THE EFFECTS OF EXCHANGE RATE ON BILATERAL TRADE BETWEEN THE UNITED STATES AND SOUTH KOREA

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ABSTRACT

The objective of this study is to examine the effects of exchange rate on bilateral trade between the United States and South Korea. The panel data for each commodity group over the period from 1989 to 2013 are employed for this study. Export supply model and import demand model are developed to analyze the effects of significant factors on the three trade sectors: agriculture, mid technology, and high technology. Random effect method is chosen in this study.

The result indicates that exchange rate has an important role for U.S. mid and high technology trade with South Korea and exchange rate volatility has positive effects on U.S. mid and high technology exports to South Korea. Intra-industry trade is affected by exchange rate more than inter-industry trade.

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CHAPTER 1. INTRODUCTION

1.1. The Bilateral Trade between the United States and South Korea and Globalization

The role of international trade is becoming increasingly important in this globalization age. Globalization is diminishing the significance of boundaries and encouraging economic integration and international trade. Economic integration, such as the Free Trade Agreement, enables member countries to unify economic policies and reduce trade. It helps member countries to achieve higher productivity through efficient utilization of resources and establishment of economies of scale. Consumers are also able to get products at a relatively lower price due to elimination and reduction of trade barriers and have more variety of products for consumption through trade. Thus, economic integration and trade eventually stimulate economic growth and increase nations' welfare. Recognizing the benefits of trade for consumers and producers in each country encourages other countries to engage in globalization through bilateral, regional and multilateral free trade negotiation.

The bilateral trade volume between the United States and South Korea has increased sharply since 1989 (Zhuang and Koo, 2004). According to the U.S. Census Bureau (2013), the bilateral trade volume between the United States and South Korea jumped from $31.3 billion in 1989 to $104.1 billion in 2013. Cooper et al. (2011) mentioned that Korea's the third-largest trading partner was the United States in 2010. The U.S. was also second-largest export market and the third-largest source of imports to South Korea in 2010. The United States used to be South Korea's number one trading partner until China displaced the United States in 2003. Figure 1.1 shows U.S. export and import volumes with South Korea from 1989 to 2013.

In 2007, the United States and South Korea started the bilateral free trade negotiation and the two nations reached an agreement on Korea-US Free Trade (KORUS FTA) in 2010. The

KORUS FTA is the second-largest FTA for South Korea, after the agreement with the European Union, and is also the second-largest FTA for the United States, after the North American Free Trade Agreement (NAFTA). The KORUS FTA will eliminate trade barriers for goods traded between the United States and South Korea. Most trade barriers, especially tariffs will be eliminated within 10 years, resulting in increasing access to each other's markets. The KORUS FTA is also expected to increase GDP and household income of the two countries (Cooper, Manyin, Jurenas and Platzer, 2011).

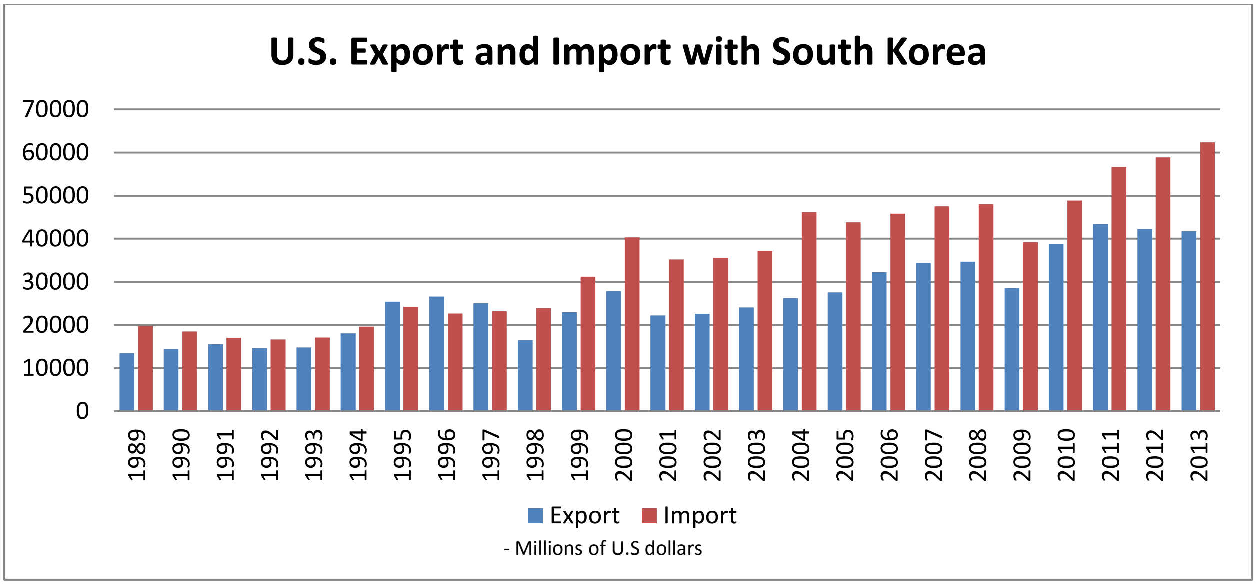

Figure 1.1. U.S. Export and Import Values with South Korea, 1989-2013
Source: U.S. Census Bureau: Country and Product Trade Data (2013)

1.2. Objectives

A bilateral trade between the United States and South Korea has increased for the last three decades. It is important to identify significant factors affecting trade between the two nations; both countries can properly deal with problems affecting trade such as economic depression, currency exchange rate and their nation's welfare through trade. Analyzing the pattern of bilateral trade between the United States and South Korea is also crucial to predict future trade trends between the two countries and prepare for changes which are related to trade. Exchange rate and exchange rate volatility is also major issues that should be considered in this study, since each country has its own currency and it is significantly related to international trade. The country's competitiveness is measured by real exchange rate since real exchange rate determines the relative prices (Auboin and Ruta ,2011). Exchange rate volatility affects firms' trading activities because it would create some uncertainty about their profits. Thus, frequent fluctuation of exchange rate can have negative effects on bilateral trade as well as discourage trading firms' activity.

This study will examine the impacts of price, income, exchange rate, and exchange rate volatility on bilateral trade between the United States and South Korea. In this study, tradable commodities are divided into three groups on the basis of the Standardized International Trade Classification (SITC): agricultural, mid technology, and high technology under the assumption that each trading commodity group is different with each other in trading pattern (intra vs inter industry). The trade patterns of the three commodity groups and the impacts of the economic variables on the bilateral trade will be analyzed. The specific objectives of this study are to:

1) Identify characteristics of bilateral trade between the United States and South Korea
2) Analyze trade pattern of the three trade sectors whether it is closer to intra-industry trade or inter-industry trade
3) Examine the effects of exchange rate and exchange rate volatility on bilateral trade between the United States and South Korea and identify the impact of exchange rate on intra-industry trade and inter-industry trade
4) Determine the significant factors on the three trade sectors
5) Potential effects of KORUS FTA on the bilateral trade between the U.S. and Korea

1.3. Method

An export supply model and an import demand model are developed to analyze the effects of exchange rate on the bilateral trade between the United States and South Korea. The main variables of the export supply model include the difference in prices between the two countries, Korea national income, exchange rate, exchange rate volatility, Korea openness index and the 1997 Korea economic crisis. The main variables of the import supply model include the difference in prices between the two countries, U.S. national income, exchange rate and exchange rate volatility, US openness index and 1997 Korea economic crisis.

The panel data for each commodity group over the period from 1989 to 2013 are employed for this study. The annual trade with Korea is classified into three SITC sectors: agricultural goods, mid technology manufactured goods, and high technology manufactured goods. GDP per capita is obtained from World Bank: World Development Indicators. The bilateral real exchange rates between the United States and South Korea are collected from the United States Department of Agriculture: Economic Research Service, and are in terms of Korean won per U.S. dollar. Annual U.S. consumer price index and Korea consumer price index are obtained from Federal Reserve Bank of St. Louis: Federal Reserve Economic Data.

Pooling technique is used to estimate the export supply and import demand equations. The Breusch-Pagan test (Breusch and Pagan 1979) and White's test (White 1980) are performed to test the null hypothesis of homoscedasticity. The Durbin-Watson test is also applied to test the null hypothesis of zero autocorrelation.

1.4. Organization

The characteristics of the U.S.-Korea bilateral trade will be discussed in chapter two. Chapter two also includes a summary of KORUS FTA. Chapter three provides the literature review on exchange rate and exchange rate volatility. In chapter four, the theoretical framework is examined to develop empirical models. Chapter five provides empirical models and statistical tests. In chapter six, the empirical results are analyzed and hypotheses are testified. Chapter seven provides a summary of the overall results.

CHAPTER 2. BILATERAL TRADE BETWEEN THE UNITED STATES AND SOUTH KOREA AND THEIR FTA

2.1. Characteristics of Bilateral Trade between the United States and South Korea

South Korea is a major economic partner for the United States. In 2010, total value of bilateral trade between the United States and South Korea was $86.9 billion and South Korea was the seventh-largest trading partner to the United States. Economically, South Korea also depends on the United States as well. In 2010, the United States was the third-largest trading partner; second-largest export market, and the third-largest imports market. The United States used to be South Korea's number one trading partner until China displaced the United States in 2003. Major products that U.S. exports to South Korea include semiconductors, machinery, aircraft, and agricultural products. Major products that U.S. imports from Korea are autos, consumer electronics and other manufactured goods (Cooper, Manyin, Jurenas, and Platxer 2011).

From 1989 to 2013, an average of high technology trade values accounts for 66% of total trade values and average of mid technology trade values is 29% of the total trade values between the United States and South Korea. Especially, share of mid technology trade used to take over 40% of total trade values in 1990, but it decreased to around 30% in 1995. Average share of agricultural trade values is only 4% of the total trade values between the two countries. Figure 2.1 shows share of each commodity group over time between the United States and South Korea.

Agricultural trade between the United States and South Korea is based on resource endowments. Since the U.S. has abundant land and technology, they utilize a larger scale on agricultural products compared to Korea; the U.S. has a comparative advantage in producing agricultural commodities over Korea and thus exports surplus agricultural products to Korea.

Korea's exports of agricultural products are limited to processed good. The United States has a trade surplus with South Korea in the agricultural trade, and figure 2.2 shows U.S. exports and imports of agricultural goods and exchange rate. Note that U.S. exports are presented in $10million dollars (real terms) while U.S. imports are expressed in $1million dollars (real terms) in U.S. price. In general, U.S. exports to Korea are ten times larger than U.S. imports from Korea in the value term. The U.S. agricultural exports have fluctuated and have been inversely related with exchange rate. The volume of agricultural commodities that the United States exported was $2.43 billion in 1989, and it increased to $5.53 billion in 2013. The U.S. agricultural imports from Korea had decreased from $344 million to $187 million between 1989 and 1998. It had increased steadily since 1999 and the U.S. imported $553 million agricultural commodities from Korea in 2013.

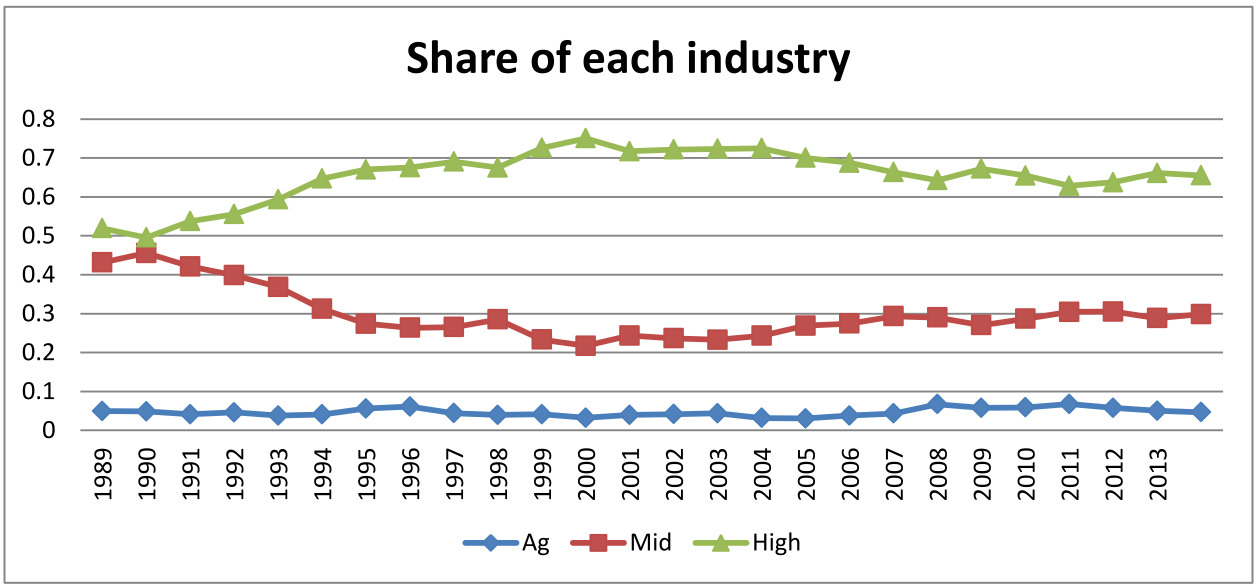

Figure 2.1. Share of Each Industry in the Bilateral Trade between the U.S. and South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

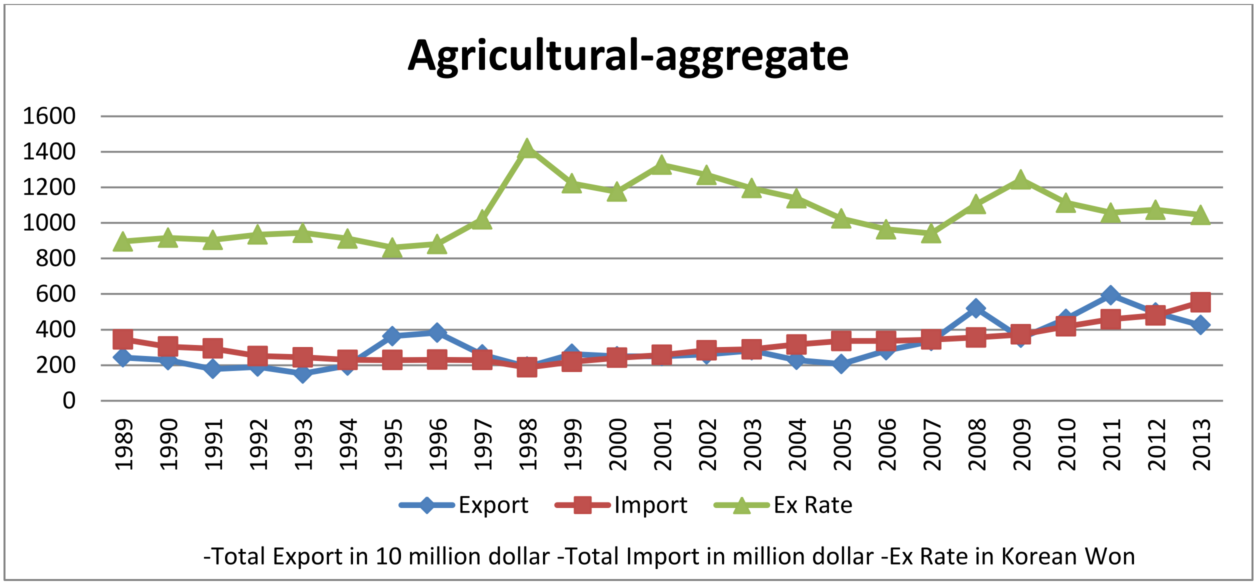

Figure 2.2. Total Values of the U.S. Agricultural Export and Import with South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.3 shows agricultural exports of United States to South Korea. Cereals and cereal preparation is the largest product that United States has exported to South Korea from 1989 to 2013. Meat and meat preparations is the second largest product that United States has exported to South Korea. Because of Mad Cow Disease (MCD) on U.S. meat occurred in 2003, U.S. export of meat and meat preparations decreased sharply between 2003 and 2007. The major products that the U.S. has exported to South Korea are land-intensive products.

Figure 2.4 shows agricultural imports of United States from South Korea. Fish is the largest product that United States has imported from South Korea from 1989 to 2013. However, the U.S. imports of Korean fish have been decreased over time since other countries such as China and Thailand have become more competitive in the fish trade. Miscellaneous edibles are the second largest product that United States has imported from South Korea and it has been increased gradually. All agricultural products that the U.S. has imported from Korea have not been affected by the exchange rate.

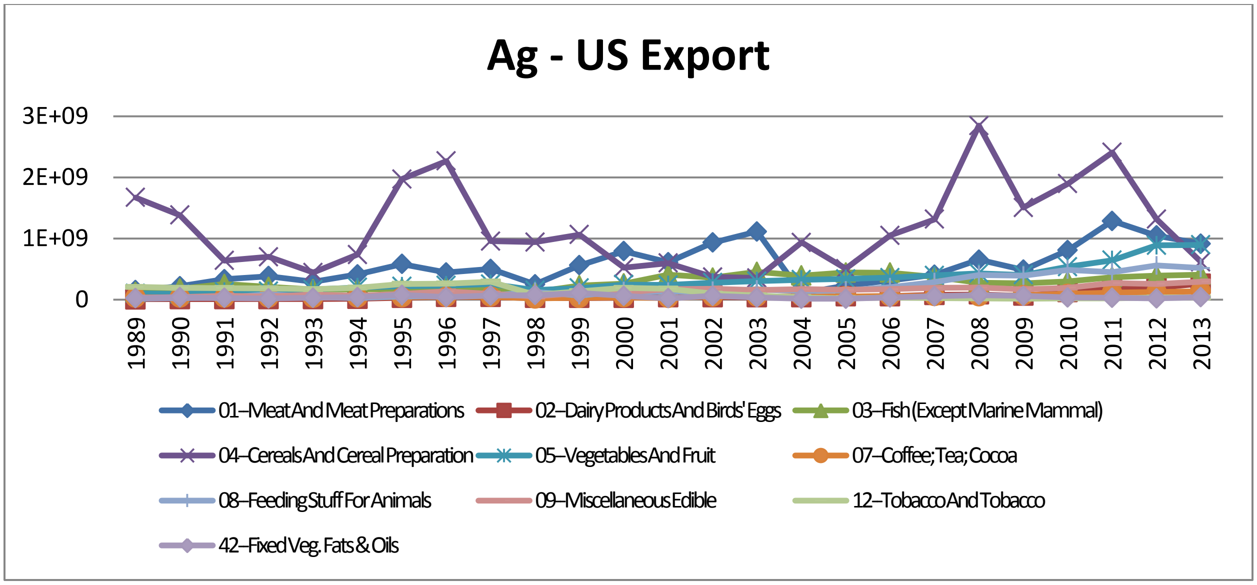

Figure 2.3. Values of U.S. Agricultural Export to South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

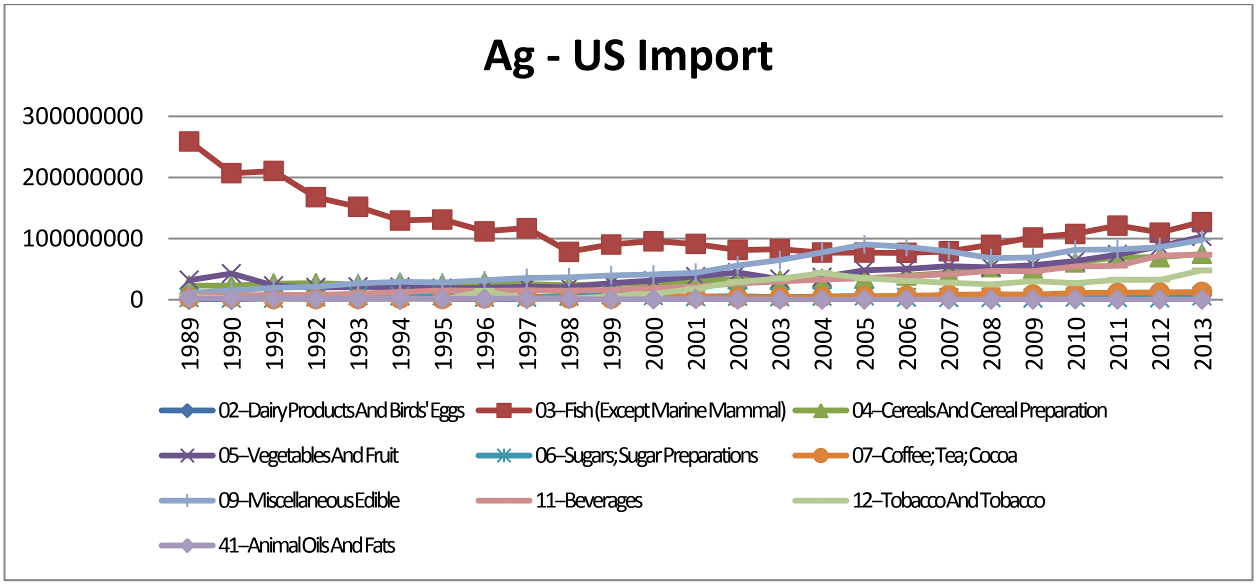

Figure 2.4. Values of U.S. Agricultural Import from South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.5 shows total values of the US mid technology exports and imports with South Korea from 1989 to 2013. The U.S. has a trade deficit with South Korea in the mid technology sector but the U.S. trade deficit has decreased to -\$2.59 billion from -\$6.46 billion between 2013 and 1989. The U.S. mid technology exports have fluctuated and have a negative relationship with exchange rate. The U.S. mid technology imports have also fluctuated, but have a positive relationship with exchange rate. Thus, when U.S. dollar appreciates, the U.S. exports go down while the U.S. imports go up. On the other hand, when U.S. dollar depreciates, the U.S. exports increase, while the U.S. imports decrease.

Figure 2.6 shows the U.S. mid technology exports to South Korea. Organic chemical is the largest product that United States has exported to South Korea from 1989 to 2013. It had increased rapidly from $955 million to $2.276 billion between 2001 and 2004. Metalliferous Ores is second largest product that United States has exported to South Korea. From 2006 to 2008, the U.S. export of Metalliferous Ores has increased by $953 million to 2.12billion.

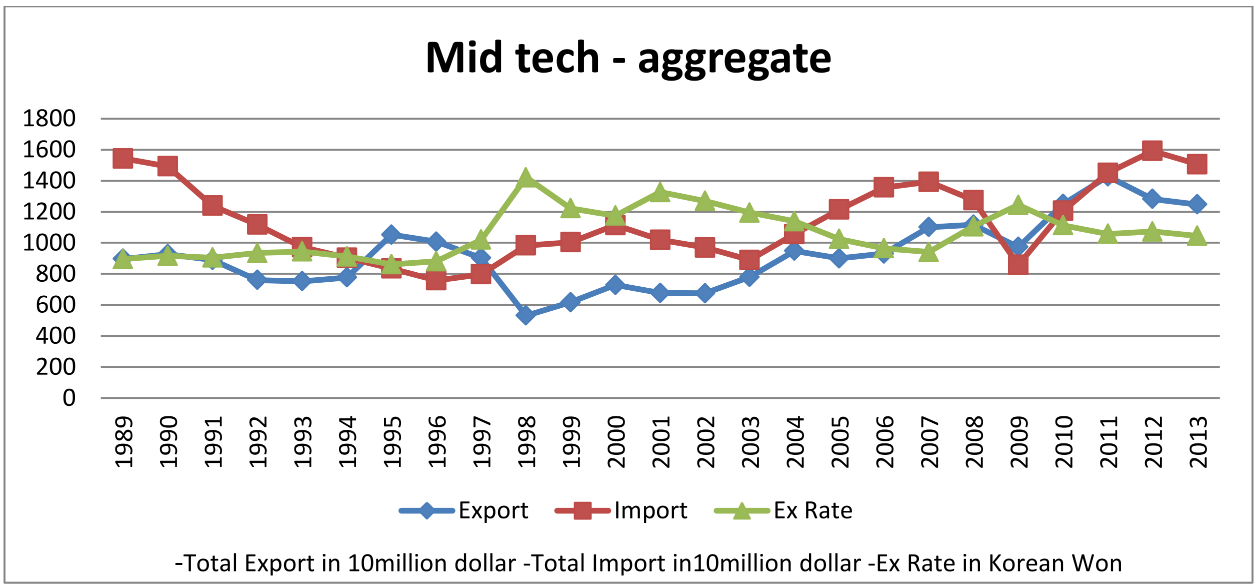

Figure 2.5. Total Values of U.S. Export and Import with South Korea in Mid Tech Industry
Source: U.S. Department of Commerce: National Trade Data 1989-2013

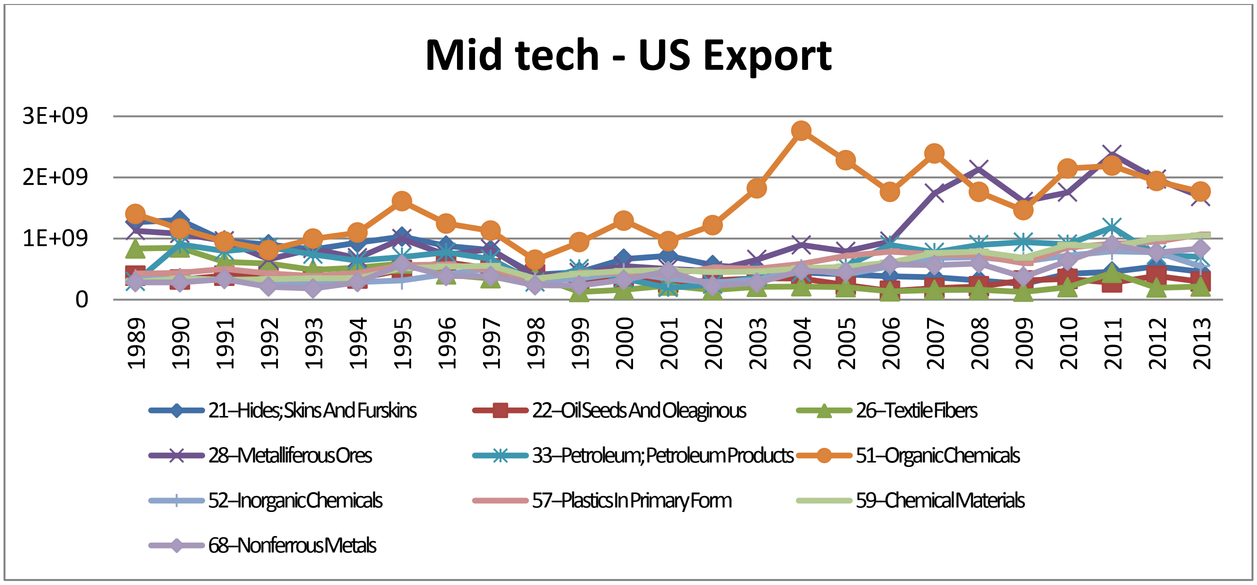

Figure 2.6. Values of U.S. Mid Technology Export to South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.6 shows the U.S. mid technology exports to South Korea. Articles of apparel and clothing had been the largest product that the United States imported from South Korean from 1989 to 2004. However, the U.S. import of this product has decreased dramatically because of the third-country effect. Recently, South Korea is less competitive in producing articles of apparel and clothing relative to other countries such as China, Indonesia, and Latin American countries. For this reason, the United States has preferred importing articles of apparel and clothing from other countries rather than from South Korea. Petroleum has been the largest product that United States import from South Korea during the periods of 2005 to 2007 and the U.S. imported $4.20 billion of petroleum from Korea in 2007. Iron and steel also one of largest products that the United States import from South Korea and it has increased gradually since 1989.

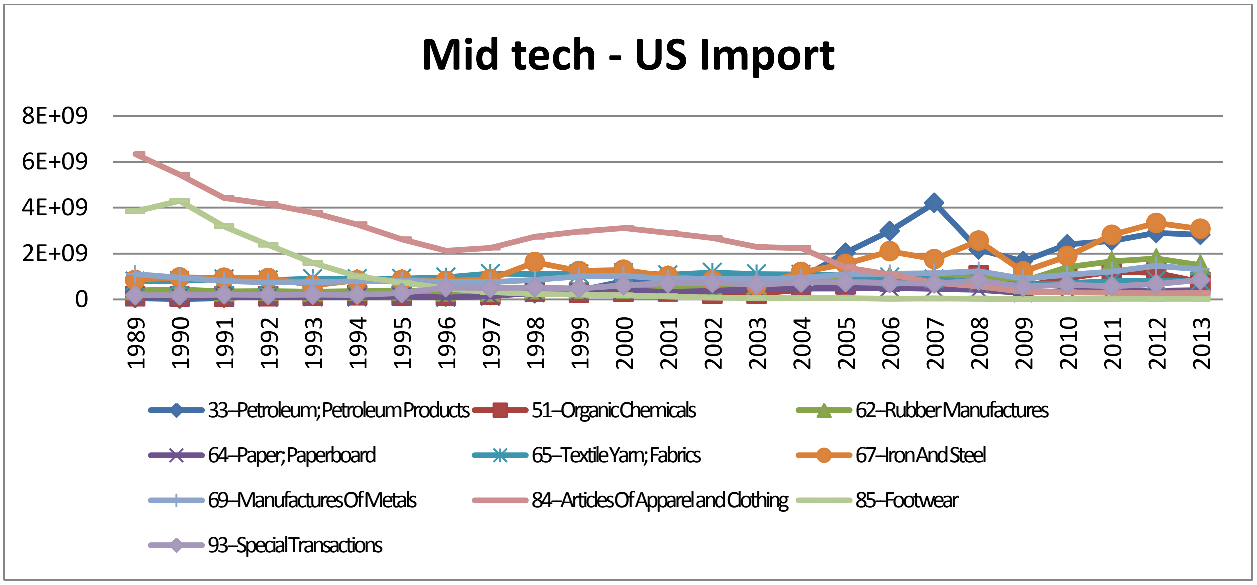

Figure 2.7. Values of U.S. Mid Technology Import from South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.8 shows total values of the U.S. high technology exports and imports with South Korea from 1989 to 2013. The U.S. has a trade deficit with South Korea in high technology sector and it has increased over time. The U.S. trade deficit with Korea was -$8.42 billion in 1989 and it increased to -$21.60 billion in 2013. U.S. high technology exports and imports have increased by an average of 4.5% annually since 1989. U.S. high technology imports had exponentially increased by 80% between 1998 and 2000. The U.S. high technology exports have an inverse relationship with exchange rate. From 1997 to 1998, exchange rate between the United States and South Korea jumped up to 1420 Korean Won to U.S. dollars from 1019 Korean Won to U.S. dollars and it led a decrease of 33% in U.S. exports.

Figure 2.9 shows the U.S. exports of high technology products to South Korea. Electrical machinery is the largest product that the United States has exported to South Korea between 1989 and 2013 and it had increased by 66% from 1998 to 1999. Transport equipment and machinery specialized are the second and third largest products that South Korea has imported from the United States. Most high technology products that the United States exported to South Korea have increased steadily.

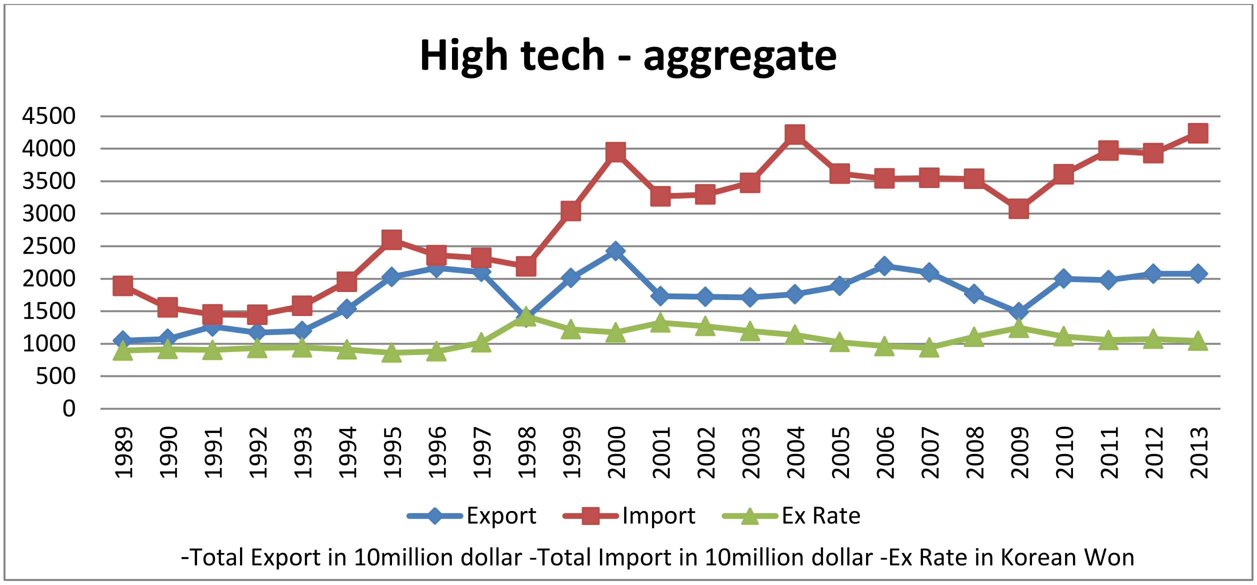

Figure 2.8. Total Values of U.S. Export and Import with South Korea in High Tech Industry
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.10 shows the U.S. imports of high technology products from South Korea. Electrical machinery was the largest product that the United States had exported to South Korea between 1989 and 2000. Since 2001, motor vehicles have been the largest product while telecommunication equipment is the second largest product that South Korea has exported to the United States. As Korean automobile has become more popular with competitive pricing in the U.S. market, the U.S. import of Korean motor vehicle has increased dramatically since 1998. Telecommunication equipment also has increased sharply since 1998 and it is because Korean cellular phone companies have gained popularity in the U.S. market.

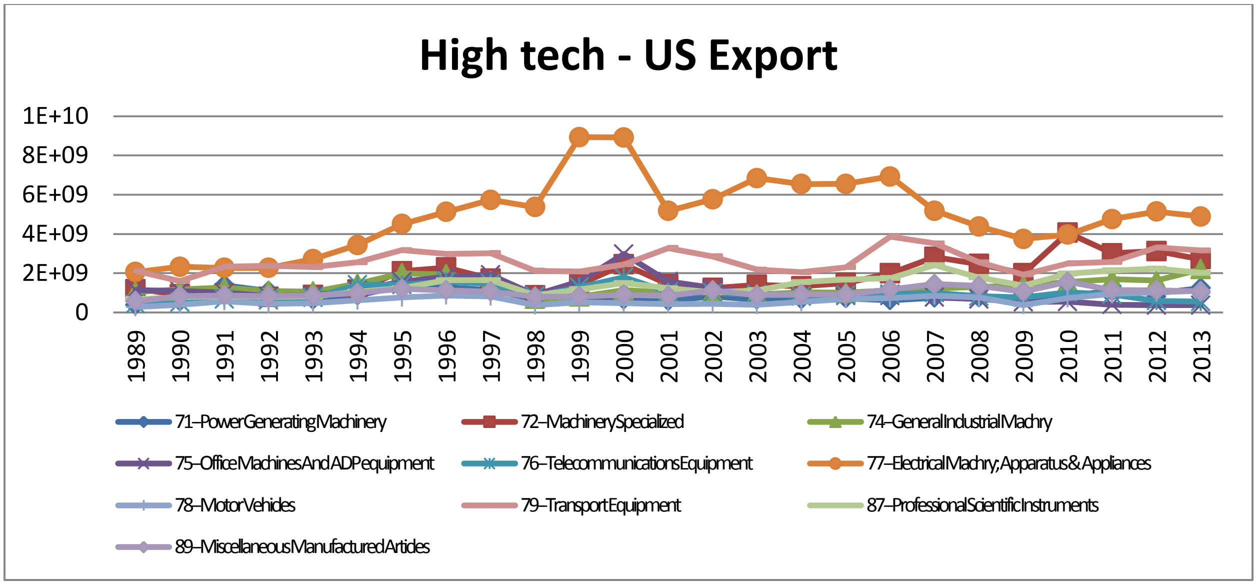

Figure 2.9. Values of U.S. High Technology Export to South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

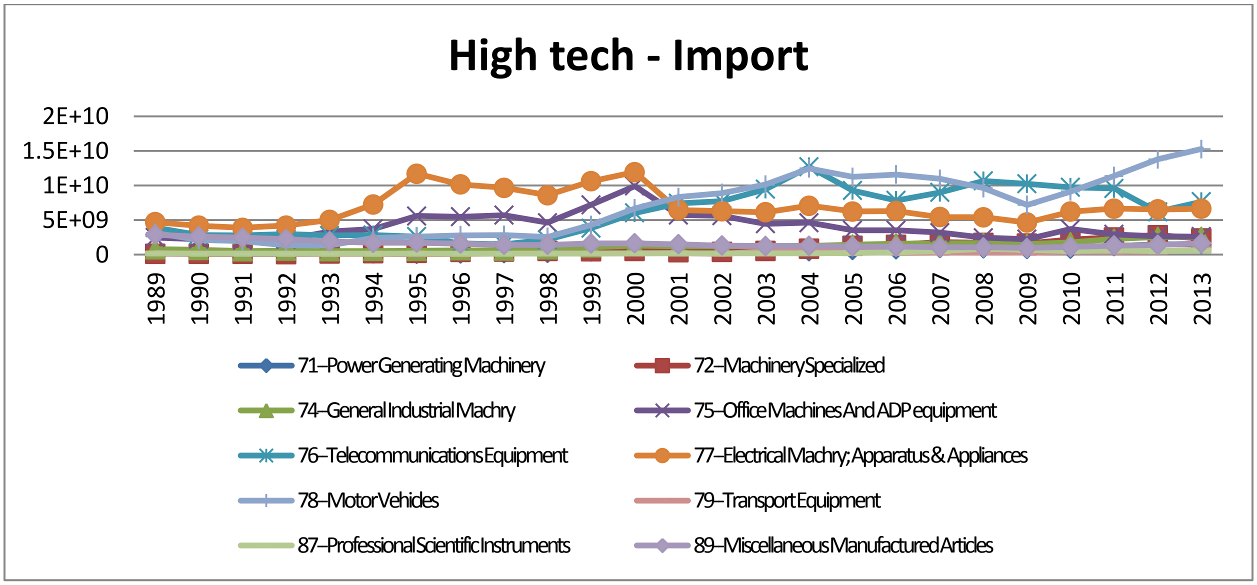

Figure 2.10. Values of U.S. High Technology Import from South Korea
Source: U.S. Department of Commerce: National Trade Data 1989-2013

Figure 2.11 shows the composition of U.S. trade with Korea in 1989 and 2013. Mid technology trade value was 43% of total U.S.-Korea bilateral trade value in 1989, but it has decreased to 29% since 1989. On the other hand, high technology trade between the two nations has increased to 66% from 52% between 1989 and 2013. The share of U.S.-Korea agricultural trade has not changed from 1989 to 2013.

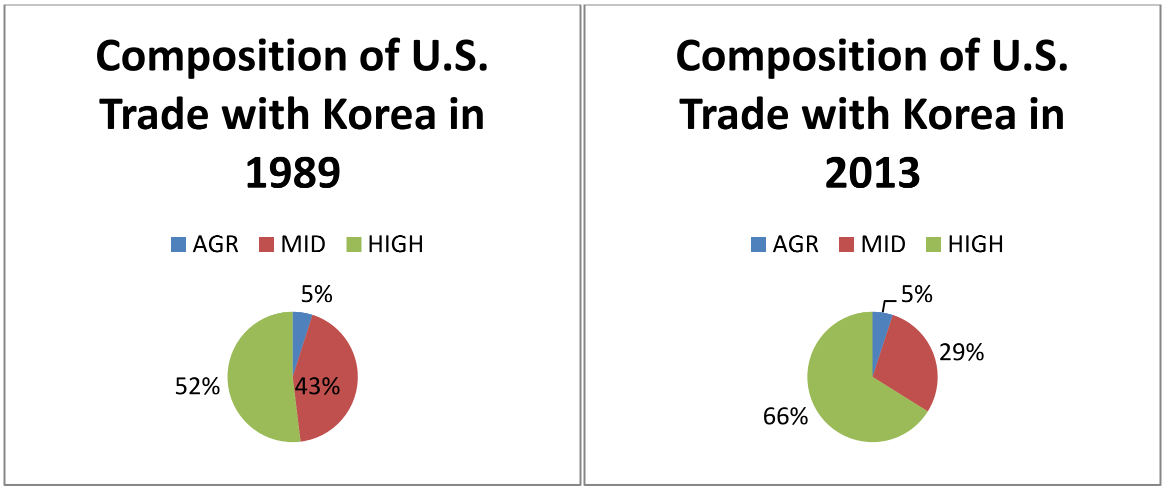

Figure 2.11. Composition of U.S. Trade with South Korea in 1989 and 2013
Source: U.S. Department of Commerce: National Trade Data 1989-2013

2.2. Korea-U.S. Free Trade Agreement

Note that this section is based on two papers, The Proposed U.S. - South Korea Free Trade Agreement (KORUS FTA): Provisions and Implications (Cooper, 2011), and South Korea-U.S. Economic Relations: Cooperation, Friction, and Future Prospects (Manyin, 2004).

On June 30, 2007, the United States and South Korean trade officials signed the proposed Korea-US Free Trade Agreement (KORUS FTA), but the U.S. Congress or the Korean National Assembly did not approve the KORUS FTA. On December 3, 2010, the United States and South Korea reached an agreement on changes in the KORUS FTA, and the respective legislatures ratified the KORUS FTA (Schott, 2010). According to Cooper et al. (2011), KORUS FTA is the second-largest FTA for both countries and the bilateral trade between the United States and South Korea would be expanded through the KORUS FTA. Most U.S.-South Korean trade in consumer and industrial products become duty-free within the next three years and all remaining tariffs would be removed within 10 years. Moreover, the two countries will open their market for services and it will beyond what they have followed to do in the World Trade Organization (WTO).

Under the KORUS FTA, the main objective of the United States is increasing access to South Korean markets in agricultural products, pharmaceuticals and medical equipment, some other high technology manufactured goods and services area. For South Korea, it is expected that South Korea can reform its own economy and gain a competitive advantage in the U.S. market for automobiles and other manufactured goods. Gaining market access is not a major issue for South Korea, because South Korea already has taken a significant market share in areas in which they are competitive, especially consumer electronics and automobiles. Improving its competitive position in the U.S. market is critical issue for South Korea under the KORUS FTA, and the elimination of tariffs also helps South Korea to gain some price advantage relative to its neighboring country, Japan (Cooper, Manyin, Jurenas, and Platxer, 2011).

United States International Trade Commission (2007) examines that the KORUS FTA would improve economic conditions by increasing GDP as well as household income in both countries. The economic effect of the KORUS FTA is that the U.S. GDP would increase from $10.1 billion to $ 11.9 billion. U.S. exports of goods would increase from $9.7 billion to $10.9 billion, mainly in agricultural products, machinery, electronics, transportation equipment, including passenger vehicles and parts. U.S. imports would increase from $6.4 billion to $ 6.9 billion, mainly in textiles, apparel, leather products, footwear, machinery, electronics, and passenger vehicles and parts. The economic effect of the KORUS FTA would be more than these effects, because this range does not consider the impact of the reduction of barriers to trade in services and to foreign investment flows. The impact of changes in regulations which is a result of the KORUS FTA would help to improve economies of both nations. However, it is expected that employment in textile, apparel, and electronic equipment manufacturers would decline in the U.S. under the KORUS FTA. According to the Korea Institute for International Economic policy, South Korea's GDP would increase from 0.42% to 0.59% and this result comes from a static analysis. According to a dynamic analysis, South Korea's GDP would increase from 1.99% to 2.27% (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.1. Agriculture

South Korea have got pressed by the United States and other countries to open more its agricultural market since South Korea has one of the most closed market for agricultural products among members of the Organization for Economic Co-operation and Development. South Korea is one of the largest markets for U.S. agriculture. In 2010, the United States exported $5.3 billion agricultural products to South Korea and it was the fifth-largest export market for the United States. Under the KORUS FTA, almost two-thirds of current U.S. agricultural exports are approved duty-free status immediately by South Korea. South Korea would phase out tariffs and import quotas on most other agricultural goods within 10 years. Access to several U.S. products would be slowly expanded, and Korean import quotas remain for those products because of their sensitivity (Cooper, Manyin, Jurenas, and Platxer, 2011).

It took a few years to mediate between the two countries about exports of the U.S. beef since outbreak mad cow disease in U.S. cattle herd in 2003. Mad cow disease brought a major concern for human health in Korea and importing U.S. beef became a significant political issue in South Korea. Under the KORUS FTA, South Korea reduces its 40% tariff on imported U.S. beef muscle meats and eliminates the 18% tariff on imports of beef offals such as tongues, livers, tails, and feet. Tariffs ranging on other U.S. beef products are from 22.5% to 72%. Also, South

Korea would have the right to impose safeguard tariffs on a temporary basis when U.S. beef meats are above specified levels (Cooper, Manyin, Jurenas, and Platxer, 2011).

South Korea did not agree to open market for U.S. rice and rice products. It was South Korea's major objective when they negotiated agriculture products in the KORUS FTA. The Korean government tried to preserve Korea's rice production since rice farming makes up a major part of its farming industry. For this reason, South Korea tried to exclude the entry of U.S. rice on preferential terms to protect its domestic rice market. The Korean government also established rice quotas so the U.S. does not have wide access to the Korean rice market (Cooper, Manyin, Jurenas, and Platxer, 2011).

The two countries negotiators also took a long time to agree how quickly to liberalize trade of fresh oranges. Currently South Korea imposes a 50% tariff on all imports of oranges. The United States wanted Korea to eliminate border protection on all citrus products, but South Korea wanted to maintain its quotas and tariffs because the citrus industry is very important to Cheju Island in Korea. Therefore, negotiators agreed to a multi-part solution. They divided one year into two parts: one is 'in-season', when Korea does not produce a variety of oranges and the other one is 'off-season'. In-season which is between September 1 and the end of February, a small duty-free quota would be imposed on U.S. navel oranges. Off-season which is between March 1 and the end of August 31, import tariffs of 30% are imposed on U.S. orange. Also, South Korea imposes import tariffs of 144% on other mandarin oranges and it would be phased out over 15years (Cooper, Manyin, Jurenas, and Platxer, 2011).

South Korea would phase out 25% tariff on 90% of the U.S. pork products (primarily frozen product) from January 1, 2016. 22.5 % import tariffs of other U.S. pork products (primarily fresh pork meat) would be eliminated over 10 years. South Korea secured safeguard to its fresh pork products, and it would expire at the end of 10 years. In 2010, South Korea was the fourth-largest market for U.S. pork (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.2. Auto

South Korea would eliminate import tariffs ranging between 8% and 4% on U.S. - built passenger cars immediately. In five years, import tariffs on U.S. - built motor vehicles are eliminated to zero. The United States keeps current import tariffs of 2.5% on Korean-built automobiles for five years. U.S. import tariffs on Korean - built cars with larger gas engines and diesel engines would be phased out over three years. Even though the United States would not eliminate all U.S. import tariffs on Korean automobile, Korean would get the potential benefit. It is because Korean automobile producers would get comparative advantages relative to Japanese automobile companies under the KORUS FTA. In the U.S. vehicle market, Japan would be the biggest competitor to South Korea. Thus, having advantages relative to Japanese companies is very important to South Korean automobile companies (Cooper, Manyin, Jurenas, and Platxer, 2011).

Automotive-specific taxes are one of the most important factors to determine the final price of a vehicle. U.S. automakers complained that South Korean automotive-specific taxes would be another barrier to foreign car sales in South Korea. South Korea imposed high rate of vehicle tax on vehicles with larger engine capacities and it made U.S. cars more expensive than smaller South Korean cars. As a result of the renegotiated 2010 agreement, South Korea agreed to additional transparency on tax treatment on U.S. automobiles as well as agrees to improve regulatory transparency for new automotive regulations (Cooper, Manyin, Jurenas, and Platxer, 2011).

Automotive safety and environmental regulations of South Korea are closed to foreign countries' automobile producers and are not transparent. South Korea automobile producers have the greater part of the domestic market share and they are able to operate one line for domestic production and another for export. However, foreign companies would not be able to operate one line for South Korean market because of high unit cost of customizing a small number of vehicles. Therefore, South Korean automotive standards would discourage imports U.S. automobile. In the revised 2010 agreement, South Korea agreed to provide self-certification to U.S. federal safety standards for a limited number of U.S.-exported vehicles. Moreover, U.S. auto manufacturers would be exempted from meeting new higher South Korean environmental standards (Cooper, Manyin, Jurenas, and Platxer, 2011).

The 2010 KORUS revisions included a specific safeguard to U.S. automotive industry so any harmful surges would not hurt the U.S. auto industry. If there is an unexpected import surge for up to two years, the United States would impose extra duties. The auto safeguard would be lasted for 10 years after the full elimination of tariffs. Under the KORUS, U.S. automotive exports to Korea would not increase that much since the U.S. has exported a low amount of automobiles to South Korea. However, there would be a positive effect on U.S. exports in that Korean consumer would be able to purchase U.S. vehicle at cheaper price than before tariff elimination (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.3. Textiles and Apparel

U.S. import tariffs on 52% of Korean textiles and apparel (in terms of value) would be eliminated immediately. U.S. import tariffs on 21% of Korean textiles and apparel would be passed out over five years and would be eliminated to zero in ten years. Korean import tariffs on 77% of U.S. textiles and apparel would be eliminated immediately and on 13% of U.S. textiles and apparel would be phased out over three years. The remaining Korean import tariffs on U.S. textiles and apparel would be reduced to zero over five years (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.4. Capital Goods Machinery and Equipment

Under the KORUS FTA, U.S. machinery industry would get the largest benefits and U.S. exports of machinery to South Korea would increase by $3 billion. Before the KORUS FTA is approved, South Korea imposes import tariffs ranging between 3% and 13% on U.S. machinery products. U.S. products are already competitive in South Korean market and its market share is between 15% and 20% in Korea. Under the KORUS FTA, South Korea would eliminate its tariffs immediately on most U.S. machinery products. The machinery sector already has recorded a trade surplus with South Korea, so South Korean tariff reductions and eliminations would help U.S. manufacturers of machinery increase their trade surplus (Cooper, Manyin, Jurenas, and Platxer, 2011).

South Korean tariffs on civilian aircraft imports are already zero. Aircraft is also one of major capital goods that the United States has a strong bilateral trade position. In 2008, the United States exports $2.7 billion of aircraft and parts to South Korea (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.5. Electronic Products and Components

Most electronics products including semiconductors, telecommunications equipment, and computers are already duty-free in the two respective countries. The United States used to have a trade surplus in semiconductors with South Korea in 2006, but the United States had recorded a trade deficit in semiconductors in 2009. The United States also has a deficit in computer equipment, large imports of computers and office equipment parts and accessories (Cooper, Manyin, Jurenas, and Platxer, 2011).

2.2.6. Pharmaceuticals and Medical Devices

Although pharmaceuticals and medical devices are a small part of U.S.-South Korea trade, U.S. manufacturers expect that export would increase as the South Korean economy matures. South Korea is one of the world's top 12 largest markets for pharmaceuticals and annual sales in pharmaceuticals are $8 billion. It is also expected that the South Korean market for medical devices would grow 10% -15% each year in the next several years, and annual sales in medical devices are around $2.5 billion. However, South Korean pharmaceutical policies would be designed to protect the South Korean industry so U.S. manufactures would have limitation to increase market share in South Korea. Therefore, U.S. manufacturers want South Korea to establish transparency as an important principal under the KORUS FTA. Under the KORUS FTA, South Korea agreed to establish proposed laws, regulations, and procedures that apply to the pricing, reimbursement, and regulation of pharmaceuticals and medical devices in a nationally available publication. South Korea also allowed U.S. pharmaceutical manufacturers to apply for increased reimbursement levels based on safety and efficacy (Cooper, Manyin, Jurenas, and Platxer, 2011).

CHAPTER 3. LITERATURE REVIEW

3.1. Studies of U.S.-South Korea Economic Relations

According to previous studies of Manyin (2004) and Odell (1985) , the United States and South Korea have had a close relationship with the United States since they entered the Korean War on the South Korean side in 1950 . In 1960, Korean government had received US official aid and it was a crucial help for establishing Korean economical foundation. South Korea had experienced a high level of economic growth since 1960s, and South Korea became one of the United States' largest trading partners. However, the bilateral trade relationship between the United States and South Korea was still unequal and South Korea economy relied on the United States a lot more than the United States economy did on Korea.

According to Zhuang and Koo (2007), the U.S.-Korea bilateral trade relationship changed, during the late 1980s. The bilateral trade volume between the United States and South Korea has increased rapidly since 1989, and the United States had experienced a trade deficit, except the 1995-1997 periods. In 2004, the United States was Korea's third-largest trading partner and second largest export market and South Korea was the Unites States' seventh-largest trading partner. Moreover, Manyin (2004) argued that South Korea became a more important trading partner for some western states and U.S. sectors because South Korea is the fifth-largest market for California's exporters, second-largest for Oregon's exporters and fourth-largest for U.S. agricultural exporters.

According to previous studies of Kang (2007) and Zhuang and Koo (2007), the United States and South Korea concluded the United States- Korea Free Trade Agreement (KORUS FTA) on June 30, 2007 and the U.S.-Korea trade agreement started taking effect on March 15, 2012 (United States Trade Representative, 2014). This is the largest trade agreement for the

United States since the North American Free Trade Agreement (NAFTA). Under the KORUS FTA, not only would bilateral trade volume between the United States and South Korea increase but also GDP, household income and national welfare for both countries would be improved.

3.2. Characteristics of U.S.-South Korea Bilateral Trade

Bae and Kwon (2013) argued that firms are very sensitive to foreign exchange rate, especially against the US dollar because they depend a lot on foreign trade and capital a lot. According to Zhuang and Koo (2007), the U.S.-Korea bilateral trade has moved to intra-industry trade from inter-industry trade. Until 1994, the U.S- Korea bilateral trade was on the basis of resource endowments and the U.S. – Korea bilateral trade was mainly inter-industry trade. Major goods which the United States exported to South Korea were land-intensive and natural resources-based industry goods and technology and capital-intensive goods, and the United States imported labor-intensive goods from South Korea. Beginning 1995, differentiated high-technology products and mid-technology have increased dramatically in the U.S. - Korea bilateral trade and intra-industry trade which is based on product differentiation has been significant in the U.S. – Korea bilateral trade.

3.3. Review of Exchange Rate Studies

According to Sun, Kim, Koo, Cho, and Jin (2002), many empirical studies have tried to establish the appropriate measurement of exchange rate volatility as well as figure out the relationship between exchange rate volatility and bilateral trade. However, Wang and Barrett (2002) examined that there is no unique definition for the measurement of exchange rate volatility at both the theoretical and empirical level. The relationship between exchange rate volatility and bilateral trade is also indeterminate.

Mckenzie and Melbourne (1999) defined exchange rate volatility as the risk associated with unexpected movements in the exchange rate. They also summarized measurements of exchange rate volatility which have been used in many articles. Moving average of the standard deviation of the exchange rate has been used the most in the literature and standard deviation of the yearly percentage changes of a bilateral exchange rate also has been used extensively in the literature. In addition, many studies have used long run exchange rate uncertainty, ARIMA model residuals and ARCH models.

Devereux and Lane (2003) examined what variables determinate bilateral exchange rate volatility in a broad cross section of countries. Their model shows the relationship of a set of standard optimal currency area variables, the size of the domestic financial sector, and a measure of the financial dependence between two countries to the level bilateral nominal exchange rate volatility between two countries. They measure exchange rate volatility with the standard deviation of the log first difference of bilateral exchange rate and they collected data from International Financial Statistics. Their result shows that financial variables and the standard optimal currency variables have a significant effect on exchange rate volatility.

Bahmani-Oskooee and Ardalani (2006) examined the effect of the dollar devaluation on inpayments and outpayments of a specific industry. They also estimated import and export demand elasticities of the specific industry to a change in real exchange rate. They analyzed monthly import and export data from 66 industries from 1991 to 2002, and they focused on industry level rather than country level. They measured short-run and long-run impacts of currency devaluation on industry. Bahmani-Oskooee and Ardalani modified a model previously developed by Oskooee and Goswami (2004), and they figured out sensitivity of import and export values of each industry to a change in exchange rate to conform to industry data. Their first model shows the relationship of world income and real effective value of the dollar to the industry's export. The other model shows that the relationship of U.S. income and real effective value of the dollar to the value of imports by industry. They estimated import and export values as well as volume to figure out impacts of the dollar devaluation on inpayments and outpayments of the specific industry. Bahmani-Oskooee and Ardalani (2006) extended these long-run models to incorporate short-run dynamics with estimating the long-run relations. They used error-correction model that include a linear combination of the lagged level of all variables. They applied Autoregressive Distributed Lag (ARDL) approach which developed by Pesaran, Shin and Smith (2001) to conduct F-test and determine if they maintain the lagged-level variables. Then they applied Akaike Information Criterion (AIC) to select the optimum number of lags. Bahmani-Oskooee and Ardalani (2006) found that the dollar depreciation encourages export earnings of many U.S. industries in the long-run, while it has no effect on most importing industries. They explained that world income and U.S. income are major factors of U.S. exports and imports at the industry level.

Bahmani-Oskooee and Bolhassani (2014) analyzed the impact of exchange rate uncertainty on the trade between the United States and Canada by examining the trade flows of 152 industries. They used disaggregated bilateral trade data to avoid aggregation bias and observe the third-country effect, especially the fluctuation of the U.S. dollar against the currency of Mexico which is the third member of NAFTA. Followed the models previously built by Bahmani-Oskooee and Bolhassani (2012). The previous models show the relationship of Canadian real GDP (the U.S. real GDP), real bilateral exchange rate between the U.S. and Canada and a volatility of the U.S.-Canadian dollar to volume of exports by the U.S. to Canada (volume of imports of commodity by the U.S. from Canada). Bahmani-Oskooee and Bolhassani extended the previous models by adding the volatility of the U.S. dollar against the Mexican peso and the volatility of the U.S dollar against the currencies of OECD countries to examine the third-country effect. Also Bahmani-Oskooee and Bolhassani developed error-correction models which include lagged adjustments to see short-run and long-run effects of all variables, and Akaike Information Criterion (AIC) is used to select the optimum lags with a maximum of four lags on each first-differenced variable. Bahmani-Oskooee and Bolhassani found that exchange rate uncertainty has effects on two-thirds of the industries in the short-run and exchange rate uncertainty has effects on one-third of the industries in the long-run. Bahmani-Oskooee and Bolhassani also found that the volatility of the U.S. dollar against the Mexican peso carries a significantly negative long-run coefficient in 49 of the 56 industries, and affects U.S. exports to Canada in more industries compared to the volatility of the U.S. dollar against the currencies of OECD. Bahmani-Oskooee and Bolhassani's explanation for this result is that due to Mexico is a member of NAFTA.

Baek and Koo (2010) examine the effect of the bilateral exchange rate on consumer-oriented agricultural products between the U.S. and its 10 major trading partners. They used disaggregating agricultural commodity export and import data from 1989 to 2007 and they divided U.S agricultural trade into two groups: bulk and consumer-oriented products. An autoregressive distributed lag (ARDL) model is employed to measure the existence of the long-run relationship among real exchange rates, income and the U.S. agricultural trade volume. Their results illustrate that for consumer-oriented products, U.S. exports are highly sensitive to the bilateral exchange rate and foreign income in both the short and long-run and U.S. imports are responsive to the U.S. domestic income. For bulk products, U.S. income and its trading partners' income play significant roles in U.S. exports and imports. However, exchange rate carries an insignificant coefficient in bulk products.

Wang and Barrett (2002) analyzed the effect of exchange rate volatility on the case of Taiwan’s exports to the United States from 1989 to 1998 by using an autoregressive moving average (ARMA) model with eight different productive sectors monthly export data. The uncertainty of exchange rate is estimated by employing a multivariate generalized autoregressive conditional heterscedasticity in mean estimator (GARCH) approach to avoid the generated regressors problem. Their results illustrate that the effect of real exchange rate risk is statistically insignificant on Taiwan’s exports to the United States except the agricultural sector. Exchange rate volatility has significant negative effect on Taiwan’s agricultural exports to the United States.

Bahmani-Oskooee and Harvey (2012) examined the effects of exchange rate volatility on bilateral trade flows by applying cointegration analysis to set of 146 U.S. export and 115 U.S. import industries. They used annual trade data over the period from 1979 to 2010 and they employed autoregressive distributed lag (ARDL) model of Pesaran et al (2010) to estimate short and long-run coefficients. Their models show the relationship of real exchange rate, real exchange rate volatility and the purchasing country’s income to the volume of export or volume of import. They found that 72 of the U.S. export industries and 52 of the 115 import industries have cointergrating relationship among trade flow, income the real exchange rate, and real exchange rate volatility. Bahmani-Oskooee and Harvey concluded that exchange rate volatility does not affect large industries but small industries show sensitive relationship between risk and trade volume, particularly for export. Also they found that ‘risk loving’ behavior existed among U.S. importers, so increased volatility leads to increased trade.

Bahmani-Oskooee, Harvey, and Hegerty (2012) analyzed the effect of won-dollar exchange rate volatility on industry-level trade between the United States and South Korea. They looked over annual trade flows from 1965 to 2006 for bilateral import and export flows. Bahmani-Oskooee, Harvey, and Hegerty build the model which shows the relationship of the purchasing country's income the relative price of exports or imports relative to competing substitutes, and a measure of real exchange rate volatility to import flows or export flows. The trade flows are modeled as volumes or dollar values. They focused on industry-level trade rather than bilateral trade and applied the Autoregressive Distributed Lag (ARDL) method. The ARDL works well in small samples as well as it provides short-run estimates, long-run estimates, and a cointegration test within a single Ordinary Least Squares estimate. They also added a dummy variable to explain the 1997 Asian Crisis in their long-run model. Bahmani-Oskooee, Harvey, and Hegerty found that most industries' exports and imports are affected by exchange rate in the short-run effects. In contrast, exchange rate volatility has a significant relationship with few industries.

Arize, Osang, and Slottje (2000) analyzed the impact of real exchange rate volatility on the export flows of 13 less developed countries and the period of data set is from 1973 to 1996. They suggested that the benefits of international trade would be reduced by the uncertainty of exchange rate, and the degree of risk aversion would determine the effects of exchange rate uncertainty on exports. The moving sample standard deviation is used to measure exchange rate volatility and they applied cointegration test to know the number of cointegrating vectors in nonstationary time series. They also applied the general to specific paradigm which conducted by Henry (1987) to find a dynamic error correction representation of the data. Arize, Osang, and Slottje found that exchange rate volatility has a negative long run relationship with export flows and this relationship is also statistically significant. Furthermore, exchange rate volatility affects export flows in the short-run.

Sauer and Bohara (2001) examined the trade effects of real exchange rate volatility in 91 countries and they divided these countries into two groups to know regional differences of trade effect of real exchange rate volatility between developing and industrialized countries. They used 21 years annual panel datasets for 22 industrialized and 69 developing countries. They could reduce the multicollinearity problem while increasing efficiency by using the panel data approach. The panel data approach can control for the effects of unobservable or missing variables. Moreover, fixed- and random-effects models are used to estimate the pooled export equations so cross-country structural and policy differences that would affect export performance could be considered. Their model shows the relationship of foreign real income, the relative price of exports, and real exchange rate volatility to real aggregate exports. They found that exchange rate volatility has significant effects on exports from the developing countries, but not on exports from industrialized countries. Especially exchange rate volatility affects to exports from Latin American and Africa negatively. They also found that foreign real income is significant in both developed countries and less developed countries, while the real exchange rate is significant only in the developing countries.

Chit, Rizov, and Willenbockel (2010) analyzed the effects of exchange rate volatility on the bilateral export flows of five emerging East Asian countries – China, Indonesia, Malaysia, the Philippines and Thailand. They used a panel dataset for five East Asian countries as well as 13 other industrialized countries. The panel dataset consists of 85 cross-sectional quarterly observations for the period from 1982 to 2006. They could control for unobserved individual heterogeneity and eliminate the effects of omitted variables by using panel data estimation.

Mainly the fixed-effect model is used to estimate their model but the random-effects estimation is also used to check the robustness of results and to control for the effects of the time-invariant explanatory variables. Their model shows the relationship of real exports to home country's GDP, importing country's GDP, relative price between the trading partners, relative price between the importing country and other exporting countries, bilateral exchange rate volatility, third-country exchange rate volatility, the distance between the two countries, an indicator for sharing of a common border, and an indicator for membership of the ASEAN Free Trade Area to real exports from one country to another. They found that bilateral exchange rate volatility has significantly negative impacts on bilateral exports. They also figured out that the relative volatility is important for bilateral export flows of emerging East Asian countries. It is because that a rise in exchange rate volatility between the importing country and other exporting countries encourages bilateral exports between two trading partners.

Byrne, Darby, and MacDonald (2008) examined the impact of exchange rate volatility on the volume of bilateral US trade. Sectoral trade data is used in this paper to consider differences in the impact of exchange rate volatility across sectors. A fixed-effects panel approach was employed to test for cross sectional parameter heterogeneity. They found that exchange rate volatility has a negative effect on trade. Especially, the effect of exchange rate volatility is significantly negative for differentiated goods, which take most of trade, and it is not significant for homogeneous goods. Their result would be evidence that there are sectoral differences in the impact of exchange rate volatility.

CHAPTER 4. DEVELOPMENT OF THEORETICAL FOUNDATION

4.1. Inter-Industry Trade and Intra-Industry Trade

Each country has unique advantages when producing particular goods because each country has different resource endowments. Each country can specialize in producing certain goods with their resource endowments and they can trade with other countries or regions for other goods which they want to consume. Therefore, each country can enhance their welfare through trade. The bilateral trade is divided into two types by the pattern of trade between the two countries. One is inter-industry trade and the other one is intra-industry trade. The relationship between trade and exchange rate can be different depending on the types of trade between the two countries. Inter-industry trade is based on the comparative advantage of countries which is based on their resource endowments. Inter-industry trade can be understood better by studying two theorems that are built by David Ricardo (1799) and Heckscher-Ohlin (1933). Intra-industry trade is a result of several factors, including economies of scale and market structure. The trade theory was developed by Paul Krugman (1979), and explained intra-industry trade between nations with a similar resource endowments.

4.1.1. Inter-Industry Trade

David Ricardo presented the principle of comparative advantage and a concept of relative labor requirements is used to explain comparative advantage. If the labor requirements in producing two commodities in a country are smaller than those in the other country, the country has the absolute advantage to produce those commodities relative to the other country. According to David Ricardo, the country should not produce the two commodities to maximize the total output of the two commodities between the two countries. It is because the relative labor inputs which are used to produce commodities are a key determinant of trade. The degree of advantage that the country has over the other country is different depending on their commodities. Therefore, each country should specialize in producing one commodity that requires less labor relative to other commodities.

The Heckscher-Ohlin theorem explained comparative advantage with differences in resource endowments such as labor, capital and technology. A country can specialize in producing some specific goods depending on its comparative advantage to other countries based on its resource endowments. If country A is a labor-abundant country relative to country B, then country A has a comparative advantage over country B in producing labor-intensive goods. If country B is a capital abundant country relative to country A, then country B has a comparative advantage over country A in producing capital-intensive goods. Thus, country A specializes in producing labor-intensive commodities, while country B specializes in producing capital-intensive products. Therefore, country A and country B will export their specialized products to each other to exchange for other commodities. It implies that trade flows between two nations are determined on the basis of differences in resource endowments between the nations.

4.1.2. Intra-Industry Trade

Intra-industry trade is defined as the exchange of similar goods in the same industry between the two countries. Intra-industry trade is different with inter-industry trade in that it is not a result of comparative advantage. Paul Krugman (1979) initially built a new trade theory that explains what factors cause an intra-industry trade. This theory is based on economies of scale and market structure.

There are economies of scale if outputs increase by a larger percentage than a percentage increase in inputs. Each country can improve its efficiency by concentrating on the production of specific goods. However, the large scale product focusing on a few products results in reducing the variety of products available for consumption without trade. In this situation, each country would be able to maintain a variety of products for consumption through trade. The production practices by a firm in an industry can maximize its production efficiency. In addition, the country maintains its social utility by importing other commodities for domestic consumption from the other nation. It enables countries to maximize profit by realizing economies of scale. Therefore, the existence of increasing returns to scale would encourage countries to participate in trade with other countries.

Monopolistic competition is a type of imperfect competition such that producers can differentiate their products from that of their rivals. Each imperfect competition can result in trade even though resource endowments and technology are similar across different countries. Under the given condition, a country can decide to produce a few products with reduced prices under economic of scale rather than producing all lines of the product. Then the other country will produce the remaining goods and trade with each other. For this reason, countries trade differentiated products between them even though they have relatively similar resource endowments. Thus, the two countries would trade differentiated products under monopolistic competition and economies of scale.

4.1.3. Intra- and Inter-Industry Trade

Based on the trade theory discussed above, trade flows between two countries are divided into inter-industry trade based on Ricardo (1799) and Heckscher-Ohlin (1933) and intra-industry trade based on Krugman (1979). Grubel and Lloyd (1971) developed an index which identifies the two trade patterns. Because of the globalization effort through bilateral, regional and multinational free trade agreement, trade pattern is changing from inter-industry trade to intra-industry trade since intra-industry trade is based on market structure and economies of scale.

According to Hellvin(1996), inter-industry products has less possibilities to be replaced with domestic products. However, intra-industry products can be replaced with domestic products more easily since there are domestic substitutes. If imported goods are becoming increasingly more expensive and there are domestic substitutes, a country would replace imported goods with domestic goods. However, inter-industry trade has fewer possibilities to find domestic substitute for imported goods, since inter-industry trade is based on their resource endowments. Therefore, it is expected that intra-trade is more sensitive to changes in price rather than inter-industry trade. Grubel and Lloyd developed a formula to identify whether a particular trade between two countries is intra or inter industry trade. The formula developed by them is:

$$\text{Grubel-Lloyd Index} = 1 - \left(\sum_{i=1}^{n} |X_i - M_i|\right) / \left(\sum_{i=1}^{n} |X_i + M_i|\right) \qquad \text{(Eq. 4.1)}$$

where X_i and M_i are a country's exports and imports of industry i (i = 1, …, n) and n is the number of industries at a chosen level of sector. The index will be 1 if there is only intra-industry trade. Thus, trade is balanced which means that the quantity of exports is same as the quantity of imports. It will be zero, if there is only inter-industry trade. In this case, every industry is either an export or an import industry (Koo and Zhuang, 2007).

4.1.4. Analyze Trade Pattern between the United States and South Korea

Trade pattern between the United States and South Korea used to be inter-industry trade since the U.S. exported technology and capital intensive products to Korea and imported relatively labor intensive goods from Korea. Currently, the U.S. mainly exports technology and capital intensive goods as well as importing these goods from Korea since the two countries' market structures are getting very similar with each other.

Figure 4.1 shows intra-industry trade indexes of the three trade sectors between the United States and South Korea. From 1989 to 2013**,** the agricultural intra-industry trade index is below 0.3. Therefore, agricultural trade between the United States and South Korea is inter-industry trade which is based on resource endowment. On the other hand, mid technology and high technology trade between the United States and South Korea is intra-industry since intra-industry index is closely to 1. Thus, the United States trades differentiated mid technology and high technology products with South Korea that are relatively similar across countries.

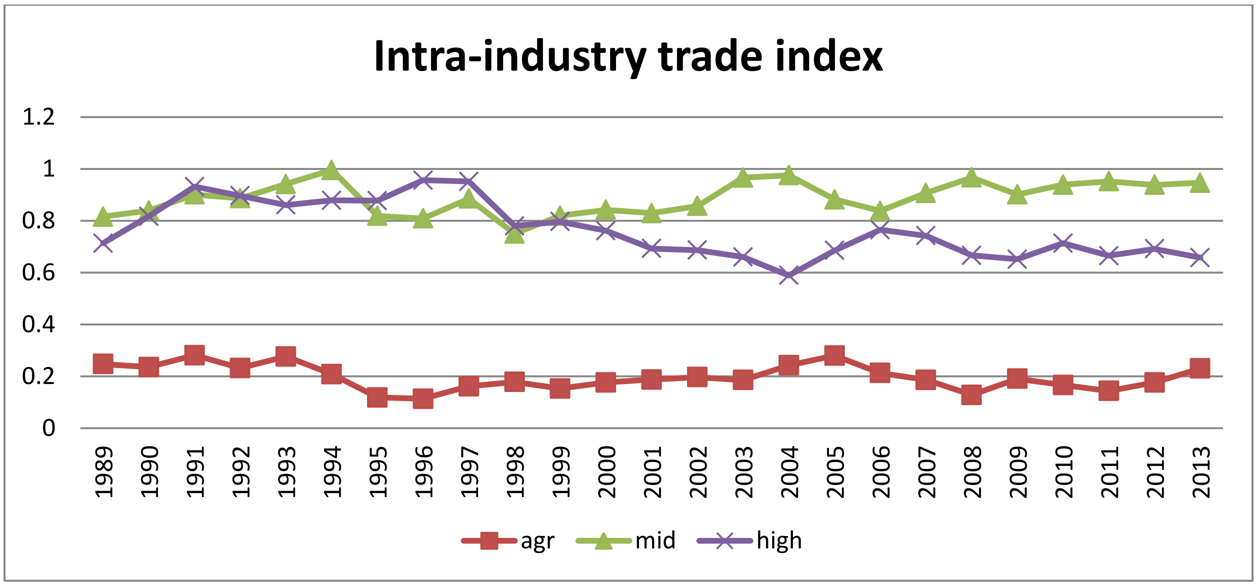

Figure 4.1. Intra-Industry Trade Index between the U.S. and South Korea
Source: U.S. Department of Commerce: National Trade Data 1989

4.2. Import Demand and Export Supply

The theory of demand indicates that domestic demand for a good is specified by maximizing consumers' utility subject to their budget constrains (Walter and Snyder, 2007) Demand for a good is, therefore, a function of prices of the good and competing goods and the consumer's income as

$$D = f_d(P, Y) \quad \text{(Eq. 4.2)}$$

where D is demand for domestically produced goods, P is price of the good and Y is disposable income. On the other hand, supply for a good is specified by minimizing production costs (Walter and Snyder, 2007) as

$$S = f_s\ (P, Z) \qquad \text{(Eq. 4.3)}$$

where P is the price of goods and Z is a value of exogenous variables effecting supply. In equilibrium, P is obtained when supply and demand are equal. However, under global economy, a country may import or export based on its competitiveness in the global market. If the country has a competitive disadvantage in producing a good, the country will import the good. On the other hand, if the country has a comparative advantage, then country will export the good. Under a free market condition, trade flows between the two countries are determined on the basis of the domestic demand and supply condition as shown Figure 4.2.

Figure 4.2 shows the international equilibrium between the U.S. and Japan for rice. As U.S. rice price increases from $291 to $485.5, the domestic quantity supplied increases, while the domestic quantity demanded decreases in the United States. Thus, there is an excess supply for rice in the United States. Japan's rice price was $680 before trading. When trade is allowed, the international market equilibrium occurs at the point where the export supply curve crosses the import demand curves. The equilibrium price is equal to $485.5 and the equilibrium volume of 194.5 rice units in the international market. In this situation, Japan's importing of rice occurs since the international equilibrium price is lower than Japan's domestic price. Thus, U.S. exports of rice are equal to Japan's imports of rice (Koo and Kennedy, 2004).

When demand for the domestic good is greater than the supply for the domestic good at a given price, import demand for the commodity occurs. Therefore, excess demand leads to import demand and the import demand function is defined as follows:

$$Q_m(P) = Q_d(P) - Q_s(P) \qquad \text{(Eq. 4.4)}$$

$Q_m(P)$ represents the quantity of the good imported at price P, $Q_d(P)$ represents the quantity of the good demanded at price P, and $Q_s(P)$ is the quantity of the good supplied at price P. Price is an important factor to determine domestic demand of a commodity and domestic supply of a commodity. Import demand is also functionally related with price. Similarly, export supply is defined as domestic supply minus domestic demand as

$$Q_x(P) = Q_s(P) - Q_d(P) \qquad \text{(Eq. 4.5)}$$

Figure 4.2 shows the deviation of export supply (left figure) and import demand (right figure) and international equilibrium (middle figure). Export supply in middle figure is obtained for domestic supply and demand in exporting country (left figure). As shown in the figure, it has up-ward slop with increases in price. On the other hand, the import demand (middle figure) is determined for domestic demand and supply in an importing country and has down-ward slop.

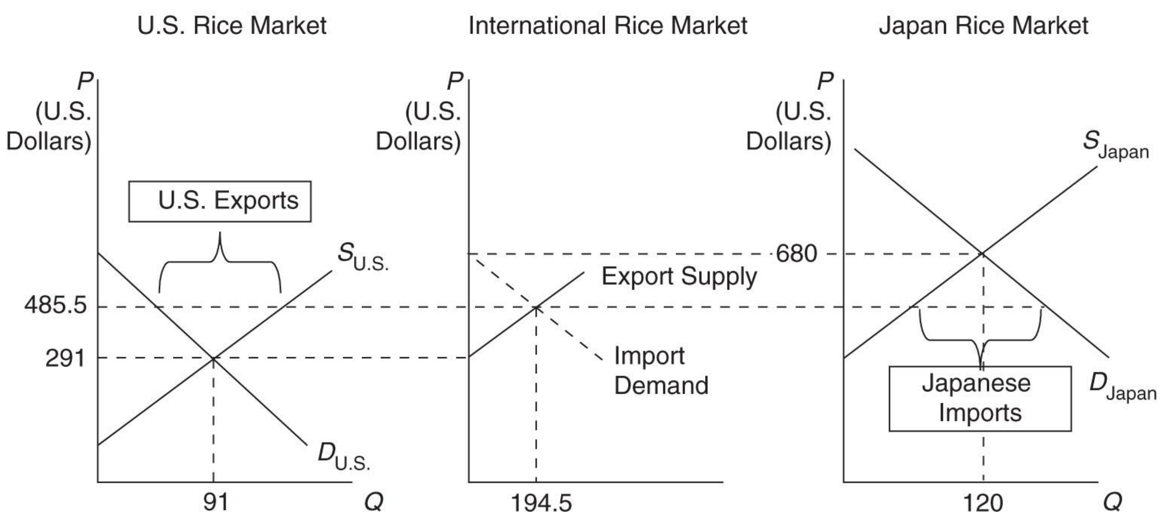

Figure 4.2. Example of International Equilibrium
Source: Agricultural Marketing and Price Analysis (Norwood and Lusk, 2007)

4.3. The Role of Exchange Rate

Each country has its own currency so exchange rate is significantly related to international trade. The exchange rate and exchange rate volatility affects the willingness of consumers to import goods and services as well as the ability of companies to export their products. Therefore, it is important to have an efficient foreign exchange market to promote international trade (Koo and Kennedy, 2004).

The nominal exchange rate is defined as the prices of a currency in terms of the prices of other currencies (Koo and Kennedy, 2004). Under the floating exchange rate system, the value of a currency is determined by the supply and demand for the currency in the exchange market where international currency trades take place. Commercial banks, corporations, non bank financial institutions, and central banks are the major players in the currency exchange market. There are several main factors affecting the supply and demand for currencies (Koo and Kennedy, 2004).

The demand for foreign exchange is related to international transactions. Foreign currency is required to import goods or services from other countries for paying for the imported goods or services in that foreign currency. The demand for foreign currency also occurs when people buy foreign goods, or goes abroad, or invests in another country. Conversely, the supply of foreign exchange depends on the level of international transactions which require payments in the home currency by foreigners. Moreover, the supply of foreign exchange is increased when foreigners visit a country or foreigners invest in the country (Koo and Kennedy, 2004).

4.3.1. Impact of Exchange Rate on Trade

According to Auboin and Ruta (2011), real exchange rate affects the incentive to allocate resources, such as capital and labor. The country's competitiveness is also measured by real exchange rate since real exchange rate enables them to capture the relative prices, costs, and productivity of one particular country as opposed to the rest of the world.

Real exchange rate affects the competitiveness of exports and imports since it brings about changes in the prices of products. When the U.S. dollar appreciates against the Korean won, U.S. goods and services become more expensive in Korea. Thus, Korea's import from the U.S. decreases as a result of the appreciation of the U.S. dollar. On the other hand, Korean goods and services are less expensive in the U.S. with appreciation of the U.S. dollar. Thus, U.S. imports from Korea are increased. As a result, the demand for the U.S. dollar is decreased and the supply for U.S. dollar is increased. Then the U.S. dollar would ultimately depreciate.

When the U.S. dollar depreciates against the Korean won, the U.S. goods and services are cheaper in Korea and it makes Korea's imports from the U.S. increase. Thus, depreciation of the U.S. dollar can give incentive to U.S. firms to export and make sure U.S. commodities are preferred relative to imported goods. Thus, imports would decrease while exports would increase. It results in that the demand for the U.S. dollar increases and the supply of U.S. dollar decreases.

4.3.2. Impact of Exchange Rate Volatility on Trade

It is often argued that exchange rate volatility has negative effects on the volume of international trade. Importers and exporters become risk-averse if their activities have risk or uncertainty about profits. Thus, exchange rate volatility would affect decreases in demand and supply of traded goods. Analytically, however, the relationship between exchange rate volatility and trade flows is ambiguous. The impact of exchange rate volatility depends on many factors including the degree of risk, and the availability of hedging opportunities (Sauer and Bohara, 2001).

According to De Grauwe (1988), the degree of impact of exchange rate volatility on trade would be different in every situation, since an increase in risk has both a substitution and an income effect. The substitution effect encourages agents to move from risky export activities to less risky export activities so export activities decrease. On the other hand, the income effect encourages agents to move resources into the export sector when expected utility of export revenues declines as a result of the increase in exchange rate risk. Thus, if the income effect dominates the substitution effect, exchange rate volatility will have a positive impact on export activities.

This paper uses the moving sample standard deviation of the percentage real exchange rates to measure exchange rate volatility. It is short-term exchange rate volatility since it is one-period ahead and has a window of one or two years (Sun, Kim, Koo, Cho, and Jin, 2002). The equation (4) shows exchange rate volatility function V_t:

$$V_t = \left[m^{-1} \sum_{i=1}^{m} (lnR_{t+i-1} - lnR_{t+i-2})^2\right]^{1/2} \quad \text{(Eq. 4.6)}$$

where R_t is the real exchange rate at time t: m is the order of moving average.

4.4. Hypothesis

Exchange rate is one of the most important factors to affect the bilateral trade since it determines the relative prices of products. The relative prices affect the competitiveness of products between importing goods and domestic goods. If currency appreciates relative to foreign currency, price competitiveness of importing goods increase since the relative price of importing goods decreases compare to domestic goods. While depreciation of currency increases importing goods' prices relative to domestic goods, so domestic goods become more competitive compare to importing goods. Thus, exchange rate affects consumers' expense for purchasing specific goods and consumers would purchase cheaper goods between importing goods and domestic goods. Trading firms' profits also would change depending on the exchange rate. Consequently, the following hypothesis emerges:

Hypothesis1: The effects of exchange rate are significant for bilateral trade between the United States and South Korea.

If exchange rate is fluctuating, bilateral trade flow would not be stable since the price of products also changes a lot and there is uncertainty for profits. If involved agents are risk-adverse, exchange rate volatility would discourage these agents to participate in the bilateral trade, and the exchange rate volatility would have some negative impact on the countries' trade flows. This leads to the hypothesis that:

Hypothesis 2: Exchange rate volatility has negative impacts on the bilateral trade between the United States and South Korea.

If the trade pattern between the two countries is intra-industry trade which is based on market structure and economies of scale, the two countries would trade similar goods across other countries. When the trading goods are similar between the two countries, consumers would prefer to purchase cheaper goods no matter what the origin of products. Thus, price is the most significant factor to affect consumers' purchases in this situation. Exchange rate is also an important factor affecting the intra-industry trade since it determines the relative price. On the other hand, under inter-industry trade, price would not be an important factor as much as intra-industry trade, since the two countries trade goods based on their resource endowments. Consequently, the following hypothesis emerges:

Hypothesis 3: Intra-industry trade is more sensitive to exchange rate than inter-industry trade.

Bilateral trade in the agriculture industry between the United States and South Korea is generally regarded as inter-industry trade since the agriculture industry is based on country's resource endowment. On the other hand, bilateral trade in the high-technology sector between the two countries would be intra-industry trade since the two countries' market structures are similar in that, the high-technology industry takes the biggest part of both economies in each country. Therefore, bilateral trade in the high-technology sector between the two countries would be based on market structure and economies of scale. This leads to the hypothesis that:

Hypothesis 4: The high-technology industry is more sensitive to changes in the exchange rate than the agricultural industry.

CHAPTER 5. SPECIFICATION OF EMPIRICAL MODEL AND ECONOMETRIC PROCEDURE

5.1. Development of Empirical Model

When domestic supply for a commodity is greater than domestic demand for a commodity, there is exportable surplus. Thus, excess of domestic supply leads to export and export function is defined as:

$$X_{US} = S - D \qquad \text{(Eq. 5.1)}$$

where X_{US} is exportable surplus of the United States, S represents the domestic supply for a commodity and D represents the domestic demand for a commodity. Domestic supply of a commodity depends on price and other factors, and domestic demand for a commodity depends on price, income, and other factors. Functions of domestic supply and demand are defined as:

$$\mathrm{S} = f_s(P, Z) \qquad \text{(Eq. 5.2)}$$

$$\mathrm{D} = f_d(P, Y, G) \qquad \text{(Eq. 5.3)}$$

where P is price, Y is real income, and Z and G are other exogenous variables. Z and G can be replaced with factors indicating real exchange rate, exchange rate volatility, the openness of U.S. market, and the openness of Korea's market. Empirical export supply and import demand models with the additional variables are developed as:

$$X_{US,it} = f(P, Y_K, ER, EV, OPEN_K) \qquad \text{(Eq. 5.4)}$$

$$M_{US,it} = f(P, Y_{US}, ER, EV, OPEN_{us}) \qquad \text{(Eq. 5.5)}$$

where *i* represents industry and *t* represents time, ER and EV represent real exchange rate and exchange rate volatility, respectively, and OPEN represents openness index for trade. As discussed in Chap 4, exchange rate is closely related to bilateral trade since foreign currency is needed to import goods and service from other country and pay for the import in foreign currency. The amount of foreign currency is increased when the country exports goods to other country and get payments in foreign currency by foreigners. Exchange rate volatility is also related to bilateral trade since variation of exchange rate would make trade activities is riskier. Thus, uncertainty related to profit from trade would discourage trading firms to participate in trade activities. Openness in a country shows the degree of free trade in the country and is represented by the share of total trade value (import value plus export value) of the country's GDP. Thus, openness index is positively related with international trade.

From these empirical specifications, econometric models are developed in a double log functional form to examine bilateral trade for agricultural good, low technology intermediate goods and high technology goods between the United States and South Korea. Equation (5.4) and (5.5) are rewritten in a double-logarithmic functional form as:

$$lnVE_{US,it} = \alpha_0 + \alpha_1 ln\frac{CPI_{K,it}}{CPI_{US,it}} + \alpha_2 lnY_{Kor,t} + \alpha_3 lnER_t + \alpha_4 ln\ EV_t + \alpha_5 OPEN_K + \varepsilon_t \quad \text{(Eq. 5.6)}$$

$$lnVM_{US,it} = \beta_0 + \beta_1 ln\frac{CPI_{K,it}}{CPI_{US,it}} + \beta_2 lnY_{US,t} + \beta_3 lnER_t + \beta_4 ln\ EV_t + \beta_5 OPEN_{US} + \varepsilon_t \quad \text{(Eq.5.7)}$$

where $VE_{US,it}$ represents value of U.S. export in sector *i* and $VM_{US,it}$ represents value of U.S. import in sector *i*. $\frac{CPI_{K,it}}{CPI_{US,it}}$ is the ratio of price level between the United States and South Korea, and it is used to examine the difference in general price levels (inflation) in the countries. Following Bahmani-Oskooee, Harvey and Hegerty (2012), this paper adds a dummy variable to examine impact of the 1997 Korean economic crisis.

$$lnVE_{US,it} = \alpha_0 + \alpha_1 ln\frac{CPI_{K,it}}{CPI_{US,it}} + \alpha_2 lnY_{Kor,t} + \alpha_3 lnER_t + \alpha_4 lnEV_t + \alpha_5 OPEN_K + \alpha_6 D97\ \varepsilon_t \quad \text{(Eq. 5.8)}$$

$$lnVM_{US,it} = \beta_0 + \beta_1 ln\frac{CPI_{K,it}}{CPI_{US,it}} + \beta_2\, ln\, Y_{US,t} + \beta_3 ln\, ER_t + \beta_4 ln\, EV_t + \beta_5 OPEN_{US} + \beta_6 D97 + \varepsilon_t \quad \text{(Eq. 5.9)}$$

This study also adds dummy variables to examine impact of mad cow disease (MCD) in agricultural trade. For agricultural product group, price variable is removed. Since the price variable generally represents price level for industrial goods rather than agricultural goods. Since agriculture is a small portion of the entire economy in each nation and trading agricultural products is based on resource endowments. Thus, price is not a crucial variable to affect the U.S. exports and imports in agricultural trade sector.

$$lnVE_{US,agri,t} = \alpha_0 + \alpha_2 ln\, Y_{Kor,t} + \alpha_3 ln\, ER_t + \alpha_4 ln\, EV_t + \alpha_5 OPEN_K + \alpha_6 D97 + \alpha_7 MCD + \varepsilon_t \quad \text{(Eq. 5.10)}$$

$$lnVM_{US,agri,t} = \beta_0 + \beta_2\, lnY_{US,t} + \beta_3 lnER_t + \beta_4 ln\, EV_t + \beta_5 OPEN_{US} + \beta_6 D97 + \varepsilon_t \quad \text{(Eq. 5.11)}$$

The sign of α_1 is expected to be positive. If Korean goods are more expensive than U.S. goods, Korea would import more from the United States. The sign of $\alpha_2$is positive. An increase in Korea's real income would lead Korea to import more from the United States. The sign of α_3 can be either positive or negative and it depends on the price elasticity of Korea imports of US goods e_p^m. If e_p^m is less than 1, α_3 is positive, but if e_p^m is greater than 1, α_3 is negative. The sign of α_4 is negative. An increase in exchange rate volatility would make trade activities become more risky so it would cause Korea to import less from the United States. The sign of α_5 is expected to be positive. An increase of openness of Korea market would leads to Korea import more from the United States. The sign of α_6 is expected to be negative since 1997 Asian financial crisis had a bad effect on the Korean economy. It would lead Korea to reduce import from other countries. The sign of α_7 is negative since it brings about a reduction of U.S. beef consumption in Korea.

The sign of $\beta_1$is negative. If Korean goods are more expensive than U.S. goods, the U.S. would import less from South Korea. The sign of β_2 is expected to be positive. A rise in U.S. national real income would result in an increase in consumption in the United States. Thus, the United States would import more from South Korea. The sign of β_3 can be either positive or negative, and it depends on the price elasticity of U.S. imports of Korean goods e_p^m. If e_p^m is greater than 1, β_3 is positive, but if e_p^m less than 1, β_3 is negative. The sign of β_4 is expected to be negative since a variation of exchange rate would bring about uncertainty for trade activities. Thus, trade agents would be timid for their trade activities to avoid uncertainty. The sign of β_5 is expected to be positive. An increase of openness of U.S. market would leads to the United States import more from South Korea. The sign of β_6 is expected to be either positive or negative. If β_6 is negative, 1997 Asian financial crisis resulted in Korean companies' bankruptcy and it would reduce exportable surplus in Korea. On the other hand, if β_6 is positive, depreciation of Korean won would encourage the United States import more from South Korea.

5.2. Data and Econometric Procedure

This study examines the effect of exchange rate on bilateral trade between the United States and South Korea over the period from 1989 to 2013 by using panel data. The United States annual trade volume data are collected from the United States Department of Commerce: National Trade Data and classified according to Standardized International Trade Classification (SITC) two-digit codes for industries. Following Koo and Zhuang (2007), this study classified the data into three commodity groups: agricultural goods, mid technology manufactured goods, and high technology manufactured goods. Thus, each group includes 13 to 34 commodities which belong to the group (see appendix). The total observations of agricultural goods, mid technology manufactured goods, and high technology manufactured goods are the number of each group commodities in time years (1989 – 2013). The total observations are 350 for agricultural sector, 850 for mid technology sector and 325 for high technology sector. GDP per capita is obtained from World Bank: World Development Indicators. The bilateral real exchange rates between the United States and South Korea are collected from the United States Department of Agriculture: Economic Research Service, and are in terms of Korean won per U.S. dollar. Annual U.S. CPI and Korea CPI are obtained from Federal Reserve Bank of St. Louise: Federal Reserve Economic Data.

The period from 1989 to 2013 is not a long period of time for efficient estimates. Thus, pooling technique with cross section and time series data is considered as the most appropriate method. The use of pooling technique allows solving the limited number of available data and increasing the number of data that generates additional degrees of freedom. This study also can get the efficient estimator with the use of pooling technique since the data provides more accurate information on commodities over time. Therefore, this study can examine economic effects that cannot be considered with the use of either cross section or time series data alone (Pindyck and Rubinfeld, 1976).

Estimation of the model with the pooled data is based on two effects model, fixed effects and random effects methods. The random effect method includes dummy variables representing cross-section data (commodities in a group) and each time in the time period used. The econometrics model with the fixed effect approach represented as:

$$Y_{it} = \alpha + \beta X_{it} + \sum_{i=2}^{i} \gamma_i W_{it} + \sum_{i=2}^{i} \delta_i Z_{it} + \varepsilon_{it} \quad \text{(Eq. 5.12)}$$

where Y_{kt} is the dependent variable where *i* is individual and *t* is time, and X_{it} is independent variables. W_{it} is time-series dummy variables and Z_{it} is cross-section dummy variables (commodities). γ_i is the coefficient for time-series dummy variables; δ_i is the coefficient for cross-section dummy variables and ε_{it} is the error term. Since fixed effects method has too many dummy variables, it may cause some estimation issue such as a loss of efficiency. In addition, the use of dummy variables does not clearly explain what causes the regression line to shift over time and over individuals (Pindyck and Rubinfeld, 1976). On the other hand, the random effects model assumes that cross section and time effects are random. The econometric model with the random effects method is:

$$Y_{it} = \alpha + \beta X_{it} + v_t + u_i + \varepsilon_{it} \qquad \text{(Eq. 5.13)}$$

where $v_t, u_i \; and \; \varepsilon_{it}$ represent time-series error component; cross-section error component, and combined error component, respectively. In this study, the random effects model is chosen. However, the random effects model also has some problem in that the estimated regression coefficients can be biased and inconsistent if the cross section characteristic is correlated with included explanatory variables (Podesta, 2000). To solve this problem, this study builds the model:

$$Y_{it} = \alpha + \beta X_{it} + \sum_{n=2}^{n} \delta_i Z_i + v_t + u_i + \varepsilon_{it} \qquad \text{(Eq. 5.14)}$$

Since estimation of the model uses both cross section and time series data, this study tests for heteroscedasticity and auto correlation. To test the null hypothesis of homoscedasticity, the Breusch-Pagan test (Breusch and Pagan 1979) and White's General test (White 1980) are performed. The null hypothesis of homoscedasticity is rejected since the test statistic exceeds chi-square distribution at the 5 percent level. The results are presented in Table 5.1. To correct for heteroscedasticity, this study recomputes the test using the heteroscedasticity-consistent co variance to obtain the heteroscedasticiy-consistent standard errors.

Table 5.1. Breusch-Pagan and White Tests

Heteroscedasticity Test							
Equation	Test	Statistic	DF	Pr>ChSq	R-Sq	Observations	ChSq @ 5%
Agr Export	White'sTest	235.7	49	<.0001	0.7826	350	26.51
	Breusch-Pagan	148.1	9	<.0001	0.7826	350	2.73
Agr Import	White'sTest	173.3	43	<.0001	0.8465	350	26.51
	Breusch-Pagan	116.8	9	<.0001	0.8465	350	2.73
Mid Export	White'sTest	471.0	125	<.0001	0.8702	848	95.70
	Breusch-Pagan	316.9	19	<.0001	0.8702	848	9.39
Mid Import	White'sTest	600.7	125	<.0001	0.8945	848	95.70
	Breusch-Pagan	323.2	19	<.0001	0.8945	848	9.39
High Export	White'sTest	206.8	53	<.0001	0.8379	325	26.51
	Breusch-Pagan	206.8	9	<.0001	0.8379	325	2.73
High Import	White'sTest	220.8	53	<.0001	0.9122	325	26.51
	Breusch-Pagan	72.49	9	<.0001	0.9122	325	2.73

The Durbin-Watson test (1950) is applied to test the null hypothesis of no autocorrelation. The Durbin-Watson statistic ranges in value from 0 to 4. If the DW statistic is near 2, it indicates non-autocorrelation. If the DW is toward 0, it indicates positive autocorrelation. If the DW statistic is toward 4, it indicates negative autocorrelation. All the DW statistics are substantially near 2, so this study considers that serial correlation is not presented in the estimated residulas. Table 5.2 shows the results of Durbin-Watson statistics test.

Table 5.2. Durbin-Watson Statistics Test

Durbin-Watson Statistics	
Trade Sector	DW
U.S. Agricultural Export	1.9682
U.S. Agricultural Import	1.8347
U.S. Mid tech Export	1.6838
U.S. Mid tech Import	1.7521
U.S. High tech Export	1.6872
U.S. High tech Import	1.9764

CHAPTER 6. EMPIRICAL RESULTS

This section is divided into three parts. First, the impacts of price, income, exchange rate, exchange rate volatility and other exogenous variables on bilateral trade of the three commodities groups between the United States and South Korea are analyzed. Second, the effects of exchange rate and exchange rate volatility on inter-industry trade and intra-industry trade are examined. Third, the hypotheses which are built in the previous chapters are confirmed with empirical results.

6.1. U.S. Exports to South Korea

Table 6.1 summarizes the estimation results showing the effects of major variables on United States exports to South Korea in the three commodity groups: AGR (agricultural group), MID (mid technology group), HIGH (high technology group). The fit between the estimated regression line and the data can be measured by an R-square (Pindyck and Rubinfeld, 1976). An R-square value of each industry is greater than 0.82, indicating that over 82% of the variation is explained by the independent variables in the model.

6.1.1. Agricultural Sector

In the agricultural sector, exchange rate volatility, Korea's national income, and Korea economic crisis are significant at the 5%, 10%, and 10% significant levels for U.S. agricultural exports to South Korea, respectively. Exchange rate volatility has positive effects on U.S. agricultural exports, indicating that an increase in exchange rate volatility increases the volume of U.S. agricultural exports to South Korea. As the United States exports more agricultural commodities to Korea, the U.S. would be able to reduce at a loss per exported unit which comes from exchange rate volatility. In this situation, the income effect dominates the substitution effect on U.S agricultural export activities (Auboin and Ruta, 2011). Korea's national income has positive effects on U.S. agricultural exports. An increase in Korea's national income causes an increase in consumption for agricultural products and then results in an increase in the demand for U.S. agricultural commodities. Korea's economic crisis has negative effects on the volume of U.S. agricultural exports to South Korea and it indicates that an economic depression of South Korea decreases U.S. agricultural exports to South Korea.

The estimated coefficient for the variables of real exchange rate between the United States and South Korea, Korea's openness index and mad cow disease are not significant for U.S. agricultural exports to South Korea. The real exchange rate is not an important factor in affecting U.S. agricultural exports to South Korea. The possible reason for the insignificance of exchange rate is that the relative price of agricultural goods which is determined by real exchange rate is not that important of a factor affecting agricultural trade since agricultural goods are generally inelastic with price. In addition, trade patterns of the agricultural goods between the two countries are inter-industry trade which is based on resource endowments rather than differences in prices. Korea's openness index is also not a significant factor to affect U.S. agricultural exports to South Korea. Korea's openness index would decreases the prices of agricultural goods imported from the U.S., but the decrease in price would not increase import significantly, since agricultural goods are generally a necessity and inelastic with regard to prices of agricultural goods. The estimated coefficient of mad cow disease has an expected sign but it is not statistically significant. There are a number of commodities in the agricultural sector. South Korea banned import of beef from the U.S. for 2 years just after mad cow disease occurred in the United States. However, Korea continued to import other agricultural goods. Thus, the total volume of U.S. agricultural exports to South Korea did not decrease significantly.

6.1.2. Mid Technology Sector

For the mid technology sector, the exchange rate between the United States and South Korea and exchange rate volatility are significant at the 1% and 5% significant levels for U.S. mid technology exports to South Korea. Exchange rate has a negative sign as indicated in trade theory. An appreciation of U.S. dollar (Korean Won per U.S. dollar) makes the U.S. mid technology products' prices increase in Korea. Thus, U.S. mid technology exports to Korea decreases. On the other hand, if U.S. dollar depreciates, the U.S. products become relatively cheaper in Korea. Thus, the demand for U.S. products increases in Korea and it leads an increase in U.S. mid technology exports. Exchange rate volatility has positive effects on U.S. mid technology exports to South Korea. This positive relationship is consistent with the result of Auboin and Ruta (2011) and De Grauwe (1988). Some firms export more to offset the decreased revenue per exported unit under a high degree of volatility and it brings an increase in trade volume between the two nations. Korea's openness index and Korea's economic crisis are significant at 1% and 5% significant levels for U.S. mid technology exports to South Korea. Korea's openness index has a positive sign indicating that the volume of U.S. mid technology exports to South Korea increases, as the Korea's openness index increases. Korea's economic crisis is negatively related to U.S. mid technology exports to South Korea. The price of U.S. mid technology products went up dramatically because of a sharp appreciation of U.S. dollar. Also, many Korean manufacturing firms stopped importing U.S mid technology inputs due to bankruptcies. Thus, Korean imports of U.S. mid technology products decreased as a result of Korea's economic crisis.

The estimated coefficients for the variables of price difference between the United States and South Korea and Korea's national income are not significant for U.S. mid technology exports to South Korea. The possible reason for insignificance of price difference and Korea's national income would be that Korean companies import U.S. mid technology inputs to produce technology intensive products and exports technology intensive products to foreign countries including the United States. Since Korea's high technology manufacturing industry somewhat relies on the U.S. technology inputs, Korea would import U.S. technology inputs. Korea's national income has a negative sign but it is statistically insignificant.

6.1.3. High Technology Sector

For the high technology sector, the price variable is significant at the 5% significant level for U.S. high technology exports to South Korea. The price ratio is calculated by the Korean general price index divided the U.S. index. An increase in price ratio means that the Korean goods price goes up relative to the U.S. goods price. Trade pattern of the high technology industry between the two countries is intra-industry trade which is based on market structure and economies of scale, so price is an important factor affecting consumers' demand. Thus, an increase in price difference increases U.S. high technology exports to South Korea, since U.S. products have price competitiveness relative to Korea products. Exchange rate between the United States and South Korea and exchange rate volatility are significant at the 1% significant level for U.S. high technology exports to South Korea. Exchange rate has negative effects on U.S. high technology exports to South Korea, indicating that an appreciation of U.S. dollar reduces U.S. high technology exports to South Korea. It implies that the price elasticity of Korea imports of U.S. goods is sensitive to price changes. Exchange volatility is positively related to U.S. high technology exports to South Korea, indicating that an increase in exchange volatility increases U.S. high technology exports. It is consistent with the results of Bahmani-Oskooee, Harvey, and Hegerty (2012) in that exchange rate volatility has positive long-run effects on most industries exports (12 industries out of 16 industries) between the U.S. and Korea. They also mentioned that large trading firms are able to deal with the risk through trade, since trade flow between the two nations is intra-industry trade. One of examples they provided is that trading firms can offset the fall in export revenue by importing intermediate inputs from a country whose currency is depreciating. Therefore, it is expected that the U.S. high technology exporting firms would be large enough to not be sensitive with exchange rate volatility and the decreased export revenue can be covered by an increase in U.S. high technology exports. According to De Grauwe(1987), the exporters decide their export activity based on the degree of risk aversion if there is high exchange rate volatility. Thus, it is expected that the U.S. high technology exporting firms are risk takers rather than risk averters. Korea's economy crisis is negatively related to U.S. high technology exports to South Korea, indicating that Korea experience economic depression led to a decrease in Korea imports of U.S. high technology products. The economic crisis in 1997 has a significant effect on U.S. high technology exports. Because of a significant appreciation of the U.S. dollar against the Korean currency, U.S. high technology exports were decreased.

The estimated coefficient for the variables of Korea's national income and Korea's openness index are not statistically significant for U.S. high technology exports to South Korea, indicating that U.S. high technology exports are not affected by Korea's national income and openness index.

Table 6.1. Estimation Results for U.S. Exports to South Korea

Independent variables	AGR	MID	HIGH
Intercept	18.15474 (0.0001)	32.55406 (0.0001)	34.39272 (0.0001)
Price ratio	-	0.95175 (0.5330)	2.86892** (0.0481)
U.S.-Korea exchange rate	-0.37615 (0.1790)	-1.89614*** (0.0001)	-1.53185*** (0.0012)
Exchange rate volatility	0.11111** (0.0339)	0.08623** (0.0165)	0.11299*** (0.0021)
Korea's national income	0.26733* (0.1024)	-0.32839 (0.2945)	-0.20151 (0.5339)
Korea's openness index	0.00113 (0.7688)	0.00730*** (0.0054)	-0.00340 (0.2669)
Economic crisis in 1997	-0.28045* (0.1003)	-0.34132** (0.0464)	-0.28140* (0.0559)
Mad Cow disease	-0.13277 (0.4435)	-	-
Number of observations	350	850	325
R-Square	0.8226	0.8702	0.8379

Note: *, **, *** indicate significance at 10%, 5%, and 1% respectively.

6.2. U.S. Imports from South Korea

Table 6.2 summarizes the estimation results about the effects of major variables on the U.S. imports from South Korea in the three commodity groups: AGR (agricultural group), MID (mid technology group), HIGH (high technology group). An R-square value of each industry is greater than 0.88 indicating that over 88% of the variation is explained by independent variables in the model.

6.2.1. Agricultural Sector

For the agricultural sector, exchange rate is significant at the 1% significant level for U.S. agricultural imports from Korea and has a positive sign. It indicates that an appreciation of the U.S. dollar increases U.S. agricultural imports from Korea, since the relative price of Korean products becomes cheaper. U.S. national income is significant at the 5% significant level for U.S. agricultural imports from South Korea. U.S. national income has positive effects on U.S. agricultural imports, indicating that an increase in U.S. national income increases the demand for Korean agricultural commodity.

The estimated coefficients for the variables of exchange rate volatility, U.S. openness index and the Korean economic crisis are not significant factors in affecting the U.S. agricultural imports from South Korea. The estimated coefficient of exchange rate volatility is statistically insignificant. Thus, U.S. agricultural imports from South Korea are not affected by exchange rate volatility. The U.S. openness is also an insignificant factor for U.S. agricultural imports from Korea since U.S. imports of Korean agricultural goods are not related to their prices. Korean economic crisis is not a significant factor affecting U.S. agricultural imports from South Korea. The possible reason for the insignificance of the Korea economic crisis is that U.S. import demand for Korean agricultural goods was not affected by the event happened in Korea. Moreover, the impacts of the 1997 Korea economic crisis were serious for the mid technology and high technology industries, not for the agricultural industry. Thus, U.S. agricultural imports are not affected by the Korean economic crisis.

6.2.2. Mid Technology Sector

For the mid technology sector, exchange rate and U.S. openness index are significant at the 1% and 5% significant levels for U.S. mid technology imports from South Korea. Exchange rate is positively related with U.S. mid technology imports, indicating that the United States imports more commodities from Korea when U.S. dollar appreciates. U.S. openness index has positive effects on U.S. mid technology imports from South Korea implying that an increase in U.S. openness correlates with an increase in U.S. mid technology imports from Korea.

The estimated coefficients for the variables of price difference, exchange rate volatility, U.S. national income and Korean economic crisis are not significant for U.S. mid technology imports from South Korea. The estimated coefficients of price ratio and U.S. national income have expected signs but are not statistically significant. Thus, these variables would not be major factors affecting U.S. mid technology imports from Korea. Korea's economic crisis did not play a significant role to explain an increase in U.S. mid technology imports.

6.2.3. High Technology Sector

For the high technology sector, exchange rate, U.S. national income, and U.S. openness index are significant at the 1%, 1%, and 5% significant levels for U.S. high technology imports from South Korea, respectively. Exchange rate has positive effects on U.S. imports, implying that an appreciation of U.S. dollar makes Korean high technology products become relatively cheaper. As a result, the demand for Korean high technology goods increases and the U.S. imports more high technology goods from Korea. There is a positive relationship between U.S. national income and U.S. high technology imports. As U.S. national income increases, domestic consumption for high technology products increase. The U.S. openness index is positively related with U.S. high technology imports from Korea, indicating that the U.S. imports more high technology goods from Korea, as the U.S. openness index increases.

The estimated coefficient of price ratio does not have expected signs but are not statistically significant. Exchange rate volatility is positively related to U.S. high technology exports but it is also not statistically significant. Korea economic crisis has a negative sign and it is not significantly related with U.S. high technology imports.

Table 6.2. Estimation Results for U.S. Imports from South Korea

Independent variables	AGR	MID	HIGH
Intercept	-13.14901 (0.0001)	-10.98023 (0.0164)	-8.3785 (0.0010)
Price ratio	-	-1.03998 (0.3518)	0.0569 (0.9152)
U.S.-Korea exchange rate	1.60976*** (0.0001)	2.15219*** (0.0010)	2.2276*** (0.0001)
Exchange rate volatility	0.03104 (0.6300)	-0.002259 (0.9584)	0.00493 (0.8631)
US national income	0.98520** (0.0149)	0.42007 (0.3059)	0.7264*** (0.0052)
US openness index	0.02807 (0.3123)	0.04282** (0.0256)	0.0254** (0.0496)
Korea Economic crisis in 1997	0.00564 (0.9737)	0.02138 (0.8579)	-0.0623 (0.5171)
Number of observations	350	850	325
R-Square	0.8816	0.8977	0.9418

Note: *, **, *** indicate significance at 10%, 5%, and 1% respectively.

6.3 Inter- and Intra-Industry Trade

As previous chapters mention, agricultural trade between the United States and South Korea is inter-industry trade which is based on their resource endowments. Exchange rate is not statistically significant for U.S. agricultural exports while it is statistically significant for U.S. agricultural imports. The positive coefficient of exchange rate volatility is statistically significant for U.S. exports while it is not significant for U.S. imports.

Trade flows of mid technology and high technology trade between the United States and South Korea are regarded as intra-industry trade which is based on economies of scale and market structure. The results show that the negative coefficients of exchange rate are statistically significant for U.S. mid technology and high technology exports. Also, U.S. mid technology and high technology imports are positively related with exchange rate and the relationship is statistically significant. These results indicate that the role of exchange rate for intra industry trade is important compared to inter industry trade.

Exchange rate volatility is positively related to U.S. mid technology and high technology exports and it is statistically significant. However, U.S. mid technology and high technology imports are not significantly related to exchange rate volatility. Korean firms are eager to export to the U.S. and they absorb the volatility.

6.4 Examination of Hypothesis

Empirical models (12), (13), (14) and (15) are estimated to test the hypotheses by using pooling technique. The results confirm hypothesis 1 in that the effects of exchange rate are significant on bilateral trade between the U.S. and Korea. Since U.S. mid technology and high technology trade are significantly affected by exchange rate. However, the results do not confirm hypothesis 2 in that exchange rate volatility has negative impacts on the bilateral trade between the two nations. The role of exchange rate volatility for U.S. mid technology and high technology trade is important and its effects are positive. Thus, an increase in exchange rate volatility encourages U.S. technology firms to trade with Korea more than before. The results verify hypothesis 3 in that intra-industry trade is more sensitive to exchange rate rather than inter-industry trade. Trade flow in agricultural sector between the U.S. and Korea is inter-industry trade and U.S.-Korea agricultural export is affected by exchange rate. On the other hand, U.S. mid technology and high technology trade are significantly related with exchange rate. The results also test hypothesis 4 that high technology trade is more sensitive to exchange rate rather than agricultural trade. Exchange rate is more elastic for both U.S. high technology exports and imports while it is less elastic for U.S. agricultural trade.

CHAPTER 7. CONCLUSION

This study examines the characteristics of U.S.-Korea bilateral trade from 1989 to 2013. In this study, trade patterns of the three trading groups (agricultural, mid technology, and high technology) between the two nations are analyzed. Export supply and import demand models are also developed to analyze factors affecting U.S.-Korea bilateral trade by using the pooling technique.

The U.S.-Korea bilateral trade volume has increased sharply since 1989 (Zhuang and Koo, 2004). Especially, trade of high technology goods between the two nations has increased dramatically and it accounts for 66% of the total U.S.-Korea bilateral trade. An increase in differentiated high technology products between the U.S. and Korea results in an increase in intra-industry trade between the two nations which is based on economies of scale and market structure. U.S. trade mid technology goods with Korea is also intra-industry trade which is based on economies of scale and market structure, while U.S. agricultural trade is inter-industry trade.

In 2010, the two nations reached an agreement on Korea-US Free Trade (KORUS FTA) which is the second-largest FTA for both countries, the U.S. and Korea. Under the KORUS FTA, it is expected that the volume of U.S.-Korea bilateral trade would increase since trade barriers for trading goods will be removed. The KORUS FTA will improve GDP, household income, and employment of the two countries. In KORUS FTA, the U.S. expects to increase access to Korean market in agricultural products, pharmaceuticals and medical equipment, and some other high technology manufactured goods. Korea’s main object is increasing its competitiveness in U.S. markets of consumer electronics and automobiles.

This study concludes that Korea’s national income, exchange rate, and Korea’s economic depression play significant roles for U.S. agricultural exports. U.S. agricultural imports are affected by U.S. national income and exchange rate. For the U.S. mid technology exports, exchange rate, exchange rate volatility, the Korea openness index, and Korea economic depression are statistically significant. U.S. mid technology imports are significantly related with the U.S. openness index and exchange rate. For the U.S. high technology trade, price level, exchange rate, exchange rate volatility, and Korea economic depression are important factors affecting U.S. exports. U.S. imports are affected by exchange rate, the U.S. national income and the U.S. openness index.

The results show that mid technology and high technology trade between the U.S. and Korea are more sensitive to exchange rate and exchange rate volatility than agricultural trade. It indicates that intra-industry trade is affected by exchange rate and exchange rate volatility more than inter-industry trade. The effects of exchange rate on U.S. mid and high technology exports are negative, implying that an increase in exchange rate reduces the volume of U.S. mid and high technology exports to Korea. On the other hand, exchange rate volatility has positive impacts on the U.S. mid and high technology exports, indicating that an increase in exchange rate volatility encourages the U.S. mid and high technology exports to Korea. Exchange rate has a positive relationship with U.S. mid and high technology imports, indicating that an increase in exchange rate makes Korean mid and high technology products become relatively cheaper than U.S. products, and increases U.S. imports of the goods.

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APPENDIX. SITC TWO-DIGIT DESCRIPTION FOR DATA ANALYSIS

Industries in the Agriculture Group	Industries in the Mid tech Group	Industries in the High tech Group
00. Live animals 01. Meat and meat preparations 02. Dairy products and birds' eggs 03. Fish (except marine mammal) 04. Cereals and cereal preparation 05. Vegetables and fruit 06. Sugars; sugar preparations 07. Coffee; tea; cocoa 08. Feeding stuff for animals 09. Miscellaneous edible 10. Beverages 11. Tobacco and tobacco manufactures 41. Animal oils and fats 42. fixed vegetable fats and oils	21.Hides; Skins And Furskins 22.Oil Seeds And Oleaginous 23.Crude Rubber 26.Textile Fibers 27.Crude Fertilizers 28.Metalliferous Ores 29.Crude Animal And Vegetable Materials 33.Petroleum; Petroleum Products 34.Gas; Natural And Manufactured 51. Organic chemicals 52. Inorganic chemicals 53. Dyeing; tanning and coloring materials 55. Essential oils 56. Fertilizers 57. Plastics in primary form 58. Plastics in nonprimary form 59. Chemical materials 61. Leather; leather manufactures 62. Rubber manufactures 63. Cork and wood manufactures 64. paper; paperboard 65. Textiles yarn; fabrics 66. Nonmetallic mineral 67. Iron and steel 68. Nonferrous metals 69. Manufactures of metals 81. Prefab buildings, sanitary, and plumbing, etc. 82. Furniture and bedding 83. Travel goods; handbags 84. Articles of apparel and clothing 85. Footwear 93. Special transactions 95. Coin including gold 97. gold, nonmonetary	54. Medicinal and pharmaceutical products 71. Power-generating machinery 72. Machinery specialized 73. Metalworking machinery 74. General industrial machinery 75. Office machines and automatic data-processing equipment 76. Telecommunications equipment 77. Electrical machinery; apparatus and appliances 78. Motor vehicles 79. Transport equipment 87. Professional scientific instruments 88. Photographic apparatus, equipment and supplies and optical goods 89. Miscellaneous manufactured articles

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