The Effect of South Korean FTAs on Trade:

Country-level and Industry-level Analyses

Plan-B paper

submitted to the faculty of the graduate school of

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by

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Dedication

To my wife, Hae Suk, and two lovely daughters, Dain and Damin

Abstract

I evaluate the degree to which South Korea's FTAs have affected trade between South Korea and its FTA partner countries and trade of 11 industrial sectors of South Korea. I use both a fixed effects regression model and a Poisson pseudo-maximum likelihood fixed effects model, in order to deal with biases from country-pair fixed effects and zero-trade values. For the country-level analysis, I utilize 1990–2011 trade data of 95 countries from the IMF's Direction of Trade Statistics and find that the South Korea–Chile and South Korea–India FTAs have had positive effects on trade, but the effect of the South Korea–EFTA FTA has no statistical significance. The South Korea–ASEAN FTA has had a wide spectrum of trade effects among the 10 ASEAN countries. Additionally, I try to estimate the differential effects of South Korea's FTAs on its exports from 11 industrial sectors using HS 4-digit–level export data for South Korea to 33 countries. Korean FTAs have considerably increased South Korea's textile, food, paper, and chemical exports. However, Korean FTAs have not brought any positive effects on electronics and motor industry exports in South Korea.

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1. Introduction

The trade policies of a country affect its own industries and consumers, as well as those of other countries. Traditionally, the main issues of trade policies have related to tariff rates, anti-dumping, quotas, and export subsidies. However, the importance of such traditional trade policies has decreased substantially under the GATT and WTO system. Many regulations of GATT and WTO have banned export subsidies or importing quotas, while imposing many constraints to countries that try to increase tariff rates in order to protect a domestic industry. Since 1990, the focus of trade policy has shifted to bilateral trade agreements, Free Trade Agreements[1] (FTAs), and multilateral trade negotiations. The Doha round has come to a standstill; therefore, many countries have more eagerly participated in FTA negotiations, in order to increase trade between the participating countries. According to the World Trade Organization (WTO),[2] there are 250 FTAs in force, as of March 2013. Among these, 232 agreements (91%) have been put into force since 1990. All WTO members except Mongolia[3] have participated in one FTA or more.

As FTAs have become more and more important in reality, international trade literature has focused on study of aggregate effects of FTAs. However, it has paid relatively a little attention to the differential effects of FTAs by an individual country and industry. The aggregate effects of FTAs on trade have been debated in empirical studies. Recent studies using more theory-based gravity models, have confirmed that FTAs have

[1] In this paper, the term Free Trade Agreements (FTAs) includes agreements to form and operate customs unions and free trade areas under Article XXIV of GATT, as well as preferential trade arrangements between developing countries, under the Enabling Clause of GATT.

[2] http://rtais.wto.org/UI/PublicAllRTAList.aspx.

[3] Mongolia launched FTA negotiations with Japan in 2012.

positive effects on trade (Baier & Bergstrand, 2007; Magee, 2008). However, it would be difficult to conclude that all FTAs have the same positive effects on trade between two countries. As Frankel (1997) already showed, many FTAs have differential effects on trade. For example, when FTAs between Central and Eastern European countries (CEECs, i.e., Bulgaria, Hungary, Poland and Romania) and the EU came into effect in the early 1990s, it would be very difficult to expect that the magnitude of the trade increase between all EU member countries and CEECs would have been the same, since specific countries in EU have more been benefitted from the FTA for some geographical or some industrial reasons. Therefore, in order to analyze the effects of an FTA more accurately, it is necessary to analyze the differential effects of FTAs by each country. On top of that, individual industrial sectors, such as agriculture, food, textiles, and electronics, can be diversely affected under specific FTAs, even though such agreements have brought aggregate positive effects on trade.

This paper focuses on analyzing the differential effects of South Korean FTAs. First, I evaluate the degree to which South Korean FTAs with ASEAN, Chile, India, and the EFTA have affected trade between South Korea and its FTA partner countries. The effects of Korean FTAs on trade with each individual country have been analyzed using both a fixed-effects regression model and a Poisson pseudo-maximum likelihood fixed-effects model. I use the 1990–2011 trade data of 95 countries from the IMF’s Direction of Trade Statistics for this country-level analysis. I find that the South Korea–Chile and South Korea–India FTAs have positive effects on trade, but the effect of the South Korea–EFTA FTA has no statistical significance. The effects of the South Korea–ASEAN FTA have had a wide spectrum of trade effects among the 10 ASEAN countries.[4] South Korea's trade between Brunei, Laos, Thailand, and Vietnam has increased with statistical significance since the South Korea–ASEAN FTA came into effect. However, South Korea's trade with Indonesia, Malaysia, and Myanmar has decreased with statistical significance.

Additionally, this paper tries to estimate the differential effects of Korean FTAs on exports from 11 industrial sectors, such as agriculture, food, textiles, chemicals, and electronics. The HS 4-digit level export data of South Korea to 33 countries was used for this industrial sector analysis. South Korean textile, food, paper, and chemical exports have increased considerably, due to South Korea's FTAs. However, Korean FTAs have not brought any positive effects to exports of the electronics and motor industries in South Korea—which are known to be relatively competitive in the world market—compared to other industrial sectors of South Korea.

The remainder of this paper is organized as follows: Section 2 provides an explanation about South Korean FTAs. Section 3 discusses the theory and literature about the effects of FTAs on trade. In section 4, I analyze the effects of Korean FTAs on trade with individual countries. Section 5 estimates the effects of Korean FTAs on exports from each industry in South Korea. Section 6 contains concluding remarks.

[4] ASEAN is the Association of Southeast Asian Nations, which was established in August 1967. It has 10 current member states, including Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. (See http://www.asean.org/asean/about-asean)

2. Context of South Korean FTAs

The three main Asian economies—China, Japan, and South Korea—did not have any free trade agreements with other countries until 2000. However, these 3 countries, especially South Korea, have eagerly participated in negotiations with many countries since 2000. South Korea's first FTA partner was Chile; they started negotiations in December 1999, and the FTA between the two countries took effect in April 2004. According to the South Korea–Chile FTA's tariff elimination schedule (Korea Customs Service, 2013)[5], South Korea must abolish tariffs on 87.2% of all items immediately, and the tariffs on other items will be abolished in 16 years. 0.2% of the total items that South Korea imports, such as rice, apples, and pears, were excluded from the tariff elimination schedule. Chile will immediately eliminate the tariffs on 41.8% of all imported goods and reduce the tariffs on other goods to zero within 13 years after the implementation of the FTA. In Chile, 46 items, such as refrigerators and washing machines, are excluded from the tariff elimination schedule.

The second FTA partner[6] is the EFTA, which includes Iceland, Liechtenstein, Norway, and Switzerland. The market of the EFTA is relatively small, but South Korea wanted to prepare for a future FTA with the EU, as well as create a steppingstone towards a large EU market. The EFTA eagerly sought an outpost in an Asian market. The

[5] Tariff elimination schedule of South Korea–Chile FTA comes from http://www.customs.go.kr/kcshome/main/content/ContentView.do?contentId=CONTENT_ID_000002349&layoutMenuNo=23266

[6] In chronological sequence, the South Korea-Singapore FTA is the second. This paper includes discussion on the South Korea–Singapore FTA into the South Korea-ASEAN FTA, since Singapore is one of ASEAN's 10 member countries.

South Korea–EFTA FTA took effect in September 2006. The EFTA abolished all tariffs on goods from South Korea immediately, while South Korea will eliminate the tariffs on 99.1% of imported items within 10 years.

South Korea's third FTA is with ASEAN. South Korea wanted to open up the markets of ASEAN countries and seek international outsourcing partners in ASEAN. The ASEAN countries also wanted to increase their trade with South Korea and to encourage investment from South Korea. The economies of ASEAN's member countries are diverse. Singapore is a highly developed country; on the other hand, Cambodia, Laos, and Myanmar are least developed countries. Therefore, the time and tariff schedule plans of the South Korea–ASEAN FTA were designed to be different from country to country. The South Korea–ASEAN trade-in-goods agreements[7] took effect from 2006 to 2010 in South Korea and ASEAN's member countries (see Table 1).

Table 1 Time when the South Korea-ASEAN FTA took effect by country

Month/Year	ASEAN member countries	Year when Korea-ASEAN FTA dummy is 1
03/2006	Singapore	2006
07/2007	Malaysia, Vietnam, Myanmar	2007
01/2008	Indonesia, Philippines	2008
07/2008	Brunei	2008
11/2008	Cambodia, Laos	2009
01/2010	Thailand	2010

The 3 least developed countries in ASEAN—Cambodia, Laos, and Myanmar—will reduce their tariffs on goods from South Korea in phases until 2018, whereas South

[7] The South Korea–ASEAN trade-in-service agreement and investment agreement entered into force in 2009. This paper only considers the South Korea–ASEAN trade-in-goods agreement.

Korea had to reduce all tariffs on normal track items from these three countries by 2010. The other ASEAN member countries, except Thailand, were scheduled to reduce their tariffs on about 90% goods from South Korea by 2010.

South Korea’s fourth FTA partner is India. Negotiations between these two countries launched in 2006, and the South Korea–India FTA (Comprehensive Economic Partnership Agreement) came into effect in January 2010. India will abolish tariffs on 74.5% of imported goods within 8 years, and South Korea will eliminate tariffs on 84.7% within 8 years. After implementation of the India–South Korea FTA, South Korea made three more FTAs: a South Korea–EU FTA (July 2011), a Korea–Peru FTA (August 2011), and a South Korea–US FTA (March 2012). However, this paper does not deal with these subsequent FTAs.

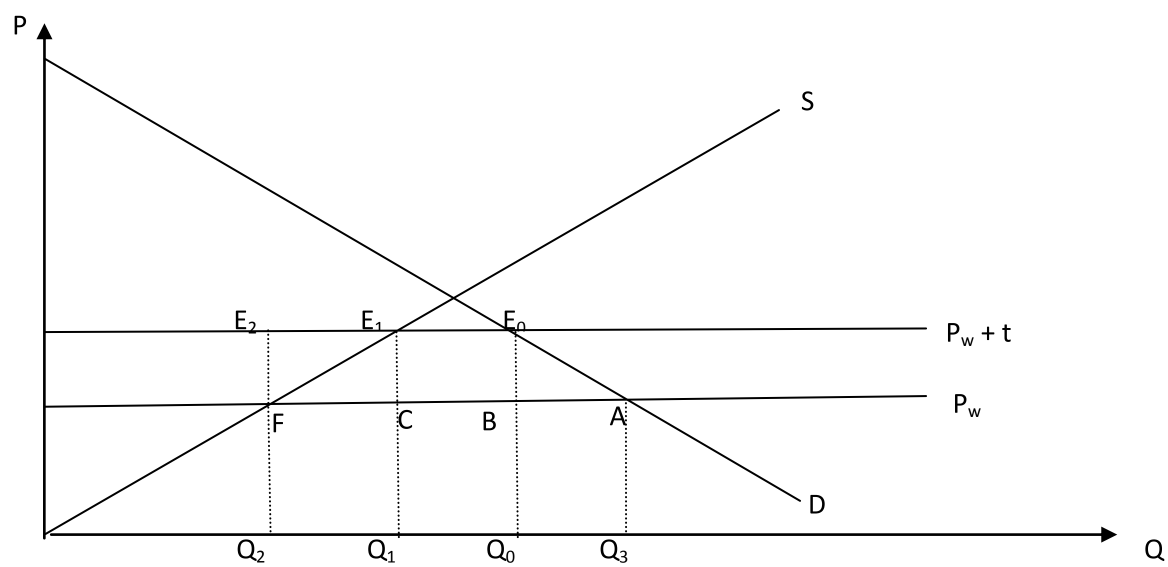
3. Theory and Literature Review

3.1. Theoretical Review

3.1.1. Partial equilibrium theory

When a free trade agreement between countries is in effect, each country abolishes its tariffs within a specific time period. The price of foreign products in the domestic market decreases in conjunction with the degree of tariff abolishment. The consumption of each partner country's products increases in the other country, which increases international trade. Figure 1 shows this partial equilibrium of this process. To simplify the analysis, we will assume that firms in the partner country of an FTA are competitive in the world market and can supply products at the world price (P_w) without any limitations. The domestic price before the FTA is $P_w + t$ (tariff rate), and the quantity of consumption is Q_0. The domestic firms supply Q_1, and the domestic market imports products from the partner country at Q_0–Q_1. The tax revenue is E_0E_1CB.

Figure 1 Effects of tariff abolishment through an FTA



Now, we can analyze the effects of tariff reduction or abolishment through an FTA on trade and welfare. When a tariff is repealed, firms in the FTA partner country can supply at the price of P_w. The total consumption in the domestic market increases from Q_0 to Q_3. The imports from the partner country will increase from Q_0Q_1 to Q_3Q_2, which means that the total trade between FTA partner countries will increase. The tariff revenue becomes zero, and the surplus of domestic firms decreases. Since the welfare of domestic consumers increases by the amount of E_2E_0AF, total social welfare[8] increases by the amount E_1FC+E_0BA.

Even though this partial equilibrium theory provides good insights into the directional effects on trade when an FTA or customs union is implemented, it is difficult to estimate the magnitude of the effect on trade by making use of this model. In reality, trade can be affected by many factors, such as consumer tastes in the importing countries, the capacity of suppliers, factor market conditions in the exporting countries, and shipping costs. Also, certain cultural factors, such as a common language and colonial ties, can affect the real trade between two countries. However, the partial equilibrium model cannot afford to take all of these factors into account.

3.1.2. Gravity equation based on general equilibrium theory.

The gravity equation has been widely used in the international trade field to explain and predict trade levels between countries. Many empirical studies have

[8] Viner (1950) showed that there is a possibility for the creation of a customs union or a free trade agreement to decrease member countries' social welfare. When the trade diversion effects of an FTA are greater than the trade creation effects, the social welfare of member countries in an FTA decreases.

demonstrated that the gravity model predicts bilateral trade flows very well. On top of that, Anderson (1979), Bergstrand (1985), and Aderson & van Wincoop (2003) derived the gravity equation from the general equilibrium theory in micro- and macroeconomics. According to its theoretical foundations, the gravity equation predicts that international trade between two countries is positively related to the GDPs of the exporting and importing countries, but negatively related to trade costs, which include transport costs, tariff rates, various legal costs, exchange rates, and intangible costs. This gravity equation explains that, if two countries are distant from each other, bilateral trade flows will decrease, since transportation costs will increase. In the gravity equation, when two partner countries implement a free trade agreement that abolishes all tariffs between them, trade costs between the respective countries will decrease. Therefore, the implementation of an FTA will induce an increase in bilateral trade flows. However, this equation no longer says how large the effect of an FTA will be on trade. This is the subject matter of empirical studies in the international trade field that try to estimate the parameters of an FTA variable.

3.2. Literature Review

Tinbergen (1962) first introduced the gravity model to identify the relationship between trade and the GDPs of exporting and importing countries, as well as to estimate the effects of preferential trade relationships, including British Commonwealth preference[9] and Benelux preference.[10] By using GDP and export data from 18 countries,

[9] British Commonwealth preference was operated as preference between the British and its colonial nations from 1932 to 1973, when the British joined the European Community.

[10] Benelux is a customs union signed in 1944 among Belgium, Netherlands, and Luxembourg.

Tinbergen found that British Commonwealth preference only increased trade flows by about 5%, but Benelux preference did not make any difference in the trade flows. After Tinbergen's study, many studies tried to estimate the effects of free trade agreements. There are three main streams of these studies (Gunther, 2012): the first is to attempt to simultaneously estimate the effects of multiple FTAs on trade flows; the second is to attempt to estimate individual FTA's effects on trade, especially NAFTA's effects; and the third is to estimate the effects of FTAs on trade of agricultural products.

First, many studies try to simultaneously estimate the effects of multiple FTAs, especially the effects of the EEC (European Economic Community) and EFTA (European Free Trade Association), by using the gravity equation; however, the results of these studies were unstable for data from between the 1970s to the 1990s. Aitken (1973) found that, even though the EEC and EFTA had some trade diversion effects on other countries, the EEC and EFTA had created considerable trade in its member countries; thus, net trade effects were created as a result. Abrams (1980) observed that the EEC and EFTA increased trade flows by about 36% and 28%, respectively. Bergstrand (1985), however, argued that price and exchange terms, which influence international trade flows, should be added when estimating the gravity model. He showed that the formation of the EEC did not have any statistically significant positive effect on trade, when adding exchange rates and export and import unit value indices, but the EFTA had increased trade flows by about 107%. Frankel (1997) also found that many regional blocs had different effects on the trade flows of its bloc members. He estimated that the EFTA did not have any significant effect on trade from 1970 to 1990, and that the Canada–U.S. FTA never had a significant effect. He found that the EC's effects on trade were very unstable, but were only positive since 1980, and that Mercosur (the Southern Common Market) created considerable amounts of trade in its member countries since 1975. Frankel's findings suggested that each FTA or customs union could cause very different effects on trade flows. Ghosh and Yamarik (2004) re-evaluated the effects of FTAs on trade in the gravity model literature by using the extreme bounds analysis method. They concluded that the effects of FTAs have been very fragile, by pointing out "that the pervasive trade creation effect found in the international trade literature reflects not the information content of the data but rather the unacknowledged beliefs of the researchers" (Ghosh & Yamarik, 2004, p. 387). Many recent studies, however, have reconfirmed the positive effects of FTAs on trade flows. Anderson and van Wincoop (2003) derived a theoretical-based, but relatively easily estimable, gravity equation that provides the foundation for researchers to attain unbiased estimates of FTA' effects. Their gravity equation shows that trade is considerably affected by "multilateral resistance," which consists of all bilateral trade barriers[11] between two countries, as well as the overall price levels of the importing and exporting countries. Their model implies that the error terms in the previous gravity model can be correlated with independent variables, including the FTA dummy; therefore, the previous estimates can suffer biases from unobserved factors. Subsequent studies have also paid a great deal of attention on controlling for unobserved factors in the gravity model. Baier and Berstrand (2007) systematically analyzed the effects of multiple FTAs by applying diverse gravity models. They showed that FTAs have, on average, increased the two members' trade by about 100% after 10 years, and that their estimates were very robust. However, they fail to deal with the problem that

[11] Anderson and van Wincoop (2003) argue that trade barriers between two countries include non-pecuniary trade costs, as well as tariffs.

zero trade flows pose. Magee (2008) tries to reflect the zero trade flows in his model, using the Poisson maximum likelihood estimator. Magee (2008) finds that the average effects of multiple FTAs are quite large.

Second, some studies have focused on the effect of a single FTA. Krueger (1999) uses aggregate and micro-panel data to analyze the effects of NAFTA on trade flows between the U.S., Canada, and Mexico. Krueger finds that NAFTA has resulted in slight positive trade flows, but other factors, such as Mexico's reduction of quantitative restrictions and changes in exchange rates, have played a more important role in trade increases between Mexico and the U.S. By using the shift–share analysis at the commodity level, Krueger finds no evidence of trade diversion from NAFTA. Clausing (2001) estimates the trade creation and trade diversion effects of the CUSFTA by analyzing disaggregate trade data from 1989 to 1994. She first estimates that the tariff elasticity, which measures the effects of tariff changes, is about 10%. She finds by using this estimated tariff elasticity, that the CUSFTA has increased trade flows between the U.S. and Canada by about 26% ($42 billion in 1994), but there is no evidence of trade diversion from third countries. Caporale et al. (2009) estimate the effects of FTAs between EU and the CEEC 4 countries (Bulgaria, Hungary, Poland, and Romania), which came into effect in early 1990s. Caporale et al. (2009) mainly use fixed effects vector decomposition (FEVD) and try to compare the trade flows between the EU–CEEC 4 countries and those of control groups.[12] They conclude that the FTA between the EU and the CEEC 4 countries had increased trade flows 14% more than the FTAs of the control

[12] As their control group, Caporale et al. (2009) use other CEEC countries (Russian Federation, Belarus. and Ukraine) that did not sign any FTAs with the EU.

groups. Calvo-Pardo et al. (2009) examined the ASEAN FTA's effect on trade within its bloc members and with third countries. They use the scheduled tariff reduction as an instrumental variable of the implemented tariff reduction and conclude that the ASEAN FTA has increased trade flows without hurting any trade flows with outsiders.

Other studies on FTAs analyze their effects on trade of agricultural products. Koo, Kennedy, and Skripnitchenko (2006) find that the aggregate effects of FTAs on agricultural trade are positive and statistically significant. However, they do not deal with biases from fixed effects of an importer, an exporter, or country pairs. Grant and Lambert (2008) try to test the hypothesis that FTAs have greater impact on agricultural trade than on trade of other products, since agricultural tariffs are set to be higher than those of other products, after controlling for fixed effects biases. They conclude that "the average effect of RTAs was to increase members' agricultural trade by 72%, compared to just 27% for members' non-agriculture trade using our preferred specification" (Grant & Lambert, 2008, p. 779). However, their model does not adequately deal with zero trade flows. Sun and Reed (2010) try to attain unbiased estimates of FTA effects on agricultural trade after controlling for the fixed effects of country-pairs, using the PPML method to deal with zero trade flows in their model. They find that the ASEAN–China FTA, EU enlargement, and Southern African Development Community agreements have increased agricultural trade flows among their members, but they do not find any positive effects of NAFTA on agricultural trade. Until now, there are very few studies which focus on the trade of other industries' products, other than that of agricultural products.

4. Effect of South Korean FTAs: Country-level Analysis

4.1. Data

This chapter focuses on analyzing the effects of South Korea's FTAs on trade between South Korea and its FTA partners; these represent 15 countries that have an FTA with South Korea, if we count each country individually. In order to control for time and unobserved exporter and importer factors, I collected the trade data on 95 countries from 1990 to 2011 from the Direction of Trade Statistics (DOTS) of the IMF (see table 2). The trade values are in terms of the nominal value[13] of the current US dollar.

Table 2 List of 95 countries

Argentina	Australia	Austria	Bangladesh
Barbados	Belgium	Brazil	Brunei
Bulgaria	Cambodia	Cameroon	Canada
Chile	China	Colombia	Costa Rica
Cote D'Ivoire	Croatia	Cyprus	Czech
Denmark	Ecuador	Egypt	Estonia
Fiji	Finland	France	Gambia
Germany	Ghana	Greece	Guatemala
Guyana	Honduras	Hong Kong	Hungary
Iceland	India	Indonesia	Ireland
Israel	Italy	Jamaica	Japan
Jordan	Kenya	Korea (South)	Kuwait
Laos	Lithuania	Luxembourg	Macao
Madagascar	Malaysia	Malta	Mauritius
Mexico	Morocco	Myanmar	Netherlands
New Zealand	Nigeria	Norway	Pakistan
Panama	Paraguay	Peru	Philippines

[13] Trade data can be transformed to constant U.S. $ by using the CPI or GDP deflator indices. However, since I include each year dummy in the main regression equations, data transformation will not change any results.

Poland	Portugal	Romania	Russia
Saudi Arabia	Senegal	Singapore	Slovakia
Slovenia	South Africa	Spain	Sri Lanka
Sweden	Switzerland	Tanzania	Thailand
Trinidad and Tobago	Tunisia	Turkey	Ukraine
United Kingdom	United States	Uruguay	Venezuela
Vietnam	Zambia	Zimbabwe	

Since 95 countries imported products from 94 countries over 22 years, there are 196,460 (= 95 * 94 * 22) total observations in the data. The descriptive analysis of trade for this data over 22 years is in table 3. Some small countries have not had international trade relationships with other small countries. For example, trade flows between Brunei and Costa Rica has not occurred for 22 years. In the statistical analysis, I treat all missing trade flows as zero trade;[14] the zero observations in the analysis represent 16.7% of the total observations (32,841 observations).

Table 3 Descriptive analysis of trade of 95 countries for 1990-2011

Imputed zero value (32,841: 16.7%)		Mean	Median	Maximum (from China to the USA in 2011)
Missing	Zero			
9,172 (4.7%)	23,669 (12.0%)	796,074	8,200	417,354,000

The GDP, GDP per capita, and population data came from the World Bank's World Development Indicators (2013). GDP and GDP per capita are in constant 2000 U.S. dollars. Since the World Bank's World Development Indicators do not have any data on Myanmar, GDP and GDP per capita of Myanmar from 1998 to 2011 were

[14] In international trade, this is very common way to treat missing trade flows (Gunther, 2012).

gathered from a different source (Trading Economics, 2013)[15]. The distance between each country pair was calculated using Vincenty in the STATA program. In order to calculate the distance of Vincenty in the STATA, I collect the longitude and latitude of the most populated cities[16] of the 95 countries. This latitude and longitude data came from CEPII(*Centre d'Etudes Prospectives et d'Informations Internationales, 2013*). Information about a common language and colonial ties between two countries also came from CEPII. In order to control for other FTAs' effects, apart from FTAs with South Korea, I created a new dummy variable, in which 1 represents two countries that share an FTA or customs union not with South Korea.

4.2. Methodology

4.2.1. Simple gravity equation

The simple gravity equation can be expressed as follows:

$$T_{ijt} = \alpha*(GDP_i^{\beta1})*(GDP_j^{\beta2})/ (Distance^{\beta3}) * U_{ijt} \quad (i \neq j), \qquad (1)$$

Where T_{ijt} is the value of exports from country (i) to country (j) at time period t; GDP_i is the GDP of exporting country (i); GDP_j is the GDP of importing country (j); Distance is the distance between the most populated cities of the importing and exporting countries; and U_{ijt} is the log error term, in which $E(\ln(U_{ij})) = 0$.

By taking the logarithm in both sides of equation (1), we get:

[15] http://www.tradingeconomics.com/myanmar/gdp

[16] Distance can be defined several ways. Some authors define the distance as between the borders of the exporting and importing countries. When two countries border each other, the distance is zero. In this case, it is difficult to take the logarithmic transformation

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(Distance) + u_{ijt} \quad (i \neq j). \tag{2}$$

Equation (2) can be expanded by taking into account other factors, such as population, borders, language, and free trade agreements. Thus, a more expanded equation for the gravity model is:

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(Pop_i) + \beta_4 \ln(Pop_j) + \beta_5 \ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTAs + u_{ijt} \quad (i \neq j). \tag{3}$$

Here, Pop_i and Pop_j are the populations of exporting country (i) and importing country (j), respectively. Border is a dummy variable, where 1 represents that two countries borders each other, and 0 otherwise. Language is a dummy variable; it is 1 if two countries have a common language or 0 otherwise. Colony is a dummy variable; it is 1 if the importing and exporting countries have had any colonial relationship in the past. Lastly, Korea_FTA is 1 if a country participates in an FTA with South Korea or 0 otherwise, and other_FTA indicates 1 if countries participate in an FTA or customs union together, other than with South Korea, or 0 otherwise.

Some studies use the GDP per capita variable in place of the population variable; (Frankel & Wei, 1997; Gunther, 2012). The equation utilizing GDP per capita can be expressed as follows:

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(GDP_i/Pop_i) + \beta_4 \ln(GDP_j/Pop_j) + \beta_5 \ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTA + u_{ijt} \quad (i \neq j). \tag{4}$$

GDP per capita can easily be drawn from GDP and population. Therefore, we get similar results when using either equation (3) or (4) (Anderson, 1979).[17]

4.2.2. Gravity equation with time dummy

If trade data are collected for only one year, then equations (3) and (4) suffice. When trade data are collected for a certain time period, it is necessary to reflect the time trend or each-year fluctuations in the regression models. The simple way to reflect this time trend in the regression model is by including a linear year variable. We can express our model as equation (5):

$$\begin{aligned}\ln(T_{ijt}) = \ln(\alpha) + \beta_1\ln(GDP_i) + \beta_2\ln(GDP_j) + \beta_3\ln(Pop_i) + \beta_4\ln(Pop_j) + \\ \beta_5\ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \\ \beta_9 Korea\_FTA + \beta_{10} other\_FTA + \gamma year + u_{ijt} \quad (i \neq j). \qquad (5)\end{aligned}$$

Equation (5), however, assumes that there is a secular linear time trend in international trade and that such a trend is stable. However, external shocks in a specific year can affect international trade at different magnitudes and directions in trade flows. For example, even though there is an increasing trend in international trade in the world in the long run, the financial crisis in 2008 could reduce all international trade in the world. Therefore, the more appropriate method for incorporating time variation is to include a time dummy for each year in equation (6):

[17] Other studies, such as Silva and Tenyero (2006), include the landlocked variable, which represents whether an exporting country or importing country is landlocked. The inclusion of this variable does not significant change the estimates of the parameters.

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(Pop_i) + \beta_4 \ln(Pop_j) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTA + \gamma_1 year_1 + \ldots + \gamma_k year_k + u_{ijt} \quad (i \neq j). \qquad (6)$$

4.2.3 Unit GDP elasticity of gravity equation

Anderson (1979) presents the theoretical foundations for a gravity equation that does not require unit GDP elasticity in the model. However, when Anderson and van Wincoop (2003) recently derived a simpler gravity model with theoretical foundations, they argued that an estimable gravity equation should include income or GDP elasticity. When we impose unit GDP elasticity in equation (6), it can be expressed as:[18]

$$\ln(T_{ijt} / GDP_i * GDP_j) = \ln(\alpha) + \beta_5 \ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTA + \gamma_1 year_1 + \ldots + \gamma_k year_k + u_{ijt} \quad (i \neq j). \qquad (7)$$

4.2.4. Fixed effects estimation: Dealing with biases from unobserved factors

If FTAs are strictly exogenous, we can estimate the coefficient of an FTA variable without any biases by using the pooled Ordinary Least Squares (the pooled OLS) method in equations (6) or (7). However, the pooled OLS estimators of the FTA coefficient are

[18] When imposing the unit GDP elasticity in the gravity equation, Anderson and van Wincoop (2003) do not include population variables or GDP per capita variables. I have followed their method.

usually biased[19] (Wooldridge, 2009) when an FTA variable and error terms are correlated as follows:

$$Cov(FTA, u_{ijt}) \neq 0.$$

Many studies observe that the FTA variable can be endogenous. In political science, Mansfield et al. (2002) found that democratic governments tend to cooperate economically and sign FTAs with each other. If political factors affect both the formation of an FTA and trade levels, then the error terms in a gravity model can be systematically correlated with the FTA variable. Anderson and van Wincoop (2003) also show that FTA variables are systematically related with multilateral resistance terms, which are usually included in the error terms. Therefore, the pooled OLS estimates using a traditional gravity model can be biased according to the theory-based gravity model by Anderson and van Wincoop (2003).

On top of that, bilateral FTAs can be intentionally selected from partner countries. Baier and Bergstrand (2007) state:

> The likelihood of the two countries' governments selecting into an FTA may be high if there is a large expected welfare gain from potential bilateral trade creation if the FTA deepens liberalization beyond tariff barriers into domestic regulations (and other non-tariff barriers). (p. 78)

[19] Biases of OLS estimation can also come from measurement error. This paper does not deal with the measurement error, since almost every study in the social sciences can suffer from these measurement problems (see Baier and Bergstrand (2007) for more detail on measurement error in the gravity model).

When the formation of an FTA is greatly affected by the selection process of both FTA partner countries, the FTA variable cannot be exogenous. Therefore the pooled OLS estimates suffer additional biases.

Other estimation methods are needed to deal with these biases from unobserved factors and the selection process in the gravity model. In the cross-sectional data, we can obtain unbiased estimates by using the Instrumental Variable (IV) method. To be a good IV, the IV variable should not be correlated with the error terms of the trade flows, but be correlated with an FTA variable. As Baier and Bergstrand (2003) point out, a good instrumental variable in the international trade is difficult to attain.[20] In the panel data, the fixed effects method can deal with biases from unobserved factors or selection problems. Since my data is panel data from 1990 to 2011, this paper uses the fixed effects method.[21]

4.2.4.1. Importer and exporter fixed effects estimates

We can write a structural equation that includes an importer and exporter's fixed effects as equation (8). This equation is almost the same as equation (6), except that it includes a_i and a_j, where a_i is an exporter fixed effect, and a_j is an importer fixed effect.

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1\ln(GDP_i) + \beta_2\ln(GDP_j) + \beta_3\ln(Pop_i) + \beta_4\ln(Pop_j) + \beta_5\ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTA + \gamma_1\, year_1 + \ldots + \gamma_k\, year_k + a_i + a_j + u_{ijt} \quad (i \neq j). \qquad (8)$$

[20] Some papers use political variables as independent variables. Baier and Bergstrand (2003), however, argue that these political variables can be correlated with trade flows. Therefore, the IV method using political variables can be biased.

[21] Since error terms are correlated with an FTA variable, the random-effects model is inadequate here.

We can first average this equation over time, in order to attain the averaging equation. Since a_i and a_j are fixed over time, the mean of equation (8) has the same value as a_i and a_j[22]. By subtracting the averaging equation from equation (8), we can finally derive the fixed effects equation as follows:

$$\overline{\ln(T_{ijt})} = \beta_1\overline{\ln(GDP_i)} + \beta_2\overline{\ln(GDP_j)} + \beta_3\overline{\ln(Pop_i)} + \beta_4\overline{\ln(Pop_j)} + \beta_5\overline{\ln(Distance)} + \beta_6\overline{Border} + \beta_1\overline{Language} + \beta_8\overline{Colony} + \beta_9\overline{(Korea\_FTA)} + \beta_{10}\overline{(other\_FTA)} + \gamma_1\overline{year1} + \ldots + \gamma_k\overline{year\ k} + \overline{u_{ijt}} \quad (i \neq j) \qquad (9)$$

By using equation (9), we can attain fixed effect estimates of the Korea_FTAs variable with importer and exporter fixed effects[23].

4.2.4.2. Country-pairs fixed effects estimates

Two countries can have more trade flows than those predicted by the gravity equation, since specific historical, political, religious, or cultural similarities between two countries may have affected their trade flows. In order to reflect these factors, the gravity model usually includes cultural factors, such as colony and/or language variables. However, it is difficult to reflect all these factors in the gravity equation. If these omitted factors are systematically correlated with an FTA variable, the estimate of an FTA variable using only an exporter or importer fixed effect model can be biased. In order to

[22] Magee (2008) expresses exporter-year fixed effects and importer-year fixed effects. However, since equation (9) already includes year dummies, this paper only includes exporter fixed effects and importer fixed effects.

[23] In the importer and exporter fixed effects estimates, ln(Distance), Border, Language, Colony variables varies between exporter country (i) and importer country (j). Therefore, we can get the fixed effects estimates in these variables in the importer and exporter fixed effects model.

take into account these country-pair fixed effects, the structural gravity equation is expressed as follows:[24]

$$\ln(T_{ijt}) = \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(Pop_i) + \beta_4 \ln(Pop_j) + \beta_5 \ln(Distance) + \beta_6 Border + \beta_7 Language + \beta_8 Colony + \beta_9 Korea\_FTA + \beta_{10} other\_FTA + \gamma_1 year_1 + \ldots + \gamma_k year_k + a_{ij} + u_{ijt} \quad (i \neq j). \qquad (10)$$

By demeaning equation (10), we can derive a country-pair fixed effects equation as follows[25];

$$\overline{\ln(T_{ijt})} = \beta_1 \overline{\ln(GDP_i)} + \beta_2 \overline{\ln(GDP_j)} + \beta_3 \overline{\ln(Pop_i)} + \beta_4 \overline{\ln(Pop_j)} + \beta_9 \overline{(Korea\_FTA)} + \beta_{10} \overline{(other\_FTA)} + \gamma_1 \overline{year1} + \ldots + \gamma_k \overline{year\ k} + \overline{u_{ijt}} \quad (i \neq j) \qquad (11)$$

4.2.5. Poisson estimation: Dealing with biases from zero trade values

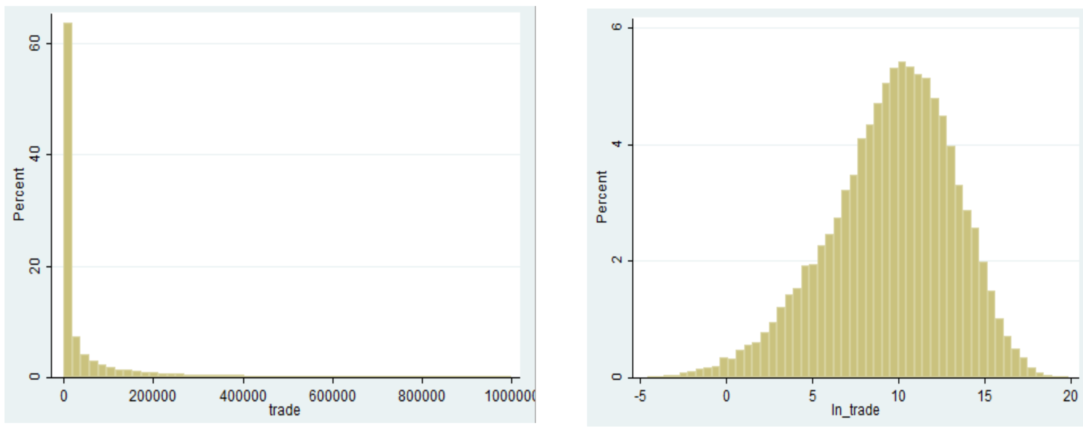
Since the logarithm of zero is not defined, dealing with zero trade values poses a challenging task. Traditionally, many studies have estimated the gravity equation after taking the logarithmic transformation of trade, ever since Tinbergen (1962) used the gravity model for the first time. There are some appealing reasons for this logarithmic transformation of trade. As seen in Figure 2, raw trade distribution is extremely skewed to the right. When we take the logarithm of trade, the logarithm of trade's distribution is close to the normal distribution. That is, the logarithmic transformation of trade approximately satisfies the normality assumption of the regression analysis. Moreover,

[24] Magee (2008) includes both country-pair fixed effects and importer and exporter fixed effects. However, since my panel data is balanced, these inclusions cause perfect collinearity.

[25] In country-pair fixed effects, some variables, such as distance, language, are invariable. Therefore, these time-invariant variables are dropped in country-pair fixed effects estimates

the logarithmic transformation can reduce the variance of the variables (Woodridge, 2009). Therefore, the logarithmic transformation of trade flows has been a general method for estimating the gravity model.

Figure 2 Trade (1,000$) distribution and the log of trade distribution



In the process of taking the logarithm of trade, we drop all zero trade values, which are 16.7% of the observations in my data. If these zero trade flows occur randomly, dropping the zero trade flows does not pose any problems. However, it is known that zero trade flows usually occur because of a selection process, rather than a random process. Firms in small countries face high trade costs when they try to sell their goods to other small, but extremely distant, countries. Thus, there are higher possibilities of no trade between extremely distant countries.[26] Therefore, the estimates of an FTA variable after log transformation can cause biases (Burger, Oort, & Linders, 2009).

There are two traditional ways to deal with zero trade flows in the international trade field. The first method is to add small values to trade, in order to take the logarithm of trade. For example, add 1 to zero trade values and take the logarithm on the value of

[26] Zero trade flows can occur for political or religious reasons. Zero trade flows between Israel and Saudi Arabia and between Israel and Kuwait show these examples.

(trade + 1); then, estimate the parameters. These estimates, however, are known to be inconsistent. The other way is to estimate parameters using a Tobit model. Soloaga and Winters (2001) use the Tobit method to estimate the effect of FTA on trade in the 1990s.

Recently, the most widely used method to deal with zero trade values is to estimate the parameters by using a Poisson pseudo-maximum-likelihood method (PPML). Silva and Tenreyro (2006) show that the PPML method provides an appropriate way to deal with zero trade flows[27]. On top of that, PPML has another good property in dealing with heteroskedasticity. In general, heteroskedasticity of error terms can be handled with heteroskedastic-robust methods in the OLS or fixed effects estimates. However, when error terms are correlated with independent variables, the heteroskedasticity can cause more serious biases in the OLS (Silva and Tenreyro, 2006). Silvan and Tenreyro argue that "PPML[28] method is robust to different patterns of heteroskedasticity" (p. 653). After their study, numerous new studies, such as Westerlund and Wilhelmsson (2006), Magee (2008), Liu (2009), and Sun and Reed (2010), have used the PPML method to estimate the effect of FTAs. Therefore, this paper will use the PPML method as well. In order to use PPML, trade flows between two countries are assumed to be:

$$T_{ijt} = \text{Exp}\{\ \ln(\alpha) + \beta_1 \ln(GDP_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(GDP_i/Pop_i) +$$

$$\beta_4 \ln(GDP_j/Pop_j) + \beta_5 \ln(Distance) + \beta_{6*}Border + \beta_{7*}Language +$$

[27] Silva and Tenreyro (2011) have recently found that the PPML method behaves well, even in data with excessive zero trade values.

[28] Originally, the purpose of the PPML method was to estimate the parameters of count data. However, one previous study (Gourieroux, Monfort, & Trognon, 1984) found that even trade data do not have the strict properties of count data. Therefore, using PPML on trade data does not present any problems.

$$\beta_8\text{Colony} + \beta_9\text{Korea\_FTA} + \beta_{10}\text{other\_FTA} + \gamma_1 \text{ year}_1 + \ldots +$$

$$\gamma_k \text{ year}_k\} + \varepsilon_{ijt} \quad (i \neq j). \tag{12}$$

In the abbreviated form, trade flows can be expressed as:

$$T_{ijt} = \text{Exp}(X'_{ijt}*\beta) + \varepsilon_{ijt} \quad (i \neq j). \tag{13}$$

By taking the expectation, we get:

$$E(T_{ijt}|X) = \text{Exp}(X'_{ijt}*\beta). \tag{14}$$

From the properties of the Poisson distribution, we get:

$$P(T_{ijt} = h \mid X) = \text{Exp}[-\text{Exp}(X'_{ijt}*\beta)][\text{Exp}(X'_{ijt}*\beta)]^h / h!. \tag{15}$$

From equation (15), we can get the maximum likelihood estimates of the Poisson method.

The PPML fixed effect method can be applied to the panel data, in order to obtain unbiased estimates when there are endogenous explanatory variables. Magee (2008) and Sun and Reed (2010) are examples of studies that use PPML fixed effects. Since the FTA variable is endogenous in our equations, this paper uses the PPML fixed effects as the preferred method.

4.3. Regression Results

4.3.1. Basic regression results

I estimate equation (3) and equation (6) by using the OLS method in the pooled data to observe the effect of South Korea's FTAs on trade. Column (1) in table 4 shows the OLS regression results without the time dummy. I find that the estimates for GDP, distance, and the cultural variables are similar to those of previous studies. The estimate for an GDP variable of the importing country is 1.02, and the estimate for the GDP of the exporter is 1.18. These estimated results indicate that, when the GDP of the importing country or exporting country increases, bilateral trade has increases at a proportional rate with GDP. The estimate of the population variable of an importing country in column (1) of table 4 is slightly negative. This shows that more populated importing countries tend to participate less in trade, compared to smaller countries. This negative population estimate in the gravity model is also consistent with that of other literature. As above mentioned, some studies use GDP per capita variables instead of population variables. I show the estimates using GDP per capita in Table A5 in an appendix, which show the very similar results using population variables. Other estimates show the expected signs; the estimate of the logarithm of distance is negative, and the estimates of the Border, Common language, Colony variables are positive. The estimate of the other FTAs variable is 0.382, which shows that FTAs have a positive effect on trade worldwide. Therefore, if two countries have FTAs or customs union relations other than with South Korea, they trade with each other about 46.5% (= exp (0.382) – 1) more than with other countries. The estimate of the Korea_FTAs variable in column (1) shows that South Korea's FTAs have increased trade between South Korea and its 15 partner countries by about 457% (= exp (1.717) – 1).

Column (2)[29] in Table 4 shows the effects of individual South Korean FTAs on trade between South Korea and its FTA partner countries. The South Korea–ASEAN FTA has increased South Korea's trade with Singapore by about 1,587%, Brunei by about 1,448%, and Malaysia by about 1,221%, respectively.

[29] Column (2) also includes other variables. I do not show the results, since the estimates of column (2) are the same as column (1) for the other variables.

Table 4 Pooled OLS estimates using equations (3) and (5)

	Without time dummy		With time dummy	
	(1)	(2)	(3)	(4)
Log importer's GDP	1.022*** (.003)		1.021*** (.003)	
Log exporter's GDP	1.181*** (.003)		1.180*** (.003)	
Log importer's population	-.009** (.004)		-.009** (.004)	
Log exporter's population	.003 (.004)		.004 (.004)	
Log distance	-1.108*** (.007)		-1.109*** (.007)	
Border	.396*** (.027)		.397*** (.027)	
Language	.769*** (.014)		.765*** (.014)	
Colony	.566*** (.027)		.566*** (.027)	
Other FTAs	.382*** (.014)		.384*** (0.014)	
Korea all FTAs	1.717*** (.107)		1.662*** (.107)	
<u>ASEAN FTA</u>				
Brunei		2.740*** (.632)		2.675*** (.628)
Cambodia		1.157*** (.306)		1.124*** (.292)
Indonesia		2.129*** (.149)		2.066*** (.143)
Laos		.806** (.370)		.772** (.378)
Malaysia		2.581*** (.087)		2.518*** (.086)
Myanmar		.599*** (.135)		.533*** (.133)
Philippines		1.196*** (.036)		1.132*** (.041)
Singapore		2.826*** (.069)		2.777*** (.068)
Thailand		1.741*** (.103)		1.673*** (.098)
Vietnam		2.392*** (.141)		2.328*** (.141)
<u>Chile FTA</u>		3.371*** (.124)		3.343*** (.119)
<u>India FTA</u>		.440*** (.110)		.378*** (.101)
<u>EFTA FTA</u>		.612*** (.144)		.549*** (.143)
R-squared	.731	.731	.731	.732

Note - The dependent variable is the log of trade (thousand dollars). Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively. The number of observations is 159,712.

Also, the South Korea–Chile FTA has increased trade between the two countries by about 2,800%. However, South Korean FTAs have had a relatively small effect on trade with Myanmar and Laos. Also, the South Korea–India FTA has only increased trade by about 55%, and the South Korea–EFTA FTA has increased trade by about 84%.

Columns (3) and (4) of Table 4 show the regression results using equation (6), which includes the time dummies. These results show the similarities with the estimates of many independent variables to those in columns (1) and (2). The estimates of the Korean FTAs variable decrease very slightly, but the basic direction and magnitude of Korea FTAs' effects are the same as columns (1) and (2).

4.3.2. Fixed effect estimates

Since FTA variables can be correlated with various fixed effects in the error terms of the gravity equation, the OLS estimates in Table 4 can suffer biases. In order to get unbiased estimates, it is necessary to control for these fixed effects. Columns (1) and (2) in Table 5 show the estimates using equation (9), which controls for exporter and importer fixed effects. Compared to estimates in Table 4, the estimates of GDP, population, and distance variables are slightly changed. However, the estimated results of the Korean FTA variable are lower. The magnitude of total Korea FTAs' effects on trade decreases from 457% to 54.6%. The effects of the South Korea–ASEAN FTA on trade with Singapore and the Philippines become insignificant. The magnitude of the South Korea–Chile FTA's effect on trade between the two countries lowers from 2,800% to about 630%, and the South Korea–India FTA has a negative effect on trade between the two countries.

The estimates in columns (1) and (2) of Table 5 can be biased if there are country-pair fixed effects. By controlling for bilateral country-pair fixed effects, I can eliminate the effects of specific political, religious, and historical reasons that may influence trade between two countries. Columns (3) and (4) in Table 5 show the fixed effects estimates after controlling for country-pair and time fixed effects. The estimate of the total Korean FTA variable is still positive, but not statistically significant. The estimate of the other_FTA variable lowers from 0.324 to 0.184.

Column (4) in Table 5 shows that Korean FTAs have very different effects on trade with individual countries. The South Korea–ASEAN FTA has increased South Korea's trade with Brunei, Laos, and Vietnam by about 77.5%, 167%, and 73.3%, respectively. However, it has reduced trade with Indonesia, Malaysia, Myanmar, and Singapore by about 12.9%, 29.5%, 60.0%, and 15.2%, respectively. A plausible interpretation for the negative effects of the South Korea–ASEAN FTA is that it might have a trade diverting effect within ASEAN countries. Of course, it is necessary to do more research in the future. In the country-pair fixed effects estimates, column (4) shows that the South Korea–India FTA and the South Korea–Chile FTA have increased trade with the countries by about 40% and 35.3%, respectively. However, the Korea–EFTA FTA has not brought any aggregate positive effects on trade.

***Table* 5** Fixed effects estimates using equations (9) and (11)

	Importer, exporter and time fixed effects		Bilateral country pair and time fixed effects	
	(1)	(2)	(3)	(4)
Log importer's GDP	1.229***		1.287***	
	(.041)		(.063)	
Log exporter's GDP	1.233***		1.209***	
	(.003)		(.066)	
Log importer's population	.134		.280**	
	(.082)		(.126)	
Log exporter's population	-1.360***		-1.125***	
	(.090)		(.135	
Log distance	-1.273***		-	
	(.007)			
Border	.224***		-	
	(.027)			
Language	.705***		-	
	(.016)			
Colony	.955***		-	
	(.029)			
Other FTAs	.324***		.184***	
	(.014)		(0.024)	
Total Korea_FTA	.436***		.069	
	(.113)		(.104)	
ASEAN FTA				
Brunei		3.307***		.574***
		(.883)		(.068)
Cambodia		.247		.486
		(.337)		(.490)
Indonesia		.450***		-.138***
		(.106)		(.017)
Laos		.290		.983**
		(.405)		(.198)
Malaysia		.111**		-.349***
		(.056)		(.133)
Myanmar		.447**		-.915***
		(.189)		(.208)
Philippines		.155		-.247
		(.109)		(.254)
Singapore		-.065		-.165***
		(.043)		(.034)
Thailand		-.906***		.037
		(.136)		(.031)
Vietnam		.160		.550***
		(.167)		(.197)
Chile FTA		1.988***		.302***
		(.132)		(.019)
India FTA		-.436***		.340***
		(.061)		(.050)
EFTA FTA		-.213		-.029
		(.163)		(.275)
R-squared	.801	.801	.232	.233

Note - The dependent variable is the log of trade (thousand dollars). Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively. The number of observations is 159,712.

4.3.3. Poisson pseudo maximum likelihood estimates

In order to deal with problems related to zero trade values, I estimate the effects of South Korean FTAs by using PPML methods. For comparison purposes, columns (1) and (2)[30] in Table 6 show the PPML estimates without controlling for any fixed effects. However, the PPML fixed effects estimates, which are the preferred results, are shown in columns (3) and (4) in Table 6, since they are free from the biases of country-pair fixed effects, as well as those of non-randomly distributed zero-trade-values. Table 6 shows that the PPML fixed effects estimates are consistent with the general fixed effects estimates in column (3) and (4) of Table 5.[31] The magnitude of the total Korean FTA effect is positive but statistically insignificant. The South Korea–ASEAN FTA has increased trade between South Korea and Brunei, Laos, and Vietnam by about 60%, 109%, and 46%, respectively, which are similar to the general fixed effects estimates of column (4) in Table 5. However, the FTA has been estimated to decrease trade between South Korea and Malaysia, Myanmar, and the Philippines by about 19%, 60%, and 21%, respectively. The estimate effects of South Korea's FTAs with Chile, India, and the EFTA are consistent with the fixed effects in general, as well. One of the differences between the general fixed effects estimates and PPML estimates occurs in the trade effects between South Korea and Thailand. In the PPML estimates, the South Korea–ASEAN FTA has a positive and statistically significant effect on trade between South Korea and Thailand, although it is insignificant using general fixed effects estimates.

[30] The results found in columns (1) and (2) are consistent with other estimates from Silva and Tenreyro (2006), who show the PPML estimates using cross-sectional data.

[31] The biggest difference between PPML fixed effects and general fixed effects lies in the estimates of the other FTA variable, which is no longer significant in PPML estimates.

Table 6 PPML estimates (dependent variable: trade) using equation (12)

	No fixed effects (but with year dummy)		Bilateral country pair and time fixed effects	
	(1)	(2)	(3)	(4)
Log importer's GDP	.792***		1.186***	
	(.008)		(.100)	
Log exporter's GDP	.675***		.974***	
	(.008)		(.146)	
Log importer's population	-.003		-.1.473***	
	(.009)		(.280)	
Log exporter's population	.148***		-.781***	
	(.012)		(.315)	
Log distance	-.557***		-	
	(.016)			
Border	.542**		-	
	(.032)			
Language	.237***		-	
	(.030)			
Colony	-.041		-	
	(.038)			
Other FTAs	.367***		.018	
	(.039)		(0.064)	
Total Korea_FTA	1.069***		.069	
	(.110)		(.069)	
<u>ASEAN FTA</u>				
Brunei		1.908***		.469***
		(.315)		(.118)
Cambodia		-.064		.249*
		(.404)		(.139)
Indonesia		1.341***		-.015
		(.069)		(.090)
Laos		-.480		.736*
		(.425)		(.420)
Malaysia		1.731***		-.205***
		(.040)		(.051)
Myanmar		-.591**		-.909***
		(.238)		(.176)
Philippines		.507***		-.234**
		(.086)		(.103)
Singapore		2.196***		.082
		(.089)		(.118)
Thailand		1.059		.097***
		(.203)		(.037)
Vietnam		1.604***		.381***
		(.235)		(.140)
<u>Chile FTA</u>		1.805***		.388***
		(.065)		(.073)
<u>India FTA</u>		-.010		.382***
		(.065)		(.070)
<u>EFTA FTA</u>		.142		.142
		(.148)		(.331)
Pseudo R-sqaured	.866	.877	-	-

Note - Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively. The number of observations is 189,075

4.3.4. Estimates imposing unit GDP elasticity

I estimate equation (7), which imposes unit GDP elasticity in the general fixed effects model. Moreover, I estimate the Poisson fixed effects equation on which the unit GDP elasticity is imposed. Both results are shown in table A2 in an appendix. The results are consistent with the regression estimates in Tables 5 and 6. At the individual country-level, the total effect of South Korean FTAs on trade is not statistically significant. South Korean FTAs have a positive impact on trade between South Korea and Brunei, Laos, Vietnam, Chile, and India. They, however, have not increased trade between South Korea and other South Korean FTA partner countries.

4.4. Section conclusion

From the estimated results of the ordinary fixed effects and the PPML fixed effects methods in Tables 5 and 6, I conclude that South Korean FTAs have very differential effects on trade with South Korea and its FTA partners. They have positive impacts on trade only with Brunei, Laos, Vietnam, Chile, and India. For trade between South Korea and its other FTA partner countries, such as Cambodia and the EFTA, the Korean FTAs do not have positive impacts. A surprising finding is that the South Korea–ASEAN FTA sometimes has negative effects on trade of South Korea with Malaysia, Myanmar and the Philippines, which suggest that there might be a trade diversion effects from the South Korea–ASEAN FTA.

5. Effect of South Korean FTAs: Industry-level Analysis

5.1. The Need for an Industry-level Analysis

It is traditional in economics to think that FTAs will bring benefits to consumers, since FTAs usually lower domestic prices through the abolishment of tariffs between two countries. The increase of consumers' surplus is guaranteed if the effect of the trade creation is greater than that of trade diversion, which can be estimated in empirical studies. Thus, traditional literature has focused on how FTAs have affected trade, from the consumers' perspective. In reality, an FTA between two countries is driven not only from the viewpoint of consumers, but also from the perspective of businesses that expect to increase their sales to the markets of potential partners. For example, when the US and South Korea negotiated an FTA between 2004 and 2008, the Generic Pharmaceutical Association (GPhA) and many agri-business associations in the U.S. strongly supported the FTA. On the other hand, some associations, such as the National Textile Association, strongly opposed the U.S.–South Korea FTA. Therefore, it is necessary to investigate the effects of an FTA at the industry-level in order to figure out how much some specific industries have benefits or losses from the FTA. Until now, there are few studies to estimate the effects of an FTA at the industry-level. Some studies have tried to estimate the effects of FTAs at the products or goods level (Krueger, 1999; Gunther, 2012). However, this product-level analysis does not directly reveal which industries or businesses have been benefitted or harmed the most from the implemented FTAs.

This ex-post industry-level analysis about the effects of FTAs is needed for at least three main reasons. First, such an analysis directly indicates which industries have actually increased or decreased their trade to a partner country after FTAs were formed. This could provide an idea of how much each industrial sector has benefitted from FTAs. Some industries expected to be disadvantaged by the abolishment of tariff protection tend to overstate their harms. Therefore, we need to estimate more exactly the effects of FTAs on each industry, in order to create effective FTA-related policies in the future.

Second, an ex-post industry-level analysis using the gravity model facilitates the comparison of ex-ante results of the Computable General Equilibrium (CGE) model. The CGE model is widely used to predict the effects of FTAs for each industrial sector. For example, Brown et al. (1992) analyzed the predictable effects of NAFTA on industrial sectors. Cheong (2005) also predicted that FTAs in East Asia, including ASEAN, China, Japan, and South Korea, would impact intra-regional trade in industrial sectors using the CGE simulation method. Since empirical studies using the gravity model focus on the overall trade creation or trade diversion, the results from both the gravity model and the CGE model are not usually compared. However, an industrial sector analysis using the gravity model can be a good foundation to test the CGE model on industrial sectors.

Lastly, the results of industry-level analysis using the gravity model can be used to create better industrial policies. Until the 1990s, as Stiglitz (2005) pointed out, industrial policies had been thought to be a waste of resources, since government failure was more serious than market failure. However, there has been a growing trend towards rethinking industrial policy for growth by Chang (2009) and Lin and Monga (2011). Lin and Monga (2011) argue that “the role of developing-country governments in inducing and accompanying structural change (industrial upgrading and economic diversification) to promote growth, employment and poverty reduction must regain center stage” (p.

286). Also, industrial policies are still prevalent in some countries, like Japan and South Korea. Therefore, ex-post industry-level analyses of FTAs would be useful for making smart industrial policies.

In this chapter, I will analyze the effects of South Korean FTAs on the exports of each industrial sector in South Korea. However, I will not conduct industrial sector analysis for other countries, due to limitations in data.

5.2. Data and Methodology

5.2.1. Data

Since the Direction of Trade Statistics of IMF only has aggregate trade data, this chapter uses different data from the Korea International Trade Association (KITA).[32] Since the trade data of KITA come from the Korea Customs Service, which is a central government organization in South Korea, the accuracy of the KITA data is usually guaranteed. KITA provides export and import data for South Korea with other countries. First, I retrieved export trade data between South Korea and 33 countries from 1990 to 2011. The criteria for the 33 countries are as follows: first, 15 countries are included as partner countries of South Korean FTAs; second, another 18 countries are added as control countries, since 15 countries among them are the largest importers of South Korean products in 2007, and the other 3 countries[33] are assumed to be competing with ASEAN countries in the world market. These 33 countries are listed in Table 7.

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[32] With over 70,000 member companies, KITA is one of the largest business organizations in South Korea and represents the interests of its member companies, especially in the area of trade.

[33] Bangladesh, Pakistan, and Sri Lanka

Table 7 List of 33 countries for industry-level analysis

Australia	Bangladesh	Brunei	Cambodia
Chile	China	Germany	Hong Kong
Iceland	India	Indonesia	Italy
Japan	Laos	Malaysia	Mexico
Myanmar	Netherlands	Norway	Pakistan
Philippines	Russia	Saudi Arabia	Singapore
Spain	Sri Lanka	Switzerland	Thailand
Turkey	United Kingdom	United States	Vietnam
Taiwan			

The trade data of the KITA are organized using the Harmonized System 2007[34] (HS 2007). The HS system, an international standard system to classify traded goods, was developed and is maintained by the World Customs Organization (WCO). It has been widely used by the customs authorities of over 170 countries to recode trade data and impose tariffs since 1988. Since the classification of products in the HS 2007 is not directly related to industrial activities, it is necessary to convert the data into industrial classifications, that is, "the International Standard Industrial Classification (ISIC) Rev. 4 division." Many HS 2-digit codes can exactly correspond to an ISIC rev.4 division code. For example, the HS 31 chapter, "products of fertilizers," can correspond to ISIC division 20, which is "manufacture of chemicals and chemical products"; the HS 83 chapter, "miscellaneous articles of base metal," can correspond with ISIC division 25, which includes the economic activities involved in the "manufacture of fabricated metal products."

[34] Since the trade data of KITA is organized using HS 2007, this paper uses HS 2007 codes. HS 2007 classifies all traded goods into 2-digit HS codes, which are termed HS chapters. HS chapters are again divided into 1,221 headings (4-digit HS code) and 5,052 sub-headings (6-digit HS code)

However, some products can be classified into multiple ISIC divisions. Consider "products of organic chemicals" (HS chapter 29), which includes products from acyclic hydrocarbons (HS 2901), phenols (HS 2907), and antibiotics (HS 2941). Acyclic hydrocarbons and phenols are classified into the chemical industry (ISIC division 20), but antibiotics are products of the pharmaceutical industry (ISIC division 21). Therefore, in order to get more accurate information by industrial sector, we need to consider more detailed classifications of the HS codes. In this paper, I make correspondence tables from HS 4-digit codes (1,221 codes) into ISIC divisions, with reference to the "International Standard Industrial Classification of all Economic Activities, rev.4 by UN (2008)" and "KSIC-CPC Correspondence by Statistics Korea" (see appendix for Tables A5 and A6). Some 4-digit HS codes can be classified into multiple ISIC divisions. For example, HS 7101 (natural or cultured pearls) can be classified into ISIC division 3 (fishing industry) or ISIC 32 (other manufacturing). In this case, I categorize these multi-classified 4-digit HS codes into only one ISIC division (called "criteria 1"). In the later section, I proceed to do the sensitivity analysis, where I get the regression results after categorizing these multi-classified 4-digit HS codes into another ISIC division (called "criteria 2").

Other data, such as GDP, GDP per capita, population, and distance, are the same as in the previous section. The only difference is the information about Taiwan. In the previous section, the DOTS of the IMF does not have any information about Taiwan's trade, so I could not include Taiwan. However, KITA provides trade data between Taiwan and South Korea; thus, I include Taiwan in this section. GDP, GDP per capita, and population of Taiwan come from the National Statistics of the Republic of China.

5.2.2. Model and Methodology

The gravity equation and the main methodology used to analyze the effects of South Korean FTAs by South Korean industry are the same as in the previous section. In the previous section, the estimates using exporter and importer fixed effects are different than the estimates using bilateral country pair fixed effects. However, in this section, both estimating results would be the same, since the exporting country is only one country: South Korea.

5.3. Regression results

5.3.1. Data consistency

Since this section uses a limited dataset that only includes 33 importing countries from one exporting country, South Korea, it is first necessary to determine whether we can get similar results using only this limited dataset.

Table 8 Comparison of regression results of full data and limited data

	Fixed effects		PPML fixed effects	
	Full data (1)	Limited data (2)	Full data (3)	Limited data (4)
Log importer's GDP	1.287***	.848*	1.186***	1.405***
	(.063)	(.485)	(.100)	(.127)
Log exporter's GDP	1.209***	1.728***	.974***	.845***
	(.066)	(.323)	(.146)	(.220)
Log importer's population	.280**	-.446	-.1.471***	-
	(.126)	(1.151)	(.280)	
Log exporter's population	-1.125***	-	-.781***	-
	(.035)		(.314)	
ASEAN FTA	.040	.184	.005	-.028
	(.130)	(.218)	(.069)	(.094)
Chile FTA	.302***	.340***	.388***	.417***
	(.019)	(.124)	(.073)	(.064)
India FTA	.341***	.573***	.382***	.322***
	(.050)	(.200)	(.070)	(.029)
EFTA FTA	-.029	-.506	.142	-237
	(.279)	(.386)	(.331)	(.556)

Note – Dependent of fixed effects is log of trade, and that of PPML fixed effects is trade (level). Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively. PPML fixed effects is the results without population variables.

Table 8 shows a comparison of the regression results. Columns (1) and (3) are reproduced from column (3) in Table 5 and column (3) in Table 6, respectively, for comparison purposes. Columns (2) and (4) are estimated using only the total export values of South Korea to each country from the limited KITA dataset.

When we compare the results of the country-pair and time fixed effects estimates, which are shown in columns (1) and (2), the estimates of the GDPs and FTAs change somewhat. However, the main estimates of the Korean FTA variables are similar, and the main conclusions about the effects of South Korean FTAs are sustained: The South Korea–Chile FTA and the South Korea–India FTA have a positive effect on trade, but the South Korea–ASEAN and South Korea–EFTA FTAs do not have any statistically significant effect on trade. Also, when we obtain the regression results using PPML fixed effects, we come to a similar conclusion about the effects of South Korean FTAs. From this consistency analysis of the two datasets, it is possible to conclude that using only the limited data for industry-level analyses would achieve reasonable results.

5.3.2. Main regression results by industry sector

Table 9 shows the fixed effects estimates after controlling for country-pairs and time fixed effects. Row (1) in Table 9 shows the total effects of all South Korean FTAs by industrial sector. The fixed-effects estimates of each South Korean FTA variable in food, chemicals, and metal industry are positive, but not statistically significant; however, those for the agriculture, textile, paper, pharmaceuticals, electronics, and motor industries are negative and also insignificant. Thus, we can figure out that total effects of South Korean FTAs by industry sector are neutral or at most slightly different by industry.

Table 9 Fixed effect estimates by industry

	Agriculture	Food	Textile	Paper	Chemicals
Total	*-.241*	*.132*	*-.076*	*-.213*	*.036*
	(.258)	*(.208)*	*(.193)*	*(.278)*	*(.269)*
Indonesia	-.505***	-.127	.541***	-.375	.288**
	(.173)	(.131)	(.105)	(.238)	(.109)
Malaysia	-.385*	.537***	.276**	-.041	-.141
	(.173)	(.167)	(.122)	(.257)	(.128)
Myanmar	-.049	-1.690**	-.555	-.857	-1.206**
	(.680)	(.726)	(.460)	(.731)	(.466)
Philippines	.121	.384***	.084	-.217	-.138
	(.174)	(.140)	(.109)	(.231)	(.106)
Singapore	-.708***	-.649***	-.782***	-.328	.516***
	(.217)	(.207)	(.150)	(.279)	(.155)
Thailand	.739***	.136	.148	.755***	-.293***
	(.170)	(.115)	(.106)	(.225)	(.095)
Vietnam	.418	1.126***	1.163***	.253	.402*
	(.300)	(.315)	(.207)	(.367)	(.216)
Chile	.265	.586***	-.172	.122	1.495***
	(.162)	(.127)	(.114)	(.211)	(.114)
India	-1.041***	-.175	.189	1.538***	.291
	(.294)	(.305)	(.200)	(.346)	(.204)
Observations	*661*	*689*	*705*	*700*	*705*

	Pharmaceutical	Metals	Electronics	Motor	Others
Total	*-.213*	*.106*	*-.214*	*-.290*	*.220*
	(.231)	*(.319)*	*(.195)*	*(.241)*	*(.247)*
Indonesia	-.992***	-.332***	-.434**	-.497**	.059
	(.173)	(.120)	(.158)	(.206)	(.163)
Malaysia	-.885***	-.617***	-.725***	-1.072***	.200
	(.177)	(.125)	(.187)	(.257)	(.190)
Myanmar	-2.107***	-.049	-1.500**	-1.071***	-1.640**
	(.422)	(.294)	(.599)	(.209)	(.738)
Philippines	-.009	-.070	-.156	-.243	.461
	(.180)	(.115)	(.155)	(.203)	(.159)
Singapore	-.708***	-.924***	-.656***	.170	-.125***
	(.217)	(.138)	(.221)	(.211)	(.229)
Thailand	-.114***	.519***	-.182	-.369*	.399***
	(.182)	(.115)	(.131)	(.194)	(.146)
Vietnam	-.033	.497***	.373	-.076	.881**
	(.182)	(.159)	(.305)	(.246)	(.328)
Chile	.375**	.631***	-.505***	-.318*	-.812***
	(.164)	(.115)	(.161)	(.183)	(.158)
India	-.775***	.299*	.531*	.009	.876***
	(.224)	(.149)	(.290)	(.240)	(.308)
Observations	*677*	*703*	*705*	*705*	*703*

Note – Agriculture: ISIC 1-3, Food: ISIC 10-12, Textile: ISIC 13-15, Papers: ISIC 16-18, Chemicals: ISIC 19,20,22, Pharmaceuticals: ISIC 21, Metals: ISIC 23-25, Electronics: ISIC 26-28, Motor: ISIC 29,30, Others: ISIC 31, 32. Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels respectively.

We can see the effects of South Korean FTAs by each country in every industry in other rows and columns of the Table 9. In the food industry, South Korean exports to Malaysia, the Philippines, Vietnam, and Chile have increased by about 71%, 47%, 208%, and 80%, respectively, through individual FTAs with South Korea. However, the food industry's exports to Myanmar and Singapore have decreased by about 82% and 16%, respectively. The South Korean chemical industry's exports to Indonesia, Singapore, and Chile have increased by about 33.3%, 67.5%, and 346%, respectively, but decreased by about 70% and 30% to Myanmar and Thailand, respectively, after the FTAs between South Korea and each country came into effect. The exports of the motor, electronics, and pharmaceutical industries in South Korea to its FTA partner countries have generally decreased; exports to Singapore and Chile of the South Korean electronics industry have been reduced by about 48% and 40%, respectively, and those of the motor industry to Malaysia and Indonesia have decreased by about 66% and 39%, respectively.

As already mentioned in the previous section, the preferable analysis method is PPML estimation, which is estimated by using the level data for trade, rather than the logarithm of trade. Table 10 shows the estimates of PPML after controlling for time and country-pair fixed effects by industrial sector. Row (1) in Table 10 shows the total effects of all South Korean FTAs. Unlike the fixed effects estimates in Table 10, PPML estimates controlling for some fixed effects explicitly show the different effects of South Korea's FTAs by industry. South Korea's FTAs have increased the exports of the food, textile, paper, chemical, furniture, and other industries; the magnitudes of the increase in exports for the food, textile, paper, chemical, and other industries are about 57%, 104%, 98%, 41%, and 46%, respectively.

Table 10 PPML fixed effects estimates by industry

	Agriculture	Food	Textile	Paper	Chemicals
Total	*.291*	*.451****	*.715****	*.682****	*.346****
	(.181)	*(.176)*	*(.176)*	*(.226)*	*(.091)*
Indonesia	-.108	.192	.851***	.216	.383***
	(.093)	(.118)	(.103)	(.161)	(.056)
Malaysia	.076	.993***	.601***	.386**	-.029
	(.090)	(.125)	(.098)	(.159)	(.055)
Myanmar	1.201***	-1.272***	-.605***	.805***	-1.441***
	(.680)	(.726)	(.146)	(.123)	(.031)
Philippines	.458	.321***	.355	.279*	-.012
	(.090)	(.110)	(.113)	(.149)	(.057)
Singapore	.012	-.127***	-.734***	.222	.639***
	(.088)	(.160)	(.084)	(.163)	(.051)
Thailand	.943***	.435***	.479***	1.079***	-.064
	(.082)	(.084)	(.140)	(.141)	(.066)
Vietnam	.889***	1.291***	1.055***	.707***	.421***
	(.089)	(.191)	(.095)	(.137)	(.040)
Chile	.653***	1.074***	.003	.515***	1.347***
	(.089)	(.124)	(.067)	(.198)	(.065)
India	-.286***	-.133	.324***	1.457***	.376***
	(.086)	(.191)	(.108)	(.124)	(.041)
Observations	*715*	*715*	*715*	*715*	*715*

	Pharmaceutical	Metals	Electronics	Motor	Others
Total	-*.123*	*.027*	-*.427****	*.073*	*.378****
	(.162)	*(.240)*	*(.116)*	*(.197)*	*(.144)*
Indonesia	-.808***	.066	-.431***	-.812***	.204**
	(.119)	(.080)	(.059)	(.114)	(.103)
Malaysia	-.683***	-.222***	-.700***	-1.030***	.316***
	(.115)	(.081)	(.052)	(.116)	(.090)
Myanmar	-.946***	.435***	-1.624***	-1.375***	-1.759***
	(.172)	(.087)	(.189)	(.195)	(.148)
Philippines	.161	.326***	-.368***	-.034	.792***
	(.130)	(.079)	(.049)	(.099)	(.106)
Singapore	.037	-.686***	-.622***	.533***	.092
	(.105)	(.076)	(.068)	(.116)	(.088)
Thailand	-.045	.640***	-.167***	-.017	.633***
	(.140)	(.090)	(.060)	(.068)	(.121)
Vietnam	.141	.777***	.379***	-.036	.676***
	(.106)	(.075)	(.046)	(.113)	(.068)
Chile	.448***	1.012***	-.474***	-.232**	-.639***
	(.117)	(.071)	(.106)	(.110)	(.063)
India	-.134***	.547***	.015	.050	.787***
	(.114)	(.072)	(.039)	(.090)	(.063)
Observations	*715*	*715*	*715*	*715*	*715*

Note – Agriculture: ISIC 1-3, Food: ISIC 10-12, Textile: ISIC 13-15, Papers: ISIC 16-18, Chemicals: ISIC 19,20,22, Pharmaceuticals: ISIC 21, Metals: ISIC 23-25, Electronics: ISIC 26-28, Motor: ISIC 29,30, Others: ISIC 31, 32. Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels respectively.

One of the puzzling findings in the PPML estimates is that South Korean FTAs have had a negative effect on the South Korean electronics industry. The electronics industry in South Korea is known to be relatively competitive in the world, compared to South Korea's other industries. One of the plausible explanations is that, since many IT products already have enjoyed zero tariff rates or very low tariff rates due to the Information Technology Agreement,[35] South Korean FTAs have not brought additional positive effects on exports for this industry.

PPML estimates have shown more positive effects of individual South Korean FTAs by industrial sector, rather than fixed effects estimates. However, PPML estimates also show that each industry has seen different effects. Exports of agricultural products from South Korea have increased to Myanmar, Thailand, Vietnam, and Chile, but have decreased to India. Exports from the textile industry in South Korea have increased to Indonesia, Malaysia, Thailand, Vietnam, and India, but have decreased to Myanmar and Singapore. South Korea's chemical industry's exports to Singapore, Vietnam, Chile, and India have increased by about 89%, 52%, 285%, and 46%, respectively, but decreased to Myanmar by about 74%. The exports of the pharmaceutical and motor industries have generally shown negative signs to each of South Korea's partner countries.

5.3.3. Sensitivity analysis

[35] The Information Technology Agreement (ITA) has been in effect since 1997. The ITA's 50 signatory countries (as of December 2012) should reduce their tariffs on IT products. The ITA's signatory countries (total) include 9 of South Korea's FTA partners: Iceland, India, Indonesia, Malaysia, Norway, Singapore, Switzerland, Thailand, and Vietnam.

In order to generate trade data by industry, I have made correspondence tables to convert 4-digit HS codes (headings) to ISIC division codes. However, some products in HS 4-digit codes can be classified into multiple ISIC divisions. For example, HS 4501 includes the following products: natural cork, raw or simply prepared; waste cork; and crushed, granulated, or ground cork. The production of natural cork, both raw and simply prepared, is included in the forestry and logging industry (ISIC 2), but the production of crushed, granulated, or ground cork is the manufacture of wood and of products of wood and cork (ISIC 16). Many agricultural products can be classified into the agriculture industry (ISIC 1) or food industry (ISIC 10). I classify these products into the ISIC divisions where the main activities of producing or manufacturing these products appear to occur (see Table A6; Criteria 1). However, arbitrary classification problems can occur. In order to test the robustness of our results in this arbitrary classification, I do a sensitivity analysis. For this analysis, I reclassify these potential multiple products into different ISIC divisions (Criteria 2). I regenerate industrial trade data with these new criteria and get the PPML estimates using these new trade data.

Table 11 shows the PPML estimates using new trade data by industry that are generated with criteria 2. The PPML estimates in many industries, such as the textile, paper, chemicals, electronics, and motor industries, are nearly the same as in Table 10. The estimates for the agriculture and food industries change slightly; the estimate of total effects on the food industry’s exports increased from 0.451 to 0.560, but that of the agriculture industry dropped from 0.291 to 0.266, which is insignificant. The largest differences in estimates between Tables 10 and 11 are in the metal industry and other industries, which are included in columns (2) and (5) in the bottom part of Table 11.

Table 11 PPML fixed effects estimates by industry using criteria 2

	Agriculture	Food	Textile	Paper	Chemicals
Total	*.266*	*.560****	*.716****	*.682****	*.345****
	(.157)	*(.189)*	*(.176)*	*(.226)*	*(.091)*
Indonesia	-.200*	.264***	.851***	.216	.382***
	(.112)	(.093)	(.103)	(.161)	(.056)
Malaysia	.149	.997***	.601***	.385**	-.031
	(.114)	(.099)	(.098)	(.159)	(.055)
Myanmar	.714***	-1.020***	-.605***	.805***	-1.442***
	(.213)	(.349)	(.146)	(.123)	(.031)
Philippines	-.207**	.506***	.355	.279*	-.011
	(.106)	(.085)	(.113)	(.149)	(.057)
Singapore	-.218**	-.055***	-.734***	.222	.638***
	(.116)	(.126)	(.084)	(.163)	(.051)
Thailand	.437***	.849***	.479***	1.079***	-.063
	(.092)	(.065)	(.140)	(.141)	(.065)
Vietnam	.948***	1.310***	1.055***	.707***	.421***
	(.126)	(.153)	(.095)	(.137)	(.040)
Chile	2.032***	.614***	.003	.515***	1.345***
	(.103)	(.101)	(.067)	(.198)	(.065)
India	-.660***	.019	.324***	1.457***	.374***
	(.119)	(.151)	(.108)	(.124)	(.041)
Observations	*715*	*715*	*715*	*715*	*715*

	Pharmaceutical	Metals	Electronics	Motor	Others
Total	-*.132*	*.335***	-*.427****	*.073*	-*.777**
	(.161)	*(.134)*	*(.116)*	*(.197)*	*(.397)*
Indonesia	-.813***	.060	-.431***	-.812***	-.251
	(.120)	(.077)	(.059)	(.114)	(.160)
Malaysia	-.689***	-.031	-.700***	-1.030***	-1.469***
	(.115)	(.078)	(.052)	(.116)	(.142)
Myanmar	-.986***	.439***	-1.623***	-1.375***	-1.807***
	(.165)	(.126)	(.189)	(.195)	(.242)
Philippines	.152	.345***	-.368***	-.034	.422***
	(.130)	(.077)	(.049)	(.099)	(.177)
Singapore	.025	-.212***	-.622***	.533***	-.746***
	(.103)	(.071)	(.068)	(.116)	(.110)
Thailand	-.055	.616***	-.168***	-.020	1.189***
	(.138)	(.085)	(.060)	(.068)	(.225)
Vietnam	.124	.745***	.380***	-.036	.467***
	(.103)	(.077)	(.046)	(.113)	(.091)
Chile	.437***	.941***	-.474***	-.232**	-.684***
	(.116)	(.063)	(.106)	(.110)	(.153)
India	-.137***	.566***	.016	.050	.319***
	(.110)	(.077)	(.039)	(.090)	(.111)
Observations	*715*	*715*	*715*	*715*	*715*

Note – Agriculture: ISIC 1-3, Food: ISIC 10-12, Textile: ISIC 13-15, Papers: ISIC 16-18, Chemicals: ISIC 19,20,22, Pharmaceuticals: ISIC 21, Metals: ISIC 23-25, Electronics: ISIC 26-28, Motor: ISIC 29,30, Others: ISIC 31, 32. Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels respectively.

In the Table 11, the estimate for the metal industry increased to 0.335 and became significant. The estimate for other industries (furniture and jewelry) changed to a negative value (-0.777) from a positive value (0.378), and this estimate has become marginally significant at the 10% level. This difference mainly comes from the export of products with mutual classifications of HS 71 (natural or cultured pearls and precious or semi-precious stones), more specifically HS 7106– 7112. The precious stones in HS 7106–7112 are mainly classified as products of the metal industry (ISIC 24, Criteria 1), but some of them could be classified into those of the jewelry industry (ISIC 32, Criteria 2).[36]

Since many estimates between table 10 and table 11 are consistent with each other, I can conclude that the classification criteria do not change the PPML estimates significantly.

5.4. Section conclusion

From the industry-level analysis, we can figure out that each industry has a different effect from FTAs. Even though fixed effects estimates do not show the differential effects of South Korean FTAs by industrial sector, PPML estimates shows that they have positive effects on the export of food, textile, paper and chemicals and other industry of South Korea, but negative effects on export of electronics.

[36] Since the products included in HS 7106–7112 appear to be more appropriate as products of the metal industry, the estimates of Table 10 seem more reasonable.

6. Conclusion

In this paper, I analyzed the effects of South Korean FTAs on trade by country and industrial sector. I used two different trade datasets: one from the DOTS of the IMF for the country-level analysis, and the other from KITA for the industry-level analysis. When I compared the two regression estimates using two different data sets, the two results showed consistency. As main methodologies, I used both a fixed effects regression model and a Poisson Pseudo Maximum Likelihood (PPML) fixed effects estimates, in order to deal with biases from two potential sources: country-pairs fixed effects and zero trade values. In the country-level analysis, I find that the South Korea–Chile and South Korea–India FTAs have had positive effects on trade, but the effect of the South Korea–EFTA FTA has no statistical significance. The South Korea–ASEAN FTA has had a wide spectrum of trade effects among the 10 ASEAN countries: trades between South Korea and Brunei, Laos, Thailand and Vietnam have increased because of South Korean FTAs, but trade between South Korea and Malaysia, Myanmar, and the Philippines have decreased. Additionally, I tried to estimate the differential effects of South Korea's FTAs on its exports from 11 industrial sectors using HS 4-digit–level export data for South Korea to 33 countries. Korean FTAs have considerably increased South Korea's textile, food, paper, and chemical exports. However, Korean FTAs have not brought any positive effects on electronics and motor industry exports in South Korea.

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Appendix

Table A1 Estimates using GDP per capita variables using equation (4)

	Without time dummy		With time dummy	
	(1)	(2)	(3)	(4)
Log importer's GDP	1.013*** (.003)		1.012*** (.003)	
Log exporter's GDP	1.185*** (.003)		1.184*** (.003)	
Log GDP per capita (importer)	.010** (.004)		.010 (.004)	
Log GDP per capita (exporter)	-.003 (.004)		-.003 (.004)	
Log distance	-1.108*** (.007)		-1.108*** (.007)	
Border	.397*** (.027)		.397*** (.027)	
Language	.769*** (.014)		.765*** (.014)	
Colony	.566*** (.027)		.566*** (.027)	
Other FTAs	.382*** (.014)		.383*** (0.014)	
Korea all FTAs	1.717*** (.107)		1.662*** (.107)	
ASEAN FTA				
Brunei		2.738*** (.632)		2.673*** (.628)
Cambodia		1.157*** (.306)		1.124*** (.293)
Indonesia		2.129*** (.149)		2.068*** (.143)
Laos		.806** (.370)		.773** (.378)
Malaysia		2.581*** (.087)		2.518*** (.086)
Myanmar		.599*** (.135)		.534*** (.134)
Philippines		1.196*** (.036)		1.133*** (.041)
Singapore		2.825*** (.069)		2.775*** (.068)
Thailand		1.742*** (.103)		1.673*** (.098)
Vietnam		2.393*** (.141)		2.329*** (.141)
Chile FTA		3.370*** (.124)		3.342*** (.119)
India FTA		.442*** (.110)		.380*** (.101)
EFTA FTA		.610*** (.144)		.547*** (.143)

Note - The dependent variable is the log of trade (thousand dollars). Standard errors are in parenthesis and they are heteroskedastic robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively. The number of observations is 159,712.

Table A2 Estimates after imposing unit GDP elasticity using equation (7)

	Fixed effects (country pair and time)		PPML fixed effects (country pair and time)	
Other FTAs	.209***		.063	
	(.024)		(.065)	
Total Korea_FTA	.138		-.072	
	(.101)		(.091)	
ASEAN FTA				
Brunei		.518***		.239***
		(.140)		(.087)
Cambodia		.584		.190
		(.455)		(.138)
Indonesia		-.074**		-.242***
		(.034)		(.039)
Laos		1.083***		.982***
		(.254)		(.320)
Malaysia		-.307**		-.471***
		(.051)		(.058)
Myanmar		-.648***		-.968***
		(.173)		(.114)
Philippines		-.218		-.461***
		(.180)		(.163)
Singapore		-.113***		-.293***
		(.076)		(.072)
Thailand		.100***		-.051***
		(.019)		(.032)
Vietnam		.686***		.309**
		(.150)		(.138)
Chile FTA		.383***		.133*
		(.039)		(.076)
India FTA		.457***		.298***
		(.105)		(.084)
EFTA FTA		-.003		-.090
		(.272)		(.322)

Note - The dependent variable is the log of (trade/GDPi*GDPj) in the ordinary fixed effects, and the trade divided by GDPi*GDPj in the Poisson fixed effects (thousand dollars). Standard errors are in parenthesis and they are heteroskedastic-robust. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table A3 Common language

English language			
Australia	Brunei	Cameroon	Canada
Fiji	Gambia	Ghana	Guyana
Hong Kong	India	Indonesia	Ireland
Israel	Jamaica	Jordan	Kenya
Kuwait	Malaysia	Malta	Mauritius
New Zealand	Nigeria	Pakistan	Panama
Philippines	Singapore	South Africa	Sri Lanka
Tanzania	Trinidad and Tobago	United Kingdom	United States
Zambia	Zimbabwe		
French language			
Belgium	Cameroon	Canada	Cote D'Ivoire
France	Luxembourg	Madagascar	Mauritius
Senegal	Switzerland	Tunisia	
Spanish language			
Argentina	Chile	Colombia	Costa Rica
Ecuador	Guatemala	Honduras	Mexico
Panama	Paraguay	Peru	Spain
Uruguay	Venezuela		
Portuguese language			
Brazil	Macao	Portugal	
Malay language			
Brunei	Indonesia	Malaysia	Singapore
Arabic language			
Egypt	Israel	Jordan	Kuwait
Morocco	Saudi Arabia	Tanzania	Tunisia
Dutch language			
Belgium	Luxembourg	Netherlands	
German language			
Austria	Germany	Luxembourg	Switzerland
Hungarian language			
Hungary	Romania	Slovak Republic	
Italian language			
Italy	Switzerland		
Swahili language			
Kenya	Tanzania		
Chinese language			
China	Hong Kong	Malaysia	Macao
Singapore			

Source: CEPII (2012) and Silva & Tenreyro (2003)

Table A4 Colonial relationship

United Kingdom			
Australia	Brunei	Cameroon	Canada
Egypt	Fiji	Gambia	Ghana
Guyana	Hong Kong	India	Ireland
Israel	Jamaica	Jordan	Kenya
Kuwait	Malaysia	Malta	Mauritius
Myanmar	New Zealand	Nigeria	Pakistan
Sri Lanka	Tanzania	Trinidad and Tobago	United States
Zambia	Zimbabwe		
France			
Cambodia	Cameroon	Cote D'Ivoire	France
Laos	Madagascar	Morocco	Senegal
Tunisia	Vietnam		
Spain			
Argentina	Chile	Colombia	Costa Rica
Ecuador	Guatemala	Honduras	Mexico
Netherlands	Panama	Paraguay	Peru
Venezuela			
Portugal			
Brazil	Macao	Malaysia	Netherlands
Austria			
Croatia	Czech	Slovenia	
Japap			
Korea (South)			
Russia			
Estonia	Lithuania	Ukraine	

Source: CEPII (2012) and Silva & Tenreyro (2003)

Table A5 Correspondence table from HS 2-digit code into ISIC division

Reference note: If HS 2-digit codes and HS 4-digit codes are classified into the same ISCI code, and HS-4 digit codes are only classified into single ISIC code, the classification of HS code follows table A5. But, otherwise, the classification follows table A6.

HS 2 digit	ISIC rev.4	HS 2 digit	ISIC rev.4	HS 2 digit	ISIC rev.4
01	01	33	20	65	14
02	10	34*	20	65	32
03*	03	35	20	66	32
04*	10	36	20	67	23
05*	01	37	20	68	23
06	01	38*	20	69	23
07	01	39*	20	70	23
08	01	40*	22	71*	32
09*	01	41*	15	72	24
10	01	42	01	73	24
11	10	43*	15	74	24
12*	01	44*	16	75	24
13	02	45*	16	76	24
14	02	46	16	78	24
15	10	47	17	79	24
16	10	48	17	80	24
17	10	49	18	81	24
18*	10	50*	13	82	25
19	10	51*	13	83	25
20	10	52*	13	84*	28
21	10	53*	13	85*	27
22	11	54	13	86*	30
23	10	55	13	87*	29
24*	12	56	13	88	30
25*	08	57	13	89	30
26*	07	58	13	90*	26
27*	05	59	13	91	26
28	20	60	13	92	32
29*	20	61	14	93	25
30	21	62	14	94*	31
31	20	63	13	95	32
32	29	64	15	96*	32
				97	unclassified

Sources: Created by author with reference to "International Standard Industrial Classification of all Economic Activities, rev.4 by UN (2008)", and "KSIC-CPC correspondence by Statistics Korea" (http://kostat.go.kr/kssc/main/MainAction.do?method=sub&catgrp=kssc&catid1=kssc06&catid2=kssc06e&catid3=kssc06ea&catid4=kssc06eay)

note: * represents that HS 4-digit code can be differently classified with HS 2-digit code or can be classified into multiple ISIC codes

Table A6 Correspondence table from HS 4-digit code into ISIC division

(note: This table only shows HS 4 digit codes which are differently classified with HS 2-digit code or can be classified into multiple ISIC codes)

HS 4-digit	ISIC - criteria 1 -	ISIC - criteria 2 -
0303	10	03
0304	10	03
0305	10	03
0306	03	10
0307	03	10
0401	01	01
0407	01	10
0408	10	01
0409	01	01
0410	01	01
0501	32	unclassified
0504	10	10
0508	03	03
0510	03	03
0901	01	10
1208	01	10
1801	01	10
1802	01	10
2401	01	01
2501	08	20
2618	unclassified	unclassified
2619	unclassified	unclassified
2620	unclassified	unclassified
2621	unclassified	unclassified
2701	05	19
2703	08	08
2704	19	19
2705	35	35
2706	19	19
2707	20	20
2708	20	20
2709	06	06
2710	19	19
2711	19	19
2712	19	19
2713	19	19
2714	06	19
2715	23	23
2716	35	35
2932	21	21
2933	21	21
2934	21	21
2936	21	21
2937	21	21
2938	21	21
2939	21	21
2940	21	21
2941	21	21
2942	20	21
3001	21	unclassified
3406	32	32
3407	20	21
3801	23	23
3916	22	22
3917	22	22
3918	22	22
3919	22	22
3920	22	22
3921	22	22
3922	22	22
3923	22	22
3924	22	22
3925	22	22
3926	22	22
4001	01	22
4002	20	22
4101	10	10
4102	10	10
4103	10	10
4301	10	10
4302	15	14
4303	15	14
4304	15	14
4401	02	02
4402	20	20
4403	02	02
4501	16	02
4502	16	02

Table A6 Correspondence table from HS 4-digit code into ISIC division (cont.)

HS 4-digit	ISIC - criteria 1 -	ISIC - criteria 2 -
4503	16	02
4504	16	02
5001	01	01
5002	13	13
5003	unclassified	unclassified
5101	01	01
5102	01	01
5103	unclassified	unclassified
5104	unclassified	unclassified
5201	01	01
5202	unclassified	unclassified
5301	01	01
5302	01	01
5303	01	01
5305	01	01
6309	unclassified	unclassified
7101	03	32
7102	07	32
7103	07	32
7104	20	32
7106	24	32
7107	24	32
7108	24	32
7109	24	32
7110	24	32
7111	24	32
7112	24	unclassified
8406	28	28
8407	29	30
8408	29	30
8409	29	30
8410	28	28
8411	30	30
8412	30	30
8418	27	28
8419	27	27
8422	27	28
8450	27	28
8471	26	26

HS 4-digit	ISIC - criteria 1 -	ISIC - criteria 2 -
8480	25	25
8517	26	26
8518	26	26
8519	26	26
8521	26	26
8522	26	26
8523	26	26
8525	26	26
8526	26	26
8527	26	26
8528	26	26
8529	26	26
8530	30	30
8533	26	26
8534	26	26
8540	26	26
8541	26	26
8542	26	26
8547	27	22
8548	unclassified	unclassified
8609	29	29
8701	28	28
8709	28	28
8710	30	30
8711	30	30
8712	30	30
8713	30	30
8714	30	30
8715	30	30
9001	27	27
9402	26	26
9405	27	27
9406	22	25
9616	20	20