RELATIONSHIP BETWEEN FTAS IN KOREA AND THE EXPORT OF KOREAN PETROCHEMICAL INDUSTRY

By

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THESIS

Submitted to
KDI School of Public Policy and Management
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ABSTRACT

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By

Yung Joon Byun

This study empirically examines factors to increase the export of the Korean petrochemical industry through the gravity model, investigating the relationship between FTAs and export. The gravity model is based on hypotheses that the trade amount among countries is in proportion to their economic scale and inversely in proportion to the physical distance among them. This paper adds not only the gravity model's basic explanatory variables such as GDP and distance but also FTA, number of FTAs and ethylene capacity. According to the gravity model's result, the Korean petrochemical industry follows the trade pattern grounded on the model. It exports more to adjacent countries with large GDP and trading ports. The other variables (FTA and number of FTAs) change their sign when adding more variables or excluding outliers and they are not statistically significant. Therefore it is not clear to conclude whether FTA positively or negatively affects the export amount of Korean petrochemical goods. Lastly, Ethylene capacity influences positively between countries with ethylene equipment.

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I. Introduction

1.1 Background of Study

The WTO (World Trade Organization) describes “regional trade agreements (RTAs) are defined as reciprocal trade agreements between two or more partners. They include free trade agreements and customs unions.” WTO explains that RTAs are intended to eliminate tariffs and non-tariff measures on most goods and services traded between its member countries. Recently, many countries have been trying to expand their trade volumes by establishing FTAs with other countries. According to WTO, 379 regional trade agreements were in force until Jul. 2013.

1.1.1 FTAs and Korea

According to the Korean ministry of trade, industry and energy, Korea concluded its first FTA with Chile in April 2004, since then it has established FTAs with 9 economic blocs and countries. However, not all economic sectors are favoring FTAs as there are also movements against FTAs (Bae et al.2012, 24). Agriculture is one of these sectors where it is believed that believe FTAs are not beneficial. According to Jagdish Bhagwati (1995), a combination of FTAs can create the “spaghetti bowl effect” (i.e., the more duplicating transactions there are, the more complicated the regulations and the higher the expenses). He is therefore speculating that multiple FTAs may actually complicate the trade process such as different rules of origin, customs clearance and standards of each FTA (Bhagwati 1995, 4). With this idea, even though the MFN tariffs (Most Favored Nation tariffs: a customs duty rate to treat all WTO members equally) rate in an importing country is high, the FTA in force within the country will not bring about better export opportunities (Kimura et al.2006, 3).

1.1.2 FTAs and Korean Petrochemical Industry

According to the KITA (Korea International Trade Association), Korean petrochemical industry, one of Korea's main export-oriented industries, was reported to have reached 45.9 billion dollars export in 2012, fifth biggest industry in Korea. In 2004, when Korea established its first FTA with Chile, the amount of Korean petrochemical industry's export was 17.0 billion dollars. It looks its export has been increasing according to the establishment of additional FTAs. However, its largest importer is China which imported 7.9 and 21.7 billion dollars of Korean petrochemical products in 2004 and 2012 respectively. Considering Korea has yet to establish FTA with China, the impact of Korea's established FTAs on the industry might be weak. Therefore, it should be meaningful to figure out whether petrochemical industry has a positive or negative experience with a growing number of FTAs which invariably require additional clearance and reifications as Kimura tested materials and downstream manufactured products in his study (Kimura et al.2006, 3).

If the petrochemical industry has the negative experience, other industries may have the same negative experience. If such is the case, like Bhagwati's view, we have to seriously discuss the wisdom of expanding FTAs imprudently (Bhagwati 1995, 4).

1.2 Research Questions

The main objective of this study is to investigate How FTAs affect the Korean petrochemical industry. Specifically, the purpose of this study is to examine how multiple FTAs affect the export volume of petrochemical industry in South Korea.

When Korean petrochemical companies export their products to FTA partner countries, they have opportunity to select FTA preferential tariffs or MFN tariffs. In order for them to choose FTA preferential tariffs, they need to satisfy certain conditions, most importantly proving that their products are manufactured within the area of two countries (ROO: Rules of

Origin) and building sales network in FTA partner countries. If the complication arises from the application of ROO in the FTA, and the costs for them are bigger than benefits from FTAs, they lead to paradoxical and contradictory inefficiency due to FTA.

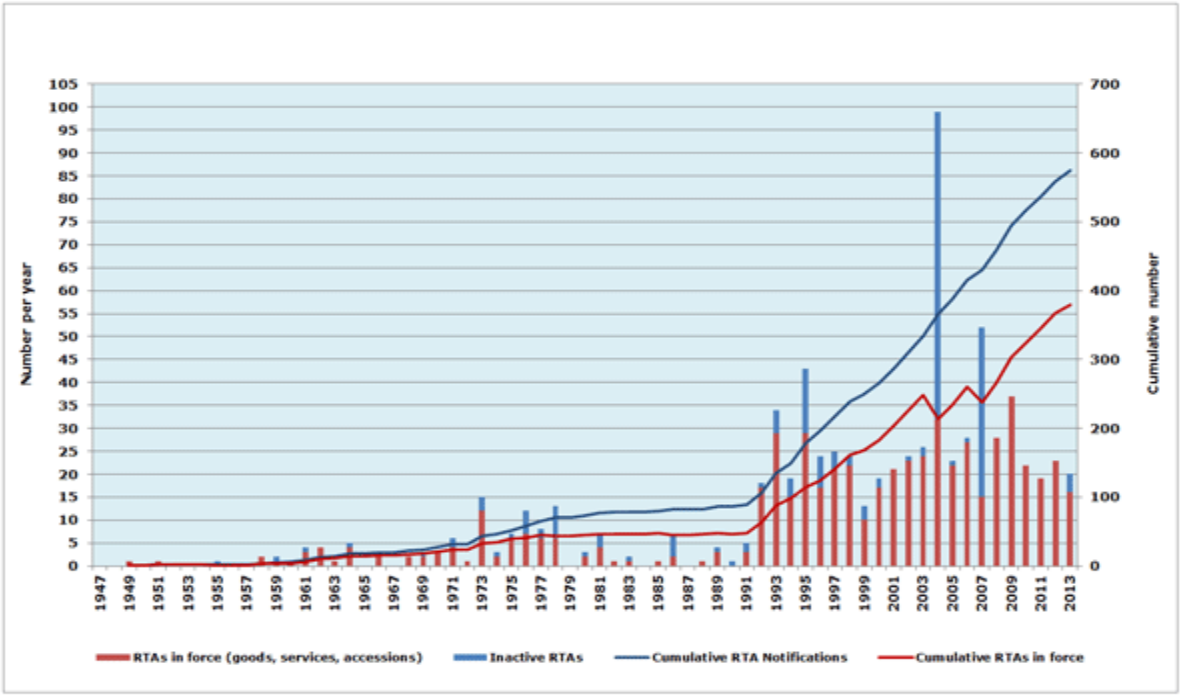
If the inefficiency on Korean petrochemical industry exists, companies are more likely to give up choosing FTAs' preferential tariffs. And multiple FTAs hardly affect the export increase of petrochemical industry in South Korea. Therefore they do not positively affect the export volume of Korean petrochemical industry.

II. Literature Review and Theoretical Foundations

2.1 FTAs and Korea

The total number of Regional Trade Agreements among countries and regions has been increasing enormously. According to Figure 1, The GATT and WTO received 575 cumulative RTAs notifications by this year (379 were in force). Now nobody can deny that RTAs are prevalent around the world.

Figure 1: Development of worldwide FTAs establishments



Source: WTO Secretariat

However, many economists earlier started to worry about this phenomenon. Krugman mentioned that FTAs may cause a loss of efficiency, stating “countries that form a trading bloc may substitute each other’s more expensive goods for goods from outside the bloc” (Krugman 1989, 4).

The term “Spaghetti bowl effect” was first coined by Bhagwati to describe that

numerous and crisscrossing FTAs increase transaction costs and facilitate protectionism (Bhagwati 1995, 4). Because of them, he said that “this policy of further expansion and creation of FTAs, instead of concentration on multilateralism at the WTO, is a mistake” (Ibid, 2).

Kimura’s paper was the first attempt to measure the trade impacts of the spaghetti bowl phenomenon which was caused by the surge of RTAs. They concentrated on exporters costs to utilize multiple RTAs, showing “relationship between the number of RTAs concluded by a country and its additional export values attributed to an RTA” (Kimura et al.2006, 3). They showed the inefficiency of FTA, saying that “the RTA preferential tariff rate is too costly to use (cost is more than or as much as benefit), firms can just continue to use the MFN rate, and therefore the effect of RTA on exports is not negative but at least zero” (Ibid, 11).

In the ADBI Working Paper, they replaced “the Spaghetti bowl effect” with “the Noodle bowl effect”. It was stated that one of elements to cause the Asian noodle bowl effect is different origin system across East Asian countries (Kawai and Wignaraja 2009, 8). But, according to their surveys of over six hundred exporting firms in Japan, Korea, Philippines, Singapore and Thailand, East Asian firms could take advantages of their business chances with FTAs. Just for a vision of futurity, they showed concern indicating “As more FTAs under negotiation take effect and the complexity of the Asian noodle bowl increases, the business impact is likely to intensify” (Ibid, 26).

Kim and Kim’s paper analyzed the impact of Korea’s established FTAs on its total exports growth, concentrating on its changes in the intensive margin (quantitative increase of existing exports) and extensive export margin (increase diversity of exports). And they concluded that “Korea’s FTAs helped its total export and export market shares increase both in terms of intensive and extensive margins in general. However, the intensive export growth played more important role whereas the extensive export growth was revealed only in minor

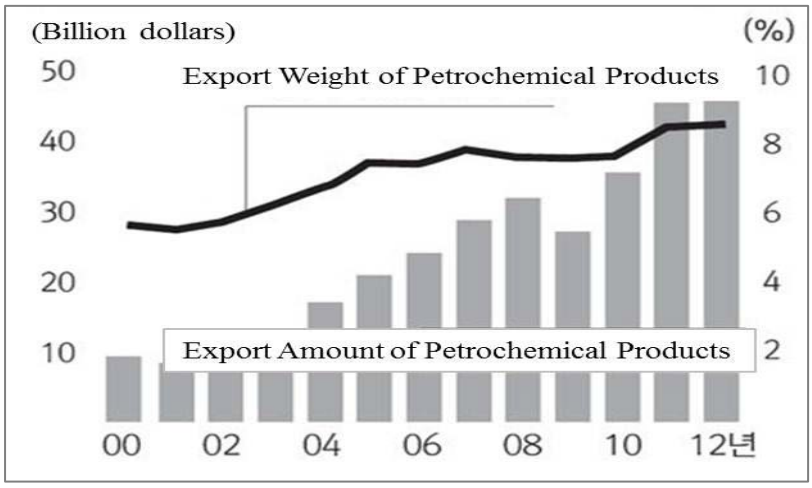
products in export markets" (Kim and Kim 2012, 62).

Bae's report was one of the most comprehensive studies to analyze not only the effect of trade and FDI (Foreign Direct Investment), but also productivity and employment. Their paper indicated that export and import volume increase followed by FTAs establishments with partner countries, saying "total amount of trade (export and import) had expanded by 100% in average" (Bae et al.2012, 191).

2.2 FTAs and Korean Petrochemical Industry

Petrochemical industry has been forming an ever-greater part of Korean economy. According to the KITA (Korea International Trade Association), the volume of manufacture reached 117 trillion won which accounted for 7.8% of whole amount of manufacture in Korea in 2011. It is also a typical export-oriented industry. Figure 2 shows that the export amount of Korean petrochemical products was 45.9 billion dollars in 2012 and it was about 8.4% of Korea's total export amount. The KITA reported that its cumulative surplus in balance of trade touched a level of 10 billion dollars since 2000.

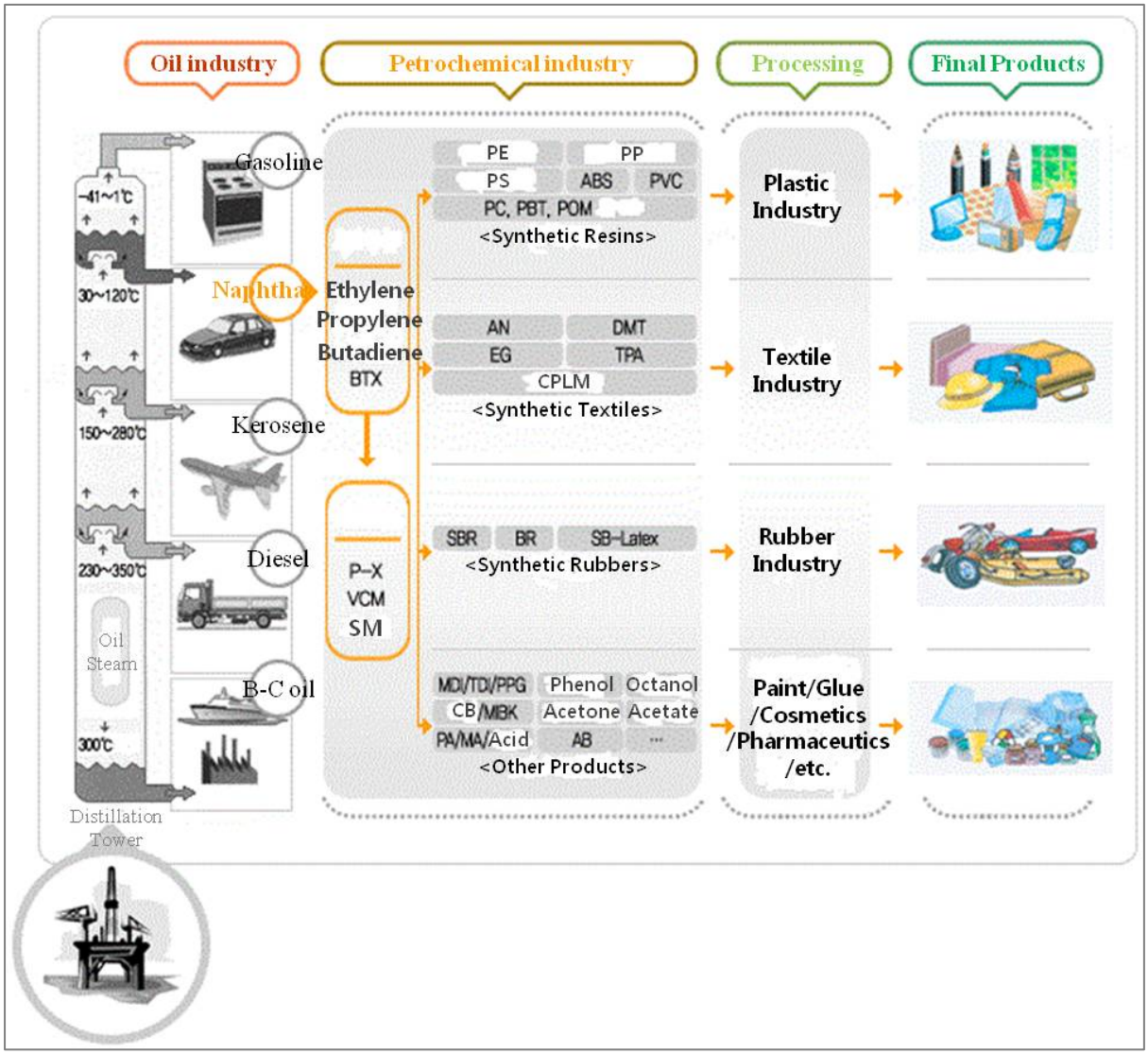
Figure 2: Export Weight and Amount of Korean Petrochemical Product



Source: Internet Hankookilbo (http://economy.hankooki.com)

The petrochemical industry mainly manufactures synthetic resins, synthetic textiles, synthetic rubbers and other petrochemical products. Then it provides them for many industries. For example, Figure 3 illustrates that plastic, textile, rubber, and even cosmetics and pharmaceutics industries are related to petrochemical industry. For this reason, the KPIA (Korea Petrochemical Industry Association) explains that petrochemical products come into request globally not only in advanced countries but also in developing countries (KPIA 2006, 71).

Figure 3: Position of Petrochemical Industry



Source: KPIA (Korea Petrochemical Industry Association) Homepage (www.kpia.or.kr)

As Korea established FTAs with partner countries, the export volume to the countries has increased. Considering the international trade was shrunk due to a financial crisis in 2009 and 2010, except the period, there has been a growth of the export amount to the country after each FTA came into force. For example, Table 1 shows that the export amount to Chile has risen almost threefold since 2004 when two countries' FTA was in force. Likewise, the export volume to ASEAN in 2012 has increased more than twice after their FTA became in force in 2007. Therefore, as Bae's report concludes, there might be a strong relationship between the export amount and FTAs (Bae et al.2012, 118).

But, it is not sufficient to monitor just absolute number increase, because table 1 also indicates that the total export amount of Korean petrochemical products more than quadrupled since 2000.

Table 2 indicates that the export ratio of Korean petrochemical products to major neighboring countries (China, Taiwan and Japan) is extremely big. From 2004, China's ratio has been over 46% until now. It might be because of their huge amount of demand and low transportation cost of short distance. Compared to them, export to FTA established countries looks insignificant. Although some FTAs were in force more than 5 years ago, specifically Chile and EFTA's ratio remains still.

Table 1: Korean petrochemical products' export amount, by FTA established country (as of 2013), 2000-2012

(Million dollars)

		'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12
FTA established countries (as of 2013)	Chile	41	42	37	52	70	129	144	133	152	74	133	192	194
	Singapore	60	44	78	146	175	162	190	244	351	370	380	501	443
	EFTA	0	0	5	5	4	5	7	7	9	5	8	24	21
	ASEAN	1,315	1,036	1,038	1,219	1,651	1,680	1,992	2,375	3,028	2,790	3,782	4,950	5,189
	India	139	83	99	163	225	373	368	527	785	1,018	1,679	1,963	2,162
	EU	552	389	487	493	634	622	791	1,236	1,585	1,116	1,308	1,820	1,903
	Peru	39	29	22	40	40	64	66	75	112	48	98	159	165
	U.S.A	412	417	356	354	618	1,007	1,042	1,101	1,324	743	1,387	2,077	2,091
	Turkey	45	28	61	74	111	159	218	359	397	286	444	615	545
Sum		2,603	2,068	2,183	2,546	3,528	4,201	4,818	6,057	7,743	6,450	9,219	12,301	12,713
Total		9,666	8,394	9,265	11,917	17,015	20,811	24,099	28,824	32,124	27,466	35,715	45,587	45,882

Source: Korea International Trade Association, MTI code 21 (Petrochemical Products)

Notes: The year when each FTA in force: Chile(2004), Singapore(2006), EFTA(2006), ASEAN(2007), India(2010), EU(2011), Peru(2011), U.S.A(2012)., and Turkey(2013)

Table 2 : Export Ratio of Korean Petrochemical products, by country, 2000-2012

(%)

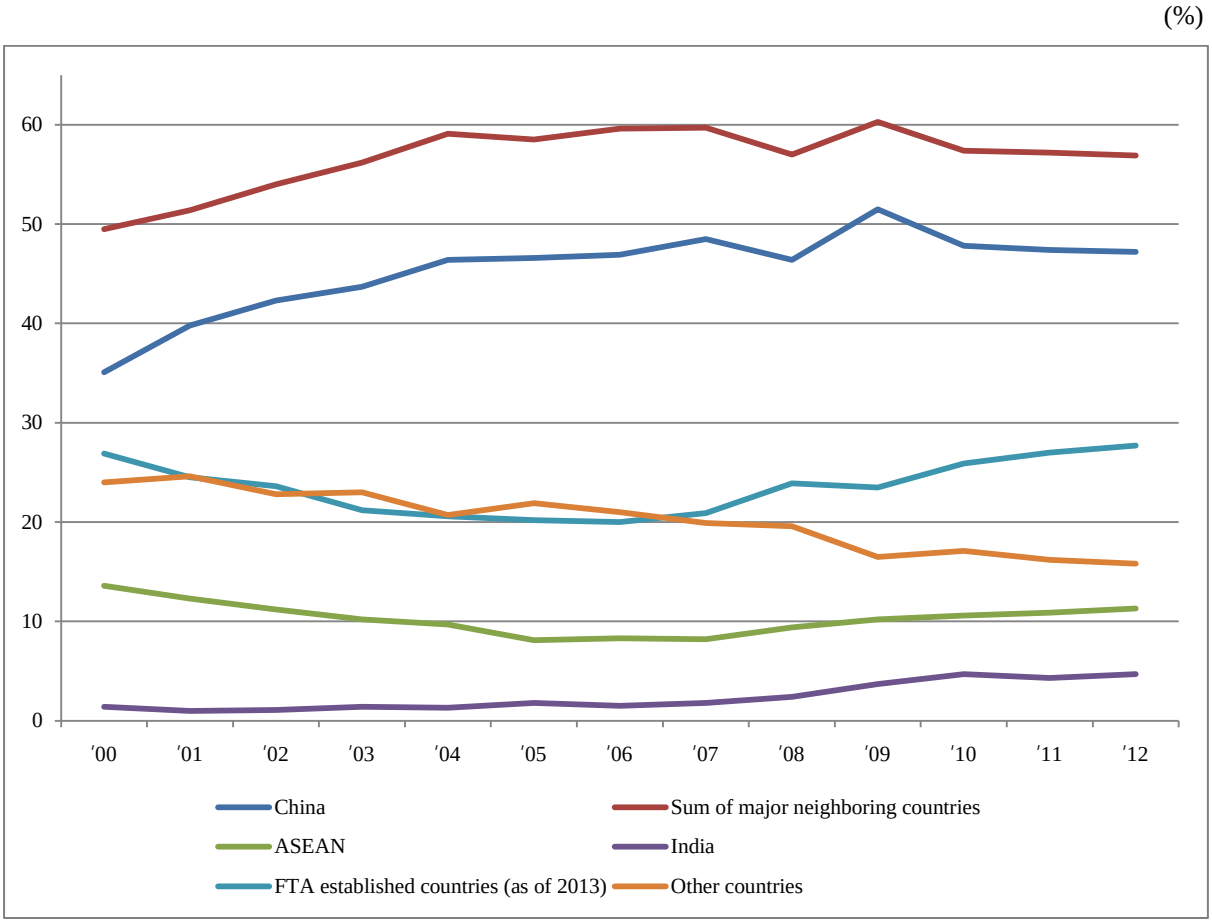
		’00	’01	’02	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
	China	35.1	39.8	42.3	43.7	46.4	46.6	46.9	48.5	46.4	51.5	47.8	47.4	47.2
	Taiwan	8.5	5.6	6.5	7.0	7.2	6.5	7.6	7.2	5.6	5.0	5.8	5.8	5.5
	Japan	5.9	6.0	5.2	5.5	5.5	5.4	5.1	4.0	5.0	3.8	3.8	4.0	4.2
Sum of major neighboring countries		**49.5**	**51.4**	**54.0**	**56.2**	**59.1**	**58.5**	**59.6**	**59.7**	**57.0**	**60.3**	**57.4**	**57.2**	**56.9**
FTA established countries (as of 2013)	Chile	0.4	0.5	0.4	0.4	0.4	0.6	0.6	0.5	0.5	0.3	0.4	0.4	0.4
	Singapore	0.6	0.5	0.8	1.2	1.0	0.8	0.8	0.8	1.1	1.3	1.1	1.1	1.0
	EFTA	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	ASEAN	13.6	12.3	11.2	10.2	9.7	8.1	8.3	8.2	9.4	10.2	10.6	10.9	11.3
	India	1.4	1.0	1.1	1.4	1.3	1.8	1.5	1.8	2.4	3.7	4.7	4.3	4.7
	EU	5.7	4.6	5.3	4.1	3.7	3.0	3.3	4.3	4.9	4.1	3.7	4.0	4.1
	Peru	0.4	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.4
	U.S.A	4.3	5.0	3.8	3.0	3.6	4.8	4.3	3.8	4.1	2.7	3.9	4.6	4.6
	Turkey	0.5	0.3	0.7	0.6	0.7	0.8	0.9	1.2	1.2	1.0	1.2	1.3	1.2
Other countries		24.0	24.6	22.8	23.0	20.7	21.9	21.0	19.9	19.6	16.5	17.1	16.2	15.8
Total		100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Korea International Trade Association, MTI code 21 (Petrochemical Products)

Notes: China does not include Hong Kong. The year when each FTA in force: Chile(2004), Singapore(2006), EFTA(2006), ASEAN(2007), India(2010), EU(2011), Peru(2011), U.S.A(2012)., and Turkey(2013)

Figure 4 shows it more vividly. But, ASEAN's ratio is slowly increasing. And the export ratio of neighboring countries except China and other countries has been decreasing gradually.

Figure 4: Export Ratio of Korean Petrochemical products, by country, 2000-2012



Source: Korea International Trade Association, MTI code 21 (Petrochemical Products)
Notes: China does not include Hong Kong.

In terms of analysis the effect between FTAs and Korean petrochemical industry, it could be difficult to anticipate because previous studies have hardly discussed the certain industries. For example, Kimura (2006) included 132 countries including Korea but drew a conclusion in a few manufacturing sectors. Kim and Kim (2012) have hardly discussed petrochemical industry as well. Then it is necessary to analyze factors to enhance the export of Korean petrochemical products. And they might be distance and demand. FTA in force should be included although its effect is controversial in the previous studies. Before coming

to an agreement of multilateral talks (i.e., Doha Development Agenda Negotiation: current trade negotiation round of the World Trade Organization, currently in the middle of negotiations), FTA is an unavoidable option and therefore it is urgent to study in various points of view.

2.3 Foundations for the Gravity Model

Gravity models by Isaac Newton (1687) have been used to describe economic and social behaviors in various social sciences. Bergstrand mentioned “The gravity equation has been long recognized for its consistent empirical success in explaining many different types of flows, such as migration, commuting, tourism, and commodity shipping (Bergstrand 1985, 474). It is originally from Isaac Newton's law of gravity. It describes that a force between two points mass is proportional to their messes and inversely proportional to the square of the distance between two. Inspired by this idea, many economists have converted it into the gravity model for trade (Anderson and Wincoop 2003, 170). In this model, as Bergstrand illustrated, trade volume among countries is explained by their economic scales which are GDPs and the physical distance among them (Bergstrand 1985, 474).

The gravity model was applied in international trade theory from early 1960. In 1979, Anderson said that “Probably the most successful empirical trade device of the last twenty-five years is the gravity equation” (Anderson 1979, 106). Tinbergen (1962) did the first quantitative research based on gravity equation, but failed to theorize. Since then, many economists concentrated on this model. Krugman and Helpman (1985), and Bergstrand (1989) proved that geographical and cultural factors could be significant variables to explain international trade phenomenon. Specifically Helpman (1987) did regression analysis using data of advanced OECD nations and showed there is a positive relationship between the value of multiplying one country’s GDP by the other country’s GDP and trade volumes of two.

Hummels and Levinsohn (1995) did the similar job, but they utilized non-OECD countries' data and proved that the gravity model has the power of explanation among developing countries as well.

After 1995, theoretical foundations for the gravity model were firmly established. And some economists started to add regional economic integrations as dummy variables to gravity model. Frankel (1997) intensified the model that not only geographical factors but also RTAs could affect trade volume between countries. Garman (1999) did a research on how Latin America's regional integration such as LAIA (The Latin American Integration Association of 13 Latin American countries), Andean Pact (Customs Union comprising the South American countries of Bolivia, Colombia, Ecuador, and Peru), CACM (Central American Common Market of Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica) influences intra-trade.

Previous studies show that the gravity model is significant when explaining factors of international trade. Simple intuition—one country exchanges goods more with bigger and nearer countries—empirically proved. In conclusion, the model is definitely a powerful tool to explain or anticipate the trade amount between countries.

III. Hypothesis Development

This chapter consists of six hypotheses. First of all it will examine how GDP, distance and being landlocked affect the export of the Korean petrochemical industry individually. Second, it will cover simple FTAs effect on the export of the Korean petrochemical industry. Then, it will include hypothesis that each country's ethylene yearly capacity influences their import of Korean petrochemical goods. And finally, there will be a hypothesis on FTA's inefficiency.

Gross domestic product (GDP) is the final value of all formally realized goods and services manufactured within a country in a certain period of time. It is now used as major index of production such as economic growth rate. In subchapter 2-2, petrochemical products are mentioned to trade actively by advanced countries as well as developing countries. It is because many industries are related to petrochemical industry. And then according to Sohn and Yoon's study, higher GDP can be assumed to have more motivation to import petrochemical goods (Sohn and Yoon 2000, 19).

Hypothesis 1: Partner country's GDP positively influence the export volume growth of Korean petrochemical industry.

Transportation does cost money and time. Importers naturally prefer inexpensive and fast transportation. Characteristic of Korean petrochemical goods is also identical. The more there is distance between two countries, the more either exporters or importers spend money and time.

Hypothesis 2: Distance between Korea and partner country negatively affect the export

volume growth of Korean petrochemical industry.

Korea is limited to exporting its products by overland traffic due to the division of territory. For this reason, Korea normally exports their products by marine transportation. But if a partner country is landlocked, it needs to pay extra cost for overland traffic. And then, there should be a restriction of importing.

Hypothesis 3: Partner countries' geographical characteristic of being landlocked negatively influences the export volume growth of the Korean petrochemical industry.

The huge boom of FTAs from the last ten-year period has become the most significant commerce policy in Korea. Such a short period, Korea has established 10 FTAs (including Columbia, waiting for each country's final procedure). It is a great accomplishment to be linked with 10 countries and economic blocs in the world via FTAs (Bae et al.2012, 23).

Korean petrochemical industry has tripled its export amount compared to ten years ago. However, relationship between established FTAs and export seems ambiguous because its largest and second largest importing countries are China and Taiwan which Korea did not establish FTAs with. Therefore, this paper raises a question the influence of Korea's established FTAs on the industry might not be positive.

Hypothesis 4: Korea's FTAs in force negatively influence the export volume growth of Korean petrochemical industry.

Like GDP in Hypothesis 1, there is an indicator to measure the scale of each industry among countries. Ethylene is regarded as petrochemical industry's essential raw material.

And the capacity of each country's ethylene facility is often compared to rank them. If the size is small, there could be more motivation to import petrochemical goods from oversees. And if the size is big, then they can be self-sufficient in petrochemical products.

Hypothesis 5: Partner country's ethylene yearly capacity negatively affects the export volume growth of Korean petrochemical industry.

Although Korea established FTAs with 10 economic blocs and countries, there is a controversy over their cost and benefit. In order for companies to enjoy FTA preferential tariffs, they need to meet each FTA's differently designed conditions. Bhagwati (1995) first raised the issue of the spaghetti bowl effect. It indicates that FTAs cause more and more complicated rules and extra costs, saying it does not save money by taking preferential tariffs of FTAs. In other word, there might be a phenomenon that a country establishes more FTAs, it could have more difficulties to satisfy multiple FTAs. This paper will figure out whether multiple FTAs positively or negatively affect the export volume of Korean petrochemical industry.

Hypothesis 6: As Korea has established more FTAs, the export volume attributed to a FTA is negatively influenced.

IV. Methodology

As previous studies established the gravity models, basic gravity equations are formulated with GDP as economic power, and geographical factors such as distance and contiguity. Cultural factors such as language and common colonizer are included. Regional trading arrangements such as NAFTA, Mercosur, and each FTA are also included.

In this chapter, since Korea does not have similarities on cultural and some geographical factors with trading partner countries, this paper's basic gravity equation includes only GDP, distance and dummy variables of inland and FTA.

Equation #1: $\ln T_{it} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln Distance_{it} + \beta_3 Inland_{it} + \beta_4 FTA_{it} + \varepsilon_{it}$

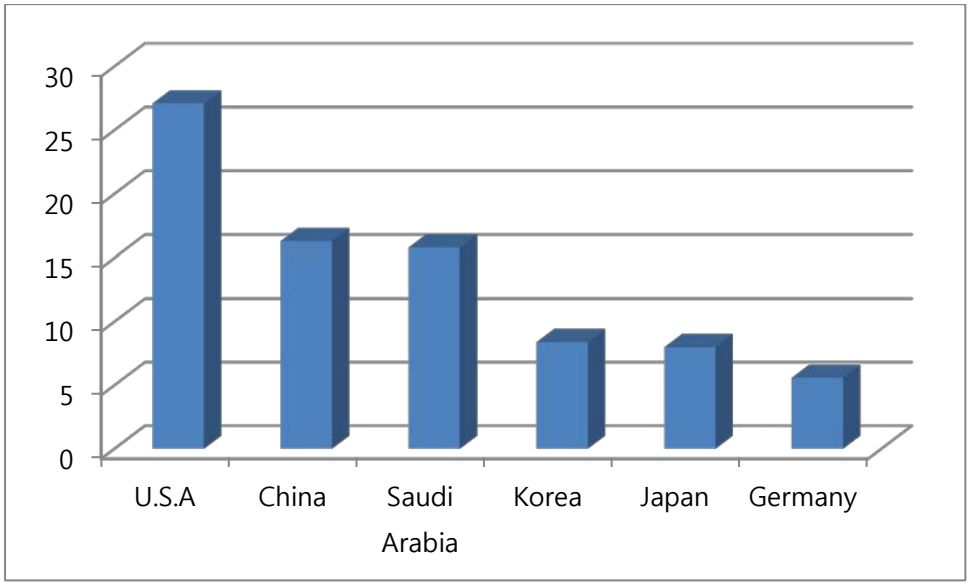
T_{it} represents export values of Korea to country i in year t, GDP_{it} denotes the gross domestic product in country i in year t. $Distance_{it}$ is geographical distance between country i and Korea in year t. $Inland_{it}$ takes one if the country i is an landlocked country and zero otherwise. FTA_{it} is also a dummy variable taking one if an FTA is in force between Korea and country i in year t and zero otherwise, ε_{it} is a disturbance term.

For the petrochemical industry, it is necessary to put industry-specific variable to have more industry-oriented analysis. According to the industry interview, they answered that ethylene is one of the most important raw materials to operate the petrochemical industry. Ethylene is a hydrocarbon of C_2H_4. It is widely used in chemical industry as a basic raw material. For this reason, it is estimated an index to measure the scale of country's petrochemical industry. Figure 5 shows major countries' ethylene production capacity in 2012.

Korea has the world's fourth-largest ethylene production facility.

Figure 5: Ethylene Capacity, by country, 2012

(Million tons)



Source: KPIA (Korea Petrochemical Industry Association) Homepage (www.kpia.or.kr)

And then, next equation includes each country's ethylene production capacity to know how it can enhance the export amount of Korean petrochemical products.

Equation #2: $\ln T_{it} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln Distance_{it} + \beta_3 Inland_{it} + \beta_4 FTA_{it} + \beta_5 \ln Capacity_{it} + \varepsilon_{it}$

$Capacity_{it}$ denotes annual capacity of ethylene of the country *i* in year *t*

Lastly, in the literature review, some papers worried about the RTA's inefficiency by the surge of RTAs. They said that there could be a possibility of increasing transaction cost as countries establish more and more FTAs. For this reason, it is important to analyze how

multiple FTAs affect the export amount of Korean petrochemical goods. And then in order to figure out how the number of FTAs affects, the final equation takes the following form.

Equation #3: $\ln T_{it} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln Distance_{it} + \beta_3 Inland_{it} + \beta_4 FTA_{it} + \beta_5 \ln Capacity_{it} + \beta_6 FTA_{it} \cdot \ln Number_t + \varepsilon_{it}$

$Number_t$ denotes the number of FTAs in force in year *t*, and if the FTA's inefficiency due to its numbers exists, β_6 should be negatively estimated.

V. Data analysis

The definition of petrochemical industry is different among countries. In order for each country's customs administration, they apply HS code system (harmonized commodity description and coding system) by international agreement by 1988. It has 7 to 10 digit numbers and first 6 numbers are identical internationally. From the left, first 2 numbers organizes line of goods with large groups. And second 2 numbers divides large groups into sub groups by their kinds. Next 2 numbers are categorizations by their functions. This is powerful tool when it is necessary to know exact products' imports and exports amount. But it is difficult to use it as a single industry, because normally an industry consists of hundreds of HS code.

In Korea, when there was Ministry of Trade and Industry until 1994, they brought industry categorization method using MTI code. MTI is the abbreviation for Ministry of Trade and Industry and it has 1 to 6 digit number codes. 6 digit numbers means the most subdivided industry group and 1 digit number stands for big class level categorization. The petrochemical industry belongs to code 21 in MTI system and this paper uses this code.

Using database of KITA (Korea International Trade Association), this study collects the export amount of Korean petrochemical products (MTI 21 code), by country, from 2003 to 2012. Since Korea's fist FTA was in force in April, 2004 with Chile, using data from 2003 is considered to be appropriate. Through this process, 159 countries 10 year data is gathered. Each country's GDP number is from the IMF and the distance from Korea is collected in the CEPII (French Centre d'Etudes Prospectives et d'Informations InternationalesI). Dummy variable of Inland is also collected form CEPII and information of Korea's FTA in force is from Ministry of Trade, Industry and Energy in Korea. When a country is landlocked, the

value of *Inland* is 1, and 0 otherwise. Likewise, if Korea has FTA in force with a country, it takes 1, and 0 otherwise.

In the second equation, each country's ethylene production capacity is added. It is referred in the field interview. The data is collected from IHS chemical (one of the most prestigious chemical consulting companies in the world). And in the third equation, *FTA* · ln*Number* is included to check the FTA's inefficiency.

Table 3 summarizes statistical characteristic of each variable used in empirical analysis. When observing ln*T*, there are only 98 numbers of 0. However, 1,057 numbers of 0 are observed in ln*Capacity*. It could lower credibility of significance test.

Table 3: Statistical Characteristic of Variables

Variables	Number of Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
ln*T*	1,590	14.96	4.7226	0	23.80
ln*GDP*	1,590	24.33	2.1263	19.29	30.38
ln*Distance*	1,590	9.05	0.5297	6.86	9.88
Inland(dummy)	1,590	0.19	0.3913	0	1
FTA(dummy)	1,590	0.09	0.2932	0	1
ln*Capacity*	1,590	4.57	6.4892	0	17.17
FTA* · ln*Number	1,590	0.17	0.5232	0	2.08

Table 4 is the result of estimating the effect on export amount using Equation 1, 2, and 3. Like other previous studies, coefficient value of GDP variable has positive sign, showing positive relationship between the export amount and partner country's GDP. The table indicates that the more physical distance there are between two countries, the less Korea exports, having negative sign in variable of ln*Distance*. Also it shows that Korean petrochemical industry exports more to non-landlocked countries.

However, according to the estimated coefficient value of FTA, FTA negatively

contributes to the scale of export. Estimating the gravity equations using the export amount as a dependent variable, there is no positive sign and it is not statistically significant in 5% level, either.

The study of Baier and Bergstrand (2007) indicated using world bilateral trade data that FTA generally increase the trade amount by 95% to 114%. In this paper, the negative effect could be because Korea has established FTAs only with countries of little export volume.

The estimated coefficient value of ln*Capacity* has negative sign as well. It is statistically significant in 1% level. From this result, it is believable that countries with basic petrochemical facilities are not likely to import more than countries with no facility. Also they could have higher self-sufficiency ratio, in terms of producing petrochemical-related products.

Finally this paper estimates whether there is the FTA's inefficiency or not in the export of Korean petrochemical goods as Korea has established more and more FTAs over the past few years. As this paper sets the equation in the previous chapter, the estimated coefficient value of FTA · ln*Number* has negative sign. On the other hand, the estimated coefficient value of FTA is changed to show positive sign. This proves that FTA effect can be divided into at least two factors, which are enhancing existing trade and FTA's inefficiency due to its number. In this study, on the whole, FTA has negative relationship with the export amount of Korean petrochemical industry, and it is because of slight export amount to FTA established countries and FTA's inefficiency. But like the variable of FTA, the variable of FTA · ln*Number* is not statistically significant in 5% level, either. It is the limitation of this model.

Table 4 : Regression Results

Explanatory variables	Equation #1		Equation #2		Equation #3	
	OLS coefficient	β coefficient	OLS coefficient	β coefficient	OLS coefficient	β coefficient
Constant	-11.752** (2.156)	-	-14.718** (2.415)	-	-14.818** (2.422)	-
GDP	1.363** (0.045)	0.614	1.496** (0.067)	0.673	1.499** (0.067)	0.675
Distance	-0.685** (0.177)	-0.077	-0.687** (0.176)	-0.077	-0.683** (0.177)	-0.077
Inland	-1.158** (0.234)	-0.096	-1.127** (0.234)	-0.093	-1.124** (0.234)	-0.093
FTA	-0.218 (0.314)	-0.014	-0.241 (0.314)	-0.015	0.524 (1.406)	0.033
Capacity	-	-	-0.057** (0.021)	-0.078	-0.057** (0.021)	-0.079
Number	-	-	-	-	-0.439 (0.787)	-0.049
Obs.	1590		1590		1590	
R^2	0.435		0.437		0.438	
Adjusted R^2	0.433		0.436		0.435	

Note: 1) **, and * shows 1%, and 5% significant level, respectively.
2) The numbers in parenthesis are standard deviations

The data using in Equation 1, 2, and 3 includes 159 countries for 10 years. Korea exports very slight amount to some countries, on the other hand, it exports extremely large scale of petrochemical products to a few countries. There could be a possibility of distorting the result of estimation, and then this paper estimates again after deleting outliers from the sample. Specifically, total 39 countries are removed—38 countries of having import amount under a million dollar and China which has 10 billion dollars of import in 2010. Most of 38 nations are located in the Pacific and the Caribbean Sea. Table 5 summarizes statistical characteristic of each variable after excluding outliers in ln*GDP*. Total number of observations becomes 1,200, 120 a year.

Table 5 : Statistical Characteristic of Variables (Excluding outliers in lnGDP)

Variables	Number of Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
ln*T*	1,200	16.73	2.3311	0	21.64
ln*GDP*	1,200	24.96	1.8904	19.83	30.34
ln*Distance*	1,200	9.01	0.5150	7.05	9.88
Inland(dummy)	1,200	0.17	0.3727	0	1
FTA(dummy)	1,200	0.11	0.3108	0	1
ln*Capacity*	1,200	5.82	6.7968	0	17.17
FTA* · ln*Number	1,200	0.19	0.5549	0	2.08

This paper does the similar job to delete countries with no ethylene facility in 2010. It is expected to show export pattern among countries to have the basic petrochemical equipment. Table 6 summarizes statistical characteristic of each variable after excluding outliers in lnGDP. Total number of observations becomes 500, 50 a year. When observing ln*T* and ln*Capacity*, there is now none and just one number of 0.

Table 6: Statistical Characteristic of Variables (Excluding outliers in lnCapacity)

Variables	Number of Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
ln*T*	500	18.09	1.7631	13.50	21.69
ln*GDP*	500	26.55	1.3533	22.71	30.34
ln*Distance*	500	8.97	0.5027	7.05	9.88
Inland(dummy)	500	0.14	0.3470	0	1
FTA(dummy)	500	0.16	0.3703	0	1
ln*Capacity*	500	13.63	1.5325	0	17.17
FTA* · ln*Number	500	0.28	0.6588	0	2.08

The estimation results excluding outliers of ln*GDP* and ln*Capacity* are in Table 7. In conclusion, the results are not changed a lot on FTA. Only R^2 becomes higher when

excluding outliers in ln*GDP*. But, the estimated coefficient value of ln*Capacity* has the positive sign now. After removing China's data, it is considered to change its sign because it has world's second largest ethylene capacity but it imports more than 10 billion of petrochemical goods from Korea. It also shows that the estimated coefficient value of ln*Capacity* is statistically significant in 5% level. Therefore it could be the significant explanatory variable to estimate relationship between countries with ethylene equipment after excluding outliers in export amount.

Table 7: Regression Results (Excluding outliers in lnGDP and in lnCapacity)

Explanatory variables	**Equation #3-1**		**Equation #3-2**	
	OLS coefficient	β coefficient	OLS coefficient	β coefficient
Constant	5.153** (1.321)	-	11.762** (1.696)	-
GDP	0.755** (0.039)	0.612	0.481** (0.059)	0.369
Distance	-0.800** (0.093)	-0.177	-0.897** (0.125)	-0.256
Inland	-0.800** (0.133)	-0.128	-1.329** (0.187)	-0.262
FTA	0.549 (0.677)	0.073	0.693 (0.640)	0.145
Capacity	0.012 (0.010)	0.034	0.127* (0.055)	0.111
Number	-0.243 (0.379)	-0.058	-0.206 (0.359)	-0.077
Obs.	1200		500	
R^2	0.524		0.442	
Adjusted R^2	0.521		0.435	

Note: 1) **, and * shows 1%, and 5% significant level, respectively.
2) The numbers in parenthesis are standard deviations

VI. Conclusion

6.1 Summary

Although Korea is such a country with limited oil resource, the reason why Korean petrochemical industry has grown amazingly and became major producers is because they actively seek for international trade. This paper analyzed specific factors including FTA to enhance the export amount of Korean petrochemical products based on the gravity model. The study of Evenett and Keller (1998) mentioned that the model is considered to be one of the most efficient models when it comes to trade volumes between two nations.

After modifying the gravity model by adding petrochemical related variables (export amount of Korean petrochemical industry and ethylene capacity), and FTA related variables (dummy variable of FTA and the number of FTA), this paper estimates how each factor affects the export amount of Korean petrochemical goods.

According to the result, Korean petrochemical industry follows the trade pattern grounded on the model. A partner country's GDP positively influences the export volume, and the distance between two countries negatively affects. FTA negatively contributes to the scale of export. However, estimating with the FTA's inefficiency due to its numbers, FTA changes to positive sign. On the other hand, as the number of FTAs in force increases, it negatively affects the export amount of Korean petrochemical goods. It might be because Korea has not established FTAs with neighboring countries such as China and Taiwan. And FTA's effect on the export is expected to sharply increase after completing bilateral economic integration with those countries. Lastly, after excluding outliers of Capacity, the ethylene capacity also turns into the positive sign. This means that as a country has more capacity, it imports more petrochemical products from countries with ethylene equipment.

To sum up, since variables of FTA and the number of FTAs are not statically significant, it is hard to conclude whether those two variables tend to have positive or negative effects on Korea's petrochemical exports. And from the point of view of Korean petrochemical industry, the Korean government should continue its active FTA policy with China which would contribute to the increase of Korean petrochemical exports.

This paper tries to draw a conclusion on economic effect of FTAs which Korea has established until now by examining specific industry's international trade performance. Unlike most of previous studies that analyzed all goods and even service sectors, this study includes only a single sector of petrochemical industry and estimates its FTA export effect. It also makes an attempt to explain the export fluctuation in more industry-oriented method. It presents a methodology to analyze specific industry's export influence by selecting a capacity of industry's essential facility as an explanatory variable.

6.2 Limitation of the study and Future Research

Limitations to the analysis made in this paper are undeniable. First of all, there is insufficient data due to the short time span. This paper includes all nine FTAs that Korea has established. But except Chile, Singapore and the EFTA, other FTAs have too short a time period to analyze. And, Korea has exported too few petrochemical products to those three countries, so the coefficient values lack credibility. Moreover, in the empirical analysis of excluding outliers, since the coefficient values show different sign, it can cause controversy.

There is also a limitation on the way of analysis. This paper utilizes only the gravity model, but there are many other economic models and tools which can explain the trade effect from other points of view.

Nevertheless, it is still meaningful to analyze export effects on manufacturing industries with the industry's facilities or other producing environment. Admittedly, this study does not

fully explain the effect of FTA's on a specific industry. This leaves room for further analysis of industry oriented approaches.

APPENDICES

APPENDIX A

Ethylene Capacity, by country, 2003-2012

(Thousand tons)

Country	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
Albania	-	-	-	-	-	-	-	-	-	-
Algeria	-	-	-	-	-	-	-	-	-	-
Angola	-	-	-	-	-	-	-	-	-	-
Argentina	733	733	758	880	880	880	880	880	880	880
Armenia	-	-	-	-	-	-	-	-	-	-
Australia	401	401	409	504	504	504	504	504	504	504
Austria	345	345	415	500	500	500	500	500	500	500
Azerbaijani	300	300	300	300	300	300	300	300	300	300
Bahamas	-	-	-	-	-	-	-	-	-	-
Bahrain	-	-	-	-	-	-	-	-	-	-
Bangladesh	-	-	-	-	-	-	-	-	-	-
Barbados	-	-	-	-	-	-	-	-	-	-
Belarus	145	145	145	145	145	145	145	145	145	145
Belgium	2,115	2,180	2,180	2,180	2,180	2,460	2,460	2,460	2,460	2,460
Belize	-	-	-	-	-	-	-	-	-	-
Benin	-	-	-	-	-	-	-	-	-	-
Bolivia	-	-	-	-	-	-	-	-	-	-
Botswana	-	-	-	-	-	-	-	-	-	-
Brazil	2,965	2,965	3,090	3,520	3,520	3,657	3,770	3,820	3,970	3,970
Brunei	-	-	-	-	-	-	-	-	-	-
Bulgaria	150	150	150	150	150	150	150	-	-	-
Burkina Faso	-	-	-	-	-	-	-	-	-	-
C.Dominica	-	-	-	-	-	-	-	-	-	-
Cambodia	-	-	-	-	-	-	-	-	-	-
Cameroon	-	-	-	-	-	-	-	-	-	-
Canada	5,245	5,245	5,265	5,318	5,318	5,138	5,048	5,048	5,048	5,048
Cape Verde	-	-	-	-	-	-	-	-	-	-
Chile	49	49	49	49	49	49	49	49	49	49

Country	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
Colombia	100	100	100	100	100	100	100	100	100	100
Congo	-	-	-	-	-	-	-	-	-	-
Costa Rica	-	-	-	-	-	-	-	-	-	-
Cote Divoire	-	-	-	-	-	-	-	-	-	-
Croatia	90	90	90	90	90	90	90	90	90	90
Cyprus	-	-	-	-	-	-	-	-	-	-
Czecho Republic	490	490	490	490	490	544	544	544	544	544
Democrat Republic Of Congo	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
Djibouti	-	-	-	-	-	-	-	-	-	-
Dominican Rep.	-	-	-	-	-	-	-	-	-	-
E.Guinea	-	-	-	-	-	-	-	-	-	-
Ecuador	-	-	-	-	-	-	-	-	-	-
Egypt	300	300	300	300	300	300	300	300	300	300
El Salvador	-	-	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	-	-
Ethiopia	-	-	-	-	-	-	-	-	-	-
Fiji	-	-	-	-	-	-	-	-	-	-
Finland	320	330	330	330	355	380	380	380	380	380
France	3,410	3,450	3,440	3,320	3,320	3,320	3,080	3,080	3,080	3,080
G.Bissau	-	-	-	-	-	-	-	-	-	-
Gabon	-	-	-	-	-	-	-	-	-	-
Gambia	-	-	-	-	-	-	-	-	-	-
Georgia	-	-	-	-	-	-	-	-	-	-
Germany	5,500	5,500	5,500	5,533	5,568	5,793	5,843	5,843	5,778	5,583
Ghana	-	-	-	-	-	-	-	-	-	-
Greece	-	-	-	-	-	-	-	-	-	-
Guatemala	-	-	-	-	-	-	-	-	-	-
Guinea	-	-	-	-	-	-	-	-	-	-
Guyana	-	-	-	-	-	-	-	-	-	-
Haiti	-	-	-	-	-	-	-	-	-	-
Honduras	-	-	-	-	-	-	-	-	-	-
Hong Kong	-	-	-	-	-	-	-	-	-	-
Hungary	350	400	620	650	650	650	650	650	650	650

Country	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
Iceland	-	-	-	-	-	-	-	-	-	-
India	2,462	2,622	2,795	3,015	3,085	3,085	3,013	3,826	4,080	4,080
Indonesia	500	500	500	520	555	590	590	590	590	590
Iran	767	767	1,092	1,693	2,608	4,538	4,868	5,202	5,368	5,368
Ireland	-	-	-	-	-	-	-	-	-	-
Israel	215	215	215	215	245	245	245	245	245	245
Italy	2,170	2,170	2,170	2,170	2,170	2,048	1,925	1,925	1,925	1,925
Jamaica	-	-	-	-	-	-	-	-	-	-
Japan	7,216	7,795	7,795	7,792	7,817	7,824	7,824	7,824	7,722	7,548
Jordan	-	-	-	-	-	-	-	-	-	-
Kazakhstan	-	-	-	-	-	-	-	-	-	-
Kenya	-	-	-	-	-	-	-	-	-	-
Kuwait	800	900	900	920	920	1,026	1,770	1,770	1,770	1,770
Kyrgyzstan	-	-	-	-	-	-	-	-	-	-
Laos	-	-	-	-	-	-	-	-	-	-
Latbia	-	-	-	-	-	-	-	-	-	-
Lebanon	-	-	-	-	-	-	-	-	-	-
Lesotho	-	-	-	-	-	-	-	-	-	-
Liberia	-	-	-	-	-	-	-	-	-	-
Libya	330	330	330	330	330	330	330	330	330	330
Lithuania	-	-	-	-	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-	-	-	-	-
Macao	-	-	-	-	-	-	-	-	-	-
Macedonia	-	-	-	-	-	-	-	-	-	-
Madagascar	-	-	-	-	-	-	-	-	-	-
Malawi	-	-	-	-	-	-	-	-	-	-
Malaysia	1,353	1,353	1,473	1,702	1,723	1,723	1,723	1,723	1,723	1,723
Maldives	-	-	-	-	-	-	-	-	-	-
Malta	-	-	-	-	-	-	-	-	-	-
Mauritania	-	-	-	-	-	-	-	-	-	-
Mauritius	-	-	-	-	-	-	-	-	-	-
Mexico	1,380	1,380	1,380	1,382	1,382	1,382	1,382	1,382	1,382	1,382
Micronesia	-	-	-	-	-	-	-	-	-	-
Mongolia	-	-	-	-	-	-	-	-	-	-
Morocco	-	-	-	-	-	-	-	-	-	-
Mozambique	-	-	-	-	-	-	-	-	-	-

Country	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
Myanmar	-	-	-	-	-	-	-	-	-	-
N.Zealand	-	-	-	-	-	-	-	-	-	-
Namibia	-	-	-	-	-	-	-	-	-	-
Nepal	-	-	-	-	-	-	-	-	-	-
Netherland	3,850	3,850	3,850	3,955	3,975	3,975	3,975	3,975	3,975	3,975
Nicaragua	-	-	-	-	-	-	-	-	-	-
Niger	-	-	-	-	-	-	-	-	-	-
Nigeria	300	300	300	300	300	300	300	300	300	300
Norway	455	455	490	575	575	575	575	575	575	575
Oman	-	-	-	-	-	-	-	-	-	-
Pakistan	-	-	-	-	-	-	-	-	-	-
Panama	-	-	-	-	-	-	-	-	-	-
Papua N.Gunea	-	-	-	-	-	-	-	-	-	-
Paraguay	-	-	-	-	-	-	-	-	-	-
Peru	-	-	-	-	-	-	-	-	-	-
Philippines	-	-	-	-	-	-	-	-	-	-
Poland	360	360	460	700	700	700	700	700	700	700
Portugal	350	350	350	370	410	410	410	410	410	410
Pr.China	5,865	6,120	7,560	8,939	10,101	10,280	11,093	14,993	15,561	16,263
Puerto Rico	-	-	-	-	-	-	-	-	-	-
Qatar	1,025	1,025	1,025	1,025	1,125	1,220	1,220	2,195	2,520	2,520
Republic of Montenegro	-	-	-	-	-	-	-	-	-	-
Republic of Serbia	200	200	200	200	200	200	200	200	200	200
Romania	200	200	200	200	200	200	-	-	-	200
Russia	2,700	2,700	2,700	2,746	2,761	2,861	2,861	2,861	2,901	3,071
Rwanda	-	-	-	-	-	-	-	-	-	-
Saudi Arabia	5,960	6,420	7,170	7,820	8,195	8,795	11,400	13,908	14,570	15,770
Senegal	-	-	-	-	-	-	-	-	-	-
Sierra Leone	-	-	-	-	-	-	-	-	-	-
Singapore	1,314	1,652	1,665	1,899	1,955	1,955	1,955	2,622	2,755	3,255
Slovak	200	200	200	200	220	220	220	220	220	220
Slovenia	-	-	-	-	-	-	-	-	-	-
South Africa	520	520	520	520	620	720	720	720	720	720
Spain	1,480	1,530	1,530	1,560	1,560	1,560	1,560	1,560	1,560	1,560

Country	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12
Sri Lanka	-	-	-	-	-	-	-	-	-	-
Sudan	-	-	-	-	-	-	-	-	-	-
Suriname	-	-	-	-	-	-	-	-	-	-
Swaziland	-	-	-	-	-	-	-	-	-	-
Sweden	610	610	610	610	610	610	610	610	610	610
Switzerland	25	25	25	30	30	30	30	30	30	30
T.Tobago	-	-	-	-	-	-	-	-	-	-
Tadjikstan	-	-	-	-	-	-	-	-	-	-
Taiwan	2,665	2,700	2,700	2,715	3,415	4,050	4,050	4,050	4,050	3,820
Tanzania	-	-	-	-	-	-	-	-	-	-
Thailand	1,876	1,901	1,973	2,298	2,397	2,428	2,528	4,120	4,428	4,428
Togo	-	-	-	-	-	-	-	-	-	-
Tunisia	-	-	-	-	-	-	-	-	-	-
Turkey	400	400	510	520	520	520	520	520	520	520
Turkmenistan	-	-	-	-	-	-	-	-	-	-
U. Kingdom	2,870	2,870	2,870	2,920	2,920	2,920	2,920	2,880	2,800	2,800
U.A.E.	600	600	600	600	600	600	600	1,300	2,000	2,000
U.S.A	27,216	27,620	28,205	28,520	28,728	28,633	27,067	26,622	27,001	27,115
Uganda	-	-	-	-	-	-	-	-	-	-
Ukraine	250	250	250	250	250	250	-	250	300	300
Uruguay	-	-	-	-	-	-	-	-	-	-
Uzbekistan	140	140	140	140	140	140	140	140	140	140
Venezuela	600	600	600	600	600	600	600	600	600	600
Viet Nam	-	-	-	-	-	-	-	-	-	-
Yemen	-	-	-	-	-	-	-	-	-	-
Zambia	-	-	-	-	-	-	-	-	-	-
Zimbabwe	-	-	-	-	-	-	-	-	-	-

Source: IHS chemical

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