A STUDY ON FACTORS AFFECTING U.S. BILATERAL TRADE WITH HER MAJOR TRADING PARTNERS

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ABSTRACT

The objective of this study is to analyze factors affecting U.S. bilateral trade with her major trading partners, including exchange rate, GDP, economic structure, market openness, and free trade agreements. Six commodity groups included in this study are agriculture, low technology, mid-low technology, mid-high technology, high technology, and overall trade. This research employs Bayesian econometric procedure to solve cross-sectional heterogeneity problem in estimating the bilateral trade model with the U.S. major trading partners for six commodity groups.

Estimation results show that capital-labor ratio is more influential in U.S. bilateral trade with her major trading partners than exchange rate. In addition, U.S. trade is largely intra-industry trade except agricultural goods, which are based on resource endowments.

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1. INTRODUCTION

Since world economy is getting more globalized, the proportion of international trade in total U.S. GDP increases from 20.57% in 1991 to 28.77% in 2010 (The World bank 2011). The amount of international trade in total GDP is $1.2 trillion in 1991 and $4.1 trillion in 2010 (Figure 1.1). Over the past decades, the amount of international trade increases more than 340%. Especially, after Uruguay Round was taken effect, international trade becomes more important part of nation's economy. U.S. trade deficit, however, increases more than 1600%. U.S. trade deficit increased from $31 billion in 1991 to $500 billion in 2010 (Figure 1.2). The U.S. trade deficit reaches over $700 billion in 2006. U.S. trade deficit has improved after the 2007 financial crisis, but the amount of the trade deficit is still huge.

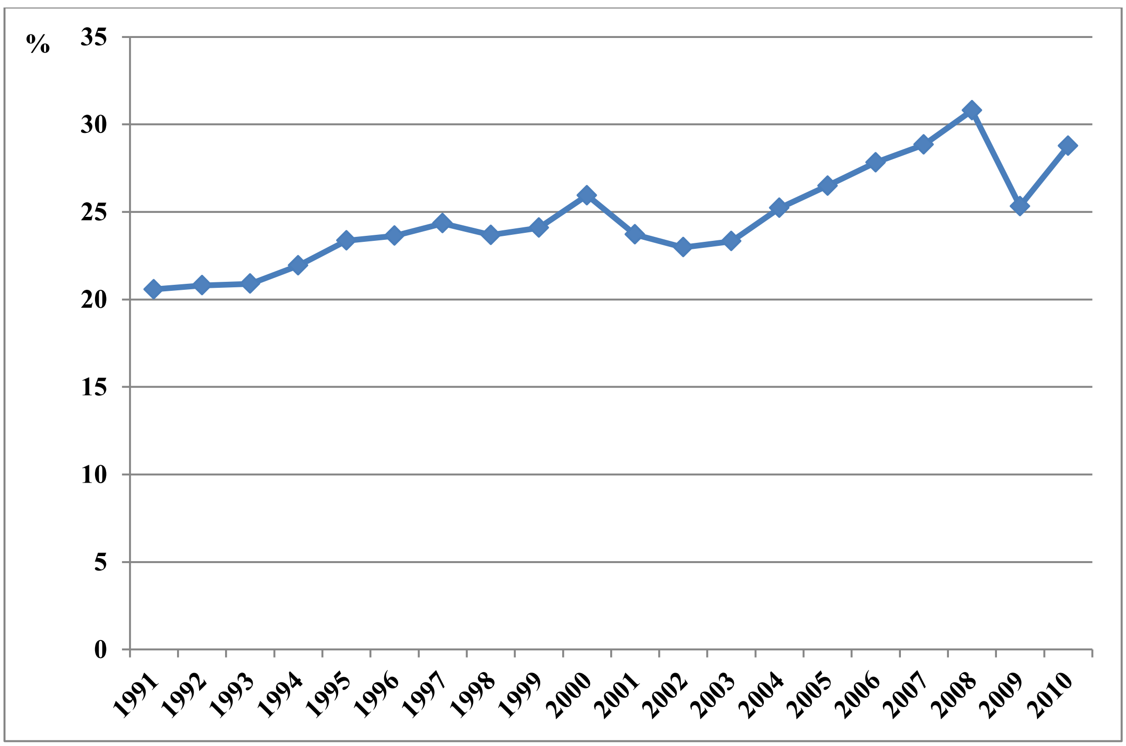

Figure 1.1 Proportion of Trade in total U.S. GDP from 1991 to 2010
Source: World Bank Database

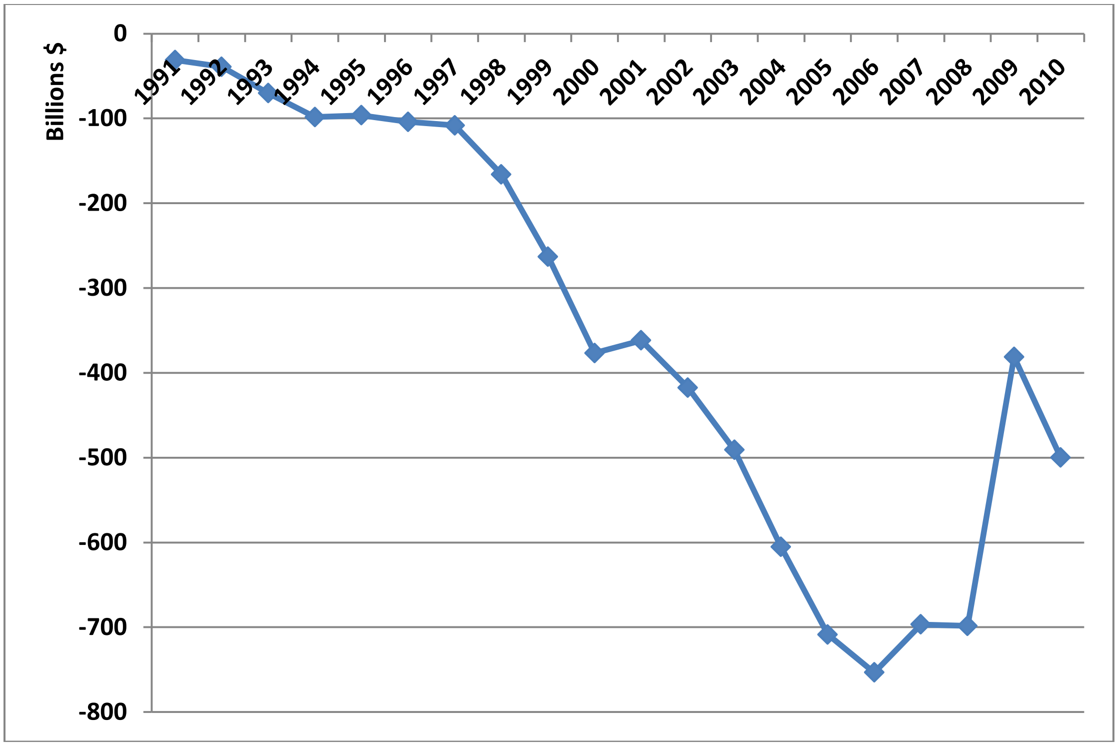

Figure 1.2 U.S. Trade Deficit from 1991 to 2010
Source: World Bank Database

Many economic studies try to analyze the reason of upsurge of U.S. trade deficit. Results are varied across studies. Most of previous researches usually name several reasons for this economic puzzle, including changes in GDP, exchange rate between U.S. and its trading partners.

GDP is known to be a main factor affecting U.S. trade flow with her trading partners. Studies by Baek and Koo (2007) and Zhuang, Koo, and Mattson (2008) analyzed the impact of disposable income on the U.S. agricultural trade balance in the short and long run. An increase in U.S. GDP strengthens consumer's purchasing power and then increases demand of imports from foreign countries. Empirical results provide that U.S. GDP is the most important factor of increasing U.S. trade deficit.

In addition, many researches assume that changes in exchange rate play a pivotal role in U.S. trade flow because international trade is basically founded on the difference of price between two countries. Change in exchange rate directly affects prices of import and export products and it mainly affect trade balance between two countries. According to the previous studies by Bahmani-Oskooee and Brooks (1999), Bahmani-Oskooee and Goswami (2003), Bahmani-Oskooee and Ratha (2004), Bahmani-Oskooee and Ardalani (2006), and Baek, Koo, and Mulik (2009), changes in exchange rate have significant impacts on the U.S. trade balance in long-run. However, U.S. trade balance has not improved even though the U.S. dollar was depreciated after 2000s. To explain this unexpected result against economic theory, economists suggest alternative explanation, which is the role of exchange rate pass-through. Campa and Goldberg (2005), Froot and Klemperer (1989), and Yang (1997) argued that exchange rate pass-through prevents the United State from improving her trade balance when the U.S. dollar was depreciated.

The U.S. trade deficits against China increased from $12 billion in 1991 to $273 billion in 2010 (U.S. Census Bureau). The trade deficits against the China occupy more than 50% of the U.S. total trade deficit in 2010. Many studies related to upsurge of the U.S. trade deficit against China have been conducted. Specific reasons about that still remain in dispute. Research by Koo and Zhuang (2007) insists that U.S.-Sino exchange rate play an important role in the U.S. trade deficit against China. However, studies by Groenewold and He (2007), Shen (2004), Wan Sing Hung (2009), and Wang and Wan (2008) indicate that the appreciation of Chinese RMB does not affect the U.S. trade balance.

Several economists propose alternative explanation for the U.S. trade deficit against China. Difference of economic structure between two countries plays an important role in bilateral trade flow. Study by Oleksiy and Koo (2011) showed that difference of economic structure is a key factor of determining bilateral trade flow. And Batra and Beladi (1998) analyzed relationship between manufacturing and trade balance. Manufacturing exporting country adapts a high rate of technical change, and it can leads to trade surplus in the long-run. On the other hand, if countries specialized their facilities not based on manufacture, their productivity growth declines and it causes trade deficit.

1.1 Objective

This study analyzes factors affecting U.S. bilateral trade with her major trading partners, including exchange rate, GDP, economic structure, market openness, and free trade agreements. This study focuses on six commodity groups, including agriculture, low technology, mid-low technology, mid-high technology, high technology, and overall trade by STAN industry classification.[1] The specific objectives of this study are:

(1) to evaluate the impacts of economic structure between the United State and her major trading partners

(2) to identify main factors affecting U.S. bilateral trade with her major trading partners based on trade theory

(3) to analyze how each commodity group is influenced by exchange rate, GDP, economic structure, market openness, and free trade agreements.

1.2 Method

The U.S. bilateral trade model with her major trading partners is developed on the basis of international trade theory. The main factors included in the empirical model are exchange rate, GDP, economic structure, market openness, and dummy variable for free

[1] http://stats.oecd.org/Index.aspx?DataSetCode=BTD_ED_2010&lang=en

trade agreements. Six commodity groups included in this study are agriculture, low technology, mid-low technology, mid-high technology, high technology, and overall trade. The panel data for U.S. trade with her major trading partners from 1991 to 2009 are used. This research employs Bayesian econometric procedure to solve cross-sectional heterogeneity problem in estimating the bilateral trade model with the U.S. major trading partners for six commodity groups. The major trading partners are Canada, China, France, Germany, Japan, Republic of Korea, Mexico, Netherlands, and United Kingdom.

1.3 Organization

Chapter 2 discusses previous study regarding U.S. bilateral trade with her major trading partners. Especially, each factor affecting U.S. bilateral trade flows is addressed. Chapter 3 describes economic comparison of the U.S. and her major trading partners. This chapter focuses on differences in economic conditions between the U.S. and foreign trading partners. A theoretical foundation and empirical model are addressed in chapter 4. In addition, data source and Bayesian econometric procedure are discussed. Chapter 5 shows empirical results based on the six commodity groups. Chapter 6 provides a summary of this study and conclusions drawn from the results.

2. LITERATURE REVIEW

This chapter reviews literature related to determinant of bilateral trade flow. Many studies have attempted to test various factors influencing bilateral trade by using different model specification and different econometrics techniques. Factors affecting bilateral trade flow and theoretical background are used in empirical model.

2.1 Exchange Rate

Many efforts to describe the relationship between bilateral trade flow and exchange rate are based on J-Curve model. J-Curve model is widely used to explain bilateral trade balance after pioneering works by Magee (1973), Junz and Rhomberg (1973), and Meade (1988). J-Curve model indicates that there is a time-lag between consumers to adjust to changes in relative price and adjustment of exchange rate.

Bahmani-Oskooee and Brooks (1999) researched the bilateral trade balance and disaggregate data about U.S. and her six major trading partners. According to their study, short-run response of the trade balance to the currency depreciation does not support the J-curve phenomenon. However, long-run pattern prove the economic theory in which U.S. dollar depreciation can lead to improvement of U.S. trade balance in the case of U.S. and her largest six partners. Also, this study applies to a new cointegration technique introduced by Pesaran and Shin (1995) and Pesaran et al. (1996).

Bahmani-Oskooee and Goswami (2003) studied how currency depreciation affects trade balance by using elasticity of trade volume. They paid attention to the case of Japanese largest trading partners. They set up the equation about elasticity of trade volume as a function of each country's income and exchange rate. When they used aggregate data, they could not find any significant result to support relation between trade balance and exchange rate in the short-run and long-run. However, in the case of bilateral data they found J-Curve phenomenon between Japan and Germany as well as Japan and Italy. In addition, they found long-run favorable relation between currency depreciation and bilateral trade balance as regards Canada, UK, and the United States.

Bahmani-Oskooee and Ratha (2004) analyzed short-run and long-run impacts of U.S. dollar fluctuation on the bilateral trade between the U.S. and 13 developing countries by using quarterly data over 1975-2000 period. Based on their results, U.S. bilateral trade balance does not affect short-run deterioration in the case of developing countries. The results are same as developed countries case. However, they found J-curve phenomenon in the bilateral trade between the U.S. and Chile, Korea, Mexico, and South Africa in the long period.

Bahmani-Oskooee and Ardalani (2006) tested exchange rate sensitivity and U.S. trade flow by using monthly 66 industrial data. They employed cointegration analysis to explain J-Curve phenomenon. They found that depreciation of the dollar promotes U.S. export in many industrial areas in the long-run whereas there is no significant effect on most importing industries.

An analysis by Baek, Koo, and Mulik (2009) investigated the dynamic effects of change in exchange rates on the U.S. agricultural bilateral trade with her 15 trading partners. The objective of this study is whether J-curve hypothesis holds for U.S. agricultural trade. They tested J-Curve hypothesis by employing an autoregressive distributed lag (ARDL) model. Results do not fully support for J-curve phenomenon influencing U.S. agricultural bilateral trade. However, they found that exchange rate is a key factor of deciding U.S. agricultural trade in the short- and long-run.

2.2 Exchange Rate Pass-Through

Many researches have investigated the relation between exchange rate and trade balance based on the J-Curve phenomenon. However, they provided mixed results about that. One of the possibilities explaining those mixed results is exchange rate pass-through. Following studies have been conducted to explain why exchange rate does not fully affect trade balance.

Froot and Klemperer (1989) provided theoretical foundation why importing company does not reflect the change in exchange rate to the price of imported goods. Based on their result, the expected return makes firms more sensitive to the expected future exchange rate than to current exchange rate. As a results, when the price of the domestic currency is expected to maintain lastingly higher, foreign firms keep their price more aggressively in the domestic market to gain more market share.

Yang (1997) suggested alternative explanation of incomplete exchange rate pass-through. He assumed that degree of product differentiation plays a pivotal role in determining the pass-through. To test his idea, this study adapted Dixit-Stiglitz model (1977) of product differentiation. Empirical results showed that exchange rate pass-through is incomplete in manufacturing industries and it showed different results across industries. He also founded that product differentiation is positively correlated with incomplete pass-through.

In addition, Campa and Goldberg (2005) analyzed exchange rate pass-through by each industry. They found effective empirical result of incomplete pass-through in the short run, especially within manufacturing industries. Also, they showed that pricing in producer’s currency is more predominant for many types of imported goods in the long-run. Even if macroeconomic variable merely affect the exchange rate pass-through elasticities, higher rates of exchange rate volatility can lead to higher exchange rate pass-through elasticities.

Recently Gopinath, Itskhoki, and Rigobon (2007) and Hellerstein and Villas-Boas (2010) suggested new approach to the exchange rate pass-through. Gopinath, Itskhoki, and Rigobon (2007) contradicted the assumption that currency choice is exogenous variable of pricing model. Their dynamic pricing model strongly supported that choice in currency of pricing is endogenous factor to determine domestic price of imported goods. Empirical result showed that exchange rate pass-through of average good price in dollars is 25 percent, while in the case of nondollars is 95 percent. Also, the study by Hellerstein and Villas-Boas (2010) implied that a significant portion of partial pass-through is caused by cross-border outsourcing processes. They adapted a structural econometric model to explain that degree of international vertical integration has an impact on exchange rate pass-through by using pricing data for the auto industry. Empirical results showed that a 10% cost shock to parts sourced from abroad affect 8% to 27% shock to retail price, and a 10% cost shock to parts sourced from multinational vertical integration has an effect on 50% to 100% shock to retail price.

2.3 Income

Baek and Koo (2007) explained the impacts of exchange rate, money supply, and income on the U.S. agricultural trade balance. They used U.S. agricultural trade data with her major trading partners and employed an Autoregressive Distributed Lags (ARDL) model to test short- and long-run effects of explanatory variables. Empirical results revealed that U.S. exchange rate plays a significant role in agricultural trade balance. In addition, U.S. income and money supply have mainly effects on the U.S. agricultural trade balance in the short- and long-run. And according to the follow-up study (2008) by same authors, results showed that the exchange rate, agricultural price, and disposable income have effects on the U.S. agricultural trade balance in the short and long run. This indicated that dollar depreciation can lead to improvement of U.S. agricultural trade balance. To claim this result, they employed cointegration analysis and a vector error-correction model with quarterly data for 1981-2003.

Zhuang, Koo, and Mattson (2008) investigated the reason why U.S. trade deficit in consumer-oriented agricultural products have increased. They employed panel cointegration analysis for the major 28 trading partners with annual data for 1989-2005. This study specified a bilateral trade model as a function of exchange rate, trade volume, per capita income of U.S. and trading partner, FDI, openness, and several dummy variables. The results showed that per capita income in the U.S. is most important factor of increasing U.S. trade deficit in consumer-oriented agricultural products. Also, per capita income and openness of foreign counties have positive impact on the U.S. trade balance. However, U.S. FDI and North America Trade Agreement (NAFTA) exacerbated U.S. trade balance.

2.4 U.S. Trade Deficit with China

Another issue in the U.S. bilateral trade research is large trade deficit with China. Trade deficit with China has dramatically increased past two decades. According to the

U.S. Census Bureau[2], trade deficit against China is 12,691 million dollars in 1991. However, in 2011, trade deficit with China increases by 295,456 million dollars. One practicable idea explaining U.S. trade deficit with China is pegged exchange rate system in China. Pegged exchange rate system maintains relative price competitiveness of Chinese products in the U.S. market and it largely extends U.S. trade deficit.

Empirical study by Groenewold and He (2007) tested whether misalignment of RMB-US dollar exchange rate affects the U.S. trade deficit. They modified two-country model based on Rose and Yellen (1989) and derived a reduced-form equation for trade balance between U.S. and China. Estimated results indicated that revaluation of RMB does not much improve trade imbalance between the U.S. and China. For instance, a 10% revaluation is probable to ameliorate the trade balance by less than 10%.

The research by Shen (2004) showed that there is no relationship between trade deficit and exchange rate in U.S.-China and thus this study insisted that trade deficit problem between U.S. and China cannot be resolved by changing RMB's exchange rate system. The research supported this claim by following reasons. First, U.S.-China trade deficit is originated from economic structure. China takes comparative advantage of manufactured goods which are labor-intensive and resource-consuming products, whereas the United States does not have comparative advantage of high-tech goods due to the export control policy. Second, trade deficit between U.S. and China is owing to discrepancy of statistical method.

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[2] http://www.census.gov/foreign-trade/balance/c5700.html

Bill Wan Sing Hung (2009) explained that a larger range of appreciation is needed to improve U.S. trade deficit against China in the short-run period. In the long-run, if RMB were to quickly appreciate, China may lose their export comparative advantage for the reason that Chinese products do not compete under strong monopolistic competition. As a result, this study suggested that appreciation in RMB must be slowly and gradually to avoid losing export competitiveness.

Wang and Wan (2008) paid attention to the role of inflow and outflow of foreign direct investment (FDI) as determinants of China's trade imbalances. They utilized annual aggregate data from 1997 to 2007 and employed Seemingly Unrelated Regression Equations (SURE) and Autoregressive Distributed Lags (ARDL) models. The authors argued that inflow FDI has a positive effect on Chinese export and trade surplus, while outflow FDI does not significantly contribute to Chinese trade flow and trade surplus. They also insisted that devaluation of RMB does not play a positive role in solving Chines trade imbalance.

Unlike afore-reviewed literatures, research by Koo and Zhuang (2007) claimed that U.S.-Sino exchange rate has contributed to China's increased trade surplus. To prove that, they employed the error component two-stage least squares (EC2SLS) method using SITC two-digit U.S.-Sino bilateral trade data. Traded goods were classified into four categories which are agriculture, mid-tech, high-tech products, and overall. Empirical results suggested that U.S.-Sino exchange rate and the weighted exchange rate between U.S. and other Asian countries affecting on the U.S.-Sino trade play an important role in the U.S. trade deficit against China. Also, they insisted that devaluation of RMB against the U.S. dollar could ameliorate U.S. bilateral trade deficit with China.

2.5 Economic Structure

Difference in structure of economy is considered as determinant shedding light on the bilateral trade flow. For instance, Chinese current Premier Wen Jiabao claimed that the RMB-U.S. dollar exchange rate does not cause the increasing U.S. trade deficit and that the reason lies in the structure of the U.S.-China investment and trade.[3] He also said that Chinese trade surplus has increased in spite of changing in exchange rate regime. Chinese trade surplus against U.S. is not based on exchange rate system but trade structure which means that the United States does not have manufacturing facilities and thus large trade deficit in manufacturing trade is an inevitable consequence.[4]

A study by Oleksiy and Koo (2011) analyzed the impacts of U.S.-Sino exchange rate and economic structure on the bilateral trade between U.S. and China. The research specified a Bayesian mixed-coefficient panel model in order to examine short- and long-run elasticities of trade balance and used bilateral trade data for 57 commodity groups based on SITC two-digit. Their finding revealed that real exchange rate and RCA (revealed comparative advantage) index play a pivotal role in determining bilateral trade flow. Compared with other studies, contribution of this study can be summarized by two things. First, they employed a Bayesian mixed-coefficient panel model to manage cross-sectional heterogeneity which is common problem while analyzing panel bilateral trade data. Second, they tried to investigate the effect of economic structure on bilateral trade balance. In recent years, economic structure of each country is regards as key factor of

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[3] "Chinese premier denies currency strength harming trade with US." *BBC Monitoring Newsfile*, 23 September 2010 ProQuest Newsstand, ProQuest. Web. 2 Aug. 2011.

[4] "Premier's speech at the Sixth China-EU Business Summit (Part I)." *Xinhua News Agency* – CEIS, 7 October 2010 ProQuest Newsstand, ProQuest. Web. 2 Aug. 2011.

bilateral trade flow. This study adapted RCA index as a proxy of economic structure and tested empirical relation between U.S. trade deficit with China and economic structure.

A study by Batra and Beladi (1998) analyzed that correlation of manufacturing and trade balance. They employed macroeconomic model to explain this puzzle. The paper showed that manufacturing exporting country has a high rate of technical change, and it can leads to trade surplus in the long-run. On the other hands, if countries lose their manufacturing facilities, their productivity growth declines and it causes trade deficit without regards currency devaluation. This paper explained the reason why large trade deficit in Mexico turns into a trade surplus in short period of time. Before the devaluation in late 1994, many U.S. companies relocated their manufacturing facilities in Mexico. And North America Free Trade Agreement accelerated relocation of U.S. companies. As a result, in 1996, Mexico had a $15 billion trade surplus against U.S. by devaluation peso.

3. ECONOMIC COMPARISON OF U.S. AND MAJOR TRADING PARTNERS

This chapter looks into macroeconomic conditions of main U.S. trading partners which are able to influence U.S. bilateral trade flow. Also characteristics of U.S. bilateral trade commodity group are examined, including trade surplus and deficit by each industry and country. Data used in this chapter are taken from the World Bank database[5] and United States International Commission.[6]

3.1 Gross Domestic Production

U.S. GDP is $14 trillion which is much larger than GDP of her major trading partners in 2010 and it accounts for 23% of the world GDP. Chinese GDP is ranked in the second place, which is $6 trillion, and that has dramatically increased for the past decade. Chinese GDP accounted for only 6.3% of U.S. GDP in 1991 and now it is approaching almost 41% of that. Japan had a second biggest economic size until 2009 but yielded the second position to China from 2010. And Germany and France are ranked in fourth and fifth (Figure 3.1). GDP growth rates of U.S. and her major trading partners are greatly influenced by international economic conditions over the last two decades. The 1997 financial crisis had dragged down growth of East Asian countries and rippled through the globe. In 2009, the second financial turmoil hit the world economy and then most countries were in economic recession (Figure 3.2).

[5] http://data.worldbank.org/
[6] http://dataweb.usitc.gov/

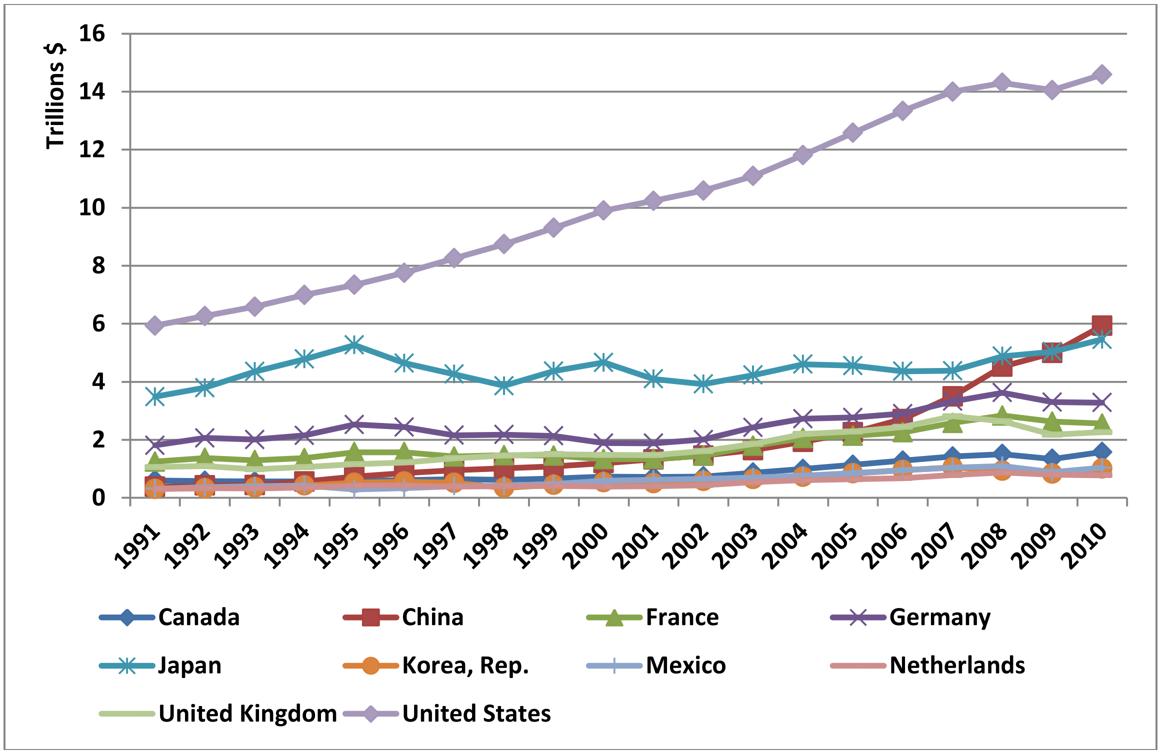

Figure 3.1 Gross Domestic Production of U.S. and Her Major Trading Partners
Source: World Bank Database

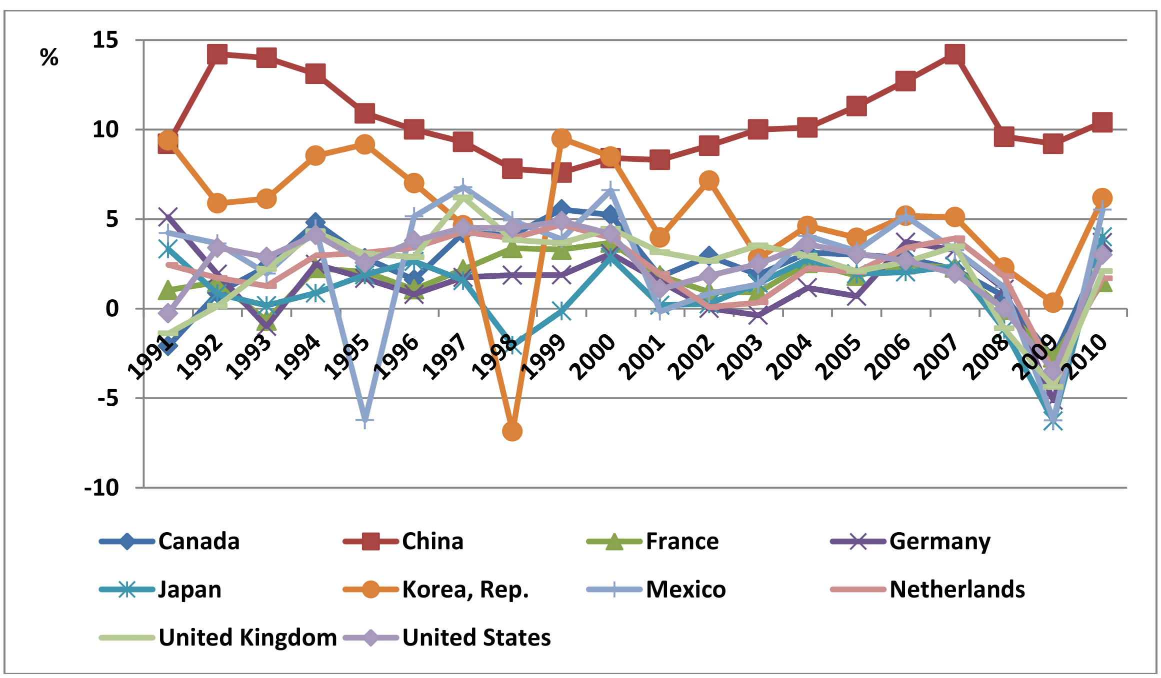

Figure 3.2 GDP Growth Rate of U.S. and Her Major Trading Partners
Source: World Bank Database

Chines economy has on average a 10% growth for past 20 years and grew nearly 15% in 2007. In the aftermath of financial crisis, Chinese economic growth rate has slowed but still exceeds 10% in 2010 (Figure 3.2).

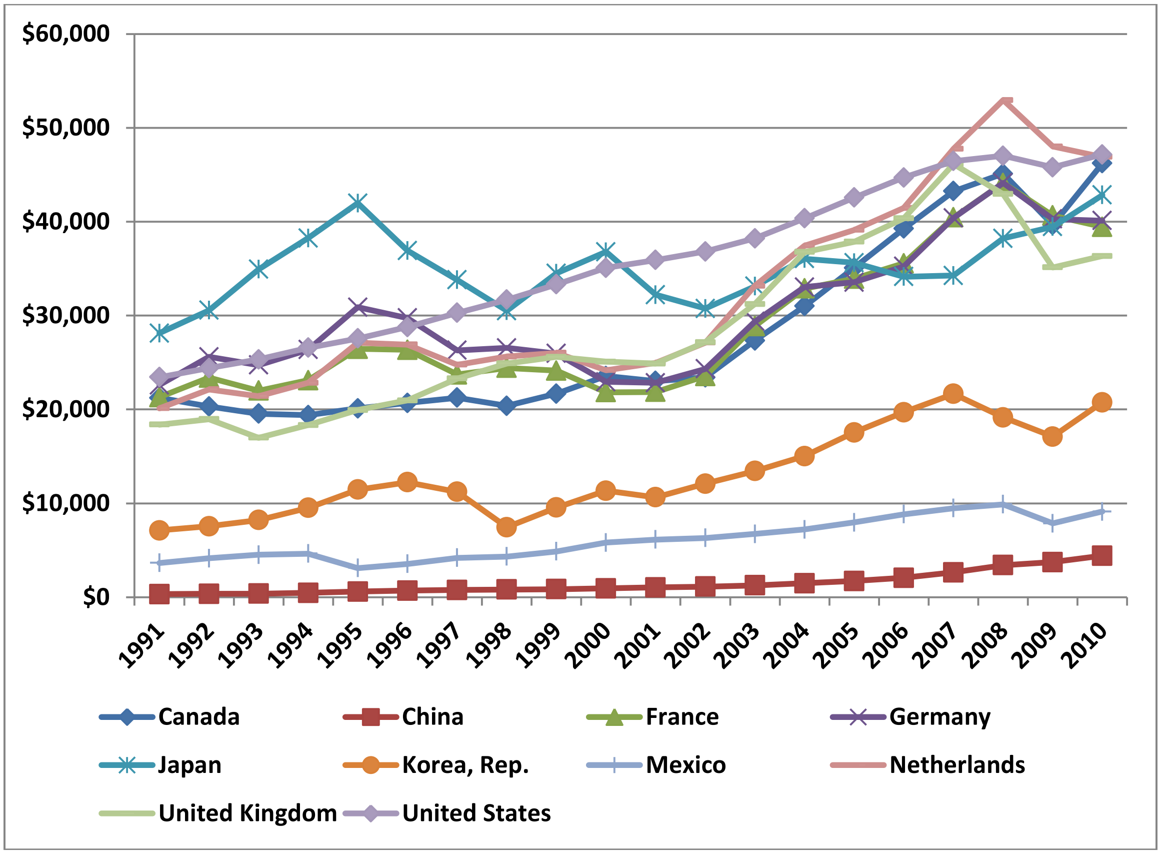

Figure 3.3 GDP per capita of U.S. and Her Major Trading Partners
Source: World Bank Database

Figure 3.3 shows trends in GDP per capita of U.S. and its major trading partners. This figure represents a growth trend over the last two decades with the peak in 2008. In general, European countries, including France, Germany, UK, and Netherlands, have higher income in comparison with other countries. Although China is the second largest economy, its per capita income is lowest among U.S. major trading partners. China's per capita income has increased from $330 in 1991 to $4,428 in 2010, while Korea's per capita income has increased from $7122 to $20,756 in 2010 (Figure 3.3).

3.2 Consumer Price Index

Among the U.S. and its trading partner, Japanese price level was highly stable during this period. Over the last two decades, consumer price index in Japan has been changed within only 5 points. In contrast, Mexican inflation is much higher than the inflation in U.S. and other trading partners. Compared to the early 1990's, consumer price level in Mexico increases more than six times that in 2010. After 2005, CPI in Mexico has still increased by 2% a year. China also faced high inflation in mid-1990s and then it lowered the risk of inflation in late 1990s and early 2000s. Recently, the upward pressure on consumer price has resurfaced in China (Figure 3.4).

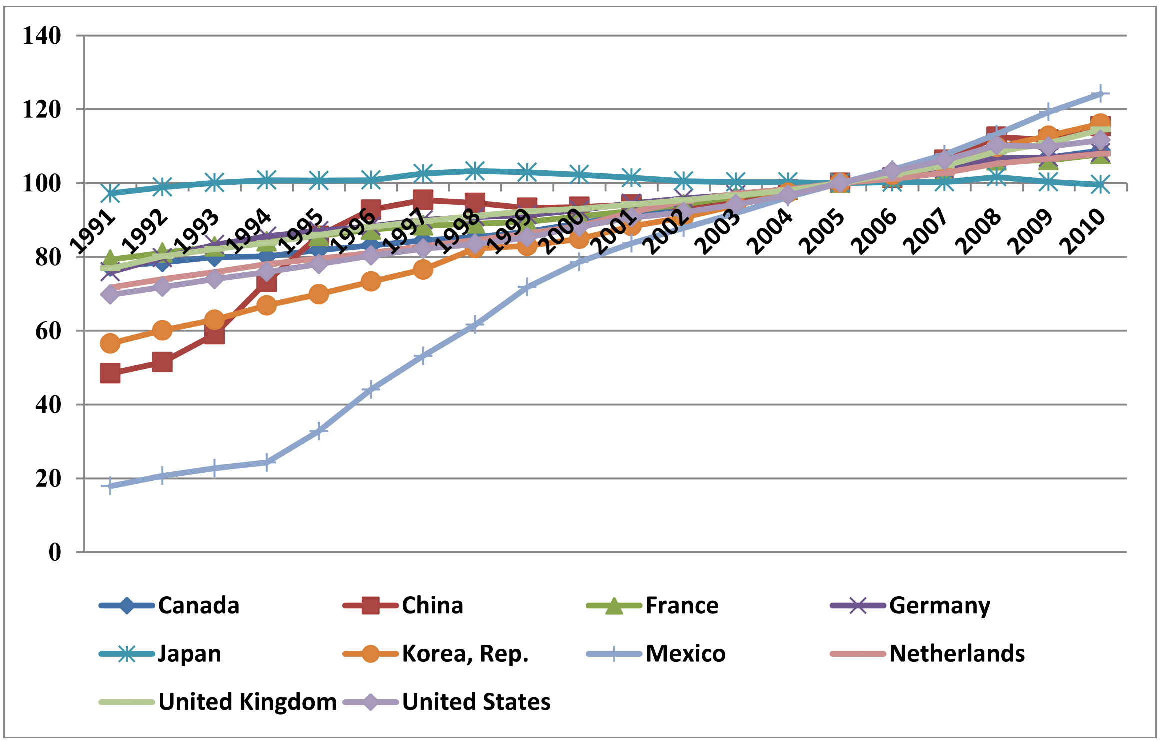

Figure 3.4 Consumer Price Index of U.S. and Her Major Trading Partners
Source: World Bank Database

3.3 Exchange Rate

Exchange rate is one of the most important factors affecting bilateral trade flow. Price of traded goods is vulnerable to change in exchange rate between two countries, even though the value of traded goods does not change. Figure 3.5 shows real exchange rate index of major trading partners against a U.S. dollar. Increasing exchange rate index means that U.S. dollar appreciates against a trading partner's currency or currency of trading partner depreciates against the U.S. dollar. In contrast, decreasing index implies that U.S. dollar depreciates against a foreign currency or currency of trading partner appreciates against the U.S. dollar.

One feature in figure 3.5 is Mexican Peso crisis in 1994~1995. The Mexican government maintained its exchange rate against the U.S. dollar began to run out of reserves in late 1994. Speculative capital had flooded into Mexico after NAFTA went into effect and the peso rapidly depreciated. The 1994 economic crisis in Mexico shows that countries which try to maintain exchange rate could fall in trouble when they do not have a considerable foreign currency reserves.

Another historical event is strength of Japanese Yen in mid 1990s. Between 1980 and 1985 the U.S. dollar was appreciated by 50% and it brought huge trade deficit to the United States. Upsurge of U.S. trade deficit drew an international agreement, Plaza Accord, with object of resolving U.S. trade imbalance by currency realignment. However, record-breaking ascent of Yen in mid 1990s led to reverse Plaza Accord to depreciate Japanese Yen.

The value of Chinese RMB has had against other countries because of its pegged exchange rate system. China fixed its exchange rate at 8.28 RMB to the dollar from 1994 to July 2, 2005. Pressure of huge U.S. trade deficit brought change in RMB exchange rate system. Since 2005, RMB exchange rate was changed to float exchange rate system which allowed exchange rate to move against basket of currencies around a fixed base rate.

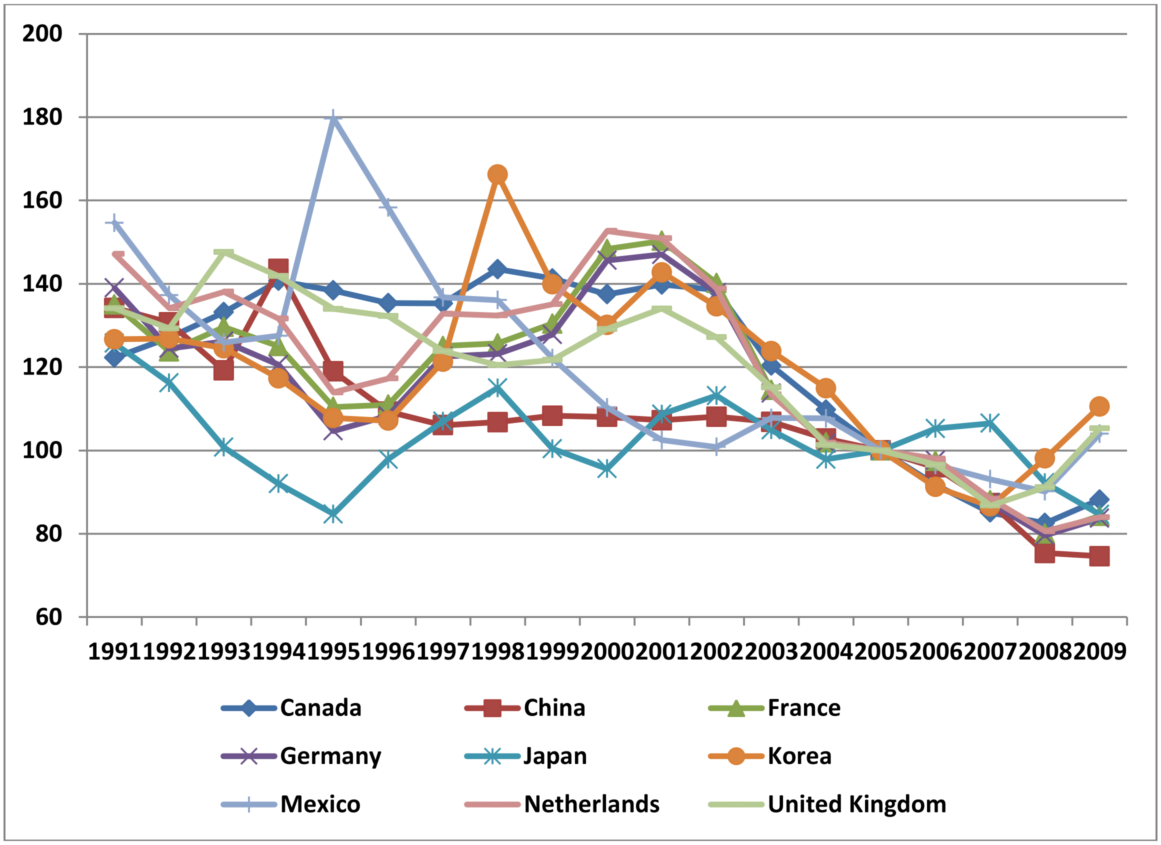

Figure 3.5 Real Exchange Rate Index (2005=100) of Major Trading Partners
Source: Author Calculation based on IMF data

3.4 Economic Structure

Among the U.S. major trading partners, Chinese economic structure has dramatically changed during last 20 years. The portion of agricultural productions to total GDP has decreased from 25% to 10%. In addition, the amounts of agricultural products have increased from $125 billion to $275 billion. It analogizes with the transition of China's economy. First, Chinese economy is rapidly breaking from the agro-based economy. The percentages of agriculture in total GDP decline more than 50% last 20 years. Second, Chinese total GDP has grown faster than its agricultural GDP. In spite of growing agricultural productions, agricultural contribution to the total GDP decreases from 25% to 10%. Third, Chinese agriculture become mechanization and modernization since agricultural productivity has improved immensely. The amounts of agricultural products have risen by more than 100% last two decades (Figure 3.6 and Figure 3.7).

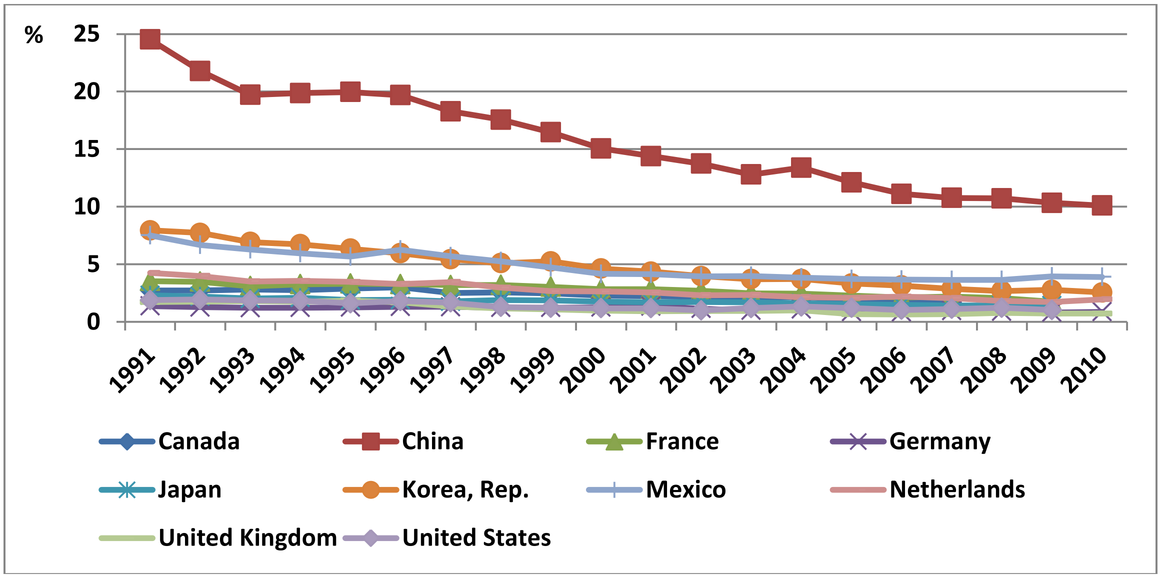

Figure 3.6 GDP Share of Agriculture of U.S. and Her Major Trading Partners
Source: World Bank Database

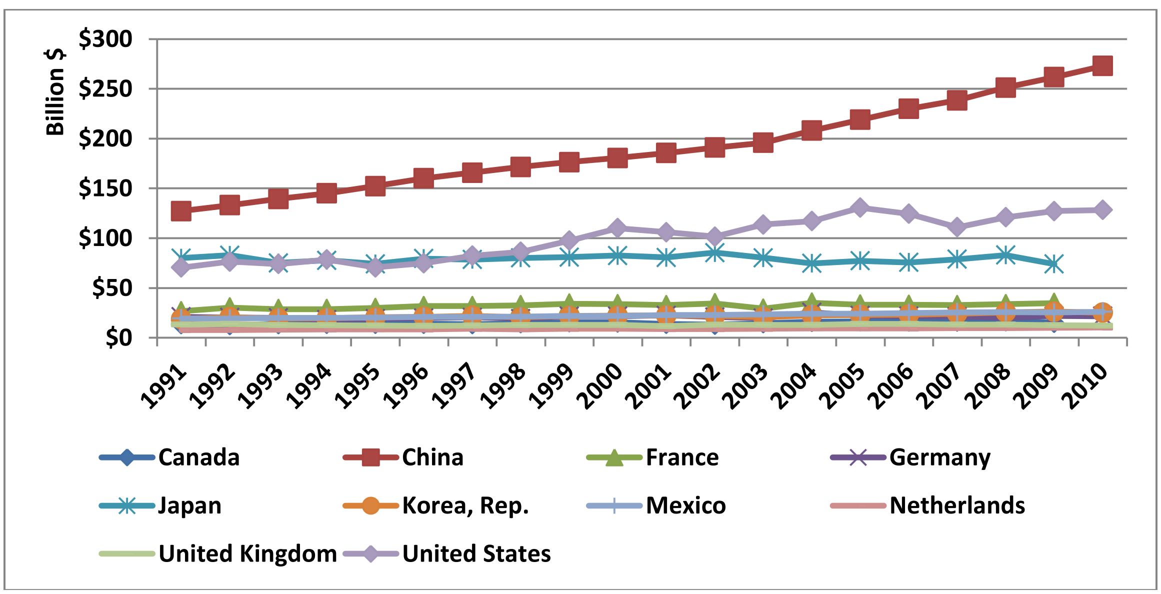

Figure 3.7 Value Added in Agriculture of U.S. and Her Major Trading Partners
Note: The amount of value is based on Year 2000 US dollar
Source: World Bank Database

Manufacturing industry in China and Korea has formed a relatively large part of total GDP in comparison with North American countries and European countries. Manufacturing proportion in these two countries exceeds 25%. Especially, China's manufacturing industry accounts for more than 30 % of total GDP. It implies that Chinese basic industry has shifted from primary industry to secondary or third industry. And the amounts of manufacturing production in China are growing at average 12% a year. As a result, China became a second biggest manufacturing country after Chinese manufacturing productions overtook those in Japan in 2008. (Figure 3.8) In the case of U.S., although manufacturing industry in the U.S. is not a biggest portion of total GDP, which is less than 20%, the United States is still world's leading manufacturing country based on the amounts of manufacturing production (Figure 3.9).

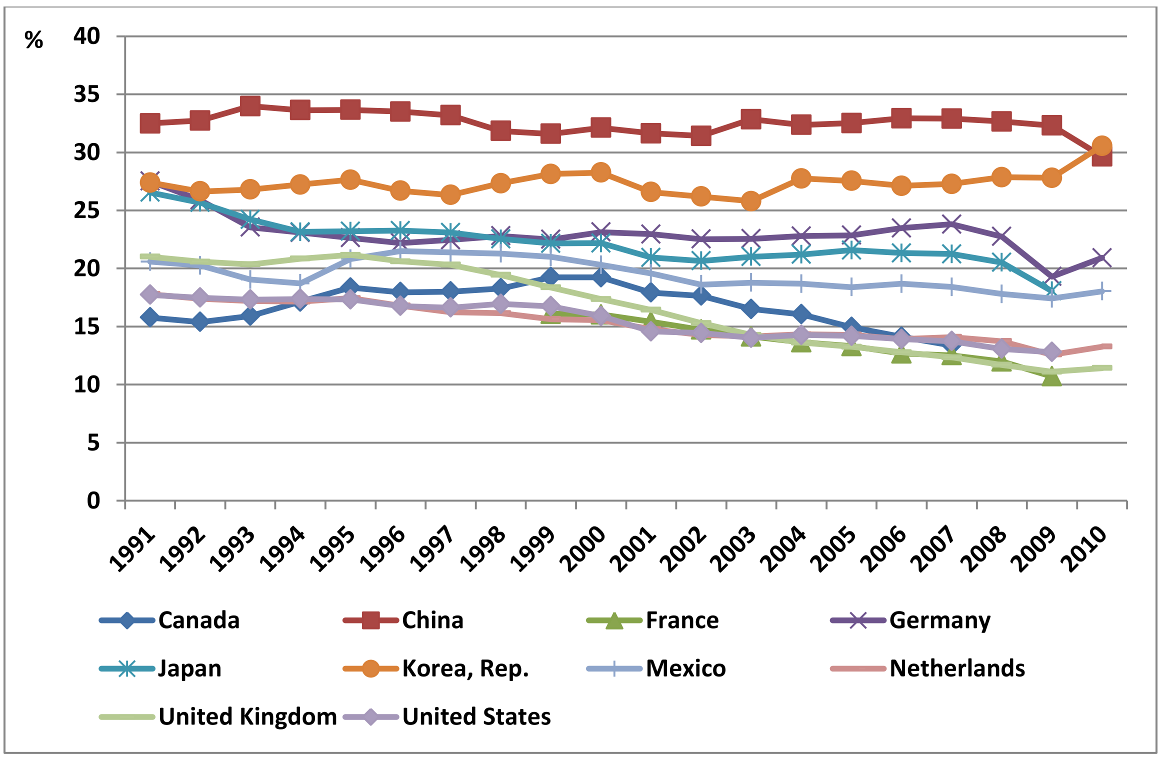

Figure 3.8 GDP Share of Manufacturing of U.S. and Her Major Trading Partners
Source: World Bank Database

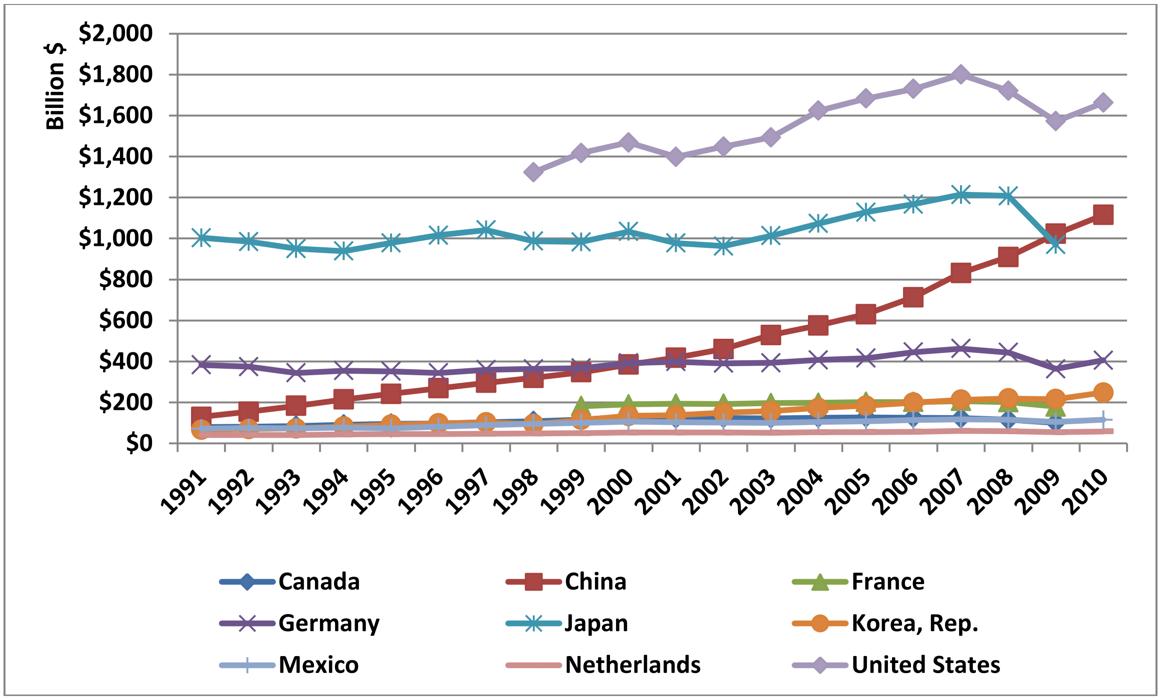

Figure 3.9 Value Added in Manufacturing of U.S. and Her Major Trading Partners
Note: The amount of value is based on Year 2000 US dollar
Source: World Bank Database

Service industry occupies a biggest portion of total GDP in U.S. U.S. service industry is approaching 80% of total GDP. Service industry occupies more than 50% of their total GDP in most U.S. trading partners except China. It suggests that the most of U.S. major trading partners have a similar economic structure of the U.S. and thus their trade with U.S. is largely intra-industry trade. However, China service industry was only 33% of total GDP in 1991 and it has constantly increased for the last 20 years. It accounts for 43% of total Chinese GDP in 2010. The United States produces over $8,000 billion of service goods in 2010. That is 40% bigger than amount of service production produced Japan (Figure 3.11).

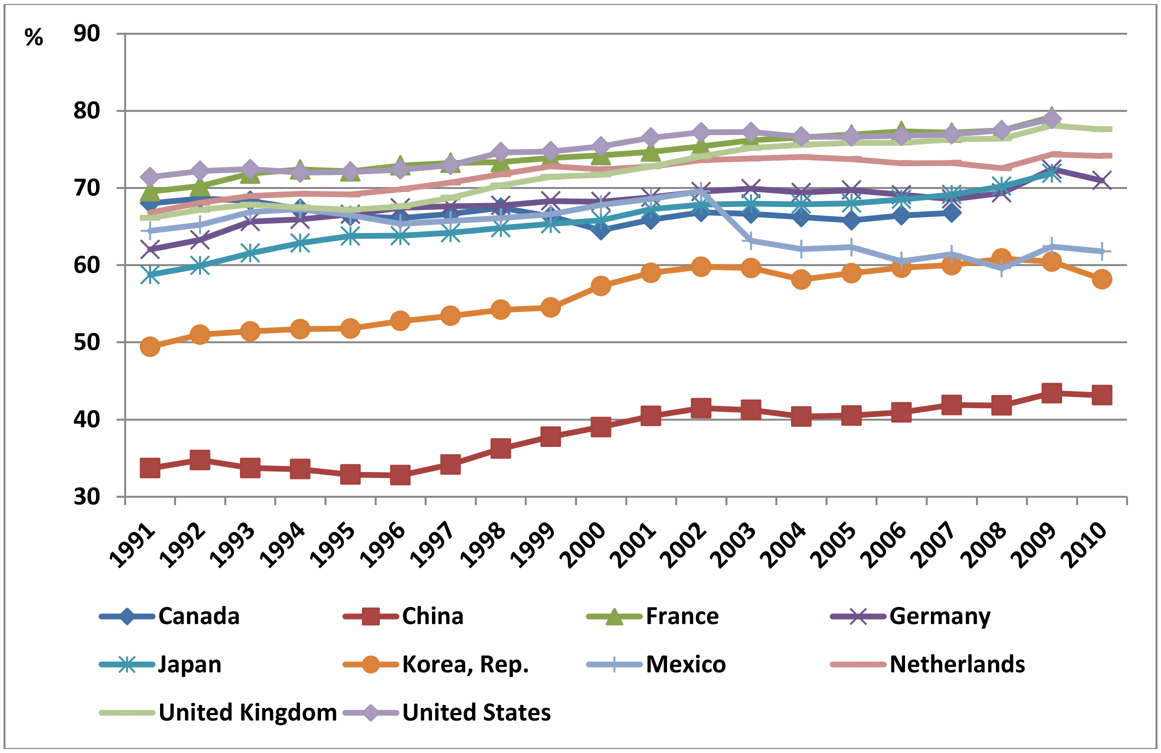

Figure 3.10 GDP Share of Service of U.S. and Her Major Trading Partners
Source: World Bank Database

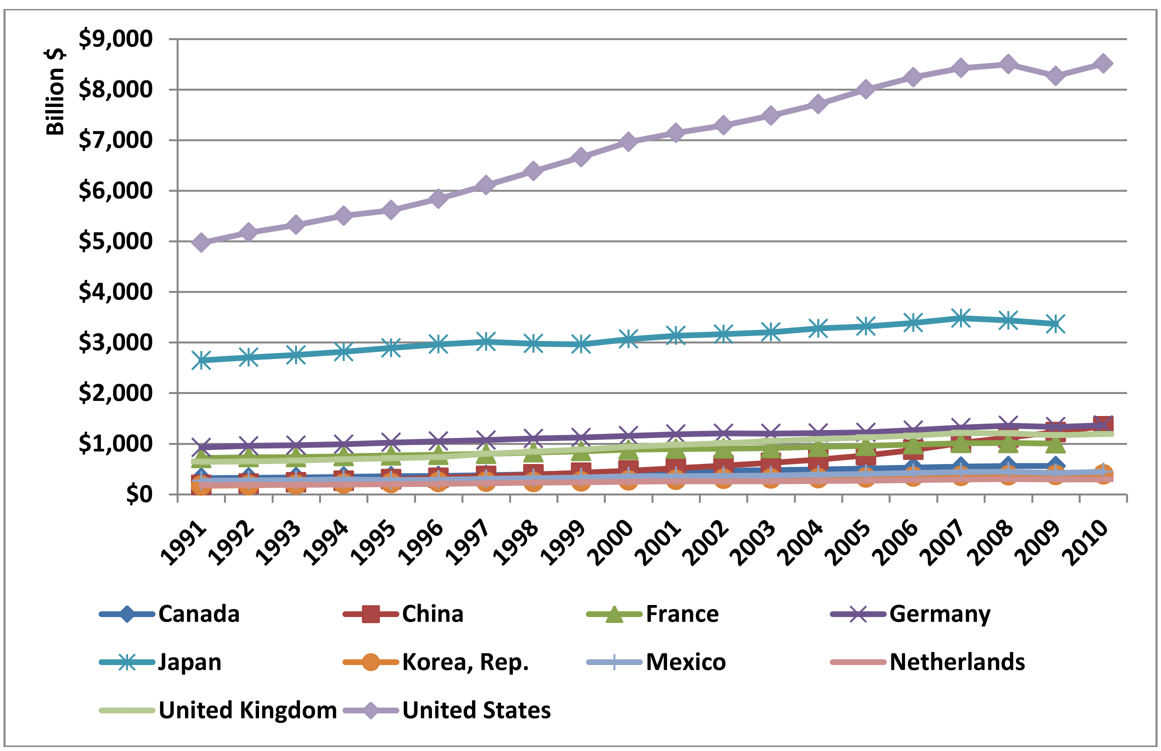

Figure 3.11 Value Added in Service of U.S. and Her Major Trading Partners
Note: The amount of value is based on Year 2000 US dollar
Source: World Bank Database

4. THEORETICAL FOUNDATION AND EMPIRICAL MODEL

This chapter examines the theoretical foundation of this study and develops empirical model, including hypothesis test. Also, data source and econometric procedure will be covered.

4.1 Theoretical Foundation

4.1.1 The Principle of Comparative Advantage

David Ricardo firstly suggested the concept of comparative advantage in his book, *On Principles of Political Economy and Taxation* (1817). Before his work, economists widely used to explain the reason of international trade based on the notion of absolute advantage. The concept of absolute advantage is pioneered by Adam Smith. He insists that if one country can produce certain commodity more efficiently than another country and other commodity less efficiently than another country, then each country can profit from specializing in the commodity which is produced more efficiently. If each country focuses on commodity production which it manufactures more efficiently and trades with each other, both countries can be wealthier than before trade because total output of both countries increases by specialization. The concept of absolute advantage was dominated concept for international trade until the principle of comparative advantage was spread by David Ricardo.

The notion of absolute advantage, however, has a critical weakness. The theory based on absolute advantage cannot explain international trade in the case that one county has an absolute advantage in both commodities. If one country produces both commodities more efficiently than another country, there is no incentive that the other country having an absolute disadvantage involves international trade. In reality, international trade frequently occurs between countries that have an absolute disadvantage in producing different commodities. The principle of comparative advantage by David Ricardo gives a reason for international trade between countries which do not have an absolute advantage. Based on the theory, international trade may happen between countries that have a comparative advantage in producing certain commodity. Even if one country produces all commodities more efficiently than another country, country can be better off by specializing in the commodity which can be made most efficiently. For instance, United State and Canada produce cloth and wine. And labor force of U.S. and Canada is three units and nine units, respectively. U.S. requires two unit of labor to produce 1 unit of cloth and one unit of labor to produce 1 unit of wine and Canada requires three unit of labor to produce 1 unit of cloth and six unit of labor to produce 1 unit of wine. According to the Adam Smith's idea, there is no incentive that U.S. trades with Canada because U.S. has an absolute advantage in producing both commodities. In comparison with total output of both countries before and after specialization, however, the reason U.S. trade with Canada is clarified. Before specialization, U.S. and Canada can produce 1 unit of cloth and 1 unit of wine, respectively. After specialization, U.S. focuses on producing wine since U.S. produce wine more efficiently than cloth and Canada specializes in producing cloth due to the fact that Canada makes cloth more efficiently than wine. Total output of cloth and wine is 3 units of cloth and 3 units of wine, an increase from 1 unit units of cloth and 1 units of wine, respectively. As a result, if each country specializes in producing commodity which it produces more efficiently and trades with each other, each country can benefit by involving international trade. Therefore, the principle of comparative advantage suggests the reason why each country specializes in its production and participates in international trade (Koo and Kennedy, 2005).

4.1.2 Heckscher-Ohlin Theorem

Heckscher-Ohlin model explains that the patterns of trade and costs of production based on resource endowments of each country. The theory states that comparative advantage of each country is determined by resource endowments such as labor and capital. For example, China exports labor intensive goods because China is a labor abundant country and then China can produce labor intensive goods at lower cost. At the same time, United States exports capital intensive goods since United States is a capital abundant country and then U.S. can produces capital intensive goods at low cost. As a result, China has a comparative advantage in producing labor intensive goods and U.S. has a comparative advantage in producing capital intensive goods. The difference in resource endowments between both countries decides patterns of trade.

The theorem assumes following conditions. First, both countries have two input factors such as labor and capital, and produce two commodities. Second, both countries have a same technology conditions. It implies that if wage and interest rate are same in both countries, same amounts of labor and capital are used in production of the commodities. Third, market condition is assumed perfect competition and transportation costs, tariffs, and other factors affecting patterns of trade are not allowed. Fourth, constant return to scale is assumed in production of commodities. It means that increasing input factors such as labor and capital increases in production of commodities by the same proportion. Fifth, factors of production are homogeneous and perfectly mobile between two countries. Sixth, All resource are fully employed in producing commodities. Seventh, social indifference curves of both countries are the same.

Suppose that there are two countries A and B which produces two commodities X and Y using two factors of production such as labor (L) and capital (K). Commodity X is a labor intensive good and commodity Y is a capital intensive good. If country A is a labor abundant country rather than country B, country A has a comparative advantage in producing labor intensive good. And country B has a comparative advantage in producing capital intensive goods if country B is a capital abundant country relative to country A. Equation (4.1) indicates that country A is labor abundant relative to country B, while country B is capital abundant relative to country A. Relationship between the two countries in term of resource endowments can be rewritten in terms of price of two factors such as capital and labor (Equation 4.2):

$$(4.1)\ (K/L)^{a} < (K/L)^{b}$$

$$(4.2)\ (r/w)^{a} > (r/w)^{b}$$

where r is price of capital, interest rate, and w is wage. Since labor abundant country has low wage and higher interest rate than capital abundant country, interest rate and wage ratio in country A is larger than in country B (Equation 4.2). It means that production costs of labor intensive goods are lower in country A while production costs of capital intensive goods are lower in country B. Therefore, country A specializes in production of commodity X and thus exports commodity X and imports commodity Y from country B. And country B specializes in production of commodity Y and thus exports commodity Y and imports commodity X from country A. For this reason, inter-industry trade occurs between countries which have different resource endowments (Koo and Kennedy, 2005).

4.1.3 Imperfect Competition and Economies of Scale in Trade

By the Heckscher-Ohlin theory, international trade only happens between countries which have different resource endowments. In reality, however, a large part of trade occurs between countries which have similar resource endowments. It is called intra-industry trade. To explain this, Paul Krugman relaxed some assumptions of the Heckscher-Ohlin theory. He introduced the concept of imperfect competition and economies of scale to international trade. The new trade theory pioneered by Krugman (1979) explains trade on the basis of imperfect market conditions and economies of scale in production.

Many companies utilize economies of scale to reduce their average production cost, meaning that doubling in input can expect to more than doubling in output. By specialization in a particular industry, country can decrease its average costs of production and increases its productivity by production specialization under the increasing return to scale. It implies that external economies of scale encourage an industry to specialize in production of a few commodities in that industry and export excess production of the commodities in exchange for other commodities in that industry. This intra-industry trade exists among countries which have similar resource endowments.

Another reason to happen in intra-industry trade is that consumer likes a variety of products in consumption. Under the imperfect competition, especially monopolistic competition, consumer taste for “love of variety” demands various products from trading partners. In the case, the effect of variety by country of origin is called national product differentiation. It causes international trade among countries having similar resource endowments (Koo and Kennedy, 2005).

4.2 Empirical Model

The model employed here will be similar to that of Koo and Zhuang (2007) and Zhuang, Koo, and Mattson (2008). Based on international economic theory discussed in the previous section, bilateral trade is principally affected by exchange rate and price differences between two countries (Dixit and Norman, 1980; Gandolfo, 2001). Following this concept, this study specified a bilateral trade model between the United States and her major trading partners as a function of exchange rate, price differences between U.S. and foreign country, and other independent variables affecting bilateral trade as follows:

$$(4.3)\ EX_t^i = \mu + \alpha\left(P_t^{us} - P_t^i\right) + \beta RER_t^i + \sum_j \lambda_j Z_t^{ij} + \sum_k \gamma_k D_t^{ik} + \varepsilon_t^i$$

where EX_t^i is U.S. exports of goods to its trading partner *i* in time *t* ; P_t^{us} and P_t^i are average prices of products in the U.S. and foreign country *i* , respectively; RER_t^i is the real exchange rate between the United States and its trading partner *i.* Real exchange rate is calculated from nominal exchange rate as follows:

$$(4.4)\ RER_t^i = \left(CPI_t^{us} * ER_t^i\right)/CPI_t^i$$

ER_t^i represents nominal exchange rate between U.S. and foreign country *i* (foreign currency divided by U.S. dollar). Year 2005 is taken as a base year for calculating the real exchange rate indices. Z_t^{ij} is a vector of other independent variables that could influence bilateral trade between the U.S. and foreign country *i* ; D_t^{ik} is a vector of dummy variable; and ε_t^i is a random error term.

Other independent variable $\left(Z_t^{ij}\right)$ can be comprised of gross domestic production, economic structure, and market openness. Gross domestic production can affect U.S. bilateral export. If foreign GDP increases, demand of imported goods in foreign country also increases. On the other hands, increasing foreign GDP negatively influences on the U.S. export if U.S. exporting products and foreign domestic products compete with each other in the foreign market. If an increase in a nation's GDP is due mainly to increases in production of import substitutes, GDP has a negative relationship with imports. It is called substitute effects. However, if GDP enhances consumer disposable income and increases imports, the relationship between GDP and imports are positive. It is called income effects. Economic structure also has an impact on U.S. export supply. Based on Heckscher-Ohlin theory, the United States is a capital abundant country which has a comparative advantage of exporting capital intensive products such as high-technology products. If U.S. trading partners are getting more capital abundant, the United States may lose her prominent position in exporting high-technology products. Market openness is another issue that influences U.S. export to the foreign market. U.S. products can be easily exported to foreign markets. Dummy variable $\left(D_t^{ik}\right)$ is also added to explain the effect of free trade agreement such as NAFTA and Uruguay Round.

Since annual time-series data on average prices between the United States and its trading partner i (P_t^{us} and P_t^i) are not available, bilateral trade volume (TV_t^i) with foreign country i is used as a proxy for the differences in prices (Koo and Zhuang, 2007; Zhuang, Koo, and Mattson, 2008). A rise in price differences between two countries would increase bilateral trade volume, and vice versa. Thus, Equation (4.3) can be rewritten as below:

$$(4.5)\ EX_t^i = \mu + \alpha TV_t^i + \beta RER_t^i + \sum_j \lambda_j Z_t^{ij} + \sum_k \gamma_k D_t^{ik} + \varepsilon_t^i$$

Since this research analyzes determinants of comparative advantage of U.S. export products, either export share of goods $\left(EX_t^i/TV_t^i\right)$ or trade balance $\left(EX_t^i - IM_t^i\right)$ to foreign country *i* can be used as a dependent variable. According to the previous studies (Koo and Zhuang, 2007; Zhuang, Koo, and Mattson, 2008), export share of goods as a dependent variable can resolve several empirical problems. First, export share of goods can be transformed into a logarithm form without any concern mainly because that range of export share is between 0 and 1. Trade balance, in contrast, cannot be transformed into a logarithm form if the United States has a trade deficit against trading partners. Second, export share of goods can be defined even though there is one-way trade between the United States and foreign country. In the case of some commodity groups, the United States only imports from its trading partners and do not export to them. Thus, this study uses an export share of goods as a dependent variable.

Other variable $\left(Z_t^{ij}\right)$ includes GDP, capital-labor ratio, and trade openness ratio which are defined as follow. Ratio of GDP between the United States and its trading partners $\left(\frac{GDP_t^i}{GDP_t^{us}}\right)$ is used as one exogenous variable to describe the effect of relative economic growth or purchasing power. If the ratio is larger than 1.0, the trading partners' GDP grow faster than the U.S. GDP and vice versa. To explain the effect of economic structure between two countries, ratio of capital-labor ratio between U.S. and trading partner $\left(\frac{K_t^i/L_t^i}{K_t^{us}/L_t^{us}}\right)$ is utilized. Since annual time series data on capital stock of each country are not available, gross fixed capital formation of each country is used as a proxy for the capital stock. If this ratio is greater than 1.0, the trading partner is more capital abundant relative to the U.S. and vice versa. Openness ratio between U.S. and foreign countries $\left(\frac{OPENNESS_t^i}{OPENNESS_t^{us}}\right)$ represent the effect of market openness. Market openness in country *i* is defined as:

$$(4.6)\ \text{Market Openness} = \frac{\mathrm{M_i} + \mathrm{X_i}}{\mathrm{GDP_i}}$$

where $\mathrm{M_i}$ and $\mathrm{X_i}$ are country *i*'s import and export. And $\mathrm{GDP_i}$ is gross domestic production in country *i*. Dummy variable D_t^{ik} is replaced with $D_t^{Trade\ Agreement}$ to test for the impact of NAFTA and Uruguay Round. And lagged dependent variable $\left(\frac{EX_{t-1}^i}{TV_{t-1}^i}\right)$ is used to capture long-run effects in the bilateral trade (Nerlove, 1972). As a result of reflecting empirical issues above, Equation (4.5) can be modified as below:

$$(4.7)\ ln\left(\frac{EX_t^i}{TV_t^i}\right) = \mu + \alpha lnTV_t^i + \beta lnRER_t^i + \lambda_1 ln\left(\frac{GDP_t^i}{GDP_t^{us}}\right) + \lambda_2 ln\left(\frac{K_t^i/L_t^i}{K_t^{us}/L_t^{us}}\right)$$
$$+\ \lambda_3 ln\left(\frac{OPENNESS_t^i}{OPENNESS_t^{us}}\right) + \gamma_1 D_t^{Trade\ Agreement} +\ \lambda_4 ln\left(\frac{EX_{t-1}^i}{TV_{t-1}^i}\right) +\ \varepsilon_t^i$$

4.3 Hypothesis Test

The relationship between independent variables and dependent variable can be hypothesized on the basis of economic theory.

4.3.1 Trade Volume

The sign of α depends upon whether industry is based on export-oriented or import-oriented. If α is positive, export of commodity group *i* is larger than imports, indicating that an increase in trade volume of commodity group *i* increases exports. In contrast, if α is negative, the U.S. exports of commodity group *i* is smaller than imports, indicating that commodity group *i* is an import-oriented industry.

4.3.2 Exchange Rate

The sign of β implies the effect of exchange rate between U.S. and its trading partners. The expected sign of β is negative which is due to the fact that an increase in the real exchange rate indicates the appreciation of the U.S. dollar compared with foreign currency. The dollar appreciation makes U.S. export products more expensive in terms of foreign currency and loses its price competitiveness in the foreign export markets. On the other hand, the dollar depreciation makes U.S. exports cheaper in terms of foreign currency and gains its price competitiveness. As a result, U.S. imports increase with the dollar appreciation and decrease with the dollar depreciation.

4.3.3 GDP Ratio

The sign of λ_1 determines the basis of import demand of U.S. exporting products. Positive λ_1 indicates that an increase in foreign GDP relative to the U.S. GDP strengthens their purchasing power, and increases imports from the U.S. On the other hand, λ_1 can be a negative because of the following reasons. First, it is based on the economic structure of the U.S. and its trading partners. If the sign of λ_1 is negative, the U.S. and its trading partners produce similar products belonging to the similar economic structure. Thus, an increase in GDP in trading partners will reduce the U.S. exports. Second, negative λ_1 indicates that importing demand of U.S. products has its roots in U.S. producing capacity. According to Krugman's study (1979), large-scale production make U.S. industry achieve economies of scale, in which can decrease the price of exported goods. It means that the United Sates accomplishes its comparative advantage of exporting products by taking advantage of increasing returns in exporting industry.

4.3.4 Capital-Labor Ratio

Testing λ_2 implies that competitiveness of U.S. exporting products based on capital-labor ratio. Heckscher-Ohlin's theory indicates that capital abundant country has a comparative advantage in producing capital intensive goods and labor abundant country has a comparative advantage in producing labor intensive goods. λ_2 is expected to be positive since an increase in capital relative to labor in the foreign country would increase the U.S. export of labor intensive products to the foreign market (Equation 4.8).

$$(4.8)\ \left(\frac{\mathrm{K}}{\mathrm{L}}\right)^{\mathrm{i}} > \left(\frac{\mathrm{K}}{\mathrm{L}}\right)^{\mathrm{us}}$$

On the other hand, λ_2 is expected to be negative since an increase in capital relative to labor in the United States would increase its export to the trading partners. It means that the United States strengthens competitiveness of its exporting products if the U.S. would be capital abundant country relative to foreign trading partner (Equation 4.9).

$$(4.9)\ \left(\frac{\mathrm{K}}{\mathrm{L}}\right)^{\mathrm{i}} < \left(\frac{\mathrm{K}}{\mathrm{L}}\right)^{\mathrm{us}}$$

4.3.5 Openness Ratio

The sign of the coefficient (λ_3) is expected to be positive when growing openness of foreign market enlarges U.S. export goods in the foreign market. In contrast, λ_3 can be negative since trading partners increase its imports from other countries than the U.S., indicating that importing demand from foreign country shifts from U.S. to other third countries. It indirectly explains that U.S. is losing its competitiveness in a foreign market.

4.3.6 FTA Effects

This study uses Dummy variable D_t^{ik} to capture the effects of free trade agreements. The sign for γ_1 reveals changing bilateral trade pattern under the regime of multilateral free trade. When increasing import demand in the United States is faster than growing U.S. export supply to trading partner, $\gamma_1$is expected to be negative. However, if U.S. exporting supply increases faster than importing demand in foreign country, free trade agreement has a positive impact on U.S. export and $\gamma_1$has a positive sign.

Expected sign of variables are summarized in Table 4.1.

Table 4.1 Hypotheses Tested in the Model

variable	expected sign and range
$lnTV_t^i$	+ (export-oriented industry, $\frac{X}{TV} > \frac{M}{TV}$) - (import-oriented industry, $\frac{X}{TV} < \frac{M}{TV}$)
$lnRER_t^i$	$ER \uparrow \Rightarrow P^X \uparrow \Rightarrow X \downarrow, M \uparrow \Rightarrow \left(\frac{X}{TV}\right) \downarrow$
$ln\left(\frac{GDP_t^i}{GDP_t^{us}}\right)$	+ (if trade is inter-industry trade based on resource endowment $\Rightarrow \frac{X}{TV} \uparrow$) - (if trade is intra-industry trade based on economies of scale $\Rightarrow \frac{X}{TV} \downarrow$)
$ln\left(\frac{K_t^i/L_t^i}{K_t^{us}/L_t^{us}}\right)$	depend upon characteristics of commodity groups
$ln\left(\frac{OPENNESS_t^i}{OPENNESS_t^{us}}\right)$	+/-
$D_t^{Trade\ Agreement}$	+/-
$ln\left(\frac{EX_{t-1}^i}{TV_{t-1}^i}\right)$	+ (0< λ_5 <1)

4.4 Data

Bilateral trade data are obtained from OECD STAN Bilateral Trade 2010 Database for 1991-2009 between the United States and her nine major trading countries such as Canada, China, France, Germany, Japan, Korea, Mexico, Netherlands, and the United Kingdom. Data cover six industrial sectors based on STAN Industry Classification (Table 4.2 and 4.3): (1) Agriculture, Hunting, and Forestry and Fishing (agr); (2) Low-Technology Manufacture (low); (3) Medium-Low Technology

Manufacture (mid-low); (4) Medium-High Technology Manufacture (mid-high); (5) High-Technology Manufacture (high); (6) Overall Trade (overall).

Annual time series data for the nominal exchange rates against U.S. dollar for major trading partners and consumer price index between U.S. and them are obtained from World Bank database. CPI is indexed based on the year 2005. Furthermore, World Bank database provides real gross domestic products (GDP) and gross fixed capital formation of each country. To obtain total employment data, this study uses several data sources. China's total employment data are taken from National Bureau of Statistics of China and Brazil's total employment data can be founded World Bank Database. Total employment data for Mexico is used from OECD database. And total employment data for the other countries such as the United States, Canada, France, Germany, Japan, Korea, Netherlands, and United Kingdom are obtained from International Labor Comparison in Bureau of Labor Statistics. Finally, openness data are taken from World Bank Database. The statistical summary of panel data set is suggested in Table 4.4.

Table 4.2 STAN Industry Classification

	description	ISIC Rev. 3[1]
1	overall trade	
2	agriculture, hunting, forestry and fishing	01T05
3	mining and quarrying	10T14
4	total manufacturing	15T37
5	food products, beverages and tobacco	15T16
6	textiles, textile products, leather and footwear	17T19
7	wood and products of wood and cork	20
8	pulp, paper, paper products, printing and publishing	21T22
9	chemical, rubber, plastics and fuel products	23T25
10	coke, refined petroleum products and nuclear fuel	23
11	chemicals and chemical products	24

Source: STAN Bilateral Trade Database, OECD
Note: ISIC Rev.3 means that International Standard Industrial Classification of All Economic Activities, Rev.3

Table 4.3 STAN Industry Classification (Contd.)

	description	ISIC Rev. 3[1]
12	chemicals excluding pharmaceuticals	24 excluding 2423 (24X)
13	pharmaceuticals	2423
14	rubber and plastics products	25
15	other non-metallic mineral products	26
16	basic metals and fabricated metal products	27T28
17	basic metals	27
18	iron and steel	271 + 2731
19	non-ferrous metals	272 + 2732
20	fabricated metal products except machinery and equipment	28
21	machinery and equipment	29T33
22	machinery and equipment not elsewhere classified	29
23	electrical and optical equipment	30T33
24	office, accounting and computing machinery	30
25	electrical machinery and apparatus not elsewhere classified	31
26	radio, television and communication equipment	32
27	medical, precision and optical instruments	33
28	transport equipment	34T35
29	motor vehicles, trailers and semi-trailers	34
30	other transport equipment	35
31	building and repairing of ships and boats	351
32	aircraft and spacecraft	353
33	railroad equipment and transport equipment not elsewhere classified	352 + 359
34	manufacturing not elsewhere classified; recycling	36T37
35	electricity, gas and water supply	40
36	scrap metal	
37	waste	
38	confidential and unallocated	
39	high-technology manufactures	2423 + 30 + 32 + 33 + 353
40	medium-high technology manufactures	24X + 29 + 31 + 34 + 352 + 359
41	medium-low technology manufactures	23 + 25 + 26 + 27 + 28 + 351
42	low-technology manufactures	15T16 + 17T19 + 20 + 21T22 + 36T37
43	information communication technology manufactures	313 + 30 + 32 + 3312 + 3313

Source: STAN Bilateral Trade Database, OECD

Note: ISIC Rev.3 means that International Standard Industrial Classification of All Economic Activities, Rev.3

Table 4.4 Summary of Statistics of the Data Set

variable	number of observ.	mean	standard deviation	min.	max.
export share (overall)	171	0.415	0.135	0.130	0.727
export share (agr)	171	0.775	0.182	0.391	0.992
export share (low)	171	0.411	0.190	0.018	0.799
export share (mid-low)	171	0.364	0.154	0.067	0.706
export share (mid-high)	171	0.402	0.159	0.133	0.745
export share (high)	171	0.503	0.172	0.127	0.895
trade volume (overall)	171	$150 billion	$126 billion	$25 billion	$532 billion
trade volume (agr)	171	$3 billion	$3 billion	$0.4 billion	$12 billion
trade volume (low)	171	$23 billion	$26 billion	$3 billion	$129 billion
trade volume (mid-low)	171	$16 billion	$17 billion	$2 billion	$82 billion
trade volume (mid-high)	171	$56 billion	$52 billion	$7 billion	$209 billion
trade volume (high)	171	$37 billion	$23 billion	$7 billion	$153 billion
real exchange rate index	171	116.018	20.417	74.619	179.661
GDP ratio	171	0.157	0.112	0.039	0.556
capital-labor ratio	171	0.767	0.387	0.028	1.709
openness ratio	171	2.533	1.094	0.722	5.431

Source: author calculation.

4.5 Potential Econometric Problems

Before the estimation, this study found several econometric problems. First, bilateral trade volume (ln*TV*) in equation (3) is correlated with the error term because it is denominator of dependent variable (ln(*EX/TV*)), causing endogeneity problem. To deal with endogeneity problem, this study applies instrumental variable technique. Following the previous researches, Glick and Rose (2001) and Rose and Wincoop (2001), the first instrumental variable is natural logarithm of sum of GDP between the United States and trading partner (ln*TGDP*), and the second one is natural logarithm of the United State

Consumer Price Index (ln*UScpi*) and foreign Consumer Price Index (ln*Fcpi*) (Koo and Zhuang (2007) and Zhuang, Koo, and Mattson (2008).

Second, cross-sectional heterogeneity problem commonly occurs in analyzing panel data sets in international trade research. Traditional panel analysis assumes that estimated coefficients are the same as all cross-sectional units. It means that each foreign country has similar marginal effects for each independent variable. However, empirical model has opposite views of this restriction. Demand of export products are varied across countries and thus marginal effects for each independent variable can be varied by each country. Without treatment of this empirical issue, estimated results may be biased since unobserved cross-sectional heterogeneity is often expected to exist in practice. Therefore, this study applies Bayesian econometric method. It is able to reflect cross-sectional heterogeneity and to estimate an individual regression coefficient to each cross-sectional unit. Detailed explanation about Bayesian estimation will be further discussed in the next section.

4.6 Bayesian Estimation Procedure

To resolve cross-sectional heterogeneity problem, this study applies Bayesian econometric method. The Bayesian inference is based on Bayes theorem as below (Equation 4.10):

$$(4.10) p(\theta|y) \propto p(y|\theta)p(\theta)$$

where θ is a vector of parameters to be estimated, y is data observations, and $p(\theta|y)$ is the posterior distribution. $p(y|\theta)$ represents likelihood function and $p(\theta)$ denotes the prior density function (Ntzoufras, 2009; Lancaster, 2004).

To conduct Bayesian inference, several empirical issues about Bayesian inference are addressed. First, Gibbs sampling, a Markov Chain Monte Carlo (MCMC) method to get a posterior density in Bayesian estimation, is used for this estimation. To check for convergence of Gibbs sampling, this research employs diffuse initial parameter values by using multiple chain method. To utilize the MCMC approach, 375,000 iterations are discarded as pre burn-in time in order to lessen initial value effect and to overcome a slow convergence problem with traditional hierarchical model and iterations are conducted until posterior mean is converged (Mulik and Koo, 2011).

Second, this study uses random effects model to analyze panel data since fixed effects model may cause severe problems when Bayesian inference is used (Lancaster, p.293, 2004). Fixed effects model leads to an unacceptable posterior distribution for all parameter even estimated results are improper in Bayesian inference. Further, fixed effect model causes slow convergence of MCMC algorithms due to the diffuse priors.

Finally, this study applies *noninformative prior distribution* to estimate Bayesian inference for the obtaining robust estimation results (Mulik and Koo, 2011).

5. ESTIMATION RESULTS

Estimation results are discussed following chapter. Empirical results show short-run and long-run effects of six explanatory variables in U.S. export by six industrial groups such as agriculture, low-technology, mid-low technology, mid-high technology, high-technology, and overall industry. The estimated posterior mean and standard deviations of short-run and long-run effect are presented in Table 5.1, 5.2, 5.3, 5.4, 5.5, and 5.6. All estimated coefficients can be interpreted as elasticities since the equations are specified in double log function.

5.1 Agricultural Products

Exporting in agricultural products is subject to trade volume, capital-labor ratio. Short-run effects of the trade volume and capital-labor ratio are estimated 0.07864 and 0.1112 at the agricultural products. It implies that the 10% increase in the trade volume is expected to correspond to 0.79% increase in the U.S. bilateral export share and the 10% increase in the capital-labor ratio is expected to correspond to 1.1% increase in the U.S. bilateral export share in agricultural products. Positive coefficient of trade volume means that U.S. is export-oriented industry. Thus, increasing bilateral trade has a positive impact on exporting U.S. products. In addition, increasing capital-labor ratio has positive effects of exporting agricultural products. An increase in foreign capital per labor relative to the U.S. would increase the U.S. export for the foreign countries at agricultural products (Table 5.1).

Table 5.1 Estimation Results of Agricultural Products

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	-2.077	1.083	
trade volume	0.07864*	0.04802	0.1267*
exchange rate	0.009784	0.06117	0.02045
GDP ratio	-0.08446	0.108	-0.1356
capital-labor ratio	0.1112*	0.07903	0.1737*
openness ratio	0.04479	0.07846	0.04916
trade agreement	-0.00128	0.02357	0.005399
lagged dependent	0.362*	0.1847	

Note: * represents significance level at 5%.

5.2 Low Technology Products

In low technology, exchange rate is the only factor affecting the U.S. bilateral export share. Short-run effects of the exchange rate are estimated -0.1891 at the low technology products. The result says that exchange rate has a negative impact on export of low-tech products because of appreciating U.S. dollar. It implies that the 10% appreciation of the U.S. dollar is expected to correspond to 1.89% decrease in the U.S. bilateral export share in low technology products. In the long-run, 10% appreciation of the U.S. dollar is expected to correspond to 8% decrease in the U.S. low-tech export share. Estimated results imply that exchange rates between the U.S. and its major trading partners are major determinant of low technology trade flow. In addition, GDP and trade openness are marginally significant in trade of low technology commodity group.

Table 5.2 Estimation Results of Low Tech Products

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	0.6179	1.546	
trade volume	0.004946	0.06568	-0.00893
exchange rate	-0.1891*	0.07664	-0.8021*
GDP ratio	0.07064	0.1225	0.4235
capital-labor ratio	0.03804	0.09388	0.09262
openness ratio	0.09564	0.108	0.416
trade agreement	-0.0288	0.03748	-0.02837
lagged dependent	0.7681*	0.08283	

Note: * represents significance level at 5%.

5.3 Medium-Low Technology Products

GDP ratio, capital-labor ratio, and free trade agreement play an important role in increasing U.S. export in medium-low technology products. Short-run effects of the GDP ratio, capital-labor ratio, and FTA are estimated –0.6305, 0.8173, and 0.06019 at the mid-low tech export. It means that the 10% increase in the GDP ratio is expected to correspond to 6.3% decrease in the U.S. mid-low tech export share and 10% increase in the capital-labor ratio is expected to correspond to 8.17% increase in the U.S. export share and U.S. mid-low tech export share increase 6% than before free trade agreement. Negative sign of GDP ratio indicates that the trading partners produce input substitute and reduce impacts as their GDP increases relative to the U.S. GDP. This happens commonly between two countries when their trades are intra-industry trade. Considering this, U.S. mid-low tech companies increase their production capacity to achieve economies of scale, in which can decrease the price of exported goods. And positive sign of capital-labor ratio implies that an increasing labor force in mid-low tech industry of the United States would increase the U.S. export for the foreign countries. In other words, marginal product of labor is higher than marginal product of capital in mid-low tech industry because of Heckscher-Ohlin theory.

In long-run, the effects of GDP ratio and capital-labor ratio are calculated at -1.08 and 1.342. It means that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 10.8% decrease and 13.4% increase in the mid-low tech export, respectively. Especially, capital-labor ratio is a main factor of determine the United States comparative advantage of mid-low tech product export. And free trade agreement increases 10.2% exporting in mid-low tech industry in the long-run.

Table 5.3 Estimation Results of Mid-Low Tech Products

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	0.903	5.1	
trade volume	-0.1269	0.1682	-0.2407
exchange rate	0.05289	0.3102	0.03014
GDP ratio	-0.6305*	0.2971	-1.08*
capital-labor ratio	0.8173*	0.2459	1.342*
openness ratio	0.1734	0.23	0.2594
trade agreement	0.06019*	0.04592	0.1028*
lagged dependent	0.3859*	0.139	

Note: * represents significance level at 5%.

5.4 Medium-High Technology Products

GDP ratio, capital-labor ratio, and free trade agreements play a key role in increasing U.S. export in medium-high technology products. Short-run effects of the GDP ratio, capital-labor ratio, and FTA are estimated –0.2798, 0.3616, and 0.038 at the mid-high tech export. It means that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 2.8% decrease and to 3.6% increase in the U.S. mid-high tech export and FTA increases exports by 3.8%. Negative sign of GDP ratio means that U.S. and trading partners produce similar mid-high tech products and they are in competition in the foreign markets. In other words, bilateral trade in mid-high products between U.S. and major trading partners is intra-industry trade. One way to differentiated with foreign products is achievement of price competitiveness by economies of scale. And positive sign of capital-labor ratio implies that U.S. has a disadvantage of producing labor intensive mid-high tech products. It means that marginal product of labor is higher than marginal product of capital in mid-high tech industry. And U.S. mid-high tech export increases 6% than before singing agreement.

In long-run, the effects of GDP ratio and capital-labor ratio are calculated at -0.6509 and 0.8389. It means that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 6.5% decrease and to 8.38% increase in the mid-high tech export, respectively. Especially, capital-labor ratio is a main factor of determine U.S. comparative advantage of mid-high tech product export. And free trade agreement increases 8.9% exporting in mid-high tech industry in the long-run.

Table 5.4 Estimation Results of Mid-High Tech Products

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	1.165	2.27	
trade volume	-0.07311	0.07915	-0.169
exchange rate	-0.06387	0.1169	-0.158
GDP ratio	-0.2798*	0.1229	-0.6509*
capital-labor ratio	0.3616*	0.08872	0.8389*
openness ratio	0.04177	0.101	0.1003
trade agreement	0.038*	0.02798	0.08945*
lagged dependent	0.5562*	0.09756	

Note: * represents significance level at 5%.

5.5 High Technology Products

Exporting in high-tech products is subject to trade volume, exchange rate, and capital-labor ratio. Short-run effects of the trade volume, exchange rate, and capital-labor ratio are estimated -0.1663, -0.116, and -0.1268. It implies that the 10% increase in the trade volume, exchange rate, and capital-labor ratio are expected to correspond to 1.66% decrease and to 1.16% decrease and 1.268% decrease in the U.S. bilateral export in high-tech industry. And negative coefficient of trade volume means that the United States imports high-tech products more than its exporting amounts. And increasing exchange rate has a negative impact on export of high-tech products because of appreciating U.S. dollar. In addition, negative sign of capital-labor ratio insists that U.S. has a comparative advantage of producing capital-intensive goods such high-tech products. United States strengthens competitiveness of its exporting products when U.S. would be more capital abundant country.

In long-run, effects of trade volume, exchange rate, and capital-labor ratio are calculated at -0.3823, -0.272, and -0.2998. It means that the 10% increase in the trade volume, exchange rate, and capital-labor ratio are expected to correspond to 3.8% decrease and to 2.7% decrease and 2.99% decrease in the high tech export, respectively.

Table 5.5 Estimation Results of High Tech Products

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	4.433	1.683	
trade volume	-0.1663*	0.06217	-0.3823*
exchange rate	-0.116*	0.07943	-0.272*
GDP ratio	0.1082	0.1191	0.2604
capital-labor ratio	-0.1268*	0.08613	-0.2998*
openness ratio	-0.0359	0.09655	-0.08328
trade agreement	3.99E-04	0.03123	-3.32E-04
lagged dependent	0.5616*	0.09066	

Note: * represents significance level at 5%.

5.6 Overall Trade

Comparative advantage of U.S. overall trade is originated from GDP ratio and capital-labor ratio. In short-run, the effects of GDP ratio and capital-labor ratio are estimated -0.5312 and 0.7214 at the overall export, respectively. It means that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 1.85% decrease and to 2.5% increase in the U.S. overall export. It claims that U.S. bilateral trade is based on intra-industry trade. Negative coefficient of GDP ratio means that U.S. and its trading partner have a similar resource endowment and thus they produce similar products belonging to the similar industrial sector. Therefore, U.S. can obtain comparative advantage of export products by economies of scale following Krugman's study (1979). Large-scale production makes the price of U.S. export products cheaper than the price of trading partners. United Sates accomplishes its comparative advantage of exporting products by taking advantage of increasing returns in exporting industry. In addition, positive coefficient of capital-labor ratio implies that an increase in capital of the foreign country or an increase in labor of the United States would increase the U.S.

export for the foreign countries. U.S. increases its comparative advantage by supplying labor force in the U.S. economy.

In the long-run effects, GDP ratio and capital-labor ratio are calculated at -0.5312 and 0.7214. It can be interpreted as the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 5.3% decrease and to 7.2% increase in the overall export, respectively.

Table 5.6 Estimation Results of Overall Trade

variable	short-run		long-run
	posterior mean	posterior stdev.	posterior mean
intercept	1.273	1.692	
trade volume	-0.06348	0.05859	-0.1718
exchange rate	-0.06648	0.07304	-0.1945
GDP ratio	-0.1859*	0.08474	-0.5312*
capital-labor ratio	0.2512*	0.06465	0.7214*
openness ratio	0.0478	0.06189	0.1441
trade agreement	0.0224	0.02323	0.06451
lagged dependent	0.6396*	0.07588	

Note: * represents significance level at 5%.

6. CONCLUSIONS

Many previous studies have discussed U.S. bilateral trade flows with her major trading partners (Bahmani-Oskooee and Brooks, 1999; Baek, Koo, and Mulik, 2009; Zhuang, Koo, and Mattson, 2008). The studies have attempted to analyze U.S. bilateral trade flows by mainly using exchange rate and income. Since world economy is getting more globalized and complicated, existing trade models do not fully explain the reason of U.S. bilateral trade flows. Therefore, this study includes additional variables such as difference in economic structure and economies of scale. Bayesian econometric procedure is applied to solve cross-sectional heterogeneity problem which is often encountered when empirical model uses panel data. Summary of empirical results are represented in Table 6.1.

Table 6.1 Summary of Empirical Results

variable	agr	low	mid-low	mid-high	high	overall
trade volume	+				−	
exchange rate		−			−	
GDP ratio			−	−		−
capital-labor ratio	+		+	+	−	+
openness ratio						
trade agreement			+	+		
lagged dependent	+	+	+	+	+	+

Empirical results insists that all empirical equations are stationary due to the fact that lagged dependent variable is showing positive sign and the range of coefficient is greater than zero and less than one. Also, openness ratio does not affect the U.S. bilateral trade flow in all commodities group. It means that globalization of U.S. and trading partners does not play an important role in U.S. bilateral trade flow.

Exporting in agricultural products can be explained by trade volume and capital-labor ratio. Positive coefficient of trade volume implies agriculture is export-oriented industry. And positive effect of capital-labor ratio in U.S. bilateral trade means that an increase in foreign capital per labor relative to the U.S. would stimulate the U.S. bilateral exporting in agricultural products. If 10% increase in the trade volume is expected to 0.79% increase in the U.S. bilateral export share and the 10% increase in the capital-labor ratio is expected to 1.1% increase in the U.S. bilateral export share in agricultural products. It indicates that capital-labor ratio is most important factor in exporting agricultural products. In the long-run effects, 10% increase in the trade volume is expected to 1.267% increase in the U.S. bilateral export share and 10% increase in capital-labor ratio is expected to 1.7% increase in the U.S. bilateral export share in agricultural products.

Exchange rate only affects the U.S. bilateral export of low-technology products. Also, negative coefficient of exchange rate explains that appreciation of U.S. dollar against foreign currency decreases exporting in low-technology products. In the short-run, the 10% appreciation of the U.S. dollar is expected to correspond to 1.89% decrease in the U.S. bilateral export share in low technology products and 10% appreciation of the U.S. dollar is expected to correspond to 8% decrease in the U.S. low-tech export in long-run.

U.S. export of medium-low technology products can be described by changes in GDP ratio, capital-labor ratio, and free trade agreement. Negative coefficient of GDP ratio implies that increasing return to scale of production in U.S. medium-low technology encourage U.S. export of medium-low technology products. It also implies that U.S. and trading partners have a similar economic structure in producing mid-low technology products and thus U.S. bilateral trade in medium-low technology products is largely intra-industry trade. Also, positive coefficient of capital-labor ratio explains that an increase in foreign capital per labor relative to the U.S. would increase the U.S. bilateral export of medium-low technology products. In addition, free trade agreement with major trading partners plays a positive role in exporting in medium-low technology products. If the 10% increase in the GDP ratio is expected to correspond to 6.3% decrease in the U.S. mid-low tech export and 10% increase in the capital-labor ratio is expected to correspond to 8.17% increase in the U.S. export and free trade agreement raises 6% of exporting in medium-low technology products. In long-run, 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 10.8% decrease and 13.4% increase in the mid-low tech export, respectively. Also, exporting in mid-low tech products grows 10.2% by free trade agreement in long-run. In particular, capital-labor ratio plays a pivotal role in exporting in mid-low tech product export.

U.S. export of medium-high technology products has been affected by changes in GDP ratio, capital-labor ratio, and free trade agreement. The result indicates that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 2.8% decrease and to 3.6% increase in the U.S. mid-high tech export share. Negative sign of GDP ratio indicates that U.S. mid-high tech products are in competition with similar products produces in the foreign. Positive sign of capital-labor ratio indicates that U.S. has a disadvantage of producing labor intensive mid-high tech products. In long-run, GDP ratio and capital-labor ratio affect negatively 6.5% and positively 8.38% in exporting in medium-high technology products, respectively when each variable increases 10%. Free trade agreement is also a key factor in exporting in medium-high technology products.

Trade volume, exchange rate, and capital-labor ratio play an important role in exporting in high-tech products. In short-run, that the 10% increase in trade volume, exchange rate, and capital-labor ratio are expected to correspond to 1.66% decrease, 1.16% decrease, and 1.268% decrease in the U.S. bilateral export of high-tech products. In long-effects, trade volume, exchange rate, and capital-labor ratio have a negative impact on export of high-tech products. Negative coefficient of exchange rate explains that appreciation of the U.S. dollar against foreign currency decreases export of high-technology products. And negative capital-labor ratio implies that U.S. has a comparative advantage of producing capital-intensive goods such high-tech products. In long-run, changes in trade volume, exchange rate, and capital-labor ratio are expected to 3.8% decrease and to 2.7% decrease and 2.99% decrease in the high tech export, respectively.

Finally, overall U.S. bilateral exports are mainly affected by GDP ratio and capital-labor ratio. Negative coefficient of GDP ratio indicates that U.S. bilateral trade with its major trading partners is mainly intra-industry trade, meaning that U.S. and its major trading partner have similar resource endowments. Positive coefficient of capital-labor ratio implies that the United States export both labor and capital intensive goods. Short-run effects of GDP ratio and capital-labor ratio can be interpreted that the 10% increase in the GDP ratio and capital-labor ratio are expected to correspond to 1.85% decrease and to 2.5% increase in the U.S. overall export. In long-run, the 10% increases in the GDP ratio and capital-labor ratio are expected to correspond to 5.3% decrease and to 7.2% increase in the overall export, respectively.

In summary, this study found that the variable representing economic structure such as capital-labor ratio is more influential in U.S. bilateral trade with its major trading partners than exchange rate. In addition, U.S. trade is largely intra-industry trade except agricultural goods, which are based on resource endowments.

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