

2011

Exchange rate volatility and bilateral agricultural trade flows: the case of the United States and OECD countries

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EXCHANGE RATE VOLATILITY AND BILATERAL AGRICULTURAL TRADE FLOWS: THE CASE OF THE UNITED STATES AND OECD COUNTRIES

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Department of Agricultural Economics
and Agribusiness

by

Kashi Ram Kafle
B.S., Tribhuvan University, 2008
December 2011

ACKNOWLEDGEMENTS

Many people think graduation is just the successful completion of the program of study toward a designated degree. For me, it is the beginning of my professional career and a step toward an accomplishment of career goal. Nobody knows what plans the future may hold for them but everybody knows how they got to the present. Simply put, there are many people to whom I am thankful. I would not have achieved this success without their help and suggestions.

To begin with, I am grateful to Dr. Lynn Kennedy who guided me not only in developing this thesis but throughout my entire graduate study. This research would not have been completed without his supervision and close guidance.

Moreover, I would like to thank the other members of my graduate advisory committee, Dr. Jeffrey Gillespie and Dr. John Westra for their assistance and suggestions throughout the research and thesis writing.

I would also like to thank Dr. Carter Hill of the Department of Economics, Dr. Hector Zapata, Dr. Krishna Paudel, Dr. Young Jae Lee, and Mr. Brian Hilbun of the Department of Agricultural Economics and Agribusiness for their helpful comments in data analysis. Furthermore, my sincere thank goes to Dr. Gail Cramer, the Department Head of Agricultural Economics and Agribusiness at Louisiana State University, for his appreciation and encouragement throughout my graduate study.

I am grateful to some wonderful people, fellows in the Department, all my Nepalese friends at LSU, the Nepalese Student Association, the Nepali community of Baton Rouge, and the host family, Gere and Joan Covert who made my stay in this place memorable and provided another home away from a home. Particularly, I am thankful to, Dr. Mukti Ghimire, Prashanna Bhattarai, Narayan Nyaupane, Basu Bhandarai, Krishna Paudel, Rajan Parajuli, Shyam Rasaily, Arun

Adhikari, Mahesh Pandit and all my other friends who were around me both in the ups and the downs during my stay at Baton Rouge. My special thanks go to Sumi Bhandari for her support and inspiration all the time.

Last but not the least; I would like to thank my brother Madhav Kafle for his love and encouragement. I would not have been at this place and position without his support. I am always indebted to my parents, Jiva Nath Kafle and Buddi Maya Kafle, brothers, Surya Kafle and Bishnu Kafle, and sister-in law Indira Pathak for their love and support throughout.

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ABSTRACT

The abandonment of fixed exchange rate systems has caused exchange rate movements to become a major concern for traders, policy makers and researchers. During the previous four decades of floating exchange rates, numerous studies have been conducted to determine whether exchange rate volatility affected international trade flows. Researchers have not yet reached a general consensus as to the magnitude and direction of the impact of exchange rate volatility on trade flows.

This study documents the effect of exchange rate volatility and real exchange rates on bilateral agricultural exports, imports and total trade flows between the United States and OECD countries. The effect of exchange rate volatility is estimated both separately from and in combination with the real exchange rate. In addition, implementation of Free Trade Agreements (FTAs) and use of the Euro as a national currency (Euro) are included as dummy variables and their effect on trade flows is determined.

This study uses panel data, which contains 28 cross-sections and 1148 observations, for bilateral trade flows between the United States and OECD countries from 1970 to 2010. Data analysis is performed as guided by the gravity model which assumes trade flows to be directly proportional to economic mass and inversely proportional to geographical distance. Based on the gravity model, the ordinary least squares procedure is applied as the fixed effect one-way procedure for panel data.

Effects of exchange rate volatility and the real exchange rate on agricultural, non-agricultural and total exports, imports and trade (exports + imports) flows were found to be statistically significant and negative. Although we were able to replicate the reportedly established notion that exchange rate volatility has an adverse effect on international trade flows, the negative effect

that the real exchange rate has on trade flows is a novel finding and bears further investigation. It is found that exchange rate volatility has a greater impact on the agricultural sector, while the real exchange rate has a greater impact on the non-agricultural sector. Effects of FTAs and the Euro are always positive, with FTAs having a greater impact on the agricultural sector and the Euro on the non-agricultural sector.

CHAPTER 1

INTRODUCTION

1.1. Background Information

The issue of factors affecting international trade flows is one of the most debated issues in both the theoretical and empirical literature of both economics and applied economics. While going over the literature of international trade flows and the exchange rate effect, it can be found that a majority of the studies have been conducted over the previous four decades. Real world scenarios have also been daily changing just like the number and extent of the studies in this discipline. Some of the changes have worsened the exchange rate fluctuation whereas some of them have improved it. Specifically, international trade liberalization along with the huge increase in cross-border financial transactions has actually increased exchange rate volatility. For instance, the currency crisis in the developing market economies is a solid example of increasing exchange rate volatility. However, on the other hand, several other changes have occurred over the previous years that have also served to reduce the unpredictability in exchange rates. For example, the rapid spreading of credit and hedging instruments in financial markets, proliferation of multinational firms, protection of agricultural industries, and the currency stabilization effort of the central banks and monetary authorities may have reduced the exchange rate fluctuations to a great extent.

With these opposing effects of several economic and fiscal policy changes on exchange rates, it is not easy to identify what exactly the net effect would be without conducting a comprehensive study. Although there is no theoretical linkage between exchange rate volatility and international trade flows, several other factors that affect exchange rates also affect trade flows either directly or indirectly. However, there exists an ambiguity as to whether the exchange

rate affects trade flows and thus it is for this reason we deem that this requires the issue to be analyzed empirically.

When the international exchange rate system switched over to a floating regime, several speculations were made about the new system of exchange rates. Based on what the literature has argued and agreed upon, it is natural to assume the following tragedy as a consequence of volatile exchange rates. Traders and businessmen could have worried about the unpredictability of then future exchange rates which might have made international trade a risky proposition. Those traders who were risk-averse could have either left the business or cut off their production and trading activities, at least for a short period of time. On the other hand, some other traders could have adjusted production costs and techniques such as downsizing their factories and employees. All in all, it could have appeared to the traders and researchers that exchange rate volatility had negative impacts on both domestic and international trade flows.

Since the 1970s, when the system of fixed exchange rates (Bretton Wood System) was abandoned, economists have been interested in exchange rate volatility and its effect on trade flows. Moreover, empirical evidence suggests that exchange rate markets have become more vulnerable and have had a negative effect on the level of exports (Cushman, 1988 and Thursby and Thursby, 1987). However, some researchers found positive trade flow effects stemming from uncertainty in the exchange rate (Klein, 1990 and Jozsef, 2011). Exchange rate volatility can have a negative effect on international trade flows, either directly through uncertainty and adjustment costs or indirectly through its effect on the allocation of resources and government policies. The volatile nature of exchange rates has always led risk-averse traders to reduce their trading activities which ultimately reduce the trade flows.

This idea is further substantiated by the simultaneous decrease in the U.S. agricultural trade surplus that has occurred with the recent decline in the value of the U.S. dollar (Baek and Koo, 2009). However, it is observed that results from the previous studies are ambiguous. For example, Dell’Ariccia (1999) found a negative effect for exchange rate volatility on international trade flows after controlling for simultaneity bias from the endogenous behavior of monetary authorities. Similarly, Kandilov (2008) found that exchange rate volatility had a negative impact on trade flows and the impact was larger in agricultural trade as compared to other sectors. Furthermore, he found a larger impact of exchange rate volatility on exports from developing countries than on exports from developed countries. Similarly, other researchers (e.g. Pick, 1990; Cho, Sheldon and McCorriston, 2002; Wang and Barrett, 2007; and Chit et al., 2010) found that exchange rate volatility has had a negative impact on trade flows. On the other hand, some researchers also found a positive impact on trade flows stemming from exchange rate volatility (Klein, 1990; Pick, 1990; Broll and Eckwert, 1999 and Jozsef, 2011).

The debate over the effect of exchange rate volatility on international trade flows has another perspective as well. Carter and Pick (1989) found that other market factors, rather than changes in the exchange rate, have had the primary impact on U.S. agricultural trade flows, while Doroodian et al. (1999) suggested significant effects of fluctuations in the exchange rate as the primary determinant, as compared to other factors, on U.S. agricultural trade flows.

Schuh (1974) originally raised the issue of the exchange rate and its effects on agricultural trade flows. His effort was followed by several other studies where the effect of the nominal exchange rate and the real exchange rate were quantified. Later in the 1990s, a study of the effect of exchange rate volatility on agricultural trade was initially begun (Pick, 1990). Since then,

most studies in agricultural trade have concentrated on exchange rate fluctuations and the impact on agricultural exports and or agricultural commodity prices (Kristinek and Anderson, 2002).

Over the past couple of years, economists have recognized the influence and importance of the exchange rate on international agricultural trade. Agricultural producers have been both more sensitive to and interested in the role that exchange rates have in determining commodity prices. The role of the exchange rate in valuing farm production and equipment has become very important because of the rapidly increasing global economy and constant change that has been occurring in both international trade law and technology. However, for many years, the role of exchange rates as an integral part of agricultural economics was overlooked. Economists have examined the influence of exchange rate movement on agricultural trade but disagreement persists as to the magnitude of the effect (ERS, 1984).

Looking back to the literature of international trade, studies can be classified into two groups based on the theoretical models and the types of data used. Most of the previous studies have used aggregate trade data whereas more recent studies have used bilateral trade data. The use of bilateral trade data is assumed to avoid aggregation bias, an error associated with aggregate trade data (Bahamani-Oskooe M. and G.G. Goswami, 2004). Moreover, most of the studies that employed both aggregate and bilateral trade data used a form of the standard trade balance model developed by Rose and Yellen in 1989. The standard trade balance is defined as the different ratio of value between exports and imports. By regressing both exports and imports together with exchange rate and income, this model did not specify which variable was impacting the trade balance and by how much. So it was realized that the effects of exchange rate and other factors (such as income) need to be studied separately.

As a consequence of the latest economic downturn, valuation of the U.S. dollar (USD) is experiencing severe fluctuation and it appears to some as a risky investment. The risk associated with the dollar and how it is affected by fluctuations in the exchange rate ultimately affects both the export and import industries of the United States. On the other hand, exchange rates between the U.S. dollar and major foreign currencies have always fluctuated with a high degree of unpredictability. For example, bilateral exchange rate volatility between the United States and four major OECD¹ countries are presented below. Several other graphs of exchange rate volatility and the real exchange rate are presented in Appendix II. The unpredictable nature of the exchange rate worsens traders' ability to make early contracts for future trade activities reducing overall trade volume. This anomaly is more prominent in the agricultural sector as agricultural produce is perishable and cannot be stored for longer periods of time.

Figure 1.1 depicts exchange rate volatility between the United States and Canada over the previous 41 years. Similarly, figure 1.2, figure 1.3 and figure 1.4 portray exchange rate volatility between the United States and Germany, Japan, and the United Kingdom, respectively. We can see that no country has had a stable exchange rate with the United States over the past 41 years. The exchange rate between the USD and Canadian dollar looks to be the worst case having ever increasing volatility. The USD – British pound sterling (BPS) exchange market shows a trend of decreasing volatility from 1991 to 2003. However, there is a continuous increase in USD – BPS volatility after 2003 (Figure 1.4).

1. OECD stands for Organization for Economic Co-operation and Development. The detailed list of member countries is presented in Table A1.2 in Appendix-I.

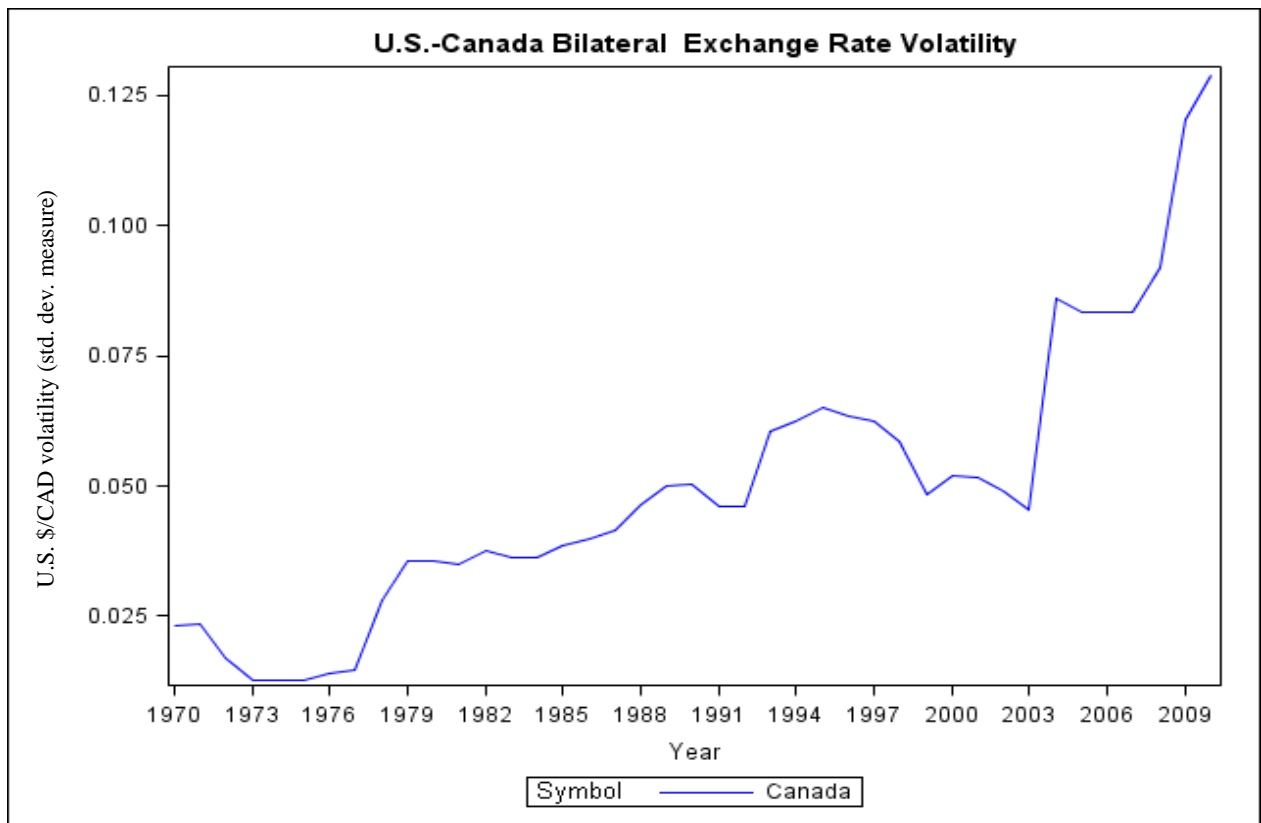


Figure 1.1 U.S.-Canada exchange rate volatility (U.S.\$/CAD): standard deviation measure

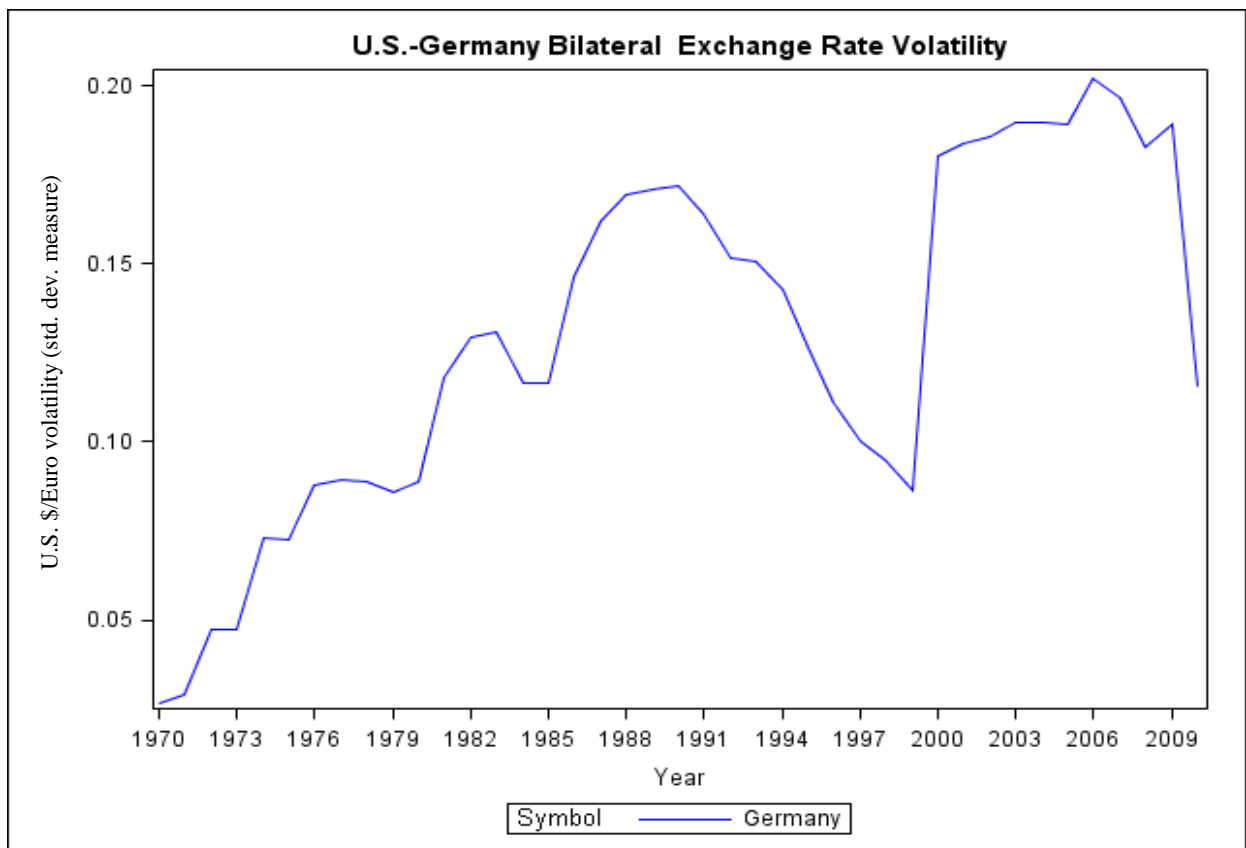


Figure 1.2 U.S.-Germany exchange rate volatility (USD/Euro): standard deviation measure.

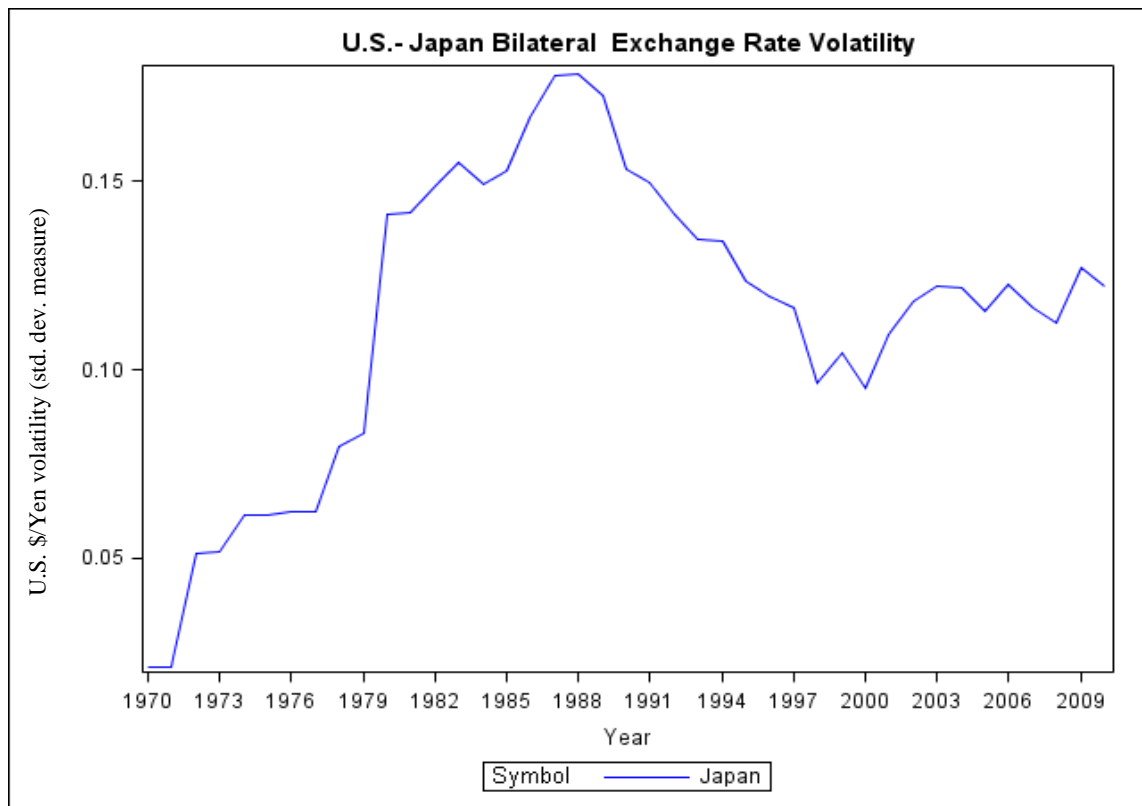


Figure 1.3 U.S.-Japan exchange rate volatility (U.S.\$/Yen): standard deviation measure

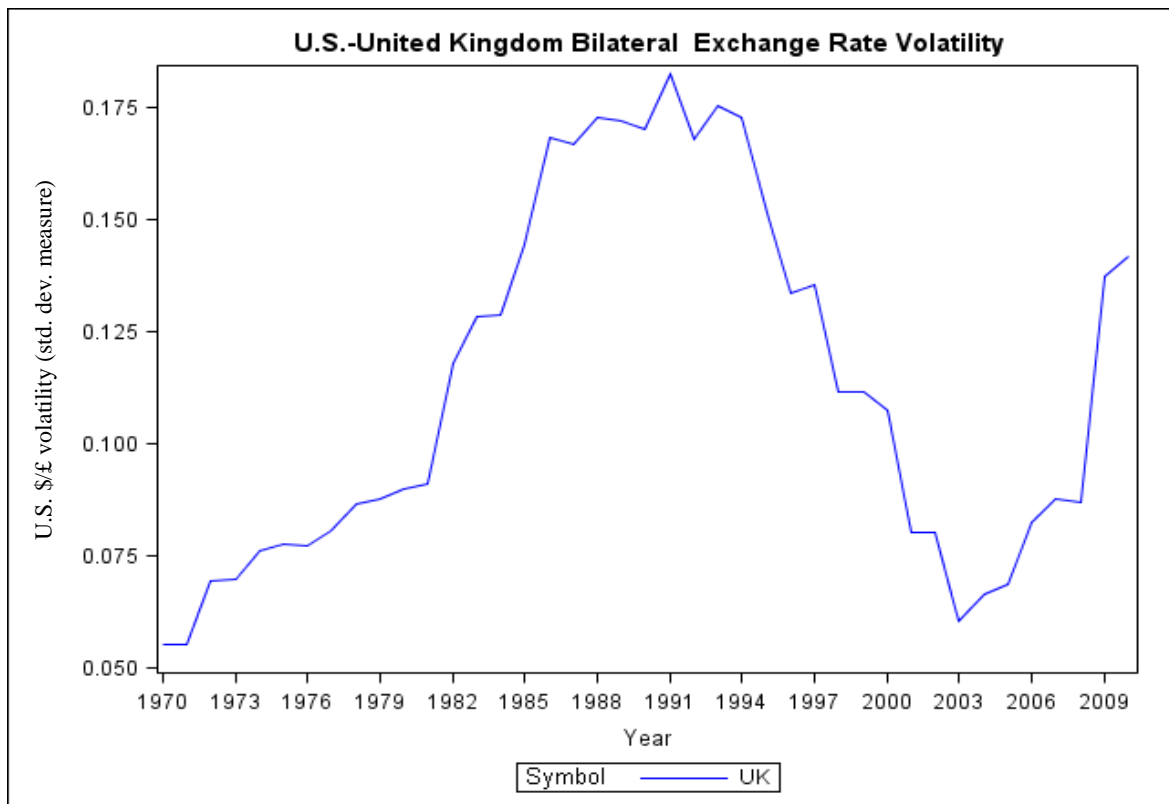


Figure 1.4 U.S.-UK exchange rate volatility (U.S.\$/£): standard deviation measure

The United States is a large market when viewed either as an export destination or as an import source. It is the largest importer of goods and services and merchandise trade. The majority of the trade partners of the United States are members of OECD countries, save China and India for now. There is a long-standing history of trade between the United States and Canada, Mexico, European countries and the OECD countries. In 2010, 64.6 % of total U.S. exports were exported to OECD² countries, Canada being the topmost export destination followed by Mexico, Japan, United Kingdom, and Germany (Table 1.1). If a country having more than 1% of export share is considered as a ‘major’ export destination, then the OECD consists of at least 12 major export destination of the United States in 2010 (Table 1.1).

Table 1.1 U.S. Export destinations and share of total export by OECD countries in 2010.

S.N.	Partner	% of Total exports	S.N.	Partner	% of Total exports
1	Canada	19.416	15	Turkey	0.822
2	Mexico	12.777	16	Spain	0.794
3	Japan	4.736	17	Ireland	0.569
4	United Kingdom	3.788	18	Sweden	0.367
5	Germany	3.758	19	Norway	0.243
6	Korea	3.039	20	Poland	0.233
7	Netherlands	2.738	21	New Zealand	0.221
8	France	2.173	22	Austria	0.181
9	Belgium	1.999	23	Finland	0.171
10	Australia	1.661	24	Denmark	0.166
11	Switzerland	1.619	25	Hungary	0.101
12	Italy	1.110	26	Greece	0.087
13	Israel	0.882	27	Portugal	0.083
14	Chile	0.851	28	Iceland	0.049
OECD					64.632

Source: This table is constructed using trade data that is used in this study.

In the import sector, the story is almost the same as it is in the export sector. In 2010, 56.25% of total imports into the United States were imported from OECD countries (Table 1.2). Canada was the largest import market followed by Mexico, Japan, Germany, United Kingdom and

2. In this particular case, OECD includes only 28 out of 34 countries. Those 28 countries are partner countries as defined in Appendix - I. Czech Republic, Estonia, Slovakia, Slovenia, and Luxemburg are not included given lack of data availability. However, Belgium incorporates Luxemburg as well.

Korea. Distribution of import share is similar to that of export share. Every one of at least 12 OECD countries has a share of at least 1% of total U.S. imports (Table 1.2).

Table 1.2 Import sources of the United States and share of total imports by OECD countries in 2010.

S.N.	Partner	% of Total Imports	S.N.	Partner	% of Total Imports
1	Canada	14.598	15	Spain	0.464
2	Mexico	12.122	16	Australia	0.458
3	Japan	6.458	17	Chile	0.390
4	Germany	4.410	18	Norway	0.376
5	United Kingdom	2.646	19	Austria	0.361
6	Korea	2.645	20	Denmark	0.321
7	France	2.048	21	Turkey	0.231
8	Ireland	1.779	22	Finland	0.211
9	Italy	1.538	23	Poland	0.162
10	Israel	1.109	24	New Zealand	0.154
11	Netherlands	1.023	25	Hungary	0.133
12	Switzerland	1.019	26	Portugal	0.116
13	Belgium	0.830	27	Greece	0.044
14	Sweden	0.568	28	Iceland	0.040
OECD					56.253

Source: This table is constructed using trade data that is used in this study.

The United States is also a large agricultural exporter and most of the U.S. farm products that are exported are exported primarily to OECD countries. The top 15 US agricultural export markets are OECD members. Canada is the largest export destination for the U.S. agricultural products followed by Mexico, Japan and European Union. For example, in 2010, Canada, which imported 15.25% of U.S. agricultural exports, was the largest agricultural export destination followed by China (13.87%), Mexico (12.82%), Japan (10.33%) and the EU (7.83%) respectively (USDA, ERS). Figure 1.5 illustrates the pattern of the U.S. – OECD agricultural trade (export + import) flows over the previous 41 years.

The overall trend of agricultural trade flows between the United States and OECD countries over the past four decades is an increasing trend (Figure 1.5). Although minor fluctuations are observed, there is a consistent increase in agricultural trade flows from 1984 to the present. This

constant growth in agricultural trade between the United States and OECD countries could be attributed to FTAs like CUSTA and NAFTA. It is important to note the fact that the topmost U.S. agricultural trade partners are also the major overall trading partners (export destinations and the import markets) of the United States. This fact further backs up why the study of the U.S. bilateral trade flows with relation to OECD countries is important for the U.S. trade policy.



Fig 1.5 Agricultural trade flows between the United States and OECD countries (1970-2010).

1.2.Problem Statement

The new era of flexible exchange rates began when the United States abandoned the Bretton Woods system of fixed exchange rates in 1973. As a consequence, the overall world macroeconomic foundation, with regards to fiscal and monetary policy, was altered affecting trading interdependence between participating countries. All the economic turmoil over the past 30 years as regards to international trade in the United States was either directly or indirectly related to devaluation or appreciation of the U.S. dollar with respect to major foreign currencies.

This volatile nature of exchange rates has become a major problem in estimating the scope and nature of trading behaviors and trade volumes extant between exporting and importing countries (Orden, 2002). The unpredictable nature of the exchange rate always leads risk-averse traders to reduce their trading activities with foreign countries and it is these traders' collective aversion which ultimately impacts the total trade of the nation in reducing exports and import volumes. As a result of reduced trading activities, the trade deficit becomes increasingly negative and nominal prices for agricultural and other primary commodities increase as a consequence of a flexible dollar.

Usually, the highly unstable nature of exchange rates forces farmers to implement various measures that avoid possible loss such as costly adjustment of production factors as they face increased risk and uncertainty. However, implementation of these measures may lead to reduced levels of farm output, leaving a negative impact of exchange rate volatility to act upon export volumes. On the other hand, the effect that the exchange rate has on export volumes is directly related with overvaluation and/or undervaluation of a currency with respect to a foreign currency. For example, overvaluation of a currency, such as the U.S. dollar, depresses agricultural prices and thereby agricultural export volumes. This may lead to an under-valuation of agricultural resources which, in the long run, induces a large technical change. This technical change resulting from an overvaluation of a currency and undervaluation of agricultural resources finally lowers the real prices of agricultural products and places severe pricing pressure on the farm sector, forcing it to make an adjustment in the factors of production, most particularly labor and capital. Again, risk-averse traders leave the business, operating farms become less profitable and farm based employment is drastically reduced (Orden, 2002).

Despite the fact that exchange rate movement is highly unpredictable, the exchange rate is itself affected by several other factors. For example, agricultural export subsidies, price stabilization policies of a central bank, the accessibility of exporters/importers to credit, and hedging opportunities are means by which exchange rate uncertainty can be mitigated. Moreover, all of these factors are related with the level of development and/or size of the economic mass of the trading countries. For example, traders in a developed economy not only have greater access to credit and hedging opportunities, but their governments also provide higher export subsidization on agricultural and other commodities. Thus, the impact of exchange rates on bilateral trade flows is a complicated phenomenon. This complication in estimating the effect of exchange rates on international trade flows itself is a problem that is frequently encountered.

As volatility in the exchange rate has been widely established as having a negative effect on trade flows, the proponents of a fixed exchange rate system use this presumption as a strong argument in their favor. This already held belief also led to the creation of the European Union which was undertaken in an effort to stabilize exchange rate fluctuations and promote intra-EU trade (European Commission, 1990). However, empirical evidence in support of the hypothesis that exchange rate volatility has a negative effect on trade flows is ambiguous. For now, it can be said that exchange rate volatility may affect various markets differently and the impact may depend upon several other factors.

Not only does exchange rate uncertainty impact trade flows, but there are also many other factors that either enhance or depress trade flows directly that are to be considered equally important while estimating the impact of exchange rate uncertainty on international trade flows. Identifying those factors, other than exchange rate uncertainty, which have a direct impact on

bilateral trade volume is yet another issue in the study of international trade. Domestic and foreign income levels, common languages, common borders, use of common currency, representation of the trading country in a custom or monetary union, free trade agreements between trading countries and the distance between the trading countries are some of the major factors that directly impact trade relations between two countries. Quantification of those variables and their inclusion in the model specification is another issue frequently encountered while analyzing trade data to isolate the effect of exchange rate volatility.

Thus, this study concentrates on identifying those factors affecting bilateral agricultural trade flows between the United States and OECD countries and tries to determine if those factors have a significant effect on agricultural trade flows as compared to trade flows in other sectors.

1.3. Rationale of the Study

Most of the previous studies have focused on the short run effect with regards to exchange rate volatility, which is believed to have a negligible effect on international trade. In this study, annual exchange rate uncertainty is used to capture the long run fluctuations associated with the bilateral real exchange rate. Most of the previous studies have used exchange rate volatility but not the level of the real exchange rate. There is no evidence that traders do not account for the real exchange rate while conducting trade activities. Instead, it can be expected that even if the volatility of the exchange rate from previous years is very high, traders can still increase their trading activities because of a favorable real exchange rate. For this reason, the effect of the real exchange rate on international trade flows needs to be estimated separately and in combination with exchange rate volatility.

It can be found in the previous literatures that most of studies have used export flows synonymously with trade flows (exports + imports). However, we expect some difference on impact of exchange rate volatility on export and import flows. The difference may arise from a

simple distinction, such as importing sector concerns with domestic demand whereas exporting sector takes account of foreign demand and domestic supply conditions. Therefore, in addition to the effect on combined trade (exports + imports) flows, the effect of exchange rate volatility and the real exchange rate on both export and import flows are estimated separately.

This study considers long run exchange rate volatility to have a detrimental effect on international trade flows. It is claimed that the risk associated with short run exchange rate can be mitigated with risk management instruments like hedging and credit opportunities provided by central banks. The exchange rate market goes through “sustained misalignment” in the long run, which cannot be hedged and is very costly if hedged (De’Grauwe & De Bellefroid, 1998; Peree & Steinherr, 1989). Therefore exchange rate volatility for a short period of time does not necessarily affect trade flows as extensively as does long run volatility.

Moreover, as trade theory suggests, the United States is likely to have more trade with those foreign countries that have a similar level of development, e.g. similar consumer preferences and resource endowments. In this regard, the OECD is the only organization that is primarily composed of developed countries. It can also be argued that the OECD is the group of countries having capital oriented production technologies and labor as a scarce factor of production as in the case of the United States. Taking these facts into consideration, this study examines the effect of exchange rate volatility and other factors on bilateral trade flows between the United States and OECD countries.

1.4.Objectives of the Study

1.4.1. Objective 1

This study first ascertains the present state of exchange rate movement and its impact on bilateral trade flows in general and for the United States in particular. Then, a thorough

investigation of the effect of a volatile exchange rate on bilateral trade flows between the United States and OECD countries is performed. The primary objective of this study is to determine the long run volatility in exchange rates and document their impact on bilateral agricultural trade flows between the United States and OECD countries.

1.4.2. Objective 2

Another objective of this study is to examine recent empirical analysis on the effects of the real exchange rate on U.S. – OECD trade flows and examine its consequences for U.S. farm policy. The question of farm policy is a vague issue and no policy recommendations can be made based on a single study. However, this issue is addressed by documenting the effect of free trade agreements and other relevant policy adjustments on bilateral trade flows over a long period of time.

1.4.3. Specific Objectives

In addition to the two major objectives mentioned above, several specific objectives are addressed by this study. A thorough literature review is presented explaining the effects of exchange rate volatility, real exchange rate, and free trade agreements on bilateral trade flows. Moreover, a theoretical framework is specified detailing the relationship between exchange rate volatility, real exchange rate, trade flows, GDP, population, and several other explanatory variables. Similarly, a quantitative model is specified based on the economic foundation of the theoretical model. Finally, quantitative results are provided along with their implications on government, traders, consumers and producers. Specific objectives are summarized as follows:

1. To present a thorough literature review;
2. To specify a theoretical framework detailing relevant relationships;
3. To specify a quantitative model related to the theoretical model; and

4. To provide quantitative results and a thorough overview of the implications of these results.

Accomplishment of these objectives is expected to answer the following research questions:

1. What effect does exchange rate volatility have on bilateral trade flows between the United States and OECD countries?
2. How does the exchange rate impact agricultural traders and farm policy?
3. Why does exchange rate volatility have a larger detrimental effect on the agricultural sector? and
4. What measures do governmental policy planners need to implement so as to minimize the impact of exchange rate volatility?

CHAPTER 2

LITERATURE REVIEW

2.1. Exchange Rate and Trade Flows

A review of the empirical literature on the effects that exchange rate volatility and the real exchange rate have on international trade flows is presented below in table 2.1. The review gives the details on type of trade flows, economic models, variables of interest, methods of measuring exchange rate volatility and direction of impact on trade flows as found by the respective authors. In most cases, the variable of interest is either exchange rate volatility (EXV) or the real exchange rate (RER) and the method of measuring volatility is either the Generalized Autoregressive Heteroskedasticity (GARCH) or the Moving Standard Deviation (MOVSD) method. It is observed that many previous studies have used the gravity model to estimate the effect of exchange rate volatility on aggregated trade (export + import) flows and most of them have found a negative impact of exchange rate volatility. Similarly, the moving standard deviation (MOVSD) was the most widely used method of computing exchange rate volatility (Table 2.1).

2.1.1. Exchange Rate Volatility and Trade Flows

Effect of exchange rate volatility on trade volume largely depends on how traders conceptualize that risk and make their decisions about trading in the future. Generally, firms make their decision about future contracts without knowing beforehand the direction of future exchange rates (Wang and Barrett, 2007). “If purchasing power parity (PPP) held, domestic and foreign trade would not systematically involve a different degree of uncertainty. However, exchange rates experience significant and persistent deviation from PPP, adding an exchange risk component to import/export activities” (Dell’Ariccia, 1999).

Table 2.1 Review of empirical literature on effect of exchange rates (EXV and RER) on international trade flows.

Author (s)	Type of Flows	Model	Variable of Interest	Volatility Method	Direction of Impact
Kandilov (2008)	Export	Gravity	EXV	GARCH	Negative
Dell'Ariccia (1999)	Trade	Gravity	EXV	MOVSD	Negative
Cho et al. (2002)	Trade	Gravity	EXV	MOVSD	Negative
Wang & Barret (2007)	Trade	Multivariate GARCH-M	EXV	GARCH	Agricultural sector only
Chowdhury (1993)	Trade	Error Correction	EXV	MOVSD	Negative
Baek & Koo (2009)	Export & Import	ARDL	RER	-	Mixed
Kim et al. (2009)	Trade	VECM, VMA	RER	-	Has impact
Gopinath et al. (1998)	Export		RER,EXV	MOVSD	Mixed
Chit et al. (2010)	Export	Gravity	EXV	MOVSD, GARCH	Negative
Zhang & Sun (2003)	Export	ECM	EXV	MOVSD	Negative
Oskooee & Hegerty (2009)	Export & Import	ECM	EXV,RER	SD method	Mixed
Kandilov & Leblebicioglu (2011)	Plant Investment	System-GMM	EXV	GARCH, MOVSD	Negative
Pick (1990)	Export	Export supply	EXV,RER	MOCSD	Mixed
Hooper & Kholhagen (1978)	Export & Import	Export Supply, Import Demand	EXV	SD method	No effect
Poonyth & Zyl (2000)	Export	ECM	RER	-	Unidirectional causal
Rose & Wincop (2001)	Trade	Gravity	CU		Positive
Rose (2000)	Trade	Gravity	EXV,CU	MOVSD	Negative, Positive
Oskooee & Kovyryalova (2008)	Trade	Export Supply, Import Demand	RER, EXV	SD method	Negative
Broll & Eckwert (1999)	Trade	-	EXV	-	Positive
Jozsef (2011)	Export	Gravity	EXV	MOVSD	Positive

As Dell’Ariccia further writes, international trade has long been a risky business because of the highly variable and unpredictable nature of exchange rates. Measurement of exchange rate risk and finding an appropriate proxy for the risk has been challenging both econometrically and economically.

In their extensive study of exchange rate, market price, and trade volume, Hooper and Kohlhagen (1978) found that U.S.-German trade volume was not significantly affected by exchange rate risk. However, they found that risk associated with exchange rate has had a significant impact on prices. As an exception, they were able to find a significant negative impact of exchange rate uncertainty on bilateral trade flows between the United States and the United Kingdom. Interestingly, Hooper and Kohlhagen (1978) further demonstrated that the impact of exchange rate volatility is sometimes determined by the notion of just who bears the exchange risk, either exporters or importers. In the case where importers bear most of the risk, exchange rate volatility is associated with a decline in trade prices. In the contrary case where exporters bear most of the risk, they found that exchange rate risk has a positive impact on U.S. imports, mainly because exporters were the risk bearers at this time.

However, they reported that exchange rate risk had a significant negative impact on trade flow, in the case when traders appeared to be risk averse, no matter who bears the risk, exporters or importers. Finally, the conclusion of the paper was simple and straightforward: “if importers bear the risk, the price falls as import demand falls, whereas if exporters bear the risk, the price goes up as exporters charge an increasingly higher risk premium”.

Pick (1990) applied a demand and supply model including exchange rate risk on the model. In his study of the U.S. export flows to 10 partner countries, he found that exchange rate risk has a negative effect on U.S. exports with 3 developing countries and a positive effect on all other

countries. A study based on the gravity model framework and a panel data of the agricultural trade between Hungary and its trading partners showed a significant positive effect of exchange rate volatility on agricultural trade flows (Jozsef, 2011). In contrast, Anderson and Garcia (1989) found a significant negative effect of exchange rate risk on the U.S. exports of soybean to three developed countries. Similarly, Maskus (1978) found that exchange rate volatility affects agriculture the greatest. However, Langley et al. (2000) found a positive effect of exchange rate volatility on Thailand's export of poultry, but not on aggregate agricultural exports.

In their study of trade flows between 10 European countries and the United States, Cho, Sheldon and McCorriston (2007) observed that average annual growth rate of bilateral trade has declined significantly since the Bretton Wood System (BWS) was collapsed in 1973. The decline led directly to a slowdown in GDP growth for those countries in the post BWS era. They hypothesized that the lower rate of growth in agricultural trade relative to that of other sectors has a theoretical reason; that the demand of agricultural products is more income inelastic as compared to other sectors. They further assumed that exchange rate volatility between the United States and Eurozone countries should be less detrimental to trade between them because one of the goals of establishing the Eurozone was to reduce exchange rate risk between them and with their trading partners. Proponents of monetary unions claim that monetary unions have better exchange rate management policies and enjoy a more stable exchange rate which is expected to promote trade flows.

Broll and Eckwert (1999) postulated why exchange rate volatility can have a positive effect on international trade flows. Empirically, they showed that the higher the exchange rate volatility, the higher will be the value of real option to export to the world market which increases the potential gains from trade. The standard property of option is that when exchange

rate volatility raises the value of the options to the world, export to the world increases. If the exchange rate fluctuates heavily, there is extremely high realization of the foreign spot exchange rate. The higher the foreign spot exchange rate, the higher will be the potential gain from trade. At the same time, there is also a low realization of the foreign exchange rate and thereby potential loss in trade, but this loss does not offset those gains. The reason is that firms always cut off their production and export activities and walk away from the export option when there is lower realization of the foreign exchange rate (Broll and Eckwert, 1999).

Moreover, given that exchange rate volatility induces uncertainty in the foreign market, expected utility of income of a firm is reduced if the firm cannot take risk and practices risk aversion. This situation leads to a dramatic decrease in production and the volume of international trade flows. However, if there were long run and persistent exchange rate volatility, the real option to international trade would be profitable. In this case, both production and export activities are resumed normally. In their study, Broll and Eckwert (1999) assumed such a market structure which allows a firm to view it as a price taking, risk-averse international firm which can produce a product for sale in the domestic or the foreign market and all prices are certain except for foreign exchange rate. The production decision has to be made before the exchange rate is resolved.

The literature on international trade suggests that exchange rate volatility can have both negative and positive impacts on bilateral trade volumes. De Grauwe (1998) found a negative impact of exchange rate volatility for risk aversion and costly adjustment of production factors, but a positive impact for convexity of the profit function with respect to exports. The effect of exchange rate volatility largely depends upon export prices and export subsidies provided. So it is always expected that exchange rate volatility has a larger impact on developing countries'

trade flows rather than on that for developed countries. Furthermore, developed countries' exporters have better access to credit and hedging opportunities that ultimately reduce the original impact of exchange rate uncertainty (Kandilov, 2008).

In his study of Hungarian agricultural exports to its export destination, Jozsef (2011) found a positive effect of nominal exchange rate volatility on agricultural trade between Hungary and 81 trade partners around the world for 9 years (1999-2008). He used the gravity model and panel data procedure in his analysis. He further concluded that because of the positive effect that exchange rate volatility has on agricultural trade flows, Hungarian agri-food entrepreneurs are not interested in joining the Eurozone.

One of several reasons behind formation of a monetary union in Europe is the perception that exchange rate volatility has a negative impact on trade flows (European Union Commission, 1990). As farm policies in the developing economies lack credibility, impacts of monetary policy on the agricultural sector in both the short and the long-run have become very important in those countries where farm income relies on exports of agricultural products (Jozsef, 2011).

It is widely believed that short run exchange rate volatility can be easily hedged at low cost and it is the long run volatility that affects trade flows negatively (Peree and Steinherr, 1989 and Cho et al., 2002). However, Vianne and de Vries (1992) showed that although hedging opportunities are available in the short run, short run exchange rate volatility still affects international trade flows by increasing the risk premium in the forward market. As Krugman (1989) argues, hedging short run volatility is not perfect and is a costly approach, particularly for a developing country's firms and firms which face a liquidity constraint.

Moreover, Chit et al. (2010) studied the effect of exchange rate volatility on exports from emerging East Asian economies. They used panel data and constructed a generalized gravity

model instead of a pure gravity model to control for possible misspecification problems which may arise from the pure gravity model. They found a significant negative impact of exchange rate volatility on exports from developing East Asian countries. Particularly, they reported that a one standard deviation (0.0052) unit increase in exchange rate volatility reduces exports from sample countries by 4.2%. Similarly, Rose (2000) used a panel random-effects model and reported that an increase in exchange rate volatility by one unit reduced trade flows by 4%. Furthermore, Clark et al. (2004) found a negative effect of exchange rate volatility on trade flows; a one unit increase in exchange rate volatility reduced trade flows by 7%.

2.1.2. Real Exchange Rate and Trade Flows

Baek and Koo (2009) reported that in the long run, both exchange rate and foreign income have significant impacts on U.S. agricultural exports while only domestic income is responsible for determining the level of U.S. agricultural imports. However, in the short run, both the changes in the exchange rate and in foreign and domestic income impact U.S. agricultural exports and imports. In a separate study, Pick (1990) did not find any significant effect of real exchange rate on trade flows between the United States and other developed countries, but reported a significant negative effect on U.S. exports to its developing partners.

Since U.S. imports are largely affected by domestic income, as compared to the effect of foreign income on U.S. exports, U.S. economic growth has a significant impact on the U.S. trade balance (Baek and Koo, 2009). They further concluded that the U.S. economic expansion in the 1990's was characterized by rising relative income, which enabled domestic consumers to consume more foreign agricultural goods, causing slow growth of agricultural exports relative to imports.

Exchange rates have both direct and indirect effects on trade policies and volumes. As a direct effect, exchange rate fluctuations determine the wedge between the domestic and foreign prices of a traded good serving an equilibrating role. On the other hand, those movements in exchange rates depend on international capital flows and other macroeconomics factors such as monetary policies for the various trading partners. Monetary shocks and other macroeconomic conditions play a key role in determining agricultural prices and policies (Orden, 2002). Changes in monetary policy induce international capital flows, which in turn cause changes in the value of the dollar which ultimately affects the level of exports and imports. Because agriculture is an export oriented business, it is always sensitive to changes in monetary and fiscal policy. All in all, exchange rate movements create a difference in foreign and domestic prices for a single good, and monetary shocks have non-neutral effects that explain some of the variability in agricultural prices (Orden et al., 1989).

With a series of case studies, Schuh (1974) developed a view that while many variables affect agriculture, it is the exchange rate that plays a role in all aspects of agriculture. Grennes (1975) also studied factors affecting the U.S. trade but came to a different conclusion. He stated that exchange rate policy may alter distribution of income between countries and between producers and consumers. However, Schuh (1984) again claimed that changes in the value of the dollar were the motivating factor behind changes in the volume of imports and exports.

Johnson, Grennes, and Thursby (1977) compared the impact of exchange rate versus the impact of foreign commercial policy in the pricing of the U.S. wheat. They found that a devaluation of the dollar had a positive impact on domestic wheat prices by way of increased export demand and in turn lower domestic supplies.

Chambers and Just (1982) noted that although plenty of studies have been conducted on the exchange rate and international trade, approaches to deal with the exchange rate were overly restrictive in the specification of the exchange rate variable in empirical agricultural trade models. Broadly speaking, the size of the exchange rate impact depends on many variables: e.g. crop, year, country, and governmental influence in markets, elasticity, measured price variables, alternative prices considered, and the definition of exchange rate effect. However, Chambers and Just (1981) concluded that exports and agricultural commodity prices are more sensitive to changes in exchange rate rather than domestic factors. Chambers (1984) developed a theoretical model that compared the short-run impact on the agricultural sector versus non-agricultural sector which changes in monetary policy brought about.

Batten and Belongia (1986) argue that the real stimulus for export demand comes from income enhancements in importing countries. In their analysis, they found exports playing a major role in transmitting monetary and fiscal policy to the agricultural sector. They did not see any evidence that monetary policy or budget deficits have had any effect on the real value of the U.S. dollar.

Changes in the exchange rate can affect both the terms of trade and international competitiveness as long as they affect the relative prices between traded and non-traded goods. Kost (1976) pointed out that there is an upper limit on how much price and quantity can change in response to a change in the exchange rate. Thus, the impacts of a movement in the exchange rate on trade are largely dependent upon the magnitude of the change in the exchange rate.

Robertson and Orden (1990) examined quarterly data for money, agricultural prices, and manufacturing prices for the time period of 1963-1987 in New Zealand and found agricultural prices responded more quickly than manufacturing prices to a shock in the money supply.

However, Babula et al. (1995) found no co-integration between exchange rates, price, sales, and shipments in regard to the U.S. corn exports. Degrees as to the magnitude of impact that stem from changes in the exchange rate on agricultural prices and quantity traded also vary with the methods of estimation utilized such as structural econometric models or time series methods.

In a separate study of exchange rates and trade flows, Espinoza-Arellano et Al. (1998) tried to figure out the primary economic forces responsible for Mexico's competitiveness in the U.S. winter melon market. They found that "exchange rates do have an important effect on trade, in particular, the weakening of the peso (exporter's currency) increases export opportunities in the short run." In his classic study of 14 African countries, Lamb (2000) found a "persistent, robust and negative" relationship between the exchange rate and aggregate agricultural output in markets.

Similarly, Gopinath et al. (1998) studied the effect of the exchange rate on the relationship between Foreign Direct Investment (FDI) and U.S. food exports using pooled regressions for time series and cross-sectional data. They found a significant negative effect of the real exchange rate on U.S. exports to 5 of 10 countries studied. Particularly, they reported that a 1% increase in the real value of the U.S. dollar reduced normalized agricultural exports by 0.13%. The result for exchange rate volatility was almost the same, i.e., 3 of 10 countries had a significant negative effect on export volume.

Kim et al. (2009) conducted a detailed study on effect of the Canada – U.S. bilateral exchange rate on agricultural trade flows and U.S. farm income. They paid special attention to the effect on agricultural trade flows under enforcement of the Canada – US Trade Agreement (CUSTA). Using vector error correction and vector moving average models, they concluded that the real exchange rate has a significant effect on U.S. – Canada agricultural trade flows but not

on the U.S. agricultural price and income. Their results showed a 0.576% increase in U.S. imports from Canada given a 1% shock in the U.S. dollar appreciation relative to the Canadian dollar. Likewise, Chowdhury (1993), using a multivariate error correction model, found a significant negative effect of exchange rate volatility on volume of exports for each of the G-7 countries.

2.1.3. Free Trade Agreements and Trade Flows

As of May 2011, the number of regional trade agreements (RTAs) had risen to 489 (WTO, Regional Trade Agreements database). Out of those RTAs, most are Free Trade Agreements (FTAs) and some are customs unions. At present, more than 250 FTAs have already come in to implementation. Although the number of FTAs has surged rapidly, economists have debated whether or not FTAs have had a positive effect on international trade flows (Sun and Reed, 2010). Jayasinghe and Sarker (2008) studied the effect of the North American Free Trade Agreement (NAFTA) on trade in six major agricultural commodities and found that NAFTA had increased trade between the member countries greatly. Similarly, Lambert and McKoy (2009) reported an increment on agricultural and food trade among the members of various FTAs for three periods: 1995, 2000, and 2004. However, their result also suggested that many FTAs have a trade creation effect in food and agriculture sectors even with non-member countries.

Regional free trade agreements have been a major factor of international trade flows. In 2003, 250 RTAs, most of which came into force in the fairly short period of time from 1995 to 2002, were reported to the WTO (Grant and Lambert, 2008). In 2004, nearly 40 additional RTAs were reported to the WTO signifying the ubiquity of RTAs in global trade. As Grant and Lambert (2008) argued, looking at the number of present RTAs, we can definitely claim that we have entered into one of the most prolific periods of RTA formation in the history of global

trade. Consequently, by the time of Doha Round of trade negotiations, the widespread proliferation of RTAs may have been due to urgently needed promotion of agriculture trade and failures of multilateral trade negotiations particularly for developing countries. In the Doha Round, developing countries made their firm stand on not to negotiate on other issues until an agreement is achieved in agricultural trade (Grant and Lambert, 2008).

The impact of free trade agreements on international trade flows is well measured by the gravity model. As Eichengreen and Irwin (1980) stated, the gravity model is “workhorse for empirical studies to the virtual exclusion of other approaches”. However, just like the effect of exchange rate volatility, the effect of free trade agreements on trade flows is ambiguous. Some studies have found significant positive effects and some have found positive but insignificant effects. Paradoxically, some of the other studies have found negative effects of free trade agreements on trade flows (Frankel, 1997 and Kruger, 2000).

Baier and Bergstrand (2007) applied the gravity model to trade flows between members of several free trade agreements and found that free trade agreements have unstable effects on cross-sectional trade data between countries. The ambiguity on effect of free trade area was not new. Frankel (1997) did not find any effect of NAFTA and the Andean Pact on member’s trade flows, but reported a large and significant effect of MERCUSOR and the Association of Southeast Asian Nations (ASEAN). In contrast, Krueger (2000) found some positive effects of Andean Pact on trade flows.

Baier and Bergstrand (2007) handled this controversy very well and finally concluded that those previous studies were biased because of endogeneity in selecting members of RTAs. Later, they used panel data and applied the same gravity model and found a relatively bigger impact of free trade agreements on trade flows. Grant and Lambert (2008) noted that all of the previous

studies have used aggregate trade data, which served as the source of aggregation bias. They applied the same model (as Baier and Bergstrand did) but used disaggregated data such as agricultural and non-agricultural trade separately and showed that the effect of RTAs on agricultural trade is much higher than on non-agricultural trade. In their particular sample, agricultural trade increased by 72% and non-agricultural trade increased by 27% as a result of a free trade agreement. They further concluded that it takes several years, may be a decade, for members to gain from RTAs.

Sun and Reed (2010) applied the gravity model in their study on the impact of FTAs on trade creation and diversion. By using the Poisson Pseudo-Maximum Likelihood (PPML) method instead of OLS, they found that members of FTAs had higher agricultural trade when the FTAs were in force. Particularly, they found a significant increase in agriculture trade among members of the ASEAN-China Preferential Trade Agreements (PTAs), EU-15, EU-25, and South African Development Community (SADC) agreements. In the case of EU-15, they noted significant export and import diversion, unlike increases in exports only in the case of SADC members. However, they did not find any trade creation, but export diversion with NAFTA. Furthermore, they concluded that time period has a significant effect that plays a role in turning early trade creation to trade diversion eventually.

Although a new FTA promotes firms to extend their exports to third party-countries, they eventually find the member countries to be a better market as transition of FTAs continues for a long period of time. This situation leads the export creation to result as export diversion (Sun and Reed, 2010).

2.2. The Gravity Model

2.2.1. Economic Foundations of the Gravity Model

There are so many factors that affect transaction costs between trading nations. In the gravity model all possible factors that affect transaction costs such as a common border, a common language, and membership in a customs union are considered (Dell'Araccia, 1999). In this model, the geographical distance between countries is inversely proportional to trade volume because with longer distance between trading partners, the transportation costs to move goods between the two will be higher, which ultimately depresses bilateral trade (Dell'Araccia, 1999). Also, the richer countries are expected to have larger volumes of trade, indicated as a per capita income variable, which represents specialization for each country and is included in the model specification.

2.2.2. The Gravity Model and International Trade Flows

The gravity model has been widely used as an economic tool to examine international trade flows (Anderson, 1979). The gravity model was used to estimate the effect of exchange rate volatility and free trade agreements in the 1960s for the first time. According to Frankel (1998), “the gravity model passed from a poverty of theoretical foundation to an overwhelming richness.” Many researchers have put a great deal of effort in to investigating the theoretical foundation of and empirical application of the gravity model (Anderson, 1979; Krugman, 1985; Eichengreen and Irwin, 1998; and Frankel, 1998). Frankel further writes that the gravity model has become a premier economic tool in conducting *ex post* trade creation and trade diversion effects associated with FTAs.

As Sun and Reed (2010) reported, most of the previous studies have suffered from two major problems when the gravity model was used as analytical tool. First, the problem of endogeneity

that mostly arises from reversed causality between higher trade volume, socioeconomic ties, similar income distribution and FTAs. Second, the problem of zero trade between countries when the trade is accounted in some specific commodities. The second issue is not really a problem when overall trade is used. In the first case, inclusion of fixed effects for bilateral country pairs solves the problem to a great extent.

2.3. Determination of Exchange Rate Volatility

2.3.1. Methods of Determination

It can be found in the literature that a variety of measures for exchange rate uncertainty have been used since the inception of studies on exchange rate uncertainty and trade volumes. A majority of the measures used were some variant of the standard deviation of exchange rate (Kandilov, 2008). Take for example the standard deviation of percentage change in exchange rates and the standard deviation of the first difference in the logarithmic exchange rate (Dell’Ariccia, 1999 and Cho, Sheldon, & McCorrison, 2002). As the exchange rate fluctuates daily and even hourly (for that matter), exchange rate uncertainty is never a perfectly predictable measure and either ignoring or including a time variable in a model in the wrong way may lead to an estimation bias. Although most previous studies have suggested measuring exchange rate volatility as some variant of standard deviation, no general consensus can be found on the exact way exchange rate volatility is measured.

Although researchers have a general consensus on how economic agents form exchange rate expectations and conceptualize associated risk, there is no common approach to quantify this risk into exchange rates (Wang and Barrett, 2007). In 1986, Bollerslev, for the first time, proposed using the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) method as a method of determining volatility in exchange rate or inflation rate. Since then, the

GARCH (1, 1) specification has been widely used by several studies (Kandilov, 2007; Dell’Ariccia, 1999; Wang and Barrett, 2007; and Clark, Tamirisa, and Wei, 2004). Among several other methods, moving standard deviation (MOVSD) of the first difference of logarithmic exchange rate has also been used by several researchers, for example, Clark, Tamirisa, and Wei (2004), Wang and Barrett (2007), Cho, Sheldon, and McCorriston (2002), and Thursby and Thursby (1987). Among the other methods are the sum of squares of the forward errors, and the percentage difference between minimum and maximum of the nominal spot rate (Dell’Ariccia, 1999). Another measure, known as the Peree and Steinherr method, in which the agents’ uncertainty is based upon the past experiences where agents remember the highs and lows of the previous period and utilize that information in their decision making process has also been used by some researchers (Cho, Sheldon and McCorriston, 2002).

2.3.2. Generalized Autoregressive Conditional Heteroskedasticity (GARCH)

As the name suggests, this approach of determining exchange rate volatility is based upon conditioning the variance by allowing changing over time based on past errors. While conventional time series and econometric models operate under an assumption of constant variance, this type of model is useful in modeling variability in the exchange rate and inflation (Hill et al., 2008). Because the ARCH model of conditional variance encountered the problem of negative variance parameter estimates in empirical applications, extension of the ARCH model including a more flexible lag structure was immediately sought (Bollerslev, 1986).

Mathematically, the GARCH (p, q) model was specified as follows:

$$\varepsilon_t = y_t - x_t' b$$

$$\varepsilon_t | \varphi_{t-1} \sim N(0, h_t),$$

$$h_t = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i h_{t-i}$$

where, $p \geq 0, q > 0$

$\alpha_0 > 0, \alpha_i \geq 0, i = 1, \dots, q$ and

$\beta_i \geq 0, i = 1, \dots, p$

where, y_t is the dependent variable, x_t is the vector of explanatory variables and b is a vector of unknown parameters.

The GARCH (p, q) model was slightly modified and used to estimate the exchange rate volatility in several previous studies. A number of researchers have used a GARCH (1, 1) specification to model exchange rate volatility because it provides a good fit for bilateral monthly exchange rate data (Kandilov, 2008). For example, Kandilov (2008), Kandilov and Leblebicioglu (2011), and Wang and Barrett (2007) are the most recent studies which used the GARCH model to measure exchange rate volatility. Kandilov's model of GARCH (1, 1) specification to determine exchange rate volatility was specified as follows:

$$100 \Delta \ln e_{ijk} = \varphi_0 + \varepsilon_{ijk}$$

$$\varepsilon_{ijt} | I_{k-1} \sim N(0, h_k)$$

$$h_k = \alpha_0 + \alpha_1 \varepsilon_{ij,k-1}^2 + \alpha_2 h_{k-1}$$

where, e_{ijk} is the real exchange rate between country i and j at time $k = t-l, l = 1, 2, \dots, 10$.

Therefore, the exchange rate variability in current year is determined as a function of real exchange rates of previous 10 years.

2.3.3. Moving Standard Deviation (MOVSD)

This method of measuring exchange rate volatility is the most widely used method in the previous literature (Clark, Tamirisa and Wei, 2004). For example, Dell'Ariccia (1999), Rose

(2000), Cho, Sheldon, and McCorriston (2007), Chit et al. (2010), Clark, Tamirisa and Wei (2004), and Jozsef (2011) used the standard deviation of the first difference of the logarithmic exchange rate as a proxy to the exchange rate volatility. The good thing about this method is that it has a property of being zero if exchange rate follows a constant trend over the particular period of time. This means that if exchange rate follows the constant trend, there will be no volatility and the exchange rate for a future time period is perfectly predictable (Clark, Tamirisa, and Wei, 2004).

Cho, Sheldon, and McCorriston (2002) made it clear that the first difference method should be time varying when used with panel data. This is because of the time series nature of the panel data. Therefore, they used a moving standard deviation of the first difference in the real exchange rates to compute an *ex ante* measure of volatility. Moreover, this measure of exchange rate volatility gives a larger weight to extreme observations. In fact, the larger weight to extreme observations adequately represents the behavior of risk-averse traders (Dell’Ariccia, 1999).

CHAPTER 3

METHODOLOGY

3.1. The Gravity Model

This study first establishes the present state of exchange rate volatility and its impact on bilateral trade flows in general and particularly for the United States. Then, a thorough investigation of the effect of volatile exchange rate on bilateral agricultural trade flows between the United States and its top trading partners (i.e. OECD countries) is conducted. Moreover, several other factors that are supposed to affect bilateral trade flows directly and indirectly are also documented.

The fundamental economic principle of the gravity model resides on properties of expenditure systems with a maintained hypothesis of identical homothetic preferences across regions (Anderson, 1979). Anderson further explains that “the gravity model constrains the pure expenditure system by specifying that the share of national expenditure accounted for by spending on tradables is a stable unidentified reduced-form function of income and population.” Similarly, if countries i and j are producing differentiated products with economies of scale, which leads to specialization in production, then the shares of countries i and j in world spending and their GDPs provide a theoretical explanation of the gravity model (Helpman, 1987).

Anderson (1979) provided a simple example for the foundation of the gravity model in the light of a pure expenditure system equation. He rearranged a Cobb-Douglas expenditure system assuming complete specialization, no tariff and transportation costs and identical Cobb-Douglas preferences anywhere. Therefore, consumption of good i in country j is expressed as

$M_{ij} = b_i Y_j$, where Y_j is income in country j which is equal to the value of its exports, b_i is fraction of income spent on good b in country i .

Thus, $Y_i = b_i(\sum_j Y_j)$

Solving the above equations yields:

$$M_{ij} = \frac{Y_i Y_j}{\sum_j Y_j}$$

This is the basic form of the gravity equation that Anderson came up with by using a Cobb-Douglas expenditure function. In his words, “if we disregard error structure, a generalization of this equation can be estimated by ordinary least squares. In a pure cross-section, the denominator is an irrelevant scale term and income elasticity should not be different than unity”.

This basic gravity model has been modified to obtain the relaxed gravity equation that has been widely used in international trade analysis. The use of the gravity model in empirical studies of international trade flow is substantiated because of its efficiency to include a wide range of variables such as border effects, languages, infrastructure availability, custom union’s effects, exchange rate uncertainty, historical and colonial ties, and so on (Wang et al. 2007). However, other trade models based on imperfect competition and the Heckscher-Ohlin model handle only core variables like income and distance between countries.

This study intends to use the gravity model as developed by Anderson (1979) to estimate the effect of exchange rate volatility on bilateral trade flows. The preference of the gravity model is supported by the inability of general and partial equilibrium analyses to document the exchange rate effect on trade flows. The general consensus amongst previous researchers whose predilection was in using the gravity model in analyzing issues related to international economics and trade helps to solidify the gravity model’s empirical validity. Furthermore, this model is characterized by its widespread use under the auspices of imperfect competition and intra-industry trade theory (Krugman, 1991). The use of the gravity model in international trade is further encouraged by theoretical literature that has developed the micro foundations for the

gravity model (Helpman, 1987). The fundamental theory behind this model is that bilateral trade volume between two countries is directly proportional to the product of their GDPs but inversely proportional to their geographical distance (Dell'Araccia, 1999). In light of this model, exchange rate uncertainty is expected to add up to the effect of distance thereby inversely proportional to bilateral trade volume.

3.1.1. Economic Specifications

In the gravity model, the trade volume of a country is directly proportional to GDP and population and inversely proportional to exchange rate volatility and transportation cost. Transportation cost is proxied by distance between trading partners. In the gravity model, bilateral trade flows between countries i and j at time t ($TRADE_{ijt}$) is represented as follows:

$$TRADE_{ijt} \sim \frac{1}{(DIST_{ij}) \cdot (EXV_{ijt})}$$

and

$$TRADE_{ijt} \sim GDP_{ijt} \cdot POP_{ijt}.$$

Therefore,

$$(1) TRADE_{ijt} = \beta_0 \cdot \frac{(GDP_{ijt})^{\beta_2} \cdot (POP_{ijt})^{\beta_3}}{(EXV_{ijt})^{\beta_1} \cdot (DIST_{ij})^{\beta_4}}$$

where $TRADE_{ijt}$ is bilateral trade flows between countries i and j at time t , GDP_{ijt} is the product of GDPs, and POP_{ijt} is the product of populations of countries i and j at time t . Similarly, $DIST_{ij}$ is a geographical distance between trading countries i and j and EXV_{ijt} is a measure of exchange rate volatility between countries i and j at time t . As the greater distance implies a higher transportation cost, the variable $DIST_{ij}$ is expected to have a negative impact on bilateral trade between countries i and j . Similarly, EXV_{ijt} is expected to have a negative impact on trade flows given the additional costs associated with increased uncertainty. Among additional variables,

$LANG_{ij}$, $BORDER_{ij}$, $EURO_{ijt}$ and FTA_{ijt} are dummy variables representing common language, common border, use of euro as national currency, and enforcement of free trade areas, respectively.

The aforementioned specification of the gravity model is slightly modified in this study. Particularly, instead of using the product of GDPs and product of population of trade partners, a product of GDP and population – defined as economic mass of the country – is used. This is because an economic mass of a country is always the product of GDP and population of that country. In the gravity model, economic mass of a country is directly proportional to trade flows from and to the country. Therefore,

$$TRADE_{ijt} \sim \frac{1}{(DIST_{ij}) \cdot (EXV_{ijt})},$$

and

$$TRADE_{ijt} \sim EM_{it} \cdot EM_{jt}.$$

Therefore,

$$(2) \quad TRADE_{ijt} = \exp^{(\beta_0)} \frac{(EM_{it})^{\beta_2} \cdot (EM_{jt})^{\beta_3}}{\exp^{(\beta_1 EXV_{ijt})} \cdot (DIST_{ij})^{\beta_4}}$$

where EM_{it} and EM_{jt} are economic masses of countries i and j at time t , respectively. Equation (2) is simply a redefined version of equation (1), where GDP and population are replaced by economic mass and exchange rate volatility is exponentiated for ease of econometric specification as described later in this chapter. As far as the constant β_0 is concerned, using an exponentiated version of β_0 in place of β_0 is equivalent in the sense that both of them are arbitrary constants.

3.1.2. Econometric Specifications

When we take the natural logarithm of the equation (2), we obtain a nice econometric model. In other words, the effect of exchange rate volatility (EXV_{ijt}) is now estimated using the Ordinary Least Squares (OLS) estimation method.

$$(3) \ln (TRADE_{ijt}) = \beta_0 + \beta_1 EXV_{ijt} + \beta_2 \ln EM_{it} + \beta_3 \ln EM_{jt} + \beta_4 \ln DIST_{ij} + \varepsilon_{ijt}$$

In equation (3), it is important to note that the coefficients β_1 and β_4 are expected to have negative signs. Theoretically, the intercept term β_0 is allowed to change over time t which assures that any change in world aggregate GDP will be captured by the intercept term (Helpman, 1987).

3.1.3. Estimating Equations

In this study, equation (3) is used to estimate the effect of exchange rate volatility and real exchange rate on bilateral trade flows between the United States and OECD countries. In addition, some other variables are added to equation (3) such as RER_{ijt} , which represents real exchange rate between countries i and j at time t . Among the additional variables, FTA_{ijt} and $EURO_{jt}$, which represent enforcement of free trade agreements between countries i and j at time t and use of the Euro as the national currency in country j at time t , respectively are added to equation (3) to obtain the estimating equation (4). The detailed definition of the variables is presented later in Chapter 4, table 4.1 and Appendix-I.

$$(4) \ln (TRADE_{ijt}) = \beta_0 + \beta_1 EXV_{ijt} + \beta_2 RER_{ijt} + \beta_3 \ln EM_{it} + \beta_4 \ln EM_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 FTA_{ijt} + \beta_7 EURO_{jt} + \varepsilon_{ijt}$$

Equation (4) is estimated using OLS for panel data in Statistical Analysis Software (SAS) version 9.2. Although most of the previous empirical studies in this discipline have used panel fixed effects, panel random effects and pooled OLS methods, we estimated equation (4) using only the panel fixed effect method. The reason for this is that random effect and pooled effect models give biased results if they are used to estimate the panel data in which the number of

cross sections is less than number of time series units. The dataset constructed herein for this study consists of 41 times series units and 28 cross sections. Therefore, the exact estimating equation for this study is equation (5), which no longer contains the time invariant variable i.e. $DIST_{ij}$ in this case.

$$(5) \ln (TRADE_{ijt}) = \gamma_0 + \beta_1 EXV_{ijt} + \beta_2 RER_{ijt} + \beta_3 \ln EM_{it} + \beta_4 \ln EM_{jt} + \beta_5 FTA_{ijt} + \beta_6 EURO_{jt} + v_{ijt}$$

where γ_0 is intercept term which is different from β_0 in equation (4). This is because now the effect of time invariant variables and any other simultaneous variables is captured by the intercept term.

In fact, the intercept term γ_0 is defined as $\gamma_0 = \beta_0 + \alpha_{ij}$, where α_{ij} accounts for the country pair specific effect and effect of any other time invariant variables and is known as the fixed effect. As usual, β_0 is the actual intercept term which appears as an intercept (γ_0) when added to the fixed effect. A policy measure can be taken as a time invariant variable and therefore the fixed effect model is an easy solution to the problem of possible simultaneity bias that arises from policy measures for example, currency stabilization effort of the central banks and monetary authorities. Moreover, the error term in equation (5), v_{ijt} is different from the error in equation (4), ε_{ijt} . However, both of the error terms have conditional mean of zero and are assumed to have identical variances irrespective of the time period as presented below.

$$E(\varepsilon_{ijt}) = E(v_{ijt}) = 0, \text{ and}$$

$$Var(\varepsilon_{ijt}) = \sigma_E^2, \text{ and } Var(v_{ijt}) = \sigma_V^2$$

In actually estimating equation (5), the explained variable $TRADE_{ijt}$ is replaced by several other variables. Not only is the explained variable replaced, but the same equation is estimated three times with different sets of right hand side variables. Therefore, in addition of (5), two other equations (6) and (7) are also estimated. In total, there are nine different dependent

variables for 3 different estimating equations which yield a total number of 27 equations to be estimated. The dependent variables are defined later in Appendix-I in detail. Three different estimating equations are given below in their general forms:

$$(5) \ln (TRADE_{ijt}) = \gamma_0 + \beta_1 EXV_{ijt} + \beta_2 RER_{ijt} + \beta_3 \ln EM_{it} + \beta_4 \ln EM_{jt} + \beta_5 FTA_{ijt} + \beta_6 EURO_{jt} + v_{ijt}$$

$$(6) \ln (TRADE_{ijt}) = \mu_0 + \alpha_1 EXV_{ijt} + \alpha_2 \ln EM_{it} + \alpha_3 \ln EM_{jt} + \alpha_4 FTA_{ijt} + \alpha_5 EURO_{jt} + u_{ijt}$$

$$(7) \ln (TRADE_{ijt}) = \alpha_0 + \gamma_1 RER_{ijt} + \gamma_2 \ln EM_{it} + \gamma_3 \ln EM_{jt} + \gamma_4 FTA_{ijt} + \gamma_5 EURO_{jt} + z_{ijt}$$

The error terms u_{ijt} , and z_{ijt} also satisfy the properties of conditional mean and homogenous variance. Similarly, the intercept terms μ_0 and α_0 include the respective fixed effects.

3.2. Measurement of Exchange Rate Volatility

If we consider literature in this area, there is not a unique method to determine exchange rate volatility. In earlier studies, the first difference method was dominant and in the most recent studies, several other methods have been used by several researchers as described above in Chapter 2. As the goal of this study does not rest on finding the best method for measuring exchange rate volatility, we do not put a significant effort in comparing several methods of computing exchange rate volatility. Following the general consensus among researchers in this area – exchange rate volatility is some variant of standard deviation of real exchange rate irrespective of the methods used—this study uses a widely used first difference method of measuring exchange rate volatility, which is also known as the moving standard deviation method.

3.2.1. Moving Standard Deviation (MOVSD) Method

This is the most widely used method of determining exchange rate volatility. Because it is just a moving standard deviation of the first difference of logarithmic real exchange rate, it has a property of being zero if the exchange rate is constant over time. Moreover, this measure is believed to represent the behavior of risk-averse traders as it gives higher weight to large values

of the exchange rate (risk-averse traders leave the business if exchange rate is too volatile). In this study, the exchange rate volatility of time period t is measured using the real exchange rate over the previous 10 years. Mathematically,

$$EXV_{ijt} = \sqrt{\frac{\sum_{k=1}^n (X_{ij,t-k} - \mu_{ijt})^2}{n-1}}$$

where n = number of years

$X_{ijt} = \ln e_{ijt} - \ln e_{ijt-1}$ (first difference of logarithmic exchange rate)

e_{ijt} = real exchange rate between countries i and j at time t .

μ_{ijt} = mean of X_{ijt} over n years.

For example, exchange rate uncertainty for the year 1970 is determined as described below:

$$EXV_{ij1970} = \sqrt{\frac{\sum_{k=1}^{10} (X_{ij,1970-k} - \mu_{ij1970})^2}{9}}$$

$$\text{or, } EXV_{ij1970} = \sqrt{\frac{(X_{ij1960} - \mu_{ij1970})^2 + (X_{ij1961} - \mu_{ij1970})^2 + \dots + (X_{ij1969} - \mu_{ij1970})^2}{9}}$$

$$\text{where, } \mu_{ij1970} = \frac{\sum_{k=1}^{10} X_{ij,1970-k}}{10} = \frac{X_{ij1960} + X_{ij1961} + \dots + X_{ij1969}}{10}$$

$$X_{ij1960} = \ln e_{ij1960} - \ln e_{ij1959} \dots$$

$$X_{ij1969} = \ln e_{ij1969} - \ln e_{ij1968}$$

Thus, exchange rate volatility between the United States and each of the other 28 countries is determined separately using the respective bilateral real exchange rate.

3.3. Data

Annual data for the past 41 years (1970-2010) were used so that the long run volatility of the exchange rate and its effect on trade flows could be captured. The bilateral total exports and imports data came from the United Nation's Commodity Trade (COMTRADE) database and are disaggregated as per SITC Rev1 for the period 1970-1977 and as per SITC Rev2 for the period

of 1978-2010. Similarly, data on agricultural exports and imports volume came from the U.S. Census Bureau, Foreign Trade Statistics as maintained by the Global Agricultural Trade System (GATS) of the United States Department of Agriculture (USDA). Similarly, data on GDP and population were obtained from the World Bank's World Development Indicators (WDI) and Global Development Finance.

It is important to note that both the bilateral exports and imports and GDP data values are in current U.S. dollars and therefore are changed to constant 2005 U.S. dollars using the U.S. Consumer Price Index (CPI, 2005=100). Moreover, data on CPI and bilateral nominal exchange rate came from International Monetary Fund's International Financial Statistics (IFS). Nominal exchange rates are in USD per National Currency (NC) and are deflated using both the United States and partner country's CPIs (2005=100) to obtain real exchange rate (USD/NC). The exchange rate volatility variable is constructed using real exchange rate data as described above. The dummy variables, Euro and FTA are also utilized. They, as they were defined earlier in this chapter, represent use of Euro as a national currency and member of common free trade areas, respectively.

CHAPTER 4

RESULTS AND DISCUSSION

There are several advantages of using panel data over cross-sectional or time series studies. The most prominent advantage is that the former can take account of unobservable cross-sectional effects such as common language, common border, and socioeconomic and cultural ties between the trading countries. However, there are some econometric issues that need to be addressed before estimating the gravity equation. The problem of heteroskedasticity in panel data analysis arises when a large country trades with a smaller country or two smaller countries trade between them. This is because trade flows between these countries is likely to be more volatile as compared to trade between two large countries (Frankel, 1997). The problem of heteroskedasticity is addressed through use of heteroskedasticity corrected standard errors. However, no heteroskedasticity corrected standard errors are used in this study. In fact, even if it is present, “heteroskedasticity does not affect the consistency of the estimators, and it is only a minor nuisance for inference” (Wooldridge, 2002).

Another problem frequently faced by researchers in international trade data analysis is the problem of simultaneity bias. As Dell’Ariccia (1999) and Cho, Sheldon, and McCorriston (2002) noted, the potential source of simultaneity bias in studies of international trade flows and exchange rate volatility is the stabilization effort by the central bank or monetary authority of the trading country’s government. They further noted that, “when exchange rate uncertainty affects trade between two countries, a national government or central bank may have attempted to stabilize the exchange rate between major trading partners”. The stabilization effort that usually comes to improve the notoriously volatile exchange rate should be included in the estimating model to obtain an unbiased estimate.

Dell'Ariccia (1999) proposed the following solution to the potential source of simultaneity bias:

$$U_{ijt} = \alpha_{ijt} - \beta \frac{T_{ijt}}{T_{it}} - \gamma \frac{T_{jit}}{T_{jt}} + \varphi_{ijt}$$

where U_{ijt} is the exchange rate uncertainty between country i and j at time t and $\frac{T_{ijt}}{T_{it}}$, and $\frac{T_{jit}}{T_{jt}}$ are exports from country i to j and j to i relative to i 's and j 's total exports respectively. The coefficients β and γ represent the stabilization effort functions of central banks of country i and j respectively. The above equation reduces to the following form if bilateral trade shares are more or less constant over time.

$$U_{ijt} = \alpha_{ijt} + \theta_{ij} + \varphi_{ijt}$$

In this case, the central bank's effort is assumed to be constant over time and taken as a fixed effect. Therefore, estimating the equation as a fixed effect model corrects for simultaneity bias and yields an unbiased estimate.

4.1. Summary Statistics and Sign Expectations

In table 4.1, all 7 independent variables as mentioned in the estimating equation (5) in chapter 3 are presented with detailed definitions and their expected signs. Following the previous literature, we expect exchange rate volatility to have a negative effect on trade flows. However, real exchange rate, on the one hand is expected to have a positive impact on international trade flows because the general conception is that the higher the spot exchange rate is, the higher will be the export and import activities. On the other hand, the real exchange rate could have a negative effect depending on the long standing history of exchange rate fluctuation and its adverse effect on trade flows. Moreover, many trade transactions are based on early contracts and do not really depend on the spot exchange rate. The latter situation may lead to minimal trade flows even if there is a higher real exchange rate.

Table 4.1 Definition of explanatory variables and expected signs.

Variable	Definition of Variable	Expected Signs
EXV _{ijt}	Exchange rate volatility between countries <i>i</i> and <i>j</i> at time <i>t</i> .	negative
RER _{ijt}	Real exchange rate between countries <i>i</i> and <i>j</i> at time <i>t</i> .	mixed
EM _{it}	Economic mass (GDP x Population) of country <i>i</i> at time <i>t</i> .	positive
EM _{jt}	Economic mass of country <i>j</i> at time <i>t</i> .	positive
DIST _{ij}	Geographical distance between countries <i>i</i> and <i>j</i> (this is used as a proxy for transportation costs).	negative
FTA _{ijt}	1 if there are free trade agreements between country <i>i</i> and <i>j</i> at time <i>t</i> , 0 otherwise.	positive
EURO _{jt}	1 if country <i>j</i> is a member of Eurozone at time <i>t</i> , 0 otherwise	positive

In table 4.2, summary statistics of all of the dependent and independent variables is presented. It appears that exchange rate volatility between the United States and OECD countries recorded as high as 3.05 and as low as 0.006, whereas the same values for real exchange rate are 2.03 and 3.05×10^{-6} . In an average, the United States exported \$1.547 billion value of agricultural products to an OECD country in a year over the previous 41 years. Similarly, the average agricultural import of the United States from a member country of OECD over the previous 41 years was \$0.883 billion per year (Table 4.2). The same values for non-agricultural exports and imports were \$14.167 billion and \$20 billion per year, respectively. It is observed that agricultural exports from the United States to OECD countries are more than agricultural imports of the United States from OECD countries. However, the pattern in the non-agricultural sector is exactly the opposite of what we see in the agricultural sector (Table 4.2). Therefore, the United States was a net exporter in the agricultural sector and a net importer in sectors other than agriculture in regard to its trade balance with OECD countries. When the agricultural and

non-agricultural net trade balance between the United States and the OECD is computed, it reveals that the United States has been a net importer over the previous 41 years.

Table.4.2 Simple statistics: OECD Countries (N=1148).

Variable	Mean	Std. Dev.	Minimum	Maximum
EXV _{ijt}	0.235	0.434	0.006	3.053
RER _{ijt}	0.432	0.495	3.046x10 ⁻⁶	2.0304
EM _{it}	3.797x10 ¹³	1.005x10 ¹⁴	532397226	8.463x10 ¹⁴
EM _{jt}	2.342x10 ¹⁵	9.384x10 ¹⁴	1.057x10 ¹⁵	4.045x10 ¹⁵
DIST _{ij}	5051	1548	1016	8935
AGEXP _{ijt}	1547244	2740549	2448	15131955
AGIMP _{ijt}	883330	1732260	728.668	16319499
AGTRADE _{ijt}	2430575	3940678	9981	31062180
NAGEXP _{ijt}	14167694	28470101	40472	221898830
NAGIMP _{ijt}	20005430	41594294	14621	291239052
NAGTRADE _{ijt}	34173124	69049556	55093	513137883

The trend of agricultural export and import flows between the United States and OECD countries is presented as a time plot in the figures below (Figure 4.1, Figure 4.2). Over the past 41 years, overall agricultural exports from the United States to OECD countries have increased. However, the export volume was greatly reduced from 1980 to 1986 (Figure 4.1) which may be partly due to the increased production of non-agricultural products for example, manufacturing products and reduced protection of agricultural producers. The subsequent increase in agricultural exports after 1986 can be attributed to free trade agreements between the United States and some OECD countries such as Canada (CUSTA), Canada and Mexico (NAFTA), Australia, Israel, and Chile. Moreover, subsidization in agricultural products and prioritization of agriculture in global trade at and after the Uruguay Round of negotiations could be responsible for this boost in agricultural trade flows.



Figure 4.1 Agricultural export flows from the United States to OECD countries (1970-2010).

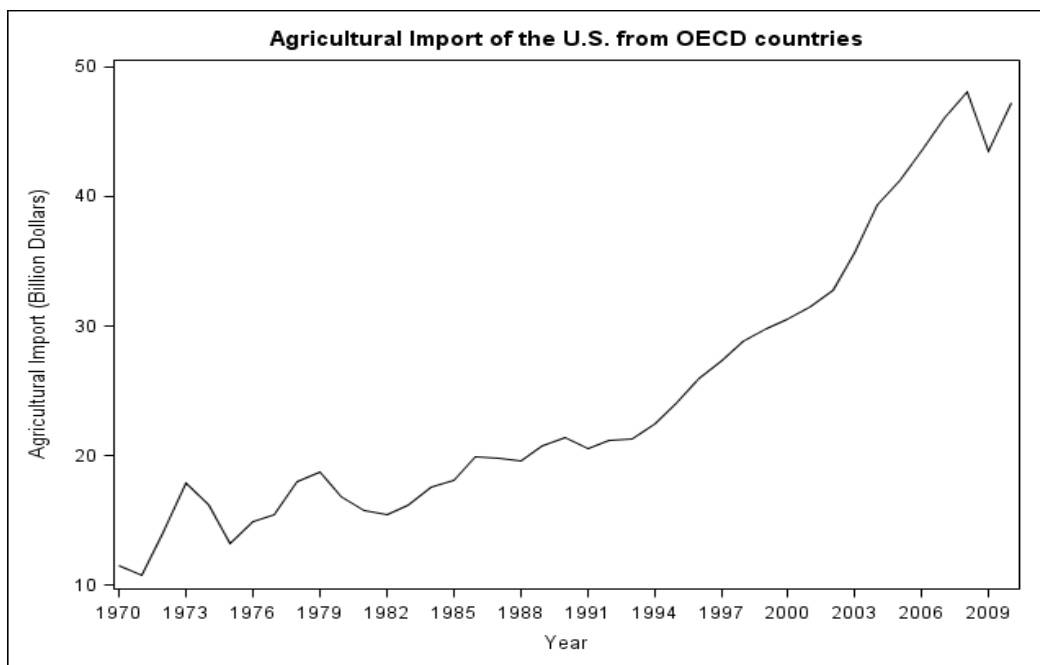


Figure 4.2 Agricultural import flows of the United States from OECD countries (1970-2010).

In Fig 4.2, an agricultural import of the United States from OECD countries is presented. Interestingly, there is a consistent increase in import from OECD countries over the past 41

years. This also backs up the fact that the United States has been involved more in manufacturing and non-agricultural production, which forces U.S. traders to import more of agricultural products to meet the domestic demand that is ever increasing.

4.2. Correlation Matrix

Table.4.3 Correlation matrix (N=1148).

Variables	EXV _{ijt}	RER _{ijt}	EM _{jt}	EM _{it}	DIST _{ij}
AGEXP _{ijt}	-0.12 <.0001	-0.082 0.0055	0.646 <.0001	0.007 0.804	-0.238 <.0001
AGIMP _{ijt}	-0.031 0.2932	0.148 <.0001	0.042 0.1584	0.211 <.0001	-0.427 <.0001
AGTRADE _{ijt}	-0.098 0.0008	0.008 0.7822	0.467 <.0001	0.098 0.0009	-0.353 <.0001
NAGEXP _{ijt}	-0.085 0.004	0.179 <.0001	0.313 <.0001	0.215 <.0001	-0.472 <.0001
NAGIMP _{ijt}	-0.075 0.011	0.101 0.0006	0.559 <.0001	0.229 <.0001	-0.388 <.0001
NAGTRADE _{ijt}	-0.080 0.0065	0.135 <.0001	0.466 <.0001	0.226 <.0001	-0.428 <.0001
TOTEXP _{ijt}	-0.091 0.0021	0.160 <.0001	0.3501 <.0001	0.202 <.0001	-0.463 <.0001
TOTIMP _{ijt}	-0.074 0.0125	0.104 0.0004	0.544 <.0001	0.230 <.0001	-0.393 <.0001
TOTTRADE _{ijt}	-0.082 0.0056	0.129 <.0001	0.468 <.0001	0.221 <.0001	-0.427 <.0001

Note: Corresponding P-values are reported just below the correlation coefficients.

In table 4.3, the Pearson correlation coefficients with corresponding P-values ($\alpha=0.05$) are presented. As expected, exchange rate volatility has a significant negative correlation with agricultural, non-agricultural and total export, import, and trade (export +import) flows between the United States and OECD countries. Similarly, the real exchange rate has a significantly positive impact on all but agricultural export flows from the United States to OECD countries. Moreover, economic mass of either country, home or foreign, always has a positive correlation

with all kinds of trade flows. At the same time, correlation between distance between countries and volume of bilateral trade flows is always negative, as expected. The reason is that distance is taken as a proxy for transportation cost, which reportedly has a negative impact on trade flows.

4.3 Effects of Exchange Rates on Export Flows

4.3.1 Exports from the United States to OECD Countries

Although the study aims to estimate the effect of exchange rate volatility on trade flows, a detailed analysis on the effect of exchange rate volatility is conducted by estimating both the separate and combined effects of real exchange rate and exchange rate volatility. Table 4.4 presents the effect of exchange rate volatility on exports from the United States to OECD countries. It is observed that exchange rate volatility has a significant negative impact in all three kinds of export flows, total, agricultural, and non-agricultural. The magnitude of impact is larger in agricultural as compared to non-agricultural exports. For example, a one unit increase in exchange rate volatility decreases agricultural exports from the United States to OECD countries by approximately³ 16.8% and non-agricultural exports by 9.5%. At the same time, total exports decrease by 20.8% (Table 4.4). This result is consistent with Kandilov (2007), and Cho, Sheldon, and McCorriston (2002). The reason behind the larger impact on agricultural exports resides in the relative sensitivity of agricultural sector to the exchange rate movements. Moreover, agricultural products have extremely limited storability as compared to non-agricultural products, which forces agricultural traders to sell their products irrespective of the fluctuations in the exchange rate market.

3. As the dependent variable is log linearized and independent variables are not, interpretation of coefficients is critical. In general, a one unit change in the independent variable results in $\beta_i \times 100\%$ change in the dependent variable holding all else constant. However, the exact % change can be calculated using back transformation. Consider equation (5): $\ln(\text{TRADE}_{ijt}) = \gamma_0 + \beta_1 \text{EXV}_{ijt} + \beta_2 \text{RER}_{ijt} + \beta_3 \ln \text{EM}_{it} + \beta_4 \ln \text{EM}_{jt} + \beta_5 \text{FTA}_{ijt} + \beta_6 \text{EURO}_{jt}$.

Back transforming equation (5) yields:

$$\text{TRADE}_{ijt} = e^{\gamma_0} + e^{\beta_1 \text{EXV}_{ijt}} + e^{\beta_2 \text{RER}_{ijt}} + e^{\beta_3 \ln \text{EM}_{it}} + e^{\beta_4 \ln \text{EM}_{jt}} + e^{\beta_5 \text{FTA}_{ijt}} + e^{\beta_6 \text{EURO}_{jt}}.$$

Replacing coefficients and variables with given values, we obtain the value of trade, say for 1970, and then can easily find the percent change in value of trade with 1 unit change in the independent variable. For simplicity, this analysis uses the approximate percent change, i.e. $\beta_i \times 100\%$.

In row 5 of table 4.4, the effect of free trade agreements on export flows is reported. It is found that free trade agreements always have a positive effect on exports from the United States to OECD countries. Moreover, it is important to note that relative advantages of free trade agreements are more than 10 times larger in the agricultural sector as compared to the non-agricultural sector with the coefficients (0.563) and (0.046) respectively. This means, when FTAs are in force, agricultural, non-agricultural and total exports from the United States to OECD countries increase by 56.3%, 4.6%, and 16.2%, respectively. This result reinforces the rapidly increasing protection of the agricultural sector under several trade agreements and negotiations, for example, the relative importance of the agricultural sector in the Doha Round of negotiations under WTO.

Table.4.4 Effect of Exchange Rate Volatility (EXV_{ijt}) on export flows (N=1148).

Variables	Exports		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.208* (0.027)	-0.168* (0.049)	-0.095* (0.028)
$\ln EM_{fr}$	0.59* (0.032)	0.739* (0.059)	0.581* (0.033)
$\ln EM_{us}$	0.282* (0.045)	-1.156* (0.083)	0.549* (0.047)
$Euro_{jt}$	0.073*** (0.038)	-0.228* (0.071)	-0.026 (0.04)
FTA_{ijt}	0.162* (0.048)	0.563* (0.089)	0.046 (0.051)
R^2	0.97	0.91	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

The effect of the real exchange rate on exports from the United States to OECD countries is presented in table 4.5 in the first row. The bilateral real exchange rate between the United States and OECD countries has significant negative impact on all types of export flows, giving the

highest impact on agricultural exports (-0.465). On average, a one unit increase in USD per foreign currency decreases U.S. agricultural exports to OECD countries by 46.5%. The same change in the real exchange rate reduces non-agricultural and total exports by 24.7% and 31.3%, respectively. It is important to note that the exchange rate is measured as U.S. Dollars (USD) per foreign currency unit. Any decrease in the real exchange rate makes the U.S. dollar weaker (a dollar depreciation). When the dollar weakens, U.S. export prices are reduced and it would be natural to expect that foreign importers will increase their consumption or imports of U.S. product. Therefore, the export volume is expected to increase with any decrease in the real exchange rate or depreciation of the dollar (USD/foreign currency). The impact of free trade agreements on export flows is the same as interpreted above and does not require further explanation.

Table.4.5 Effect of Real Exchange Rate (RER_{ijt}) on export flows (N=1148).

Variables	Exports		
	Total	Agricultural	Non-agricultural
RER_{ijt}	-0.313* (0.053)	-0.465* (0.097)	-0.247* (0.055)
$\ln EM_{fr}$	0.624* (0.032)	0.776* (0.059)	0.601* (0.033)
$\ln EM_{us}$	0.239* (0.045)	-1.185* (0.081)	0.531* (0.046)
$Euro_{jt}$	0.218* (0.059)	0.076 (0.107)	0.132** (0.061)
FTA_{ijt}	0.163* (0.049)	0.551* (0.089)	0.040 (0.051)
R^2	0.97	0.91	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

In practice, traders' decisions on doing business are based not only on their past experience relative to fluctuations in the exchange rate, but also due largely to their experience with spot exchange rates. In this regard, it is important to estimate the combined effect of exchange rate

volatility and real exchange rate to figure out how exactly the exchange rate affects trade flows. These combined effects are presented in table 4.6. It can be observed that taking exchange rate volatility into consideration, the real exchange rate always has a larger impact on all kinds of trade flows and its impacts are in the same direction as those of exchange rate volatility. Putting this all together, a one unit increase in the real exchange rate (exchange rate volatility) reduces total exports by 18.3% (17.3%). The same effect in the case of agricultural and non-agricultural exports is 39.4% (9.3%), and 20.5% (5.7%), respectively.

Table.4.6 Effects of Exchange Rates (EXV_{ijt} and RER_{ijt}) on export flows (N=1148).

Variables	Exports		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.173* (0.028)	-0.093*** (0.052)	-0.057*** (0.029)
RER_{ijt}	-0.183* (0.057)	-0.394* (0.105)	-0.205* (0.059)
$\ln EM_{fr}$	0.602* (0.032)	0.764* (0.059)	0.594* (0.033)
$\ln EM_{us}$	0.278* (0.045)	-1.164* (0.082)	0.544* (0.047)
$Euro_{jt}$	0.213* (0.058)	0.074 (0.107)	0.131** (0.061)
FTA_{ijt}	0.154* (0.048)	0.546* (0.089)	0.037 (0.051)
R^2	0.97	0.91	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

Although both exchange rate volatility and real exchange rate have negative impacts on all kinds of export flows, impacts of the real exchange rate are highly significant as compared to that of exchange rate volatility. Again, the magnitude of impact of both the real exchange rate and exchange rate volatility is larger in agricultural exports as compared to the non-agricultural sectors. It is worth explaining that no previous studies have estimated the combined effects of

exchange rate volatility and real exchange rate on trade flows. Therefore, it is safe to claim that the effect of the real exchange rate on international trade flows has been greatly overlooked.

4.4. Effects of Exchange Rates on Import Flows

4.4.1. Imports of the United States from OECD Countries

Most previous studies have estimated the effect of exchange rates either on bilateral trade flows or on export flows between and among countries. Some of the previous studies which estimated the effect on import flows are Hooper and Kholhagen (1978), Bahmani-Oskooee and Hegerty (2009), and Baek and Koo (2009). All of them found mixed effects of exchange rate volatility on import flows.

Table.4.7 Effect of Exchange Rate Volatility (EXV_{ijt}) on import flows (N=1148).

Variables	Imports		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.184* (0.033)	-0.234* (0.041)	-0.146* (0.039)
$\ln EM_{fr}$	0.487* (0.04)	0.245* (0.049)	0.49* (0.047)
$\ln EM_{us}$	0.768* (0.056)	0.127*** (0.069)	1.021* (0.066)
$Euro_{jt}$	0.274* (0.048)	0.496* (0.059)	0.107*** (0.057)
FTA_{ijt}	0.219* (0.061)	0.637* (0.075)	0.079 (0.071)
R^2	0.96	0.93	0.95

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

In table 4.7, the effects of exchange rate volatility on U.S. imports from the OECD are presented. As expected, the impact of exchange rate volatility has a highly significant and negative effect on all types of imports. The magnitude of impact is larger on agricultural imports than on that of non-agricultural and total imports. Particularly, a one unit increase in exchange rate volatility reduces agricultural, non-agricultural, and total import volumes of the United

States from OECD countries by 23.4%, 14.6%, and 18.4%, respectively. Moreover, the agricultural imports of the United States are almost twice as responsive to exchange rate movements as non-agricultural imports.

The effect of free trade agreements on U.S. imports from OECD countries is presented in the last row of table 4.7. As the results suggest, enforcement of free trade agreements between the United States and OECD member countries has benefitted U.S. importers. The proportion of benefits to the agricultural sector is almost 10 times larger than are the benefits to the non-agricultural sector. Agricultural imports increase by 63.7% when FTAs are in force but U.S. non-agricultural imports from the OECD are independent of FTAs. Again, as with the case of U.S. exports to OECD countries, U.S. agricultural importers have largely benefitted from the implementation of free trade agreements over the past 41 years. The finding reinforces the rapid proliferation of trade negotiations and free trade agreements in recent years. Government policies regarding the agricultural sector as an infant industry, minimal non-trade barriers in agricultural commodities, and input subsidization to the farmers could be the reasons behind this effect

For the previous four decades, with a free floating exchange rate that has been somewhat volatile in nature, it is no wonder that economists have vigorously debated whether fluctuations in the exchange rate have had a significant impact on international trade flows. There is no question on the assertions of those researchers who have sought to determine the possible effects of exchange rate volatility on trade flows, but it is now clear that the effect of the real exchange rate has been overlooked since the exchange rate system has entered into a floating regime.

The results in table 4.8 and 4.9 strengthen this argument. In table 4.8, the real exchange rate appears to have a negative impact on all 3 kinds of trade flows with the highest impact on non-agricultural imports (0.766) followed by total imports (0.672) and agricultural imports (0.253).

Unlike volatility, the real exchange rate has larger effect on non-agricultural import of the United States from OECD countries.

Table.4.8 Effect of Real Exchange Rate (RER_{ijt}) on import flows (N=1148).

Variables	Imports		
	Total	Agricultural	Non-agricultural
RER_{ijt}	-0.672* (0.064)	-0.253* (0.082)	-0.766* (0.075)
$\ln EM_{fr}$	0.536* (0.039)	0.279* (0.05)	0.539* (0.045)
$\ln EM_{us}$	0.739* (0.054)	0.077 (0.069)	1.004* (0.063)
$Euro_{jt}$	0.753* (0.071)	0.572* (0.091)	0.694* (0.082)
FTA_{ijt}	0.196* (0.059)	0.645* (0.076)	0.046 (0.069)
R^2	0.96	0.93	0.95

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

Table.4.9 Effects of Exchange Rates (EXV_{ijt} and RER_{ijt}) on import flows (N=1148).

Variables	Imports		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.066*** (0.035)	-0.217* (0.044)	-0.001 (0.041)
RER_{ijt}	-0.623* (0.069)	-0.091 (0.088)	-0.765* (0.081)
$\ln EM_{fr}$	0.527* (0.039)	0.251* (0.049)	0.539* (0.046)
$\ln EM_{us}$	0.754* (0.054)	0.125*** (0.069)	1.004* (0.063)
$Euro_{jt}$	0.751* (0.071)	0.566* (0.09)	0.694* (0.083)
FTA_{ijt}	0.192* (0.059)	0.633* (0.075)	0.046 (0.079)
R^2	0.96	0.93	0.95

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

It is reported in table 4.9 that both the real exchange rate and exchange rate volatility have a negative impact on U.S. imports from OECD countries. The effect of volatility on non-agricultural imports is not significant as is the case with the effect of the real exchange rate on agricultural imports. This result has some economic motivation behind it. First, non-agricultural products consist of those products which can be stored until the desirable price is reached in the market but, agricultural products often have to be sold irrespective of price fluctuations. Second, non-agricultural traders always can make exports and imports an option which is practiced when profitable. If this is the case, exchange rate volatility does not necessarily have a significant impact on non-agricultural trade flows. This result suggests that the U.S. non-agricultural importers care more about spot exchange rate unlike agricultural importers who pay more attention to exchange rate movement.

Moreover, the real exchange rate has a larger impact on non-agricultural imports but exchange rate volatility has the larger impact on agricultural import flows. Additionally, it is important to note that the real exchange rate has a larger impact on import flows as compared to the impact of exchange rate volatility. For example, the size of the impact of the real exchange rate on total imports is almost 10 times larger than the impact of exchange rate volatility on total imports. Specifically, a one unit increase in the real exchange rate reduces total imports by 62.3% but a one unit increase in volatility reduces total imports by 6.6%.

4.5. Effect of Exchange Rates on Trade Flows

4.5.1 Trade Flows between the United States and OECD Countries

The effect of exchange rate volatility on bilateral trade flows between and amongst various countries has been a widely researched issue since the 1970s when issue of exchange rate volatility first emerged. The majority of empirical studies over the past four decades have concentrated on documenting the effect of exchange rate volatility on bilateral trade (exports +

imports) flows over a certain period of time. For example, Broll and Eckwert (1999), Dell’Ariccia (1999), Rose (2000), Rose and Wincoop (2001), Cho et al. (2002), and Wang and Barrett (2007) are some of those studies which used trade (export + import) flows in their analysis. The main difference between those studies and this current study is that they did not estimate the effect of real exchange rate on bilateral total trade flows. Instead their variable of interest was exchange rate volatility.

In the first row of table 4.10, the impact of exchange rate volatility on U.S.–OECD bilateral trade flows is presented. The result shows that agricultural, non-agricultural, and total trade flows are negatively affected by exchange rate volatility. The largest size of the impacts is on the agricultural sector followed by trade flows in total and non-agricultural sector. As the results show, a one unit increase in exchange rate volatility reduces U.S.–OECD agricultural trade by 20.9%, non-agricultural trade by 12.4%, and total trade by 19.8%. This result is consistent with Kandilov (2008); Cho, Sheldon, and McCorriston (2002) and Dell’Ariccia (1999) where they found a negative effect of volatility with agriculture being the most affected sector.

Similarly, the effect of free trade agreements on U.S.–OECD trade flows is always positive and significant. It is interesting to note that, over the past 41 years the benefit from the enactment of free trade agreements between the United States and OECD member countries has primarily benefitted agriculture. For example, as shown in table 4.10, the magnitude of the impact of trade agreements on agricultural trade is approximately 6 times larger than for non-agricultural trade and 3 times bigger than for total trade flows between the United States and OECD countries. In particular, when existing FTAs are in force, the U.S.–OECD agricultural trade flows increased by 59.8%; a relatively large increment as compared to the 9.2% increase realized in non-agricultural trade and the 18.7% increase realized in total trade flows. This result is consistent

with Rose and Wincoop (2001), Grant and Lambert (2008) and Sun and Reed (2010) where they reported larger increase in member's agricultural trade during enforcement of certain RTAs that they studied.

Table.4.10 Effect of Exchange Rate Volatility (EXV_{ijt}) on trade flows (N=1148).

Variables	Trade (Export + Import)		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.198* (0.026)	-0.209* (0.036)	-0.124* (0.028)
$\ln EM_{fr}$	0.534* (0.031)	0.537* (0.044)	0.522* (0.034)
$\ln EM_{us}$	0.529* (0.044)	-0.736* (0.061)	0.759* (0.047)
$Euro_{jt}$	0.192* (0.038)	0.251* (0.053)	0.093** (0.041)
FTA_{ijt}	0.187* (0.047)	0.598* (0.066)	0.092*** (0.051)
R^2	0.97	0.94	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

The estimated effect of the real exchange rate on U.S. – OECD trade flows is reported on row 1, table 4.11. Unlike the effect of exchange rate volatility, the real exchange rate has the least impact on agricultural trade as compared to total and non-agricultural trade flows. Here, a one unit increase in the real exchange rate reduces agricultural, non-agricultural and total trade flows by 33.4%, 50.9% and 52.6%, respectively. Although there is no similarity in analytical approach, the findings of the previous studies are replicated. Two previous arguments are confirmed. First, the real exchange rate has a significant impact on trade flows (Kim et al., 2004) and second, the real exchange rate has a significant negative impact on trade flows (Bahmani-Oskooee and Kovyryalova, 2008). Again implementation of a free trade agreement,

which has a larger positive impact on agricultural trade as compared to other kinds of trade flows, may not need further explanation as it will be described later in this chapter.

Table.4.11 Effect of Real Exchange Rate (RER_{ijt}) on trade flows (N=1148).

Variables	Trade (Export + Import)		
	Total	Agricultural	Non-agricultural
RER_{ijt}	-0.526* (0.051)	-0.334* (0.072)	-0.509* (0.054)
$\ln EM_{fr}$	0.577* (0.031)	0.573* (0.044)	0.557* (0.033)
$\ln EM_{us}$	0.494* (0.042)	-0.779* (0.061)	0.742* (0.045)
$Euro_{jt}$	0.532* (0.056)	0.414* (0.079)	0.466* (0.06)
FTA_{ijt}	0.174* (0.046)	0.599* (0.067)	0.073 (0.049)
R^2	0.97	0.94	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

In the first two rows of table 4.12, the effect of exchange rate volatility (when considering the real exchange rate) on bilateral trade flows between the United States and OECD countries are reported. Again, it is consistent with the individual effects the volatility and the real exchange rate have on bilateral trade flows as shown in tables 4.10 and 4.11. Particularly, both volatility and real exchange rate have a significantly negative effect on U.S. – OECD trade flows. Not only the notion that exchange rate volatility has a negative impact on trade flows but also the idea that volatility has the largest negative impact on agricultural trade flows is verified empirically. For example, the size of the impact that volatility has on agricultural trade (-0.169) is approximately 5 times bigger than that of non-agricultural trade flows (-0.032). Here, the previous results as found by Kandilov (2008), Dell’Ariccia (1999), Cho, Sheldon, and McCorriston (2002), Wang and Barrett (2007) and Chowdhury (1993) are confirmed.

Table.4.12 Effects of Exchange Rates (EXV_{ijt} and RER_{ijt}) on trade flows (N=1148).

Variables	Trade (Export + Import)		
	Total	Agricultural	Non-agricultural
EXV_{ijt}	-0.115* (0.027)	-0.169* (0.039)	-0.032 (0.029)
RER_{ijt}	-0.439* (0.054)	-0.207* (0.077)	-0.485* (0.059)
$\ln EM_{fr}$	0.562* (0.031)	0.551* (0.044)	0.553* (0.033)
$\ln EM_{us}$	0.52* (0.042)	-0.741* (0.061)	0.749* (0.046)
$Euro_{jt}$	0.529* (0.055)	0.409* (0.079)	0.465* (0.06)
FTA_{ijt}	0.168* (0.046)	0.589* (0.066)	0.071 (0.049)
R^2	0.97	0.94	0.97

Note: Standard errors are in parentheses. The asterisk *, **, and *** indicate level of significance at 1%, 5% and 10% level respectively.

Moreover, the effect of the real exchange rate on all types of trade flows is negative as is the case with volatility (Table 4.12, row 2). Unlike volatility, non-agricultural trade is more responsive to real exchange rates than are agricultural trade flows. Specifically, the size of the impact on non-agricultural trade is more than double to the size of impact on agricultural trade flows, with coefficients of (-0.485) and (-0.207) respectively (Table 4.12, row 2). The effect of the real exchange rate and volatility as presented in tables 4.10, 4.11, and 4.12 clearly show that the agricultural sector is more responsive to exchange rate volatility, whereas the non-agricultural sector is more responsive to the real exchange rate. This notion is consistent with the results as reported by Kim et al. (2009), where, using a vector error correction model, they found a significant impact of the real exchange rate on bilateral trade flows.

4.6. FTAs, Euro, and U.S. – OECD Trade Flows

4.6.1 Effects of FTAs on Exports, Imports, and Trade Flows

It is expected that the promotion of free trade agreements (FTAs) encourages bilateral and multi-lateral trade flows not only among the members but also with non-members in several ways, such as reducing the risk premium of the traders (Grant and Lambert, 2008). Although there are few trade agreements between the United States and the other members of the OECD⁴, it is still expected that overall U.S.–OECD bilateral trade increases when FTAs are in force. The effect of promotion of FTAs on exports, imports and trade (exports +imports) flows between the United States and the OECD is presented in tables 4.4 to 4.12 above. The overall result is briefly summarized in table 4.13 below.

Table 4.13 Effect of FTAs on U.S. – OECD bilateral trade flows.

Sector	Type of flows		
	Export	Import	Trade
Agricultural	0.546* (0.089)	0.633* (0.075)	0.589* (0.066)
Non-Agricultural	0.037 (0.051)	0.046 (0.079)	0.071 (0.049)
Total	0.154* (0.048)	0.168* (0.046)	0.168* (0.046)

Note: Standard errors are in parentheses. The asterisks *, ** and *** denote the level of significance at 1%, 5% and 10% level respectively.

The first row of table 4.13 reports the effect of FTAs on agricultural exports, imports, and trade flows between the United States and OECD countries over the past 41 years. Similarly, the corresponding effects on the non-agricultural sector and the total economy are presented in table 4.13, rows 2 and 3, respectively.

4. The United States has four Free Trade Agreements (FTAs) with five member countries of OECD; they are a) the North American Free Trade Agreement (NAFTA), b) the U.S.–Australia FTA, c) the U.S.–Israel FTA, and d) the U.S.–Chile FTA.

It is important to note that participation in free trade agreements always has the largest impact on the agricultural sector, giving more benefits to U.S. agricultural importers (63.3%) as compared to U.S. exporters of agricultural products (54.6%). More importantly, the effect of FTAs on the non-agricultural sector is never significant, although it is always positive. This suggests that none of the non-agricultural exporters, either in the United States or in foreign countries have gained through these FTAs. This result is consistent with previous findings that regional trade agreements (RTAs) have had a positive effect on international trade flows and that the impact is always bigger on agricultural trade flows (Grant and Lambert, 2008; Sun and Reed, 2010 and Rose and Wincoop 2001).

4.6.2. Effects of the Euro on Exports, Imports, and Trade Flows

Table 4.14 Effect of the Euro on U.S. – OECD bilateral trade flows

Sector	Type of flows		
	Export	Import	Trade
Agricultural	0.074 (0.107)	0.566* (0.09)	0.409* (0.079)
Non-Agricultural	0.131*** (0.061)	0.694* (0.083)	0.465* (0.06)
Total	0.213* (0.058)	0.751* (0.071)	0.529* (0.055)

Note: Standard errors are in parentheses. The asterisks *, ** and *** denote the level of significance at 1%, 5% and 10% level respectively.

One of the purposes of constructing a monetary union (e.g. Eurozone) within the European Union was to promote intra-member and international trade flows (European Commission, 1990). Given this, it is important to empirically examine the validity of this assertion. Unfortunately, none of the studies reviewed have estimated the effect of the Eurozone on international trade flows. This situation led to the creation of a dummy variable, $EURO_{jt}$, which equals 1 if county j uses Euro as national currency and 0 otherwise. The effects of the euro on

exports, imports and trade flows between the United States and OECD countries are summarized in table 4.14.

As reported in table 4.14, the establishment of the Eurozone appears to have had a positive effect on international trade flows. However, unlike FTAs, the size of the impact of the euro is larger in the non-agricultural sector than in the agricultural sector. For example, U.S. – OECD bilateral trade in non-agricultural goods increased by a coefficient of 0.465 as compared to a 0.409 increment for agricultural trade (table 4.14, column 4). Moreover, U.S. agricultural exports to OECD countries (or agricultural imports of the Eurozone countries) are independent of the establishment of the Eurozone (Table 14.4, column 1, row 1). This result makes sense both economically and practically. First, Eurozone countries account for a very small proportion of U.S. agricultural exports to OECD countries and are not a major export destination of U.S. agricultural products. Second, the relatively strong market power of the United States gives its traders increased options. They may switch exports to an alternative destination if a partner's currency exchange rate is unfavorable.

4.7. Discussion

4.7.1. On the Negative Effect of Exchange Rate Volatility (EXV)

Exchange rate volatility was found to have a negative effect on all types of exports, imports, and trade (exports + imports) flows between the United States and the OECD. This is a well-established notion of the relationship between exchange rate volatility and international trade flows. The reason behind this assertion is as follows. An increase in exchange rate volatility makes the exchange rate less predictable, thereby introducing a greater factor of risk in doing business. Risk-averse traders either leave the business, greatly reduce their production activities, or require a risk premium to maintain their previous level of economic activity. Those who stay

in business are often forced to adjust their production costs by reducing the size of their production facilities and the volume of production (Dell’Ariccia, 1999; Cho, Sheldon, and McCorriston, 2002 and Kandilov, 2008). Other traders, who are risk takers, increase their export prices to offset the potential losses from the associated risk. This makes markets vulnerable and reduces export flows. Moreover, the volatile exchange rate indirectly reduces trade flows by distorting the allocation of resources and government policies (Orden, 2002).

This study was also able to replicate previous findings that exchange rate volatility has had a greater impact on the agricultural sector as compared to non-agricultural sectors (Cho, Sheldon, and McCorriston, 2002 and Kandilov, 2008). Those studies have discussed several reasons behind this result. For example, agricultural products are relatively homogenous and more perishable than manufactured products. Moreover, agriculture is characterized by greater price flexibility, short term contracts and a higher level of competitiveness. All of these factors make agricultural trade relatively more responsive to exchange rate fluctuations than trade in other sectors. Furthermore, given that traders would prefer less risk, higher exchange rate volatility reduces trade activity, impacts commodity prices, and may shift the source of supply and demand. This situation immediately leads to a change in distribution of output across countries (Chowdhury, 1993). As risk-averse traders react to the highly volatile exchange rate by favoring intra-national trade to a foreign transaction, this reduces international trade flows.

4.7.2. On the Negative Effect of Real Exchange Rate (RER)

In the results section of this chapter, it was reported that the real exchange rate has a negative impact on all types of trade flows in all three sectors, agricultural, non-agricultural, and total. There is a limited number of studies which examined the effect of the real exchange rate on international trade flows (Bake and Koo, 2009; Kim et al., 2009; Gopinath et al., 1998;

Poonyth and Zyl, 2000; Pick, 1990 and Bahmani-Oskooee and Hegerty, 2009). Considering all of their conclusions, the results from these studies are ambiguous. However, our findings indicate that the real exchange rate has a negative impact on exports, imports and trade (exports + imports) flows between the United States and OECD countries. The magnitude of this impact is greater in the non-agricultural sector unlike what we saw in case of exchange rate volatility. One possible reason behind the negative effect of the real exchange rate on U.S. – OCED trade flows could be as follows. It can be argued that there is no guarantee that a higher spot exchange rate and its volatility retain the same pattern until traders actually carry out their trading activities. This situation leads traders to depend more on the pattern of how the exchange rate fluctuates rather than just the spot rate. Moreover, as the real exchange rate used in this study is annual, no results hold true for the monthly and quarterly exchange rates.

The reason behind the result that the real exchange rate has a greater impact on the non-agricultural sector than on agricultural sector can be the following. In agricultural industries, production decisions are typically made in advance of the decision over how to allocate the produced goods, either nationally or internationally. As far as production is concerned, it does not depend on the spot exchange rate as it must be chosen before the exchange rate is realized. Although the decision on how and where to distribute the product is generally made once the exchange rate is realized, product distribution is still independent of the real exchange rate. Product distribution cannot be postponed to the extent that non-agricultural goods can, as agricultural commodities are perishable. Therefore, the effect of the spot exchange rate has a smaller effect on agricultural trade flows.

The real exchange rate plays a minimal role in determining U.S. agricultural imports. When the value of the U.S. dollar decreases, foreign exporters squeeze their profit margins to offset the

increase in their export prices in order to maintain their share of the U.S. market (Baek and Koo, 2009). However, a decrease in the value of the U.S. dollar causes an increase in U.S. exports of goods and commodities through a decline in export prices. In the case where traders are risk-averse and the exchange rate is unpredictable, the risk adjusted expected profit falls if hedging is impossible or costly (Chowdhury, 1993). The real exchange rate has a negative effect on U.S. exports because an appreciation of the U.S. dollar increases the cost of U.S. products to foreign buyers and reduces their purchases of the U.S. products. At the same time, it increases the U.S. consumer's purchasing power with respect to foreign products (Gopinath et al., 1998).

4.7.3. On the Positive Effects of FTAs and Euro

It is not surprising that the establishment of FTAs and construction of monetary unions have positive impacts on international trade flows. It is assumed that there are lower trade barriers among the members of FTAs. This promotes intra-member trade. The results are consistent with the previous findings. Baek and Koo (2009) found a positive relationship between CUSTA and NAFTA on both the export and import functions of the United States. They reported that, in the long-run, the magnitude of the effect of CUSTA and NAFTA was greater in the U.S. export sector as compared to the import sector. This result implies that the United States has benefitted more from these FTAs than have other countries.

As far as the positive effect of a monetary union (the Eurozone in this case) is concerned, it is expected that countries using same currency have a greater tendency to trade. The formation a monetary union affects trade flows in two ways. First, it stabilizes exchange rate fluctuations which give traders an incentive to carry on their trading activities. Second, the existence of a monetary union and the corresponding reduced exchange rate volatility decreased the risk premium, thus lowering production costs and market prices.

CHAPTER 5

SUMMARY AND CONCLUSIONS

5.1. Summary

This study has investigated whether exchange rate volatility has a negative effect on bilateral agricultural trade flows between the United States and OECD countries. The effect of exchange rate volatility on trade flows is estimated both separately and in combination with the real exchange rate. A balanced panel of U.S. agricultural, non-agricultural and total exports, imports and trade (exports + imports) flows to 28 OECD countries for the past 41 years (1970-2009) is constructed. This gives a long panel dataset of 28 cross-sections and 1148 observations to which the gravity model specification is applied. The use of the gravity model specification has numerous advantages over cross-sectional and time series studies, such as capturing cross country specific effects, cultural effects, and socioeconomic and policy variables. Exchange rate volatility is determined using the first difference method. This is nothing more than a moving standard deviation of the first difference of the logarithmic real exchange rate over the previous ten years. The real exchange rate is the spot exchange rate adjusted for inflation in both the home and foreign countries over time.

The gravity equation is estimated as a fixed effect model using panel data. The estimated coefficients indicate that both exchange rate volatility and the real exchange rate have a significant and negative effect on all types of trade flows in general. There was no evidence of any non-significant negative effects obtained in the results. Interestingly enough, the results obtained were not the often discussed positive effects of real exchange rate levels or volatility as has been claimed by a number of previous studies. The established notion that the agricultural sector is more responsive to fluctuations in exchange rate is confirmed. Although exchange rate

volatility always has the biggest impact on agricultural trade flows, some ambiguity exists when it comes to the real exchange rate level. Unlike exchange rate volatility, the real exchange rate level has the bigger impact on non-agricultural imports as compared to the agricultural and total imports of the United States from OECD countries. Similarly, the same pattern holds for agricultural and non-agricultural trade flows where the latter is more responsive to the real exchange rate. Interestingly, the results show that the impact of the real exchange rate on either kind of trade flows (exports, imports, or exports + imports) is always bigger relative to the impact of exchange rate volatility. This result led us to conclude that the effect that the real exchange rate has on international trade flows has been greatly overlooked.

The positive effect of FTAs and the Euro on all three kinds of trade flows suggests that the adoption of free trade agreements and construction of monetary unions enhance international trade flows. Although FTAs have a greater positive impact on the agricultural sector relative to other sectors, it is shown that agricultural importers have benefitted more than agricultural exporters. However, the effects of FTAs on the non-agricultural sector are not significant. When it comes to the effect of a monetary union on trade flows, positive effects are reported in all cases. Nevertheless, unlike FTAs, construction of the Eurozone turned out to be more beneficial to non-agricultural traders. In general, importers experience a greater positive effect than do exporters.

5.2. Implications of the Results

The policy implications of the negative effects of the real exchange rate and exchange rate volatility on U.S. – OECD bilateral trade flows are connected to the risk preferences of traders and the trade policies of the respective governments. Although most OECD countries are developed, the result evinces the notion that their governments do not have efficient instruments

to hedge against exchange rate volatility. Regarding the greater negative impact on agricultural trade flows, a more extensive farm policy could help mitigate its impact. In general, U.S. policymakers should be interested in the empirical findings that exchange rate volatility has a greater negative effect on agricultural trade flows relative to non-agricultural trade flows. The federal government should consider this as they develop farm policy.

Changes in exchange rate volatility may result in policy regime change. For example, trade liberalization in a period of high exchange rate volatility may result in increased trade flows even if the volatility does not promote trade. This assertion explains the ambiguity of the empirical results over the long run. Therefore, it is inappropriate to make policy recommendations based solely on the empirical results obtained in this study. Although the results signify that an increase in exchange rate volatility is associated with reduced trade flows, evidence does not exist indicating that trade flows would increase if currency stabilization policies were enforced.

As the exchange rate has a significant impact on trade flows, monetary authorities should consider the effects of monetary policy on trade flows. As appreciation of the U.S. dollar reduces exports and thereby trade flows, monetary officials should avoid contractionary monetary policies, such as increased interest rates, to reduce inflation in an attempt to strengthen the U.S. dollar against foreign currency. This study does not support exchange rate stabilization in an attempt to promote trade flows. Attempts to achieve currency stabilization without mitigating the actual causes of the exchange rate volatility would be counterproductive in the long run.

5.3. Limitations of the Study

This study used annual, end of period exchange rate data to compute exchange rate volatility. However, it appears that the annual spot rate does not efficiently capture the risk associated with short-run (monthly or quarterly) fluctuations in the exchange rate. Although total trade is divided

into two sectoral trade flows, agricultural and non-agricultural, this division is not disaggregated to a sufficient degree to eliminate aggregation bias. The number of cross-sections is less than the number of time series units, which limits the analysis by forcing the use of only the fixed effect model.

5.4. Future Research

It is recommended that future studies consider monthly volatility and two way trade flows between trading countries. The use of aggregated data and dividing the sample into two different sectors does not necessarily avoid aggregation bias. Hence, it is suggested that future research use disaggregated data for all agricultural and non-agricultural commodities and estimate the effect on exports, imports and trade (exports + imports) flows separately. The results demand that the issue of the real exchange rate and international trade flows be comprehensively investigated. Examining the positive effect of the Euro on the U.S. – OECD trade flows, it is recommended that future research investigate the effect of monetary unions on bilateral trade flows among all OECD countries, not just between one country and the other countries.

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APPENDIX-I

DATA, DEFINITION OF THE VARIABLES, AND INFORMATION ON COUNTRIES STUDIED

Table A1.1 Sources and Definition of the Variables

Variables	Definition	Sources
Explanatory Variables		
EXV _{ijt}	Exchange rate volatility between countries <i>i</i> and <i>j</i> at time <i>t</i> .	Constructed
RER _{ijt}	Real exchange rate between countries <i>i</i> and <i>j</i> at time <i>t</i> .	IMF's IFS
EM _{it}	Economic mass (=GDP x Population) of country <i>i</i> at time <i>t</i> .	Constructed
EM _{jt}	Economic mass of country <i>j</i> at time <i>t</i> .	Constructed
DIST _{ij}	Geographical distance between countries <i>i</i> and <i>j</i> (this is used as proxy for transportation costs).	distancefromto.net
FTA _{ijt}	=1, if there is free trade agreements between country <i>i</i> and <i>j</i> at time <i>t</i> , 0 otherwise.	WTO, RTA database
EURO _{jt}	=1, if the country <i>j</i> is member of Eurozone at time <i>t</i> , 0 otherwise	Eurostat
Explained Variables		
AGEXP _{ijt}	Agricultural export from the U.S. to OECD countries at time <i>t</i>	USDA, GFD
AGIMP _{ijt}	Agricultural import of the U.S. from OECD countries at time <i>t</i>	USDA, GFD
AGTRADE _{ijt}	Agricultural trade between the U.S. and OECD countries at time <i>t</i>	Constructed
TOTEXP _{ijt}	Total export from the U.S. to OECD countries at time <i>t</i>	UN, COMTRADE
TOTIMP _{ijt}	Total import of the U.S. from OECD countries at time <i>t</i>	UN, COMTRADE
TOTTRADE _{ijt}	Total trade between the U.S. and OECD countries at time <i>t</i>	Constructed
NAGEXP _{ijt}	Non-agricultural export from the U.S. to OECD countries at time <i>t</i>	Constructed
NAGIMP _{ijt}	Non-agricultural import of the U.S. from OECD countries at time <i>t</i>	Constructed
NAGTRADE _{ijt}	Non-agricultural trade between the U.S. and OECD countries at time <i>t</i>	Constructed
Other Variables Used		
GDP _{it}	Gross Domestic products of country <i>i</i> at time <i>t</i>	World Bank's WDI
GDP _{jt}	Gross Domestic products of country <i>j</i> at time <i>t</i>	World Bank's WDI
POP _{it}	Population of country <i>i</i> at time <i>t</i>	World Bank's WDI
CPI	Consumer Price Index (for all 29 countries)	World Bank's WDI

Table A1.2 Organization for Economic Co-operation and Development (OECD)

S.N	Country	Member Since	S.N.	Country	Member Since
1	Australia	6/7/1971	18	Japan	4/28/1964
2	Austria	9/29/1961	19	Korea, Republic of	12/12/1996
3	Belgium	9/13/1961	20	Luxembourg	12/7/1961
4	Canada	4/10/1961	21	Mexico	5/18/1994
5	Chile	5/7/2010	22	Netherlands	11/13/1961
6	Czech Republic	12/21/1995	23	New Zealand	5/29/1973
7	Denmark	5/30/1961	24	Norway	7/4/1961
8	Estonia	12/9/2010	25	Poland	11/22/1996
9	Finland	1/28/1969	26	Portugal	8/4/1961
10	France	8/7/1961	27	Slovak Republic	12/14/2000
11	Germany	9/27/1961	28	Slovenia	7/21/2010
12	Greece	9/27/1961	29	Spain	8/3/1961
13	Hungary	5/7/1996	30	Sweden	9/28/1961
14	Iceland	6/5/1961	31	Switzerland	9/28/1961
15	Ireland	8/17/1961	32	Turkey	8/2/1961
16	Israel	9/7/2010	33	United Kingdom	5/2/1961
17	Italy	3/29/1962	34	United States	4/12/1961

Source: OECD, Country Database, 2011

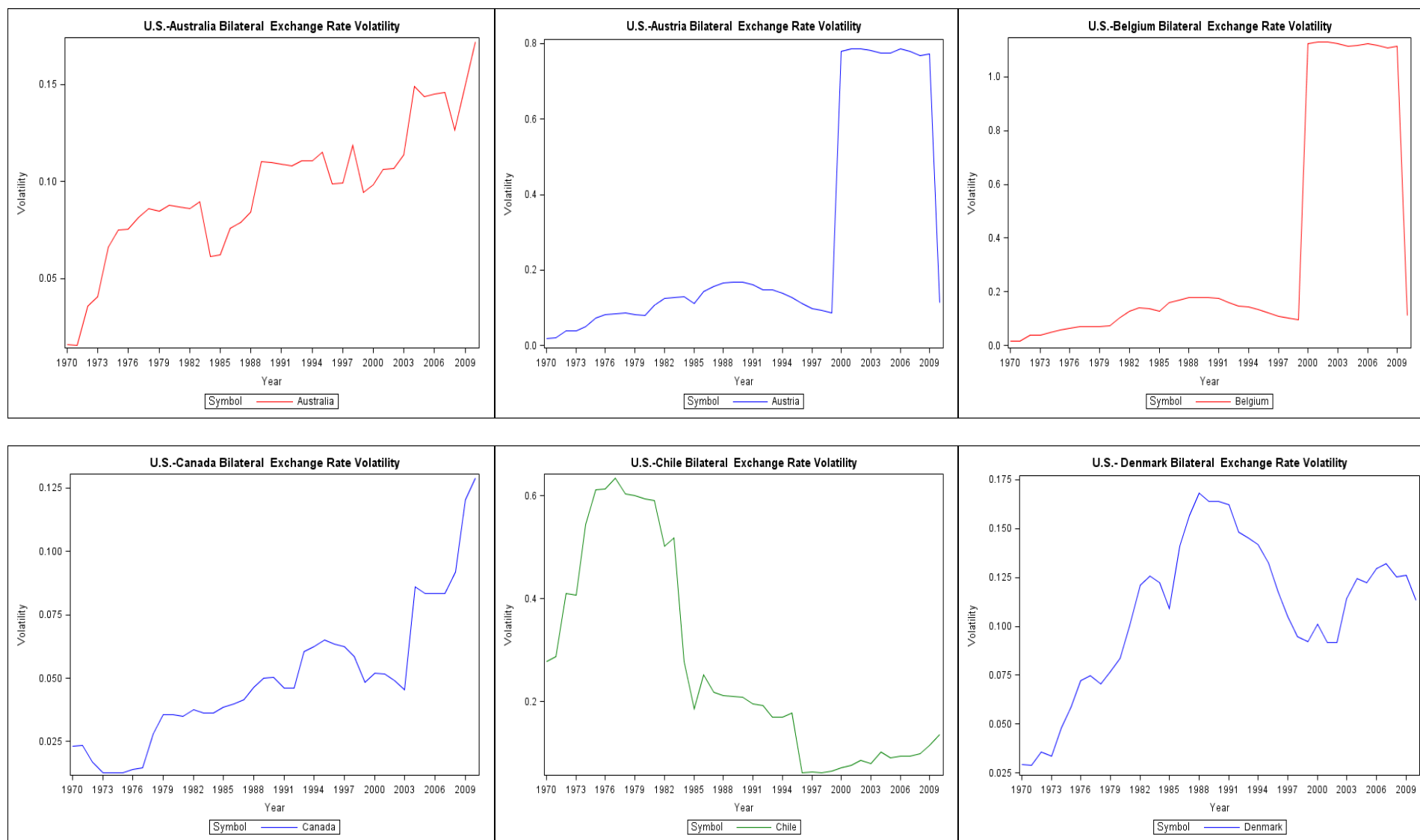
Home Country (Reporter): United States of America

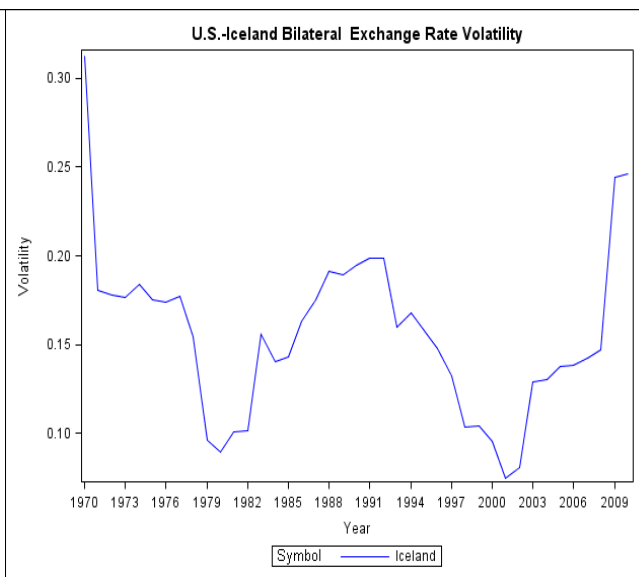
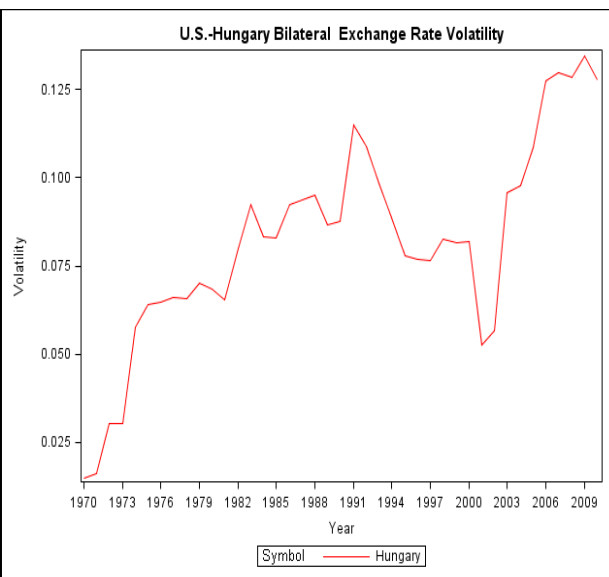
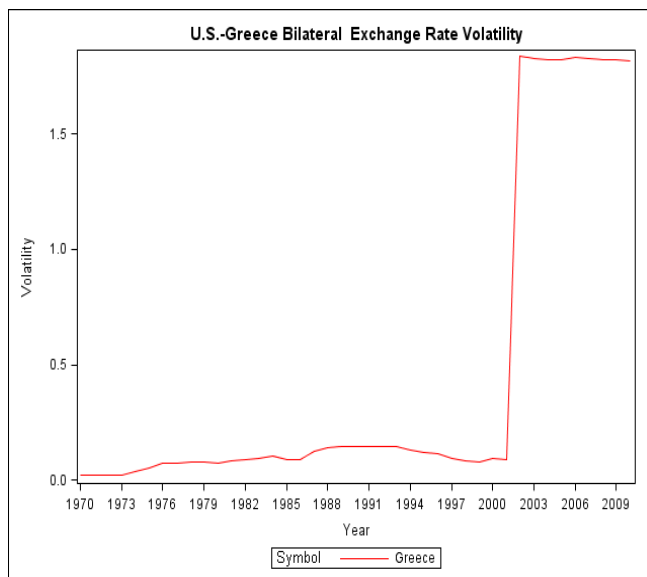
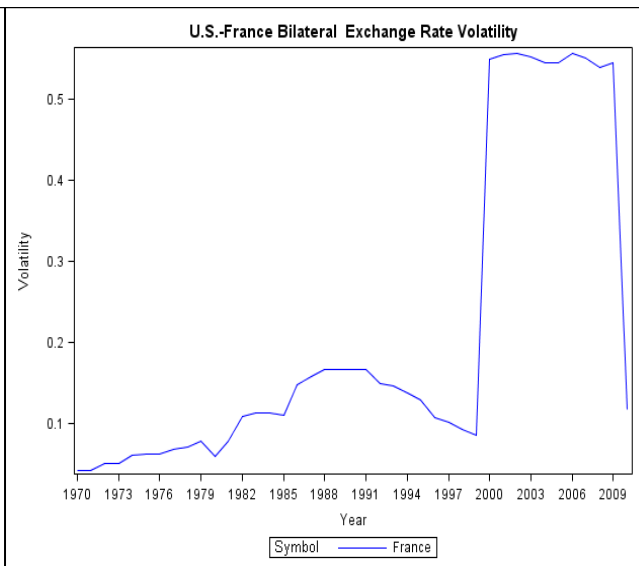
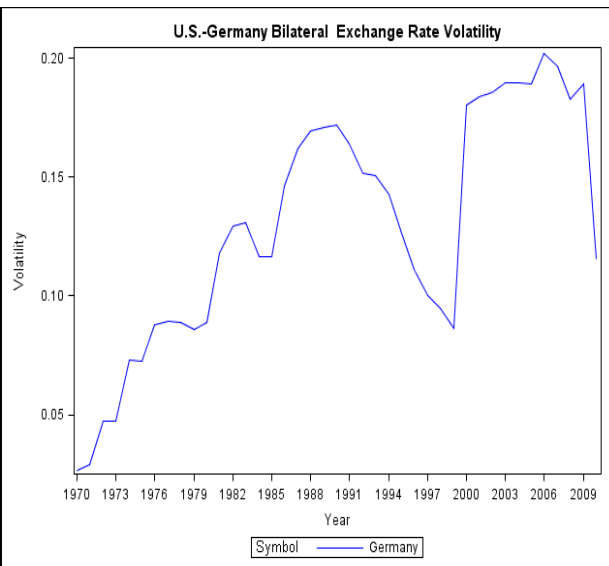
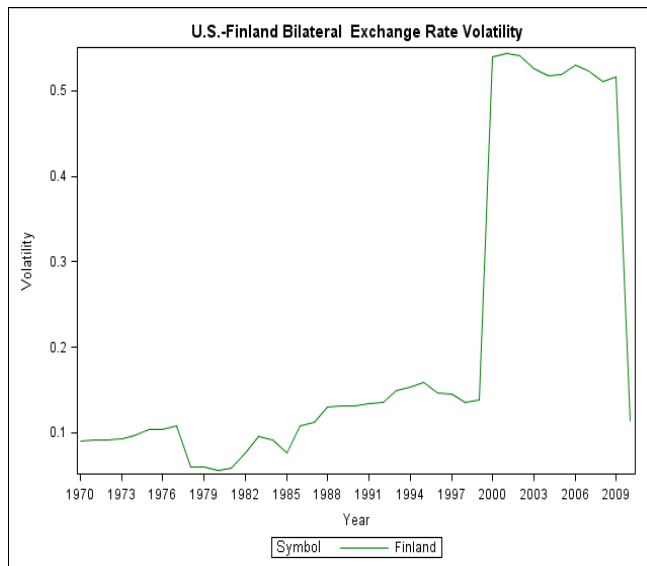
Foreign Countries (Partners): Australia, Austria, Belgium-Luxemburg, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, S. Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom

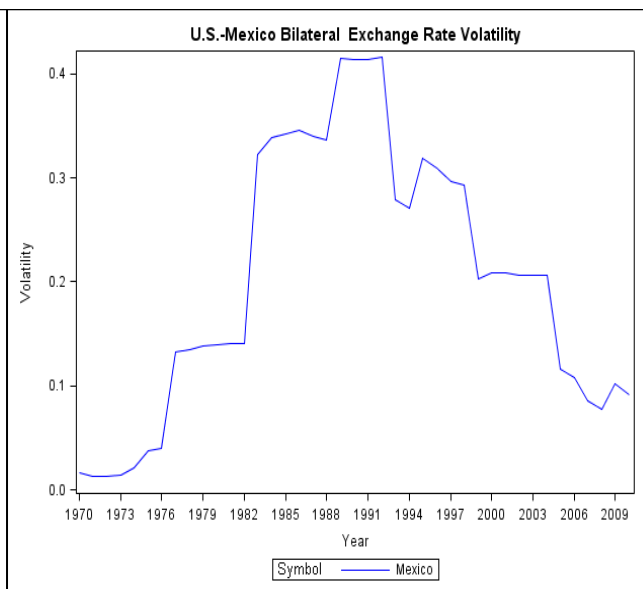
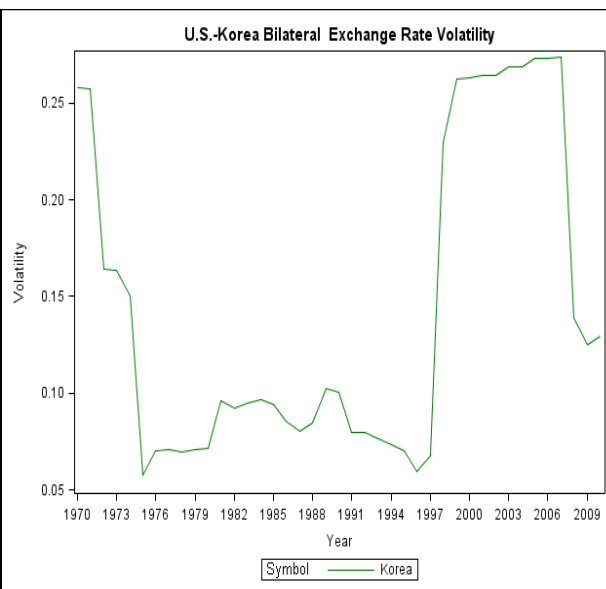
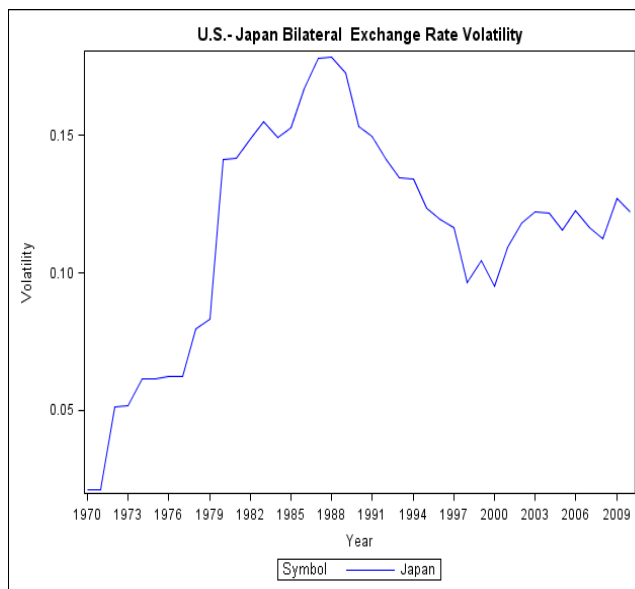
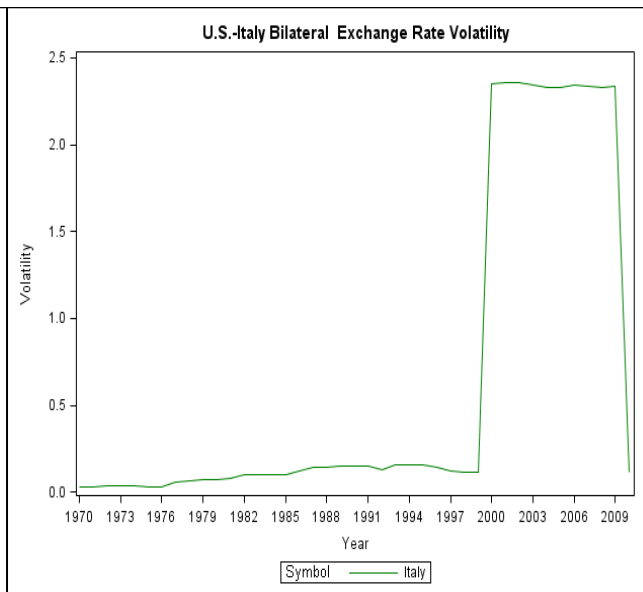
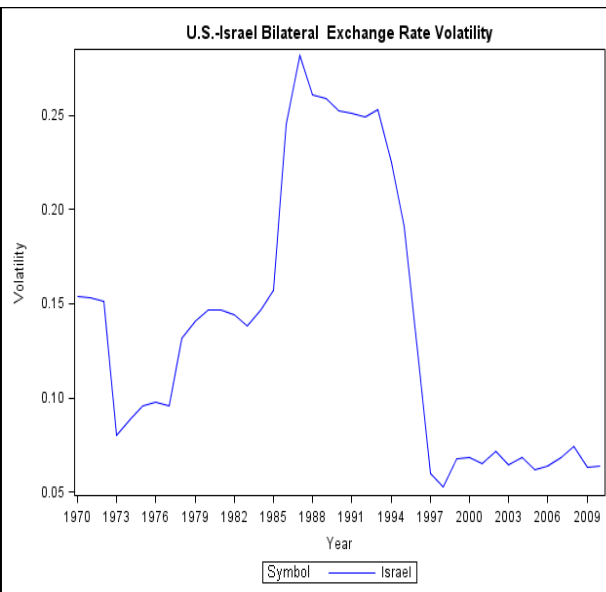
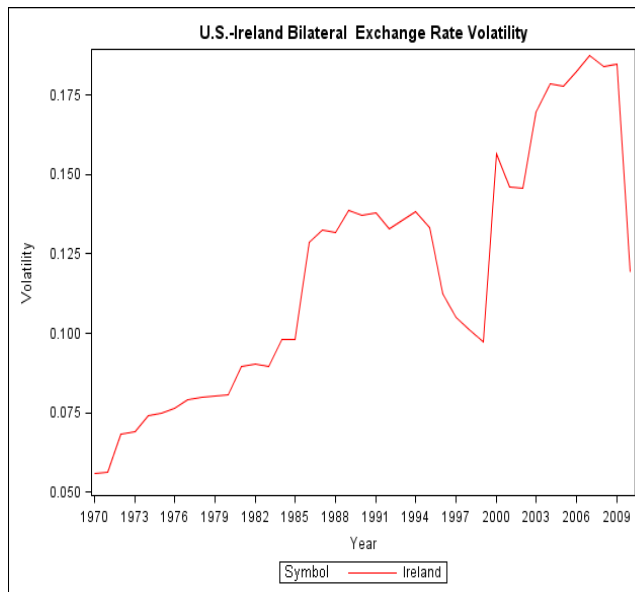
APPENDIX – II

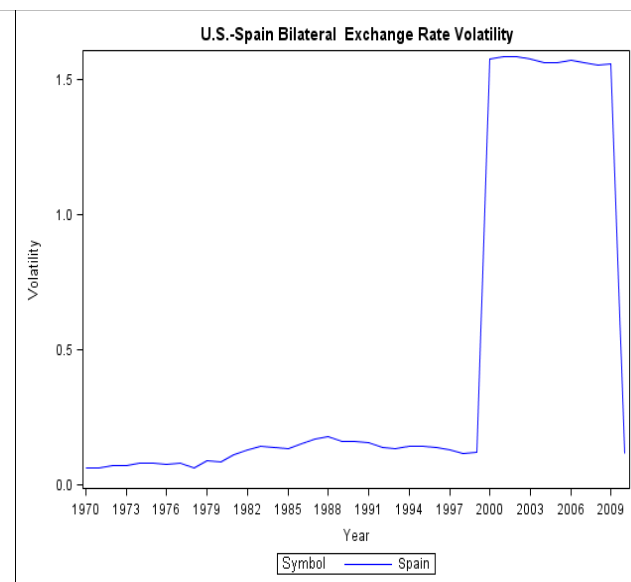
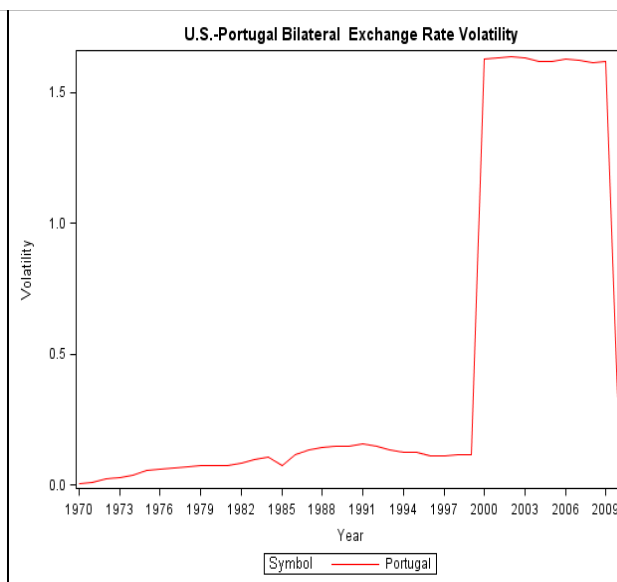
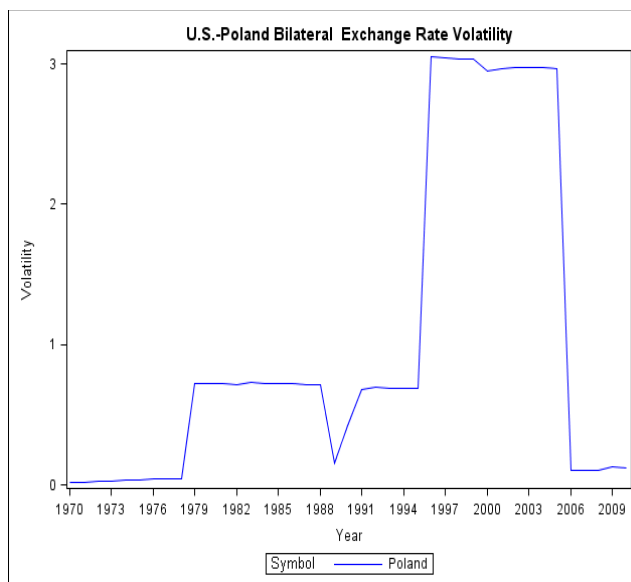
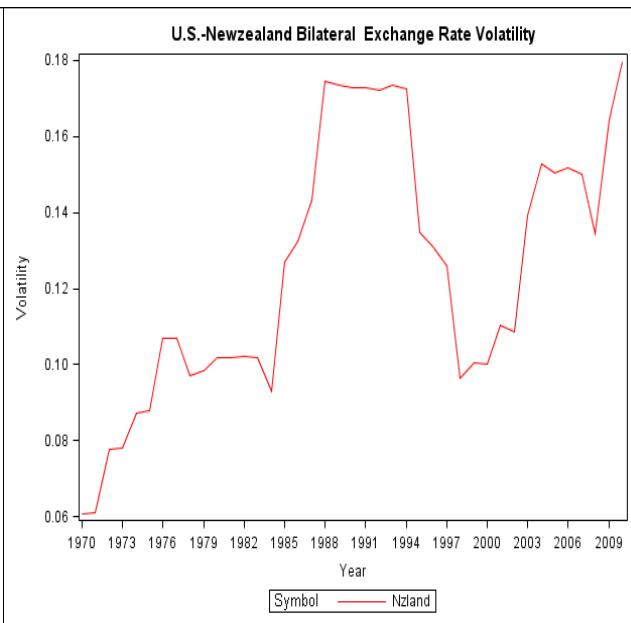
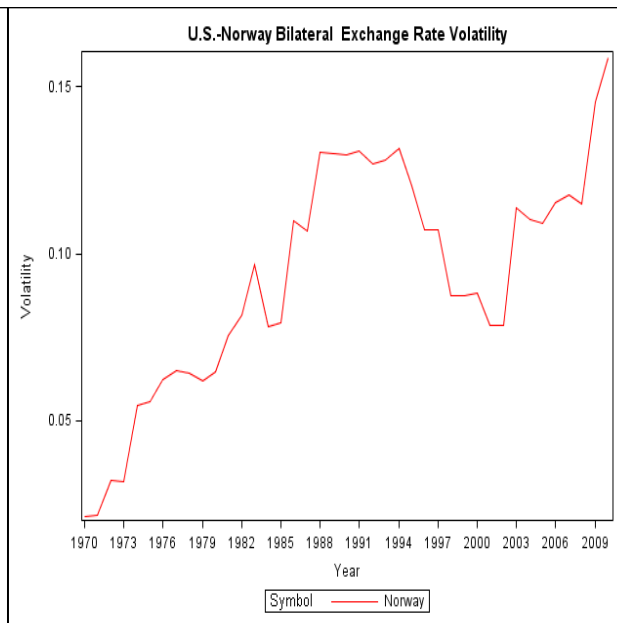
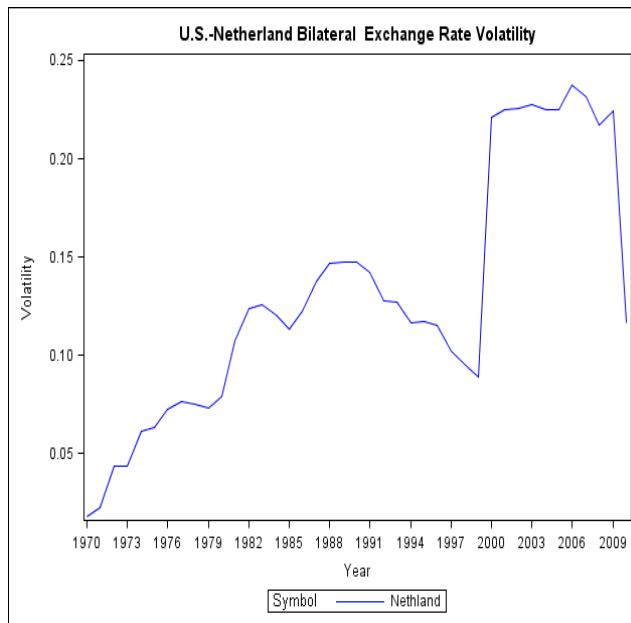
ADDITIONAL GRAPHS AND FIGURES

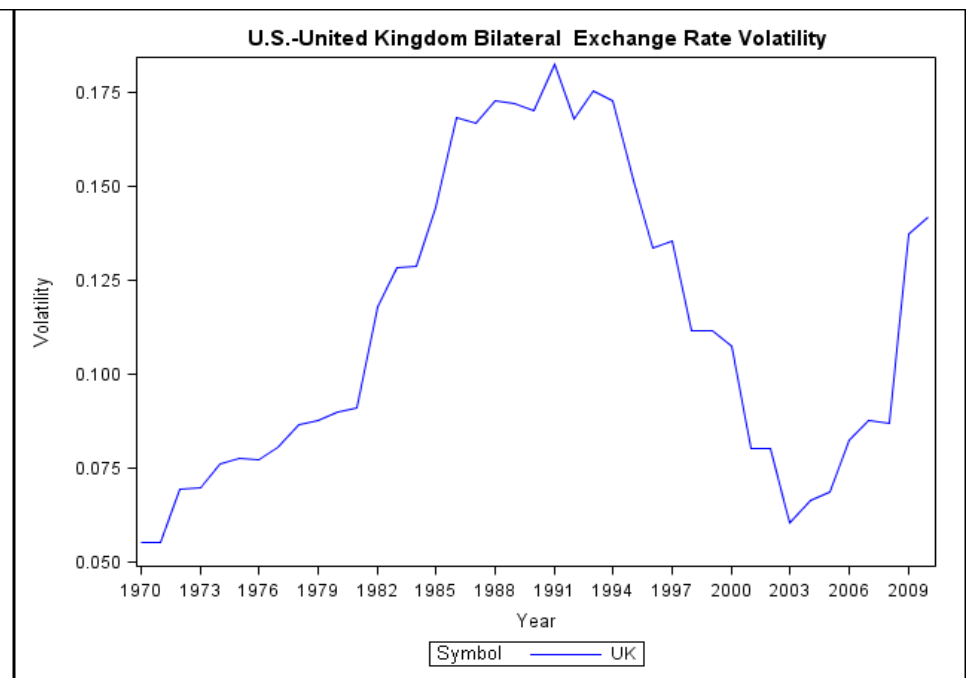
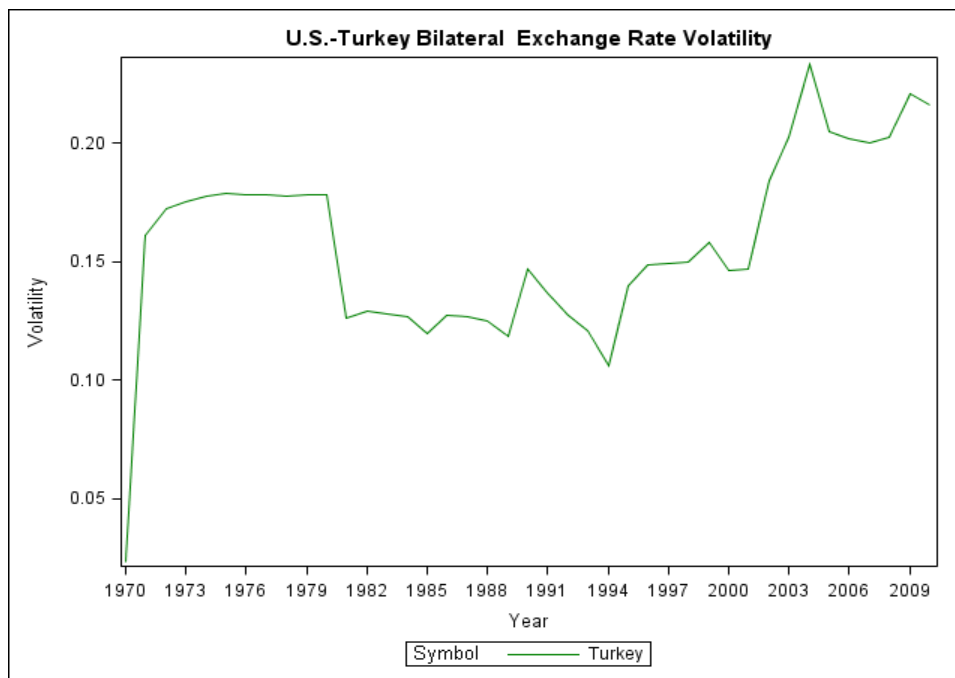
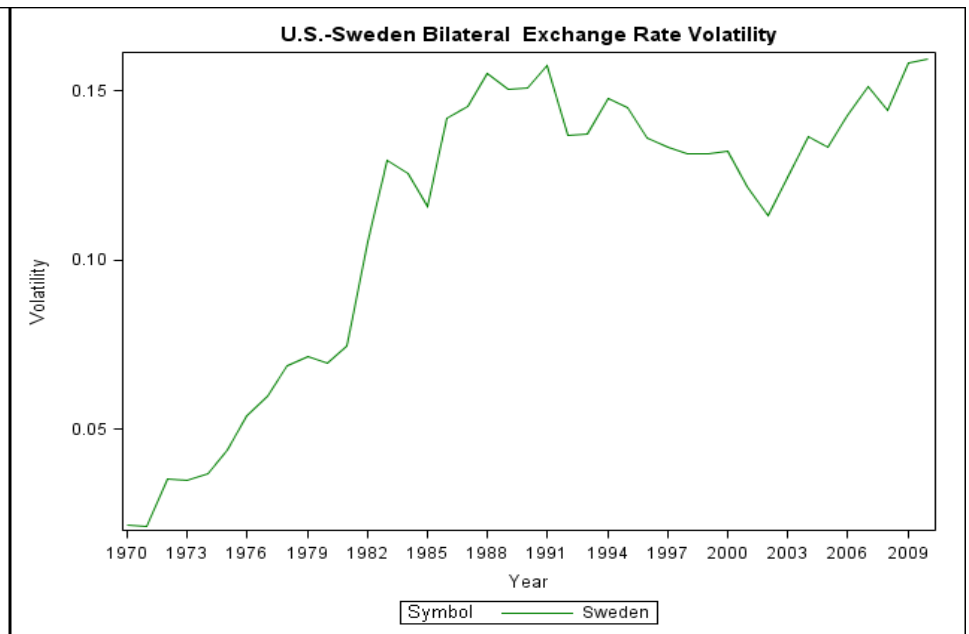
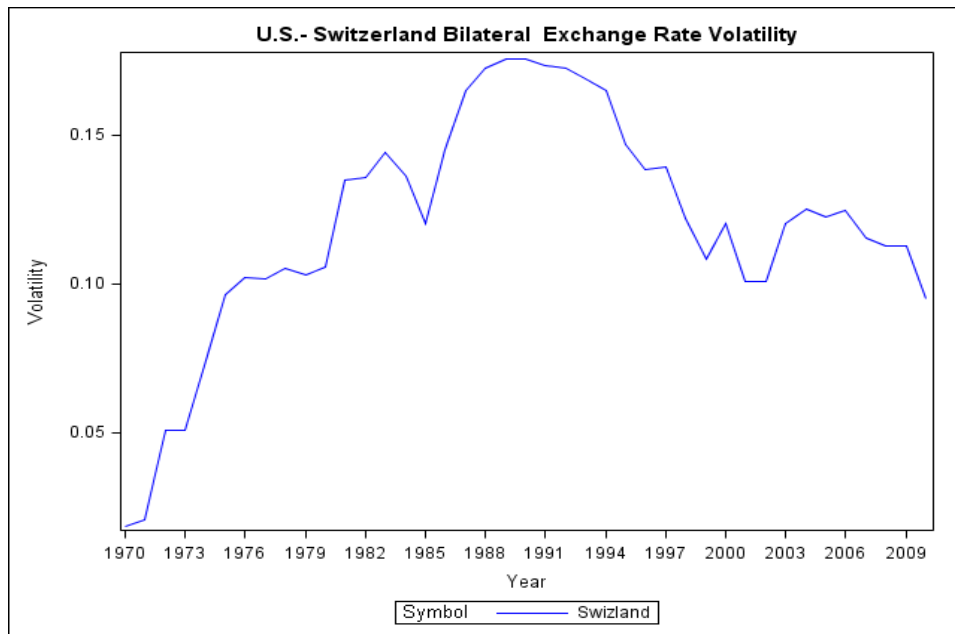
A.2.1. Exchange Rate Volatility between the United States and Individual OECD Countries



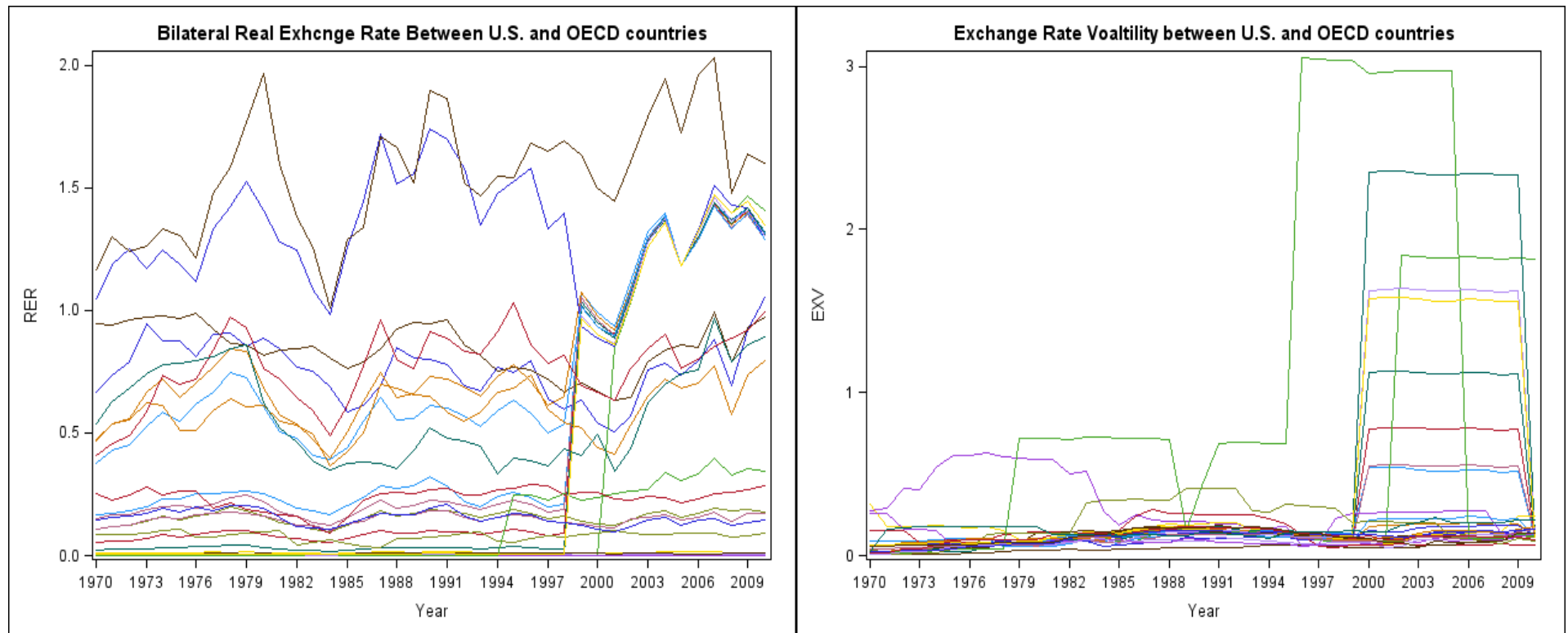




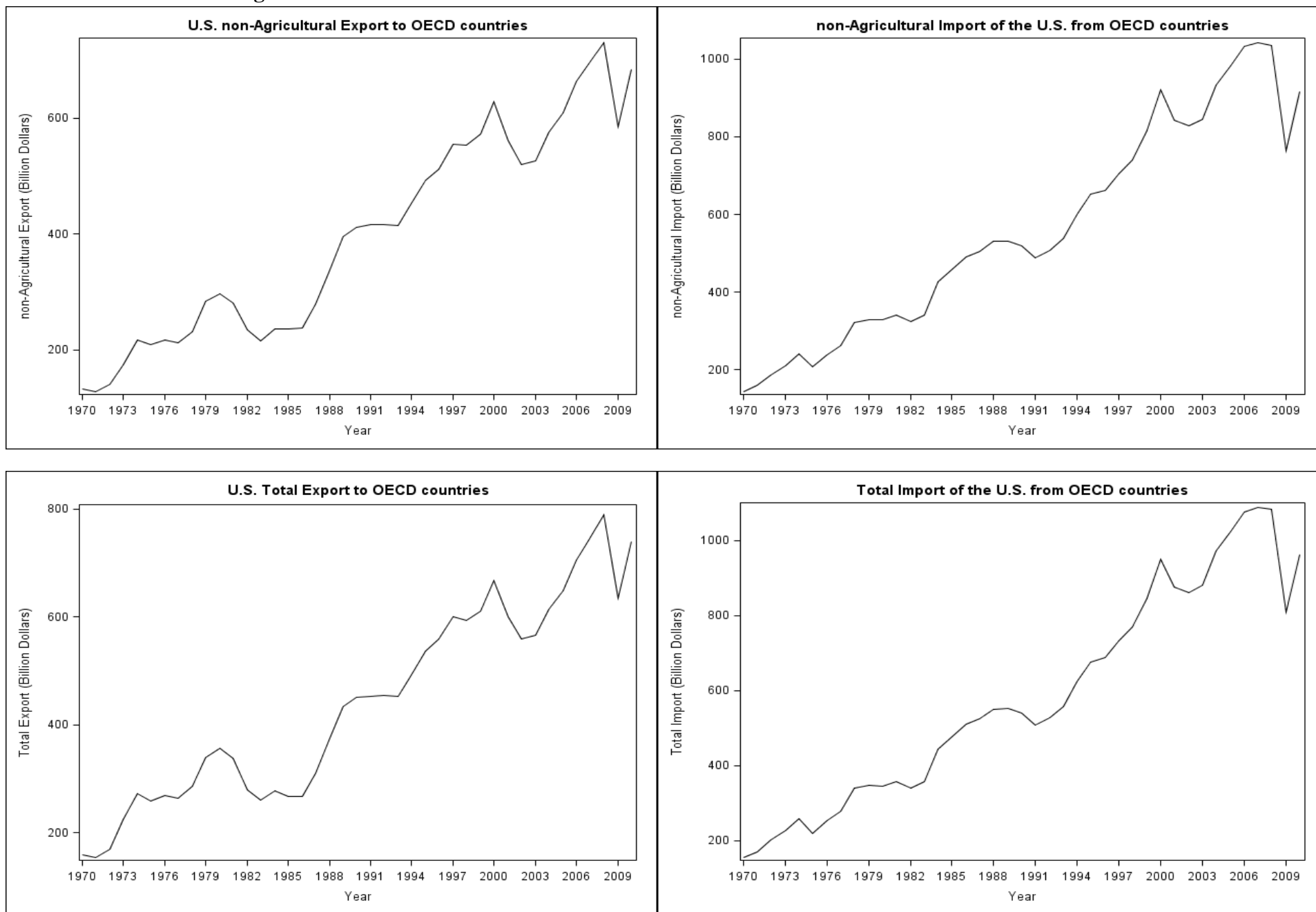




A.2.2. Real Exchange Rate and Exchange Rate Volatility between the United States and OECD Countries



A.2.3. Total and Non-agricultural Trade Flows between the U.S. and OCED Countries



APPENDIX-III

EXAMPLE SAS PROGRAM

A.3.1. Determining Exchange Rate Volatility by First Difference Method

```
Dm 'log; clear; output; clear';
options nodate nonumber ps=55 ls=78 pageno=1;
Proc import datafile="E:\RESEARCH\Economics\DATA\By Variables\exrates.xls" replace
out=exrates;
run;
ods rtf file="EXUijt.rtf";
/* 10 year moving avg, stdev assuming:
   one obs per year from 1959 to 2010.
   observations are already in the sorted order by symbol. */
%let START = 1959;
%let FINISH = 2010;
data Firstdiff;
set exrates;
Xijt=dif(log(RER));
run;
data Volatility;
  array val[%eval(&START):&FINISH] val&START-val&FINISH;
  do until (last.symbol);
    set Firstdiff;
    by symbol;
    if &START<=year<=&FINISH then val[year] = Xijt;
  end;
  do year = %eval(&START+11) to &FINISH;
    avg10 = mean(val[year-10],val[year-9],val[year-8],val[year-7],val[year-6],
                val[year-5],val[year-4],val[year-3],val[year-2],val[year-1]);
    std10 = std(val[year-10],val[year-9],val[year-8],val[year-7],val[year-6],
               val[year-5],val[year-4],val[year-3],val[year-2],val[year-1]);
    output;
  end;
  keep symbol year avg10 std10 ;
run;
proc print data=Volatility;
run;
proc export data=volatility outfile="E:\RESEARCH\Economics\DATA\By
Variables\EXUijt.xls" replace;
run;
```

A.3.2. Ordinary Least Squared Method: Fixed Effect Model

```
dm 'log;clear;output;clear';
options nodate nonumber ps=55 ls=78 pageno=1;
```



```

ods rtf file='panel.rtf';
Proc import datafile='E:\RESEARCH\Economics\DATA\By_Country\Fullpanel.xls'
out=Panel1 replace;
run;
Proc import datafile='E:\RESEARCH\Economics\DATA\By_Country\USA FullPanel.xls'
out=USA1 replace;
run;
/*
*****
* Variable Definition:                                     *
* GDPfr= GDP of the foreign country j                     *
*           at time t                                     *
* GDPUs= GDP of the United States                         *
*           i.e. country i at time t                     *
* POPfr= Population of the foreign                       *
*           country j at time t                           *
* POPUs= Population of the United States                  *
*           i.e. country i at time t                     *
* TOTexp=Total Exports from U.S.($1000)                  *
* TOTimp=Total Imports of U.S. ($1000)                   *
* AGexp=Agri. Exports from U.S. ($1000)                  *
* AGimp=Agri. Imports of U.S. ($1000)                    *
* NonAGexp=Non-agri Exports from U.S.                    *
* NonAGimp=Non-agri Imports of U.S.                      *
*****
#####
# Dummy Variables:                                       #
# DISTij=Distance btwn Country i & j                    #
# FTA= 1 if country j has FTA with                       #
#   the United States, 0 otherwise                        #
# Euro = 1 if the country uses euro                      #
#   0 otherwise                                           #
#####
*/
data Panel1;
set Panel1;
NAGexp= Totexp-AGexp;
NAGimp= Totimp-AGimp;
TOTtrade=Totexp+Totimp;*Total Trade;
Agtrade=AGexp+AGimp;*Agricultural Trade;
NAGtrade=NAGexp+NAGimp; *Non-agricultural Trade;

*merge USA and others data set;
data Panel2;
merge USA1 Panel1;
IGDPfr=log(GDPfr);

```

```

lGDPus=log(GDPus);
lPOPfr=log(POPfr);
lPOPus=log(POPus);
EMfr=(GDPfr*POPfr); * EMfr=Economic Mass (GDPxPopulation) of Foreign Country;
EMus=(GDPus*POPus); *EMus=Economic Mass of US;
lEMfr= log(Emfr);
lEMus= log(EMus);
lTottrade=log(Tottrade);
lAgtrade=log(agtrade);
lNAgtrade=log(NAgtrade);
lTotexp=log(Totexp);
lAgexp=log(Agexp);
lNagexp=log(Nagexp);
lTotimp=log(Totimp);
lAgimp=log(Agimp);
lNagimp=log(Nagimp);
lDIST=log(Dist);
run;
Proc sort data=Panel2;
by partner year;
run;
Proc corr;
var EXV RER EMfr EMus DIST Agexp Agimp Agtrade Nagexp Nagimp Nagtrade Totexp
Totimp Tottrade;
title "correaltion matrix";
run;
*fixed effects one-way time invariant variable ommitted;
* Exchange Rates and Agricultural Trade Flows;
proc panel data=Panel2;
id partner year;
model lAgtrade= EXV lEMfr lEMus Euro FTA/fixone;
model lAgtrade= RER lEMfr lEMus Euro FTA /fixone;
model lAgtrade= EXV RER lEMfr lEMus Euro FTA/fixone;
title'Fullpanel fixed effects: AgTrade';
run;
*Exchange Rates and Non-Agricultural Trade Flows;
proc panel data=Panel2;
id partner year;
model lNAgtrade= EXV lEMfr lEMus Euro FTA/fixone;
model lNAgtrade= RER lEMfr lEMus Euro FTA/fixone;
model lNAgtrade= EXV RER lEMfr lEMus Euro FTA/fixone;
title'Fullpanel fixed effects: Nagtrade';
run;
*Exchange Rates and Total Trade Flows;
proc panel data=Panel2;
id partner year;

```

```

model lTottrade= EXV IEMfr IEMus Euro FTA/fixone;
model lTottrade= RER IEMfr IEMus Euro FTA/fixone;
model lTottrade= EXV RER IEMfr IEMus Euro FTA/fixone;
title'Fullpanel fixed effects: Totaltrade';
run;

```

A.3.3. Ordinary Least Squared Method: Random Effect Model

```

*random effects one-way;
*Exchange Rates and Agricultural Trade Flows;
proc panel data=Panel2;
id partner year;
model lAtrade= EXV IEMfr IEMus Euro FTA/ranone ;
model lAtrade= RER IEMfr IEMus Euro FTA/ranone ;
model lAtrade= EXV RER IEMfr IEMus Euro FTA/ranone ;
title'Fullpanel random effects:AgTrade';
run;
*Exchange Rates and Non-Agricultural Trade Flows;
proc panel data=Panel2;
id partner year;
model lNAtrade= EXV IEMfr IEMus Euro FTA/ranone ;
model lNAtrade= RER IEMfr IEMus Euro FTA/ranone ;
model lNAtrade= EXV RER IEMfr IEMus Euro FTA/ranone;
title'Fullpanel random effects:Nagtrade';
run;
*Exchange Rates and Total Trade Flows;
proc panel data=Panel2;
id partner year;
model lTottrade= EXV IEMfr IEMus Euro FTA/ranone;
model lTottrade= RER IEMfr IEMus Euro FTA/ranone;
model lTottrade= EXV RER IEMfr IEMus Euro FTA/ranone;
title'Fullpanel random effects:Totaltrade';
run;

```

VITA

Mr. Kashi Kafle was born in 1984, in Kaski, Nepal. He attended high school at Janakalyan Higher Secondary School, Kaski and graduated in July, 2000. He went to Tribhuvan University, Nepal, where he earned a two years Proficiency Certificate Level degree in Science and graduated in July, 2002. He obtained a Bachelor of Science in Agriculture from Institute of Agriculture and Animal Science (IAAS) at Tribhuvan University, Nepal, in August, 2008. Mr. Kafle started his Master of Science in Agriculture Economics in the Department of Agricultural Economics and Agribusiness at Louisiana State University, Baton Rouge, Louisiana in January, 2010. He is a candidate for the degree of Master of Science in agricultural economics in December 2011.