sao Tome and Principe, Comoros, Central Africa Republic, Chad and Equatorial Guinea are partners with which China had the lowest trade efficiency (high export potential). On the contrary, export efficiency of China was the highest (effective partnership) with Benin, Liberia, Togo, Gambia and Djibouti.

Coming to Ethiopia, we observe that some studies have attempted to address the country's poor performance in the global trading system. Mulugeta (2009) has endeavored, in a gravity framework, to model the determinants of Ethiopia's export and import flows. Deeming a panel dataset of major trade partners, estimation was done with fixed effects model. Consequently, income and distance variables, infrastructure as well as institutional qualities were among the basic determinants. The distance variable was, in fact, found significant to affect the flow of exports only. Hussein (2008) analyzed the impact of COMESA membership and other factors on the flow of Ethiopia's exports. The study takes in to account the flow of annual exports to twenty destinations over the period 1981–2006. He used a Tobit specification with random effects to estimate the gravity model. Estimation results demonstrate that most traditional variables are significant, while the impact of COMESA membership to create or divert exports was negligible. The latter finding seems consistent with what Alemayehu and Haile (2007) have found—regional groupings in Africa had insignificant effect on the flow of bilateral trade. Alemayehu and Haile (2007) indicated that the performance of regional integration agreements was mainly constrained by problems of variation in initial conditions, compensation issues, real political commitments, overlapping membership, policy harmonization, lack of diversification and poor private sector participation.

Yishak (2009) has dealt with the supply and demand side factors that contributed for the country's poor export performance. Employing an aggregate panel data with two stage least squares (random effects) estimation, among supply side factors that significantly affected Ethiopian exports were domestic income, internal infrastructure and institutional quality. The demand side factors, namely foreign income and distance, were also statistically significant at standard levels. In a nutshell, these results are in line with the findings of Mulugeta (2009). Furthermore, Alemayehu et al (2010) examined factors that determine the export supply response constraints of Ethiopia at the micro and macro levels. The macro level analysis that makes use of secondary data in a gravity framework has two parts. At the first glance, the authors have considered the value of total exports to partners. Secondly, total exports were disaggregated by major export categories: coffee, hides and skins, oilseeds and pulses as well as nontraditional exports like cut flowers. Accordingly, estimation results generally reveal that exports are more constrained by domestic than global factors. Among these factors include domestic income, internal infrastructure, quality of institutions and distance to trading partners. The micro or firm level analysis that comprises qualitative, econometric and value chain approaches is beyond the scope of our study.

Abdulaziz (2009) has tried to evaluate the export potential of Ethiopia with the Middle East. For that purpose, the author makes use of two distinct methodologies: an export similarity index and a gravity model approach. The former was used to measure the degree to which exports of Ethiopia and a Middle East country match, indicating the level of rivalry instead of complementarity; while the latter was used to predict an in-sample trade potentials based on a panel data setting (1995-2007). From a combined result of both strategies, Abdulaziz (2009) found that Saudi Arabia, United Arab Emirates, Yemen and Israel showed the highest potential as a destination for Ethiopian exports.

3.4. Critical Review of Literatures

From all the studies noted above, we observe that the gravity model has been widely applied. Nevertheless, a critical look of the studies is likely to obtain problems of misspecification. In this regard, applications that employed cross-sectional data are the most affected (Egger, 2002). This is due to the fact that cross-sections consider only a point in time. Among such studies are Ram and Prasad (2007), Batra (2004), Oramah and Abou-Lehaf 1998), Yihong and Weiwei (2006), and Simwaka (2010). Other studies that make use of panel data (like Abdulaziz, 2009; Rahman and Ara, 2010; Alemayehu, 2009 and Matias, 2010) can also suffer from the crisis of misspecification. These problems can be observable from the static nature of the model or dataset used, which ignores the role for dynamic effects in trade (Bun and Klaassen, 2002). Besides, the focus of attention for all the studies undertaken in Ethiopia was about analyzing the determinants of exports. None of the studies have tried to evaluate the global trade potential of Ethiopia nor incorporated dynamism in their analysis. The only exception to this limitation is Abdulaziz (2009), who tried to assess the potential export of Ethiopia to the Middle East. Three things are not considered in this case too: The flow of imports, partners other than in the Middle East and dynamic effects. Therefore, it seems tricky to follow either of the above methodologies in our study.

Our particular project rather employs a dynamic gravity approach. Following Harris and Mátyás (1998), we argue that the flow of trade is persistent. That is, countries with a history of trading with one another—whether for reasons related to politics, policies or other factors—generally continue doing so (Eichengreen and Irwin, 1996). Justifications supporting the existence of dynamic effects in trade are also evidenced by empirical applications (Bun and

Klaassen, 2002; Benedictis and Vicarelli, 2005 and Nguyen, 2010). Bun and Klaassen (2002), considering a sample of 24 OECD[8] countries over the period 1950–1997, showed that a one percent increase in the level of previous trade boosts current trade by about 0.57 percent (GMM Estimator) to 0.74 percent (LSDV Estimator). Likewise, Benedictis and Vicarelli (2005), who used to estimate the export potential of five European countries with their 31 partners, found that the impact of lagged endogenous variable on current export performance was 0.53 percent (System GMM Estimator). Besides, Nguyen (2010) has tried to compare the fitness of static and dynamic gravity models using export data of Vietnam. The study shows the strong evidence that Vietnamese exports are autoregressive. By adding the lagged endogenous variable on the right hand side, explanatory power of the model has dramatically increased (from 53% to about 89%). A one percent rise in trade of the previous year causes current trade to rise by 0.72 percent (Nguyen, 2010). Consequently, we can conclude that static specifications of the gravity model leads to incorrect inferences.

In our case, whether Ethiopia's trade is a dynamic process requires its own empirical investigation. Although there is a scanty of theoretical or empirical literature in this regard, we can tentatively conclude the existence of dynamics based on aforementioned justifications. We can also hypothesize it from some historical events of trade in Ethiopia. As we know all, Ethiopia's trade is less diversified not only in its structure but also in source/destination countries (MOFA, 2007 and Getnet, 2010). Focusing on the limited number of partners, we found that Netherlands, United States, China, Germany, Italy, Saudi Arabia, Switzerland and Sudan consumed about 64% of Ethiopia's total exports over the period 2007−2009 (IMF,

[8] Organization for Economic Cooperation and Development.

2010). Similarly, some 58% of Ethiopia's imports were consumed from the United States, China, Germany, Italy, Japan, Saudi Arabia, India and Turkey over the same period (Ibid). From this trend, we stand to argue that the persistent nature of trade, among other factors, might have attributed for such limited partners. Who knows, firms might have developed distribution channels which caused costs to be sunk and (or) customers of the trading pairs being accustomed with each other's products? Along with other factors aiding or resisting trade, this circumstance makes our approach more worthwhile.

4. METHODOLOGY

4.1. Model Specification

In search of better results, our study has employed a dynamic gravity approach based on a panel data of sample countries. Panels have several advantages in terms of being able to allow researchers handle more realistic models than simple cross-section or time series data sets (Verbeek, 2008). Indeed, they incorporate both cross-section and time dimensions over the same units of observation. Such an approach not only increases the degree of freedom, but also monitors unobservable trading-pair individual effects (Batra, 2004).

Our econometric model draws on the gravity equation of Rahman and Ara (2010) with some modifications made based on Harris and Mátyás (1998) to derive a more proper specification. Gravity models that are used to estimate trade potentials need to include only the most natural determinants of trade as explanatory variables, leaving artificial variables to explain the difference between predicted and observed flows (Armstrong, 2007). While explaining Bangladesh trade potential, Rahman and Ara (2010) estimated the following two models:

$$\ln TRD_{ijt} = \beta_0 + \beta_1 \ln(GDP_{it}.GDP_{jt}) + \beta_2 \ln(POP_{it}.POP_{jt}) + \beta_3 \ln DST_{ij} + \beta_4 LAN + \beta_5 ADJ + \beta_6 RTA + \varepsilon_{ijt} \qquad (6)$$

$$\ln EXP_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 POP_{jt} + \ln \beta_5 DST_{ij} + \beta_6 LAN + \beta_7 ADJ + \beta_8 RTA + \varepsilon_{ijt} \qquad (7)$$

Equation (6) is a basic trade model where as equation (7) an export model. Variables are defined as follows: $\boldsymbol{TRD_{ijt}}$ indicates bilateral trade value (exports + imports) between country i and j at time t, $\boldsymbol{EXP_{ijt}}$ is the value of export flows from country i to j at the same time, and the

GDP [POP] variables indicate economic size [population size] of countries. $\boldsymbol{DST_{ij}}$ is the physical distance between capital cities of partners, while ***LAN***, ***ADJ*** and ***RTA*** are dummy variables for common language, adjacency and trading agreements of partners, respectively.

Although existing gravity models based on panel data are often static, we found that the ideas of Harris and Mátyás (1998) are convincing to extend the benchmark model[9]. Harris and Mátyás (1998) strongly suggested that current trade flows are likely to be strongly related to the previous ones and hence lagged trade should be added on the right hand side of the gravity model. According to Egger (2002), this procedure eliminates any systematic difference between observed and predicted trade flows as well. The empirical works of Bun and Klaassen (2002), Benedictis and Vicarelli (2005) and Nguyen (2010) have supported these economic arguments.

Besides, following the works of Batra (2004) and Rahman (2009), we added per capita income differential in the trade model. This variable enables us to determine whether differences (similarities) in the level of development of countries have an impact on the flow of trade among them. The inclusion of per capita income differential has theoretical supports as well. While traditional trade theories consider endowment differences as a basis for trade, contemporary theories believe that income similarity promotes trade (Markusen et al, 1995). These inconsistent arguments by themselves require an empirical testing. Therefore, we incorporate the above two critical adjustments and write our empirical models as:

$$\begin{aligned}\ln TRD_{ijt} &= \beta_0 + \beta_1 \ln TRD_{ijt-1} + \beta_2 \ln(GDP_{it}.GDP_{jt}) + \beta_3 \ln(POP_{it}.POP_{jt}) + \beta_4 \ln DST_{ij} + \\ &+ \beta_5 \ln PGD_{ijt} + \beta_6 LAN + \beta_7 ADJ + \beta_8 RTA + \varepsilon_{ijt} \text{-------------------} (8)\end{aligned}$$

[9] Detailed content of this concept is presented in the literature review part (section 3.2.2).

$$\ln EXP_{ijt} = \beta_0 + \beta_1 \ln EXP_{ijt-1} + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 \ln POP_{it} + \beta_5 POP_{jt} + \ln \beta_6 DST_{ij}$$
$$+ \beta_7 LAN + \beta_8 ADJ + \beta_9 RTA + \varepsilon_{ijt} ----------------------------(9)$$

Where ***TRD**$_{ijt-1}$* *[**EXP**$_{ijt-1}$]* are defined as the value of trade [export] flows between Ethiopia and the sample of partners [from Ethiopia to partners] at time t-1, and the ***PGD*** variable indicates per capita GDP differential between Ethiopia and its partners.

4.1.1. Description of Variables

Trade flows (TRD_{ijt}, EXP_{ijt}): The annual flow of trade between country i (Ethiopia) and country j (partner) and that of exports from the former to the latter group of countries are used as dependent variables of the model. For reasons outlined before, lagged values of these variables are incorporated as explanatory variables. Once again, we followed the advice of Egger (2002) to include only the first lag instead of searching for optimal number of lags.

Economic size (GDP_{it}, GDP_{jt}): The gross domestic products of countries are assumed to measure the size of their respective economies. The standard gravity model predicts that economic size has a positive impact on trade (Head, 2003). While GDP of the exporting country captures the supply side, the GDP of an importing country controls the demand side conditions. Higher income of an exporting country indicates the capacity to produce more output and hence surplus for exports. Meanwhile, higher income of importing countries boosts the affordability of their economies for imports.

Population Size (POP_{it}, POP_{jt}): Populations can also measure the size of countries (Batra, 2004). However, the signs expected for the population variables are not consistent in the literature. An exporting country with higher population can either export more because of higher production capacity (economies of scale) or export less because of more consumption capacity (absorption effect). The same explanation holds for the importing country. More populous countries can import less (self sufficiency) or import more (excess demand).

Distance (DST_{ij}): The physical distance between countries serves as a proxy for transportation costs, transaction costs, time elapsed during shipments and cultural distances (Ram and Prasad, 2007). Countries located in remote areas are expected to trade less as compared to those located closer to their partners, implying a negative sign for distance. Since physical distance is a fixed variable overtime, the estimation procedure of dynamic panels that employs first differencing drops it out of specification. For that reason, a concept developed by Karagöz and Saray (2008) was applied to make it a time varying variable. Armstrong (2007) also suggested the use of relative distance instead of absolute distance to explain gross trade volumes. Mathematically, this weighted distance is calculated as:

$$RDST_{ijt} = \frac{(DST_{ij}.GDP_{it})}{\sum_{t=1}^{T} GDP_{it}} ----------------------------(10)$$

Where $\boldsymbol{RDST_{ijt}}$ is the relative (weighted) distance between trading partners, $\boldsymbol{DST_{ij}}$ is the aforementioned geographical distance, $\boldsymbol{GDP_{it}}$ is the gross domestic product of country i (Ethiopia) at time t and that $\sum \boldsymbol{GDP_{it}}$ is the sum of all GDPs of Ethiopia over the study period.

Income differential (PGD_{ijt}): Per capita income of a country measures the level of economic development. Conceptually, when a country develops, consumers will demand more exotic foreign varieties that are considered superior goods (Rahman, 2009). The process of development may also be directed by innovation of new products, leading to exports. From such perspectives, the difference in the level of economic development may actually affect the flow of trade. The Heckscher-Ohlin theory predicts that countries with dissimilar levels of per capita income will trade more than countries with similar levels (Batra, 2004). Linder's hypothesis, on the contrary, predicts that countries with similar levels of per capita income will trade more with each other because they will have similar preferences for differentiated products (Rahman, 2009). The income differential of trading pairs was therefore used to test whether the traditional or new trade theory holds for our sample. A positive sign favors the HO hypothesis, while a negative sign for the Linder hypothesis.

Dummy variables (LAN, ADJ and RTA): Trading pairs having common language, border and (or) trading agreements between them are expected to trade more than they could otherwise. Obviously, such preferences can significantly reduce the transaction costs of trade, making partners to trade more. These variables can take the value **one** if partners have common preferences and **zero** otherwise. Once again, first differencing removes all dummy variables out of the model. Nevertheless, we are not as such interested in these variables because our sample contains not only limited number of partners with such characteristics but also extremely low share of these countries in the total trade.

4.1.2. Why not Other Models?

While our study uses a dynamic gravity approach to analyze Ethiopia's trade potential, one should however notice that it is not the sole strategy[10] to do so. The TradeSim and Stochastic Frontier Approaches are also other recently developed strategies. Nevertheless, the first strategy which keeps traditional variables out of specification is no more our concern. It

[10] Section 3.2.2 provides the detailed presentation of recent innovations in the gravity model.

further considers the use of cross-sectional data (only a point in time). For the latter one, we have a couple of reasons for not employing it. First, specification of the model is often static that neglects the role for dynamic effects. Second, the model requires a *leap of faith* in assuming that all trade restrictions are captured in the inefficiency term (Armstrong, 2007), which may be unlikely to hold in reality. Besides, the model has recently been used by Matias (2010) to assess China-Africa trade potential, inquiring our study to come up with a new contribution.

4.2. Data Sources

Our study has been conducted based on bilateral trade flows between Ethiopia and 36 major trading partners around the world[11]. Trading partners are chosen considering the relevance and availability of transactions over the study period (1995−2009). Fortunately, the sample incorporates reasonable number of countries from all continents. Over the period under consideration, Ethiopia's basic trade with the sample of countries comprises about 86% of total trade, while export transaction to a corresponding sample was 93.7 percent of total exports (IMF, 2010). Meanwhile, the number of observations (1x36x15=540) considered is moderately high. Therefore, we suspect that the study covers significant portion of trade over the fifteen years period. The study period was chosen for the very reason that Ethiopia began trade liberalization reforms in the 1990s.

The set of information used to accomplish the study was gathered from different sources: Annual bilateral trade data[12] was obtained from IMF Direction of Trade Statistics Database. In

[11] Appendix **A** provides the list of countries under consideration.
[12] The data for trade-in-services are hardly available, forcing us to consider merchandise trade only.

cases where some export values are missing, the UN COMTRADE Online Database (comtrade.un.org/db) was exhausted and filled with. The GDP and per capita GDP data of countries were collected from World Development Indicators Database of the World Bank. All monetary values are measured in dollars at current prices. Population data (in millions) was accessed from the World Economic Outlook Database, while the distance in kilometers between Addis Ababa and the capital cities of trading partners (as the crow flies) was obtained from an Indonesian website www.indo.com/distance.

4.3. Estimation Procedure

For a panel data approach, the general framework of an autoregressive model of order ***p*** with additional regressors X_{it} could be specified as (Cameron and Trivedi, 2009):

$$Y_{it} = \theta_1 Y_{it-1} + ... + \theta_p Y_{it-p} + X'_{it}\beta + \alpha_i + \varepsilon_{it}; t = 1 \to T, i = 1 \to N ------------(11)$$

Where α_i is a time invariant individual effect whose treatment may be fixed or random, ε_{it} represents a disturbance term assumed to be uncorrelated with X_{it}. For our case, the general specification of (***11***) reduces to a first-order model.

In a static model, choosing between fixed or random effects treatment of α_i can yield consistent and efficient estimators (Hausman, 1978). Where as in a dynamic model, the situation is substantially different because Y_{it-1} will depend upon α_i, irrespective of the way we treat the latter (Verbeek, 2004). That is, introducing dynamics in to a panel data model raises serious estimation problems due to inconsistency of fixed effects and random effects estimators. A within estimator applied to a first order autoregressive model yields consistent estimates only when the number of time periods ***T*** is very large (Greene, 2003). Seeking to avoid this estimation problem, Arellano and Bond (1991) proposed a two steps procedure based on differencing and instrumenting. The first step consists of differencing the dynamic equation so as to remove the individual effects ($\boldsymbol{\alpha_i}$). Cameron and Trivedi (2009) write the first step of the procedure as:

$$\Delta Y_{it} = \theta_1 \Delta Y_{it-1} + \ldots + \theta_p \Delta Y_{it-p} + \Delta X'_{it}\beta + \Delta\varepsilon_{it} ------------------(12)$$

In this regard, we assume that $\boldsymbol{\varepsilon_{it}}$ are serially uncorrelated, otherwise estimators are inconsistent. For that matter, this critical assumption is testable and can be relaxed using extended strategies (Ibid). Some of the relevant specification tests are provided in the next section.

The second step deals with instrumental variable (IV) estimation of the first differenced (FD) model that uses appropriate lags of the dependent variable as instruments. According to Drukker (2008), these couple of steps does lead to consistent parameter estimates. The fixed or random effects panel data estimators are not appropriate even for the FD equation. In contrast to a static model, ordinary least squares on the FD data produces inconsistent estimates because the regressor $\Delta \boldsymbol{Y_{it-1}}$ is correlated with the error $\Delta\boldsymbol{\varepsilon_{it}}$, even if the $\boldsymbol{\varepsilon_{it}}$ are serially uncorrelated. For serially uncorrelated $\boldsymbol{\varepsilon_{it}}$, the FD model error term $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ has correlation with $\Delta Y_{it-1} = Y_{it-1} - Y_{it-2}$ because Y_{it-1} depends on ε_{it-1}. However, $\Delta\varepsilon_{it}$ is uncorrelated with ΔY_{it-k} for $k \geq 2$, opening up the possibility of IV estimation using lagged variables as instruments (Cameron and Trivedi, 2009).

Arellano and Bond (1991) have derived a consistent generalized method of moments (GMM) estimator by employing additional lags of the dependent variable as instruments[13] (Stata, 2009). The strategy was generally proposed to construct estimators based on moment equations from further lagged levels of Y_{it} and the first differenced errors (Drukker, 2008). Endogenous and predetermined variables can also be instrumented in the same fashion (Cameron, 2008). Under weak regularity conditions, the Arellano-Bond estimator is asymptotically normal for $N \rightarrow \infty$ and fixed T (Verbeek, 2004). In a nutshell, the estimator is designed for datasets with many panels and few periods.

Nevertheless, the Arellano-Bond estimator performs poorly in terms of precision when applied to short panels (along the time dimension), making the lagged levels weak instruments (Stata, 2009). For that reason, several studies have suggested the use of additional moment conditions to obtain an estimator with improved precision and better finite sample properties (Cameron and Trivedi, 2009). Based on the works of Arellano and Bover (1995), Blundell and Bond (1998) have developed a system GMM estimator that employs additional moment conditions (Stata, 2009). These additional moment conditions can be brought to bear in increasing efficiency (Mileva, 2007; Roodman, 2006; Benedictis and Vicarelli, 2005).

The Arellano-Bond estimator employs an IV estimation strategy based on the assumption that $E(Y_{ik}, \Delta\varepsilon_{it}) = 0$ for all $k \leq t-2$ in the levels equation, so that the lags Y_{it-2}, Y_{it-3}, Y_{it-4} and so forth can be used as instruments in the first differenced equation. In the case of system GMM estimator, we consider the additional condition that $E(\Delta Y_{it-1}, \varepsilon_{it}) = 0$ and incorporate the levels

[13] The rule of thumb for such procedures is to keep the number of instruments less than or equal to the number of groups in the dataset (Mileva, 2007).

equation utilizing ΔY_{it-1} as an instrument (Cameron and Trivedi, 2009). Similar additional moment conditions can be added for endogenous and predetermined variables, whose first differences can be used as instruments.

In accordance with previous justifications, our estimated gravity equation can be written in the levels and first differenced forms as:

$$TRD_{ijt} = \beta_0 + \beta_1 TRD_{ijt-1} + \beta_2 GDP_{ijt} + \beta_3 POP_{ijt} + \beta_4 RDST_{ijt} + \beta_5 PGD_{ijt} + \varepsilon_{ijt}$$
$$\Delta TRD_{ijt} = \beta_0 + \beta_1 \Delta TRD_{ijt-1} + \beta_2 \Delta GDP_{ijt} + \beta_3 \Delta POP_{ijt} + \beta_4 \Delta RDST_{ijt} + \beta_5 \Delta PGD + \Delta\varepsilon_{ijt}$$
$$--(13)$$

$$EXP_{ijt} = \beta_0 + \beta_1 EXP_{ijt-1} + \beta_2 GDP_{it} + \beta_3 GDP_{jt} + \beta_4 POP_{it} + \beta_5 POP_{jt} + \beta_6 RDST_{ijt} + \varepsilon_{ijt}$$
$$\Delta EXP_{ijt} = \beta_0 + \beta_1 \Delta EXP_{ijt-1} + \beta_2 \Delta GDP_{it} + \beta_3 \Delta GDP_{jt} + \beta_4 \Delta POP_{it} + \beta_5 \Delta POP_{jt} + \beta_6 \Delta RDST_{ijt}$$
$$+ \Delta\varepsilon_{ijt} ---------------------------------------(14)$$

The GDP_{ijt} (POP_{ijt}) variables indicate the product of the gross domestic products (populations) of trading pairs, while other variables are as defined earlier. All variables are in natural logarithms. Using the latest version of Arellano/Bond GMM estimation, equations (13) and (14) are first estimated to determine the pattern of trade. The coefficients obtained are then used to predict the global trade potential of Ethiopia. Since the Arellano-Bond method generates several instruments (for large T) leading to potentially poor performance of asymptotic results (when the number of groups is small), we have employed the least possible number of instruments. The ***Stata/SE 10.1*** computer software was employed for the purpose of estimation.

4.4. Econometric Issues

4.4.1. Serial Correlation

For consistent estimation of dynamic models, the GMM estimators require that the error term (ε_{ijt}) be serially uncorrelated (Stata, 2009). Specifically, if ε_{ijt} are serially uncorrelated, then $\Delta\varepsilon_{ijt}$ are correlated with $\Delta\varepsilon_{ijt-1}$ because $Cov(\Delta\varepsilon_{ijt}, \Delta\varepsilon_{ijt-1}) = Cov(\varepsilon_{ijt}-\varepsilon_{ijt-1}, \varepsilon_{ijt-1}-\varepsilon_{ijt-2}) = -Cov(\varepsilon_{ijt-1}, \varepsilon_{ijt-1}) \neq 0$. Conversely, $\Delta\varepsilon_{ijt}$ will not be correlated with $\Delta\varepsilon_{ijt-k}$ for all $k \geq 2$. A test of whether $\Delta\varepsilon_{ijt}$ are correlated with $\Delta\varepsilon_{ijt-k}$ for $k \geq 2$ can be performed by using the Arellano-Bond tests for serial correlation (Roodman, 2006). Accordingly, the test results of our model indicate the presence of no serial correlation in the first-differenced errors as desired (See Annex E-1). Clearly, the literature assures that rejecting the null hypothesis of no serial correlation at order one in the first-differenced errors does not imply that the model is misspecified. Rejecting the null hypothesis at higher orders rather implies invalidity of the moment conditions generated (Drukker, 2008; Cameron and Trivedi, 2009; Stata, 2009).

4.4.2. Overidentifying Restrictions

The moment conditions implied by dynamic panel data (DPD) models often employ several instruments to estimate a small number of parameters. The joint validity of these overidentifying restrictions needs to be tested therefore. The conventional GMM test or the so called Sargan (1958) test of overidentifying restrictions performs that operation (Bowsher, 2002). Nevertheless, only for a homoskedastic error term does the Sargan test has an asymptotic chi-squared distribution (Stata, 2009). In line with that, Bowsher (2002) found the Sargan test to have no power in panels of dimensions that are commonly encountered in empirical works. The test does not totally work (produce a test statistic) when robust standard errors are specified. Arellano and Bond (1991) clearly showed that a one-step Sargan test over-rejects valid instruments in the presence of heteroskedasticity, while a two-step test has the tendency to under-reject weak instruments. These two extreme cases were exactly reflected in our models (Annex E-2). Overidentifying restrictions are invalid in the one-step estimation and highly valid in the two-step estimation of both models. In our work, this circumstance makes the Sargan test inconclusive. Since the Breusch and Pagan (1980) test of residuals indicated the presence of heteroskedasticity in the dataset (Annex E-3), we need to find an alternative test that matches with heteroskedasticity. An extended version of the system GMM estimators developed by Roodman (2006) provides one possible solution. It enables one to perform the Hansen (1982) J test of overidentifying restrictions when robust standard errors are specified. Based on this test, we found that overidentifying conditions are valid in both equations (Annex E-2).

4.4.3. Endogeneity

The gravity model of trade treats economic size (GDP of a country) as an exogenous variable (Bergstrand, 1985). In spite of such treatments, there exists theoretical and empirical support that trade can also affect income variables (Batra, 2004; Ram and Prasad, 2007; Rahman, 2009). Meaning that, causality can run in both directions of the model. If so, regression results with exogenous treatment of income may be misleading. Therefore, the possibility of endogeneity should not totally be ruled out from equations (13) and (14) as well. Accounting for such potential problems, the lagged levels and first differences of the endogenous variables are used as instruments in the GMM setting. However, we found that the use of these instruments does not significantly alter the coefficients of any of the explanatory variables.

4.4.4. Heteroskedasticity

While estimating DPD models, the default GMM estimators yield homoskedastic standard errors. Several authors, however, strongly recommend that robust standard errors need to be applied to account for heteroskedasticity (Drukker, 2008; Stata, 2009; Cameron and Trivedi, 2009). The Breusch and Pagan (1980) test of residuals was performed to check whether heteroskedasticity exists. The idea of the test lies on the auxiliary regression of squared residuals upon explanatory variables including the constant. N(T-1) times R^2 of the auxiliary regression, having an asymptotic chi-squared distribution with degrees of freedom equal to the number of regressors, produces the desired statistic (Verbeek, 2004). Results of the test (Annex E-3) suggest that the variances of our models are heteroskedastic. Consequently, the standard errors of both models are hetero corrected (robusted).

5. RESULTS AND DISCUSSION

5.1. Estimation Results

Equations (13) and (14) are estimated by the technique of generalized method of moments. For the sake of comparison, we fit the models using one-step (two-stage least squares) and two-step (optimal) GMM estimators with robust standard errors. Table 5.1 and 5.2 presents the estimation results. Estimation outputs reveal that the one-step and two-step results are slightly different. In both cases, however, the standard features of the gravity model works well, with all variables of interest having expected signs.

Table 5.1 shows that lagged trade, economic size and distance are the most statistically significant factors that determine Ethiopia's trade pattern. The coefficient of lagged trade is positive and statistically significant at the 1% level, indicating an autoregressive nature of bilateral trade flows. Since the lagged variable has a considerable impact on the dependent variable, we suspect that dynamic specification of the gravity model overwhelms the static counterparts. Based on the two-step results, for instance, a one percent increase in trade level of the previous year boosts current trade by about 0.62 percent, ceteris paribus. Likewise, economic size (GDP) of trading pairs is found to have a positive significant effect on the pattern of trade. The concept behind demonstrates that Ethiopia's trade relationship is stronger with larger economies than smaller economies. In absolute terms, when economic size increases by one percent, other things remain unchanged, the flow of trade between a pair of countries grows by some 0.67 percent. The other basic variable in the trade model is distance. Treated as a proxy for trade costs, distance has an inverse and statistically significant impact on trade. For every one percent increase in the distance between a pair of countries, merchandise trade tends to fall by 0.51 percent, ceteris paribus.

Table 5.1: Regression results of the total trade equation.

Dependent Variable: Natural Logarithm of Total Trade				
	One-step results		**Two-step results**	
Regressors	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
ln (lag trade)	0.632^{*}	0.000	0.621^{*}	0.000
ln (GDP_i . GDP_j)	0.636^{*}	0.002	0.666^{*}	0.006
ln (POP_i . POP_j)	-0.327^{**}	0.028	-0.328^{**}	0.050
ln (PGD_{ij})	-0.354^{**}	0.017	-0.353^{**}	0.027
ln ($RDIST_{ij}$)	-0.480^{*}	0.002	-0.514^{*}	0.008
Constant	-7.630^{**}	0.024	-8.750^{**}	0.049
Hansen Test of Overid. Restrictions	Chi2 (25) = 33.17		Prob > Chi2 = 0.127	
Arellano-Bond Test for Autocorrelation	AR(1): Z = -2.52		Prob > Z = 0.012	
	AR(2): Z = 0.71		Prob > Z = 0.478	
No. of Observations	36 Countries x 15 years = 540 Observation			

Note: ** and ** represents significance at the 1% and 5% levels respectively.*

The population variable carries a negative sign with statistically significant effect on trade at the 5% level. Intuitively, it would mean that Ethiopia has the tendency to trade less with populous countries. An increase in population size of trading-pairs might be associated with an excess demand effect in Ethiopia and economies of scale effect in the partner country. Per capita GDP differential is also an important factor that determines the flow of trade. Its negative sign indicates that the Linder hypothesis of trade is true. Countries with lesser per capita income differential trades more than countries with higher differential. Other factors being equal, a one percent increase in per capita income differential leads bilateral trade to decrease by 0.35 percent.

The presence of dynamics in the flow of Ethiopia's trade, one important investigation of the study, appears to be consistent with previous findings in the literature (Harris and Mátyás, 1998; Bun and Klaassen, 2002; Benedictis and Vicarelli, 2005; Nguyen, 2010). Indeed, the result seems acceptable in the real world because a business relationship established with foreign traders in the current year provides a basis for Ethiopian traders to expand their activities in the subsequent year. Our findings related to income and distance variables are also in line with previous empirical studies. Among those studies of particular interest include Batra (2004), Ram and Prasad (2007), Rahman (2009) and Rahman and Ara (2010). In spite of the same sign, the population variable was found not significant in Rahman and Ara (2010).

Having discussed the pattern of total trade, we now proceed to deal with the pattern of exports alone. The estimation results obtained from the export equation are presented in table 5.2. Once again, the positive sign of lagged export indicates that the country's exports in the previous year have an encouraging effect on the current year's export performance. Though an impressive result, the persistence of exports as compared to Ethiopia's total trade looks smaller. Ceteris paribus, a one percent shock in exports of the current year causes exports of the next year to change by only 0.25 percent. Due to the fact that Ethiopian exports are behaved with supply response rigidities (Alemayehu et al, 2010), this relatively smaller dynamic effect seems logical.

Table 5.2: Regression results of the export trade equation.

Dependent Variable: Natural Logarithm of Exports				
	One-step results		**Two-step results**	
Regressors	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
ln (lag export)	0.247*	0.006	0.245*	0.010
ln $GDP_{Ethiopia}$	1.917*	0.000	1.987*	0.000
ln $GDP_{Partner}$	0.756*	0.000	0.735*	0.000
ln $POP_{Ethiopia}$	1.174	0.364	0.539	0.661
ln $POP_{Partner}$	-0.260**	0.013	-0.290**	0.033
ln $RDIST_{ij}$	-1.589*	0.000	-1.551*	0.000
Constant	-60.47*	0.001	-49.73*	0.005
Hansen Test of Overid. Restrictions	Chi2 (25) = 28.22		Prob > Chi2 = 0.298	
Arellano-Bond Test for Autocorrelation	AR(1): Z = -2.99 AR(2): Z = 0.95		Prob > Z = 0.003 Prob > Z = 0.343	
No. of Observations	36 countries x 14 years = 504 observation			

Note: ** and ** represents significance at the 1% and 5% levels respectively.*

Meanwhile, domestic income (supply side) and foreign income (demand side) are very significant statistically. With income elasticities 1.98 and 0.74 respectively, these variables indicate stronger effects. A one percent increase in the GDP of Ethiopia, holding others fixed, boosts exports more than proportionately. The distance variable is again statistically significant with anticipated sign. If the country's relative distance with its export destinations increases by one percent, the flow of exports decline by about 1.55 percent. Our findings related to income and distance elasticities are consistent with the findings of previous studies (Alemayehu et al, 2010; Yishak, 2009; Mulugeta, 2009; Hussein, 2008).

Domestic population has a positive sign in the export model. Nonetheless, its impact is not statistically significant even at the 10% level. Partner's population rather affects Ethiopian exports adversely. The impact is also statistically significant at the 5% level. For every one percent increase in the partner population, other things remain unchanged, Ethiopia's exports decline by 0.29 percent. The fact that partners with higher population have the capacity to produce and hence supply more products to the global market (economies of scale) could justify this outcome. If properly used, populations are productive capacities that may enable countries to have the tendency of exporting rather than importing from others. Once more, the negative and statistically significant coefficient of partner population is against the findings of Rahman and Ara (2010), but consistent with that of Simwaka's (2010). These contradictory investigations are not unusual in the literature, because the signs for population variables are not *a priori* predictable.

5.2. Ethiopia's Trade Potential

Once the gravity models are estimated, the coefficients obtained are used to predict Ethiopia's trade potential. For this particular section, equation (13) was extensively used. Specifically, the calculation of an in-sample trade potential was carried out based on the more efficient[14] two-step estimates. Thereafter, two indicators are used to analyze whether Ethiopia has untapped trade potential with each of the countries under consideration. The first indicator is the difference between potential and actual (Pot−Act) trade levels (Batra, 2004, Ram and Prasad, 2007; Rahman, 2009). A positive sign of this value implies that a country has unrealized trade potential with country **j**, otherwise it has exhausted the potential. The second

[14] See Cameron and Trivedi (2009) for more efficiency gains of the two-step results.

indicator works with the ratio of potential trade as predicted by the gravity model to the actual trade values between Ethiopia and the sample of partners (Pot/Act). If the ratio exceeds one, we say that the country has the possibility of trade expansion with respective partners (Batra, 2004; Rahman, 2009; Rahman and Ara, 2010).

Depending on the above indicators, Ethiopia's trading partners in our sample are grouped in to two—those with which potential for trade expansion is observed and those with which the potential has already been exhausted. Accordingly, table 5.3 details the list of partners with which Ethiopia has untapped trade potential at bilateral levels, while table 5.4 those countries with less potential for trade expansion.

The magnitude of Ethiopia's trade potential is found maximum with countries like Japan ($202.90 million), India ($143.85 million), Italy ($92.84 million), Pakistan ($87.97 million) and Switzerland ($51.81 million). Besides, Egypt ($49.71 million), Malaysia ($38.23 million) and Austria ($30.63 million) have shown considerable amount of potentials. The last column of table 5.3 reveals that Ethiopia can potentially attain about nine times more trade with Pakistan, three times more trade with Japan and Austria, around 2.5 times more trade with Malaysia and Kuwait as well as two times more trade with Switzerland, Egypt and Australia. Therefore, Ethiopia's attempt to expand actual trade with such countries is recommended. As far as regional distribution of trade potential is concerned, the Asian continent followed by Europe and Africa appears to be the dominant one.

Table 5.3: Countries with which Ethiopia has untapped trade potential (Year 2009).

R.No.	Partner Country	Potential Trade (USD Millions)	Actual Trade (USD Millions)	Potential Indicators	
				Pot-Act	Pot/Act
1	Japan	290.52	87.62	202.90	3.32
2	India	464.32	320.47	143.85	1.45
3	Italy	382.49	289.64	92.84	1.32
4	Pakistan	98.24	10.27	87.97	9.56
5	Switzerland	95.45	43.63	51.81	2.19
6	Egypt	98.98	49.27	49.71	2.01
7	Malaysia	60.91	22.68	38.23	2.69
8	Austria	45.7	15.07	30.63	3.03
9	Israel	66.6	45.62	20.98	1.46
10	Yemen	56.38	37.05	19.33	1.52
11	Romania	59.98	41.66	18.32	1.44
12	Greece	40.57	22.37	18.20	1.81
13	Sweden	41.41	23.8	17.61	1.74
14	Kenya	44.73	28.16	16.57	1.59
15	Canada	42.44	27.36	15.08	1.55
16	Spain	65.76	51.8	13.96	1.27
17	Australia	23.92	10.82	13.09	2.21
18	Denmark	30.49	19.17	11.32	1.59
19	Thailand	47.08	36.84	10.24	1.28
20	Kuwait	13.34	5.21	8.13	2.56
21	Finland	14.53	8.38	6.15	1.73
22	Singapore	17.03	11.89	5.15	1.43
23	Germany	345.64	340.87	4.77	1.01

Source: Actual trade for 2009 taken from IMF (2010) Database.

Looking at the second group of countries, on the other hand, we observe that Ethiopia has exceeded its trade potential with China, Saudi Arabia, Turkey, Netherlands, Belgium and other countries available in table 5.4. The existence of such overtraded countries implies that Ethiopia has effective trade relationships with these countries. Any additional effort to expand trade with such partners would then be extravagant. Nevertheless, the country is expected to maintain that trend for the future. Moreover, the world is so dynamic that opportunities may change in the long term.

Table 5.4: List of countries with which Ethiopia has exploited its trade potential (2009).

R.No.	Partner Country	Trade Potential (USD Millions)	Actual Trade (USD Millions)	Potential Indicators	
				Pot-Act	Pot/Act
1	Brazil	56.42	62.54	-6.12	0.9
2	United States	403.18	412.15	-8.96	0.98
3	Sudan	170.57	186.17	-15.59	0.92
4	Djibouti	24.42	42.18	-17.76	0.58
5	Russia	117.29	141.21	-23.92	0.83
6	South Korea	76.92	101.26	-24.34	0.76
7	France	150.39	179.03	-28.64	0.84
8	United Kingdom	133.3	172.52	-39.22	0.77
9	Belgium	81.89	134.65	-52.76	0.61
10	Netherlands	116.29	180.44	-64.15	0.64
11	Turkey	161.27	283.86	-122.59	0.57
12	Saudi Arabia	506.63	705.82	-199.18	0.72
13	China, Mainland	705.69	1572.8	-867.11	0.45

Source: Actual trade for 2009 taken from IMF (2010) Database.

5.3. Export Potential in Focus

In line with export led growth strategy of the country, having a separate topic for export potential would be worthwhile. Primarily, providing a special attention for exports can help balance the long-lived trade deficit. In the same way we did for trade potentials, export potentials are predicted with an in-sample strategy. Equation (14) is applied for the purpose. The 'difference' and 'ratio' indicators are then calculated to analyze the export potential of Ethiopia.

Of the total sample of countries, Switzerland ($22.57 million), Japan ($16.02 million), France ($14.70 million), Spain ($13.76 million) and Italy ($12.74 million) showed the highest potential for absorbing Ethiopian exports. Israel ($12.15 million), Greece ($11.22 million), Yemen ($10.75 million), Egypt ($10.08 million) and Kenya ($9.86 million) are also among countries to which Ethiopia has the possibility of expanding exports. In relative terms, if utmost efforts are devoted to promote exports, Ethiopia will possibly attain around 3.5 times more export earnings from countries like Spain, Kenya, Poland, Romania and Denmark. Over two times more exports are also expected to Thailand, Malaysia, Finland, Egypt, Japan and Switzerland. As a continent, Europe remained the largest potential destination of Ethiopian exports (see table 5.5 for details).

Table 5.5: Countries that showed potential as a destination for Ethiopian exports (2009).

R.No.	Partner Country	Potential Export (USD Millions)	Actual Export (USD Millions)	Potential Indicators	
				Pot-Act	Pot/Act
1	Switzerland	36.01	13.44	22.57	2.68
2	Japan	25.70	9.68	16.02	2.66
3	France	40.91	26.22	14.70	1.56
4	Spain	19.62	5.86	13.76	3.35
5	Italy	68.06	55.32	12.74	1.23
6	Israel	44.25	32.09	12.15	1.38
7	Greece	28.05	16.83	11.22	1.67
8	Yemen	38.48	27.73	10.75	1.39
9	Egypt	17.31	7.23	10.08	2.39
10	Kenya	13.24	3.38	9.86	3.92
11	Russia	13.96	8.40	5.56	1.66
12	Finland	9.22	3.87	5.35	2.38
13	Denmark	7.63	2.28	5.35	3.34
14	Romania	6.80	2.08	4.73	3.27
15	Poland	5.95	1.62	4.33	3.68
16	Sweden	11.36	8.28	3.07	1.37
17	Malaysia	3.50	1.38	2.12	2.54
18	Singapore	6.67	4.63	2.04	1.44
19	Hong Kong	4.81	2.78	2.03	1.73
20	Thailand	3.05	1.20	1.85	2.55
21	United Kingdom	38.03	37.50	0.53	1.01

Source: Actual exports for 2009 taken from IMF (2010) Database.

Based on table 5.6, Ethiopia has already exhausted its export potential to some other partners including China, United States, Germany, Netherlands, Belgium, Djibouti, Sudan and Saudi Arabia. The fact that the former five countries are large in economic size and the last three countries are closer to Ethiopia could justify the findings. Our export model showed that Ethiopia currently trades more with larger and (or) less distant economies. If so, the country would have performed effective trade with them leaving no space for extra potentials. A critical point that deserves mention here is that the country has to maintain such effective relationships; other excessive efforts to expand exports are rather wasteful.

Table 5.6: Countries with which Ethiopia has already exhausted its export potential (2009).

R.No.	Partner Country	Potential Export (USD Millions)	Actual Export (USD Millions)	Potential Indicators	
				Pot-Act	Pot/Act
1	Australia	5.95	6.15	-0.20	0.97
2	India	12.00	14.32	-2.32	0.84
3	Turkey	29.14	31.92	-2.78	0.91
4	Pakistan	5.00	8.22	-3.22	0.61
5	South Korea	7.12	13.45	-6.34	0.53
6	Canada	6.58	14.83	-8.24	0.44
7	Portugal	7.45	16.41	-8.96	0.45
8	Saudi Arabia	98.73	111.18	-12.45	0.89
9	Sudan	52.95	65.45	-12.49	0.81
10	Djibouti	20.02	42.15	-22.13	0.47
11	Belgium	23.16	60.17	-37.01	0.38
12	Netherlands	35.74	96.14	-60.40	0.37
13	United States	43.69	108.55	-64.85	0.40
14	Germany	77.08	146.70	-69.62	0.53
15	China, Mainland	19.59	194.98	-175.40	0.10

Source: Actual exports for 2009 taken from IMF (2010) Database.

6. CONCLUSION AND IMPLICATIONS

6.1. Conclusion

Ethiopia has an unimpressive performance in the global trading system. Less diversification of tradable items and partner countries are good reflections. Employing a gravity approach, our study has examined Ethiopia's trade potential with its major trade partners around the globe. We have estimated the basic trade and export trade models for the purpose. In search of more sensible results, some of the recent developments in the gravity model are accounted for. These include extending the gravity equation in to a panel data framework and take in to consideration the existence of dynamic effects. Estimation is performed with system GMM based on annual bilateral trade flows between Ethiopia and a sample of partners over the period 1995−2009. Accordingly, we found that the standard features of the gravity equation works well, having all traditional variables statistically significant with expected signs. Coefficients of these variables are of reasonable magnitudes.

We also obtained the strong evidence that the flow of trade between Ethiopia and major trade partners is autoregressive. Current trade has a positive and statistically significant effect on trade flows of the next time. As regards to magnitude of the dynamics, we conclude that transitory shocks to current trade persist for a long time, with an estimated persistence parameter of about 0.62. Meanwhile, a one percent positive shock in current exports leads to 0.25 percent increments of exports in the subsequent year. The existence of such hysteresis in trade, therefore, demonstrates that the application of simple (static) gravity models of trade is likely to produce inconsistent results.

Another notable result obtained from the dynamic specification is that estimated coefficients did not lead to more systematic difference between predicted and observed trade flows, since exaggerated differences between predicted and actual trade values (Egger, 2002) are indications of model misspecification. Such a bias is not a problem in our analysis of trade potentials. Following an in-sample estimation strategy, we investigated that Ethiopia's unexploited trade potential is to some extent concentrated with some Asian countries. Overall, among specific countries that showed the highest potential for trade expansion include Japan, India, Italy, Pakistan, Switzerland, Egypt and Malaysia.

From the export side, Europe remained the dominant potential destination for Ethiopia's exports. Of the total sample of countries, Switzerland, Japan, France, Spain, Italy, Israel and Greece showed relatively the greatest potential for taking-in Ethiopian products. Estimation results further indicate that the country has already realized both export and basic trade potentials with some larger economies such as the United States, China, South Korea, Netherlands and Belgium. The fact that these countries are currently effective partners might have caused potentials to be inexistent. Irrespective of the magnitude that individual countries have shown, we can generally conclude that considerable amount of Ethiopia's trade is not realized. The levels of potentials obtained primarily indicate partners that deserve the foremost priority to trade with.

6.2. Implications

The overall implication of the paper lies on the type of measures that should be applied to promote Ethiopia's trade. The policy implications associated with the finding of untapped trade potential ranges from the need for country-specific export promotion and broader bilateral integration efforts to the need to anticipate major distributional changes caused by the expansion of trade flows in the near future (Batra, 2004). If bilateral trade is already exploited, on the other hand, the implication seems that trade has reached its potential level and no social cost can be expected from future integration. With such a stand point, the following specific measures are suggested for Ethiopia:

At first glance, the study suggests that diversification of exports to actualize all unexhausted trade potentials looks an important step. We need to promote both horizontal and vertical diversification of exports so as to reduce the narrow export dependency. Horizontal diversification indicates to increment of export varieties based on currently dominant agricultural sector, while vertical diversification puts down a basis for sectoral chain—export varieties are expected to diversify from a range of agricultural commodities to industrial products. Along with that, the country can intensify bilateral trade negotiations with those countries having bilateral trade potentials. Improvement of infrastructure that leads to reduction of transaction costs is also expected to be the necessary step to realize Ethiopia's trade potential. In this regard, port diversification really matters!

Secondly, Ethiopia needs to maintain effective trade relations. The fact that potentials are exhausted with some partners does not mean that trade is unnecessary. It would rather imply that priority attempts are not expected to further intensify trade relations with such overtraded partners. Looking out of the box, the country should not as well overlook diversification of export destinations beyond the sample of countries in our study. Countries having lower levels of trade partnerships at the time under consideration are perhaps enriched with higher potentials remained yet unrealized. Therefore, bilateral trade agreements that improve current status of the external sector are proposed.

Finally, we provide some propositions that we think are relevant for future empirical studies. Our comments concentrate on specifications of the gravity model and the sample of countries required for estimation of trade potentials. Although the transition from a static to a dynamic panel gravity model is important, the dynamic gravity approach we have employed is not perfect. The model can be improved by considering country heterogeneity, allowing for correlations between country-pairs and scrutinizing the nonstationarity and cointegration characteristics of panels. Thereafter, we suggest estimation of Ethiopia's trade potential that incorporates the maximum possible number of trade partners, and investigation of mechanisms through which such potentials will be exhausted. The number of sample countries can increase by taking trade values of the most recent few years. These issues are left for future investigations.

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APPENDICES

Appendix A: List of Partners Considered in the Study

Export Trade Partners				Total Trade Partners			
1	Australia	19	Netherlands	1	Australia	19	Kuwait
2	Belgium	20	Pakistan	2	Austria	20	Malaysia
3	Canada	21	Poland	3	Belgium	21	Netherlands
4	China	22	Portugal	4	Brazil	22	Pakistan
5	Denmark	23	Romania	5	Canada	23	Romania
6	Djibouti	24	Russia	6	China, Mainland	24	Russia
7	Egypt	25	Saudi Arabia	7	Denmark	25	Saudi Arabia
8	Finland	26	Singapore	8	Djibouti	26	Singapore
9	France	27	South Korea	9	Egypt	27	South Korea
10	Germany	28	Spain	10	Finland	28	Spain
11	Greece	29	Sudan	11	France	29	Sudan
12	Hong Kong	30	Sweden	12	Germany	30	Sweden
13	India	31	Switzerland	13	Greece	31	Switzerland
14	Israel	32	Thailand	14	India	32	Thailand
15	Italy	33	Turkey	15	Israel	33	Turkey
16	Japan	34	United Kingdom	16	Italy	34	United Kingdom
17	Kenya	35	United States	17	Japan	35	United States
18	Malaysia	36	Yemen	18	Kenya	36	Yemen

Appendix B: Summary Statistics of Variables

Table B-1: Summary of the Trade Model Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
lntrdijt	540	17.23503	1.531535	12.57972	21.17612
lagtrade	540	17.11493	1.574537	11.79056	20.93456
lngdpijt	540	49.45201	1.979401	42.86294	54.47747
lnpopijt	540	35.2834	1.571052	31.12905	39.24409
lnpgdijt	540	9.002738	1.654417	4.744869	11.08776
lnrdstijt	540	5.571615	.8683272	3.107241	7.66701
Groups	540	18.5	10.39793	1	36
Years	540	2002	4.3245	1995	2009

Source: Author's Calculation.

Table B-2: Summary of the Export Model Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
lnexpijt	540	15.37384	1.945063	8.35608	19.08842
lagexport	504	15.29581	1.955917	8.35608	18.8985
lngdpjt	540	26.30275	1.815208	20.01805	30.2961
lngdpit	540	23.1426	.4578835	22.77624	24.19892
lnpopjt	540	17.22642	1.493884	13.27078	21.012
lnpopit	540	18.04876	.1146483	17.85826	18.23208
lnrdstijt	540	5.593211	.860127	3.107241	7.66701
Groups	540	18.5	10.39793	1	36
Years	540	2002	4.3245	1995	2009

Source: Author's Calculation.

Appendix C: Simple Correlation Matrix of Variables

Table C-1: Correlation Matrix of Trade Model Variables

Variables	lntrdijt	lagtrade	lnxgdpijt	lnxpopijt	lnpgdijt	lnrdstijt
lntrdijt	1.0000					
lagtrade	0.8823	1.0000				
lngdpijt	0.4663	0.4540	1.0000			
lnpopijt	0.3528	0.3079	0.5879	1.0000		
lnpgdijt	0.1595	0.1815	0.5890	-0.2792	1.0000	
lnrdstijt	0.2143	0.2167	0.7386	0.3730	0.5684	1.0000

Source: Own Calculation.

Table C-2: Correlation Matrix of Export Model Variables

Variables	lnexpijt	lagxport	lngdpjt	lngdpit	lnpopjt	lnpopit	lnrdstijt
lnexpijt	1.0000						
lagxport	0.7640	1.0000					
lngdpjt	0.2105	0.2122	1.0000				
lngdpit	0.3293	0.3221	0.1654	1.0000			
lnpopjt	0.0450	0.0451	0.5837	0.0236	1.0000		
lnpopit	0.3205	0.2984	0.1649	0.7396	0.0279	1.0000	
lnrdstijt	0.0560	0.0597	0.7436	0.5398	0.2723	0.4532	1.0000

Source: Own Computation.

Appendix D: System GMM Estimation Results

Table D-1: Estimation Results of the Trade Model

Dynamic panel-data estimation, one-step system GMM

```
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       540
Time variable : year                            Number of groups   =        36
Number of instruments = 31                      Obs per group: min =        15
Wald chi2(3)  =     11.47                                      avg =     15.00
Prob > chi2   =     0.0090                                     max =        15
------------------------------------------------------------------------------
             |               Robust
    lntrdijt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lagtrade |   .6322942   .0773079     8.18   0.000     .4807735    .7838149
    lngdpijt |   .6358791   .2067275     3.08   0.002     .2307007    1.041057
    lnpopijt |  -.3270135   .1489956    -2.19   0.028    -.6190395   -.0349874
    lnpgdijt |  -.3543552   .1484847    -2.39   0.017    -.6453799   -.0633305
   lnrdstijt |  -.4799408    .154605    -3.10   0.002     -.782961   -.1769206
       _cons |  -7.629777   3.383589    -2.25   0.024    -14.26149   -.9980655
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lnxgdpijt lnxpopijt lnrdstijt lnpgdijt)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.lntrdijt
Instruments for levels equation
  Standard
    _cons
    lnxgdpijt lnxpopijt lnrdstijt lnpgdijt
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lntrdijt
```

Dynamic panel-data estimation, two-step system GMM

```
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       540
Time variable : year                            Number of groups   =        36
Number of instruments = 31                      Obs per group: min =        15
Wald chi2(3)  =      8.09                                      avg =     15.00
Prob > chi2   =     0.0044                                     max =        15
------------------------------------------------------------------------------
             |              Corrected
    lntrdijt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lagtrade |   .6210601   .0835519     7.43   0.000     .4573015    .7848188
    lngdpijt |    .666451   .2432041     2.74   0.006     .1897797    1.143122
    lnpopijt |  -.3279275   .1670652    -1.96   0.050    -.6553694   -.0004857
    lnpgdijt |  -.3533093   .1597109    -2.21   0.027    -.6663369   -.0402818
   lnrdstijt |  -.5138395   .1952221    -2.63   0.008    -.8964678   -.1312113
       _cons |  -8.750211    4.74145    -1.85   0.049    -18.04328    .5428601
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lnxgdpijt lnxpopijt lnrdstijt lnpgdijt)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.lntrdijt
```

```
Instruments for levels equation
  Standard
    _cons
    lnxgdpijt lnxpopijt lnrdstijt lnpgdijt
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lntrdijt
```

Table D-2: Estimation Results of the Export Model

Dynamic panel-data estimation, one-step system GMM

```
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       504
Time variable : year                            Number of groups   =        36
Number of instruments = 32                      Obs per group: min =        14
Wald chi2(6)  =    325.46                                      avg =     14.00
Prob > chi2   =     0.000                                      max =        14
------------------------------------------------------------------------------
             |               Robust
    lnexpijt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   lagexport |   .2472387   .0895978     2.76   0.006     .0716303    .4228472
     lngdpjt |   .7559395   .1460614     5.18   0.000     .4696644    1.042215
     lngdpit |   1.917209   .3905117     4.91   0.000     1.151821    2.682598
     lnpopjt |  -.2586741   .1042762    -2.48   0.013    -.4630518   -.0542964
     lnpopit |   1.173859   1.293911     0.91   0.364     -1.36216    3.709878
   lnrdstijt |  -1.589463   .2524683    -6.30   0.000    -2.084291   -1.094634
       _cons |  -60.47653   17.70685    -3.42   0.001    -95.18131   -25.77175
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lngdpjt lngdpit lnpopjt lnpopit lnrdstijt)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.lnexpijt
Instruments for levels equation
  Standard
    _cons
    lngdpjt lngdpit lnpopjt lnpopit lnrdstijt
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lnexpijt
```

Dynamic panel-data estimation, two-step system GMM

```
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       504
Time variable : year                            Number of groups   =        36
Number of instruments = 32                      Obs per group: min =        14
Wald chi2(6)  =    250.81                                      avg =     14.00
Prob > chi2   =     0.000                                      max =        14
------------------------------------------------------------------------------
             |              Corrected
    lnexpijt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   lagexport |   .2453079    .095302     2.57   0.010     .0585195    .4320964
     lngdpjt |   .7352828   .1376519     5.34   0.000     .4654901    1.005076
     lngdpit |   1.987849   .4071925     4.88   0.000     1.189766    2.785932
     lnpopjt |   -.288601      .1353    -2.13   0.033    -.5537841   -.0234179
     lnpopit |   .5384478   1.229676     0.44   0.661    -1.871673    2.948569
   lnrdstijt |  -1.551131   .2901929    -5.35   0.000    -2.119899   -.9823636
       _cons |  -49.71611   17.69628    -2.81   0.005    -84.40018   -15.03204
------------------------------------------------------------------------------
```

```
Instruments for first differences equation
  Standard
    D.(lngdpjt lngdpit lnpopjt lnpopit lnrdstijt)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.lnexpijt
Instruments for levels equation
  Standard
    _cons
    lngdpjt lngdpit lnpopjt lnpopit lnrdstijt
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lnexpijt
```

Appendix E: Specification Tests

Annex E-1: Tests for Serial Correlation

Table E-1.1: Serial Correlation in the Trade Model

Arellano-Bond Test for Zero Autocorrelation in First-Differenced Errors

```
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.52  Pr > z =  0.012
Arellano-Bond test for AR(2) in first differences: z =   0.71  Pr > z =  0.478
Arellano-Bond test for AR(3) in first differences: z =  -0.35  Pr > z =  0.723
```

Decision: We cannot reject the null hypothesis at higher orders (>1st order).

```
------------------------------------------------------------------------------
    Ho: No Autocorrelation.
```

Table E-1.2: Serial Correlation in the Export Model

Arellano-Bond Test for Zero Autocorrelation in First Differenced Errors

```
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.99  Pr > z =  0.003
Arellano-Bond test for AR(2) in first differences: z =   0.95  Pr > z =  0.343
Arellano-Bond test for AR(3) in first differences: z =   0.26  Pr > z =  0.793
```

Decision: The null hypothesis cannot be rejected at orders higher than one.

```
------------------------------------------------------------------------------
    Ho: No Autocorrelation
```

Annex E-2: Tests of Overidentifying Restrictions

Table E-2.1: Overidentifying Restrictions—Trade Model

Sargan/Hansen Test of Overidentifying Restrictions

```
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(25)   = 113.49  Prob > chi2 =  0.001
  (Not robust, but not weakened by many instruments: One-step result.)
```

Decision: Test rejects the null hypothesis.

```
Sargan test of overid. restrictions: chi2(25)   = 31.415  Prob > chi2 =  0.176
  (Not robust, but not weakened by many instruments: Two-step result.)
```

Decision: Test fails to reject the null hypothesis.

Overall Sargan Test Decision: Inconclusive!

```
------------------------------------------------------------------------------
```

```
Hansen test of overid. restrictions: chi2(25)   =  33.17  Prob > chi2 =  0.127
  (Robust, but can be weakened by many instruments.)

   Decision: We fail to reject the null hypothesis, meaning that our moment
             conditions (instruments) are valid.
------------------------------------------------------------------------------
    Ho: Overidentifying Restrictions are Valid.
```

Table E-2.2: Overidentifying Restrictions—Export Model

```
Sargan/Hansen Tests of Overidentifying Restrictions
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(25)   =  85.43  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments: One-step result.)
   Decision: We reject the null hypothesis.

Sargan test of overid. restrictions: chi2(25)   =  28.28  Prob > chi2 =  0.248
  (Not robust, but not weakened by many instruments: Two-step result.)
   Decision: Test fails to reject the null hypothesis.
   Overall Sargan Test Decision: Inconclusive!
------------------------------------------------------------------------------
Hansen test of overid. restrictions: chi2(25)   =  28.22  Prob > chi2 =  0.298
  (Robust, but can be weakened by many instruments.)

Decision: The null hypothesis is not rejected. Therefore, overidentifying
          restrictions (instruments) are valid.
------------------------------------------------------------------------------
  Ho: Overidentifying Restrictions are Valid.
```

Annex E-3: Tests for Heteroskedasticity

Breusch-Pagan Test for Heteroskedasticity

Test Statistic (Trade Model)	Critical Values 10%	5%	1%	Test Statistic (Export Model)	Critical Values 10%	5%	1%
500.724	9.24	11.07	15.09	450.497	10.64	12.59	16.81

Decision: We reject the null hypothesis at all significance levels, implying that variances are heteroskedastic in both models.

Ho: Constant Variance

Source: Author's Own Computation.

Thanks for Your Thorough Reading!