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Does the Gravity Model Fit Korea's Trade Patterns?

Implications for Korea's FTA Policy and North-South Korean Trade

Chan-Hyun Sohn and Jinna Yoon

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Executive Summary

The purpose of this paper is to empirically analyze Korea's trade patterns based on the gravity model and to suggest possible ways to expand trade by identifying important factors determining Korea's bilateral trade flows. The gravity model assumes that trade flows between two countries are positively related to their economic size and negatively related to the distance between them. By taking into account geographical factors, such as distance, population and adjacency, which had long been disregarded by international trade theorists, the gravity model is now recognized as one of the best models for explaining international trade volumes.

In this paper, new explanatory variables, such as the Trade Conformity Index and APEC membership, were also included in order to examine the peculiarity of Korea's trade patterns - whether they follow the Heckscher-Ohlin model or the Differentiated Product model - and to estimate the influence of a regional economic bloc on Korean bilateral trade flows.

According to the regression results of the analysis, it is found that Korea's bilateral trade patterns fit the basic gravity model well. This means that Korea tends to trade more with countries in close proximity and having large economies. By analyzing the possible impact of complementary trade structures on Korea's bilateral trade flows, it is also found that Korea's bilateral trade flows increase in proportion to the trade complementarity (TCI). This implies that Korea's trade patterns are based on inter-industry trade rather than on intra-industry. In addition, the fact that Korea trades more with APEC countries than with non-APEC countries is a clear empirical evidence of the growing importance of the regional trading arrangements.

We found two important policy implications based on the findings of this study.

First, Korea's actual trade volumes with countries like Japan and China, which in terms of economic size and distance present greater advantages, seem to fall short of the trade volumes predicted by the gravity model. Both countries showed relatively lower levels of actual bilateral trade flows than forecast, respectively only 85% and 67% of the predicted levels. This implies that there is a considerable level of missing trade between Korea and these countries due to significant trade barriers. Korea, by establishing an FTA with Japan or China, is expected to enjoy, in addition to the benefits of trade creation effect, the recovery of missing trade through the elimination of unnecessary trade barriers.

Secondly, in this study, the gravity model is also applied to compare the actual and predicted bilateral trade flows between South and North Korea. The results show that that the actual trade of South Korea with North Korea (US$ 290 million) represents only one-fifth of the predicted value (US$ 1.43 billion). This means that, with the normalization of trade relations and the elimination of trade barriers, the bilateral trade between the two countries could expand to as much as five times the current level. Furthermore, if North Korea becomes an APEC member and makes strong commitments to open its market and liberalize trade, the trade flows between South and North Korea are expected to expand to three times (US$ 4.3 billion) the level before APEC membership.

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I. Introduction

The gravity model is a model derived from physics and applied to international trade theory in order to explain that bilateral trade flows are determined by two countries' GDPs as well as geographical factors such as distance and population.

In spite of its robust analytical abilities, as observed in econometric analysis, the gravity model has long been disregarded by economists due to its lack of theoretical foundation. However, due to the successive works of various economists, including Leamer, Deordoff and Krugman, it has gradually developed into a systematic economic model with a strong economic foundation. Since the 1990s, with the renewed interest in so-called "Economic Geography," the gravity model has emerged as a new means by which to explain and predict international trade patterns. Due to its strengthened economic foundation, a great number of studies have been conducted to formulate gravity-type extended equations that incorporate other variables that might either impede or facilitate bilateral trade flows. Furthermore, empirical analysis based on the gravity model was actively conducted in order to explain the peculiarity of the trade patterns between OECD countries as well as between non-OECD countries.

Despite its theoretical relevance and successful empirical performance, no much empirical study has yet been undertaken to explain Korea's trade patterns using this model. considering the importance of international trade in Korea's economic development, it would be an important task to identify which are the determinant factors of Korea's bilateral trade flows as it would aid in the understanding of Korea's trade patterns. In this regard, this study will be the first attempt at analyzing Korea's bilateral trade patterns based on the gravity model. This study will, in particular, look at the influence of the complementarity of bilateral trade structures and regional economic

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* This is an English version of the paper titled "A Gravity Model Analysis of Korea's Trade Patterns and the Effects of a Regional Economic Bloc" published in Korean in the *Journal of International Economic Policy Studies*, KIEP, in summer 2000. In this paper, we extend our research further by applying the gravity model to predict the trade flows between South and North Korea.

blocs on Korea's bilateral trade flows.

This paper consists of the following sections: in Section II we will concentrate on providing the theoretical foundations for the gravity model; in Section III we will introduce the methodology and data used in the empirical analysis; in Section IV, based on the gravity model, we will first estimate the effect of GDP, distance and per capita GDP on Korea's bilateral trade flows and then calculate the impact of the complementarity of trade structures and regional economic blocs in determining Korea's bilateral trade; in Section V we will provide two important policy implications on the basis of the comparison between actual and predicted bilateral trade flows and, lastly, we will provide our final conclusions.

II. Theoretical Foundations

The gravity model was originally founded on Newton's physical theory which states that two bodies attract each other in proportion to their masses and inversely by the square of the distance between them. The application of the gravity model to international trade theory, on the other hand, aims at explaining the bilateral trade flows and patterns between two economies by regarding each of them as an organic body that attracts each other in proportion to their economic size (GDP) and inversely to their distance.

The basic assumption of the gravity model, therefore, states that the bilateral trade flows are positively related to the product of the two countries' GDPs and negatively related to the distance between them. The simplest version of the gravity model can take the following form.[1]

$$T_{ij} = A \cdot (Y_i Y_j / D_{ij}) \qquad (1)$$

T_{ij} = bilateral trade flows (exports+imports)
Y_i = GDP of country i
Y_j = GDP of country j
D_{ij}= Distance between country i and j
A = Constant of proportionality

In addition to the primary basic variables described above, other variables, such as population (or per capita GDP) and land area, can be included in the gravity model as proxies for economic size. Dummy variables such as common language, adjacency, landlockedness and economic integration can also be included to represent geographical and cultural factors.

The gravity model was first applied to the international trade field by Tinbergen (1962) and Pöynöhen (1963) in the early 1960s. They conducted the first econometric analyses of bilateral trade flows based on gravity-type equations but they only provided empirical evidence without supplying any theoretical justification. Following their analyses, for a period of almost 20 years, the gravity model, in spite of its perceived empirical success, did not receive much attention from economists due to its weak

[1] This gravity equation was used by Deardorff (1995) as a standard gravity model.

theoretical foundation.

However, with the increasing importance of geographical factors in international trade theory, the gravity model started to attract a reawakening interest in the 1980s. Works by Krugman and Helpman (1985), Bergstrand (1989), Deardorff (1995) and Evenett and Keller (1998) greatly contributed to the establishment of a theoretical foundation for the gravity model by showing that the gravity equation can be derived from a number of different international trade models.

There are two competing models of international trade that provide theoretical justification for the gravity model. They are the Differentiated Products Model and the Heckscher-Ohlin Model. Anderson (1979) and Krugman & Helpman (1985) tried to identify the relationship between the bilateral trade flows and the product of two countries' GDPs by utilizing the Differentiated Products Model. According to Krugman & Helpman, under the imperfect substitute model, where each firm produces a product that is an imperfect substitute for other product and has monopoly power in its product, consumers show preference for variety. When the size of the domestic economy (or population) doubles, consumers increase their utility, not in the form of greater quantity but of greater variety. International trade can provide the same effect by increasing consumers' opportunity for even greater variety. Therefore, when two countries have similar technologies and preferences, they will naturally trade more with each other in order to expand the number of choices available for consumption. The correspondence between the gravity equation and the Differentiated Products Model was empirically proven by Helpman (1987) by applying his test on OECD countries' trade data. His results supported the argument that the gravity equation can be applied to the trade flows among industrialized countries where intra-industry trade and monopolistic competition are well developed.

In contrast, Hummel & Levinsohn (1995) conducted a similar empirical test with a set of non-OECD countries where monopolistic competition was not so plausible. To their surprise, they proved that the gravity equation is also efficient in explaining the trade flows among developing countries where inter-industry trade is dominant with scarce monopolistic competition. Their findings questioned the uniqueness of the Product Differentiation model in explaining the success of the gravity equation and proved that a variety of other models, including the H-O model, can serve as alternatives. Deardorff (1995) has shown that the gravity model can be derived from several variants of the Heckscher-Ohlin model based on comparative advantage and perfect competition if it is properly considered. He found out that the absence of all barriers to trade in homogeneous products causes producers and consumers to be indifferent to the trading partners, both domestic and foreign, so long as they buy or sell the desired goods. Based on this assumption, he derived expected trade flows that correspond exactly to the simple frictionless gravity equation whenever preferences are identical and homethetic.[2]

Evenett & Keller (1998) also emphasized that gravity prediction constitutes the most important result regarding the volume of international trade. They argued that little production is perfectly specialized due to factor endowment differences and that as long as the production is not perfectly specialized across countries, both of the H-O model and Differentiated Products Model are likely to account for the empirical success of the gravity equation.[3]

Therefore, it is generally accepted that a number of trade models are responsible for the empirical success of the gravity equation. While the H-O theory would account for the success of the gravity equation in explaining bilateral trade flows among countries with large factor proportion differences and high shares of inter-industry (so-called 'North-South' trade), the Differentiated Product Model would serve well in explaining the bilateral trade flows among countries with high shares of intra-industry trade (so called 'North-North' trade).[4]

After the theoretical foundation of gravity model had been established, in the 1990s, further studies concentrated on its empirical application. Frankel (1997) formulated a more complex and advanced form of gravity equation where he particularly emphasized the role of geographical factors, such as distance, landlockedness and population, as

[2] For more detailed explanation of the derivation of the gravity equation based on the Heckscher-Ohlin model, refer to Deardorff (1995).

[3] Refer to Evenett & Keller (1998) for more details.

<The Model Identification Issue in the Gravity Equation Context>

Type of Model	Technology Differences (Ricardian)	Increasing Returns	Heckscher-Ohlin	Other Models
1. Structural Assumption: Identical homothetic demand, free trade and…	Technology Differences with industry classes across countries	Increasing Returns at the firm level, monopolistic competition, product differentiation	Hemogeneous goods and Multi-cone world (Large Factor Proportion Differences)	
Consistent with absence of factor proportions differences ?	Yes	Yes	No	
2. Implication for Nature of Trade	Intra-industry trade in goods with alternating technological superiority	Intra-industry trade in product varieties with potentially identical technologies across countries	Inter-industry trade	
Consistent with trade in goods with identical factor requirements ?	Yes	Yes	No	
3. Import Volume Prediction	**Gravity Equation**			

Source: Evenett and Keller (1998)

[4] See Frankel (1997) p53, Deardorff (1995) p8-9 and Evenett and Keller (1998) p2 for more details.

determinants of bilateral trade flows. He also included regional trading blocs, such as APEC, NAFTA and Mercosur, in his gravity equation in order to estimate the impact of regional integration on bilateral trade flows.[5] In a similar way, Garman (1999) tried to analyze the impact of economic integration, as embodied by the LAIA, the Andean Pact, and CACM, in Latin American countries' intra-regional trade flows, based on the gravity-type equation.

In addition, Wall (1999) used the gravity model to estimate the costs of protectionism in the U.S. economy and Tamirisa (1999) applied the gravity model to analyze the effect of capital and exchange controls on bilateral trade flows.

[5] In the APEC variable case, it showed a relatively higher coefficient (1.2) than other regional economic blocs, implying that two APEC countries will trade 3.3 times as much as two other similar countries. Therefore, we can see that even a loose regional economic bloc, such as APEC, can have a great influence on the determination of bilateral trade flows.

III. Methodology and the Data

1. The Data

This study is a cross-sectional analysis based on data on bilateral trade flows between Korea and its 30 main trading partners, the two countries' GDPs and distance from one another.[6] Although the standard gravity equation considers every possible bilateral trade flow between all the possible pairings, we tried to confine the dependent variables to bilateral trade flows between Korea and each of its trading partners in order to analyze Korea's own trade patterns. This method was previously utilized by Wall (1999) in modeling his gravity equation to analyze U.S. trade patterns.[7]

The data on the bilateral trade flows (total and sectoral imports and exports) was obtained from the 1995 GTAP statistics[8] and values are expressed in terms of billions of U.S. dollars. The data sample consists of Korea's 30 main trading partners, including China, Japan, ASEAN, North American countries and some of the South American and European countries. Although the data set was limited by the amount of information available, we tried to select, from all over the world, countries that would well represent the bilateral trade flows with Korea. We used the GTAP statistics for bilateral exports and imports for several reasons. Other statistics published by international organizations are often inconsistent and unreliable as they depend on statistics derived from two independent sources: reported imports and reported exports. In contrast, GTAP statistics provide more consistent and reliable statistics by relying solely on publicly available data and applying a general procedure to reconcile inconsistent trade flows of all countries and commodities using each country's reliability index, reporting time and transport costs.

As the base year, we chose the year 1995 because the use of late 1990s' data will probably lead to biased results without properly reflecting Korea's general trade performance as Korea's export and import structures experienced severe distortions due to the severe Asian financial crisis starting from 1997.

The data on GDP and population come from Korea's National Account published by the Bank of Korea and also from the IMF's International Financial Statistics. The

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6 See Appendix Table 1.

7 Wall used a panel U. S. merchandise imports and exports to and from 85 countries for the years 1994-1996 as a dependent variable.

8 For detailed explanation of GTAP statistics, see http://www. agecon.purdue.edu/gtap/index.htm

distance variable is the great-circle distance between Seoul and the capital city of each of its trading partners.[9] The Trade Conformity Index that represents trade complementarity between two countries was taken from the data in Gormely and Morrill's work "Korea's International Trade in Goods" (1998).

2. The Model

The basic gravity equation for our regression analysis takes the following form:

$$Ln\ T_{ij} = a + b_1 Ln\,[\,Y_I \cdot Y_j\,] + b_2\, Ln\,[(Y/P)_i \cdot (Y/P)_j] + b_3\, LnD_{ij} + e_{ij} \qquad (2)$$

T_{ij} = bilateral trade flow (exports+imports) between Korea(i) and its trading partner(country j)
$Y_i \cdot Y_j$ = product of Korea's(i) and country js GDPs
$(Y/P)_i \cdot (Y/P)_j$ = product of Korea's(i) and country j's per capita GDPs, P means population
D_{ij} = distance between Korea(i) and its trading partner(country j)

In equation (2), all variables are in natural logarithm form. Among the explanatory variables, the product of GDP ($Y_i \times Y_j$) serves as a proxy for the two countries' economic size, both in terms of production capacity and markets. Larger countries, with a great production capacity, are more likely to achieve economies of scale and increase their exports based on comparative advantage. They also possess large domestic markets able to absorb more imports. Therefore, an increase in the product of the two countries' GDPs is expected to increase bilateral trade volumes.

Per Capita GDP is an explanatory variable that serves as a proxy for the income level and purchasing ability of the exporting and importing county. As Korea's per capita GDP is fixed, this variable will serve to predict whether Korea's trade flows are dependent on its trading partners' overall economic size or on its income level.[10]

The distance variable is a trade resistance factor that represents trade barriers such as transport costs, time, cultural unfamiliarity and market access. The distance used in this study is the great circle distance between Korea and its trading partner

Based on the standard gravity equation (2), we included the Trade Conformity Index as another explanatory variable in order to see whether Korea' trade patterns are based on the H-O Model or the Differentiated Products Model. The resulting equation (3)

[9] See Darrell Kindred (1997) for data on great circle distance. http://www.indo.com/distance
[10] Explanatory variables in the form of GDP and per capita GDP or GDP and population are the same.

takes the following form:

$$Ln\,T_{ij} = a + b_1 Ln\,[\,Y_i \cdot\ \ Y_j\,] + b_2 Ln\,[\,(Y/P)_i \cdot\ \ (Y/P)_j] + b_3\,Ln\,D_{ij} + b_4\,TCI_{ij} + e_{ij} \qquad (3)$$

The TCI measures the degree of trade complementarity between two countries. TCI between country i and country j is calculated in the following form:

$$TCI_{ij} = S\ [\,X_{ki} * M_{kj}\,] \,/\, \ddot{O}\ [\,S\ X_{ki}^{\ 2}\ \acute{}\ \ S\ M_{kj}^{\ 2}\,]$$

i and j mean a country and its potential trade partner.
k means a commodity group.
X_{ki} = share of commodity group k in the exports of country i
M_{kj} = share of commodity group k in the imports of country j

Therefore, the TCI ranges from 0 (zero trade complementarity or perfect trade competition) to 1 (perfect trade complementarity). As it is a value measured between "0" and "1", its distribution among countries can be relatively small so as to take on a natural logarithm form. Therefore, we just included the normal value. According to the equation (3), if Korea's patterns of trade follow the H-O model, trading more with a country in complementary trade relationship, the TCI coefficient will have a positive sign. If, on the other hand, Korea's patterns of trade follow the Differentiated Product Model based on intra-industry trade, then, the TCI coefficient will have a negative sign and will be inversely related to the trade volume.

As the final step of our study, we included the APEC dummy variable as an explanatory variable in order to determine whether a regional trade arrangement is influential in determining Korea's bilateral trade flows. The resulting equation (4) takes the following form:

$$Ln\,T_{ij} = a + b_1 Ln\,[\,Y_i \cdot\ \ Y_j\,] + b_2 Ln\,(Y/P)_i \cdot\ \ (Y/P)_j] + b_3\,Ln\,D_{ij} + b_4\,TCI_{ij} + APEC_{ij} + e_{ij} \qquad (4)$$

In the equation (4), APEC is a dummy variable which takes on a value of "1" if Korea's trading partner belongs to APEC and a value of "0" otherwise. The 15 countries in the data sample were regarded as being APEC members, taking 1995 as a base year.[11]

[11] These countries are the United States, Canada, Japan, Hong Kong, Australia, New Zealand, Taiwan,

Once the APEC variable turns out to be highly significant, its effect on trade flows will depend on the sign of its coefficient. A positive sign will imply that Korea's bilateral trade flows will expand through the formation of a regional economic bloc while a negative sign will mean that Korea's bilateral trade flows will decrease as a result of a regional economic arrangement.

Singapore, Indonesia, Malaysia, the Philippines, Thailand, China, Mexico and Chile.

IV. Empirical Analysis

1. OLS Regression Results based on the Basic Gravity Equation

The cross-sectional OLS regression results for the gravity equation (2) are reported in Table 1. The overall performance of the model seems to be good with a value of around 0.786 for R-squared, meaning that the gravity model is efficient in explaining Korea's bilateral trade flows.

The log of the product of two countries' GDPs is highly significant statistically. The estimated coefficient on the GDP variable is 0.728. This means that, holding constant for other variables, a 1 percent point increase in GDP will result in, roughly, a 0.73 percent point increase in Korea's bilateral trade flows. This result is consistent with the basic assumption of the gravity model that states the trade volumes will increase with an increase in economic size. The reason why the increase in bilateral trade (0.73%) is less proportionate to the increase in GDP is that the country becomes relatively self-sufficient because the larger domestic market will absorb a greater part of the production as its economic size increases.

<Table 1> OLS Regression Results for the Basic Gravity Model

Explanatory Variable	Unstandardized coefficient		Standardized Coefficient (β -coefficient)
	Coefficient	t-statistics	
Constant	5.233* (2.623)	1.995	-
Product of GDPs	0.728*** (0.121)	6.017	0.657
Product of per capita GDPs	-0.08977 (0.141)	0.639	0.069
Distance	-0.924*** (0.208)	-4.758	-0.448
Number of observations	30		
R^2	0.786		
Adjusted R^2	0.761		

Note: 1) The numbers in parenthesis are standard deviations.

2) *** and * means significant at 99% and 90% level, respectively.

In contrast, the estimation shows that the per capita GDP variable is not a significant factor in determining Korea's bilateral trade flows. This result is different from Frankel's regression analysis that predicted that a 1% increase in per capita GDP will lead to a 0.1% increase in bilateral trade flows. This implies that Korea's trade patterns follow a GDP pattern rather than a per capita pattern, relying heavily on its trading partner's overall economic size rather than its income level. Therefore, we can say that Korea prefers exporting quantity-based low price products that are sensitive to the overall market size, rather than exporting quality-based high value-added products which are sensitive to the trading partner's income level.

< Table 2 > Comparison of Distance Coefficients

	Distance Coefficient
Linneman (1966)	-0.76
Frankel (1998)	-0.732
Wall (1999)	-0.953
Garman (1999)	-0.942
This paper (2001)	**-0.924**

The distance variable is statistically significant with the expected negative sign, showing that geographical distance is an important resistance factor for bilateral trade flows. As seen in Table 2, the coefficients of the log of the distances in this study turned out to be very similar to those estimated by other previous studies.

2. Effect of the TCI on Korea's Trade Flows

2.1. Regression Analysis of Aggregate Trade

Of the two main trade models supporting the gravity equation, the Heckscher-Ohlin model assumes that two countries in a complementary economic relationship are more likely to expand their bilateral trade through inter-industry trade, while the Differentiated Products Model presupposes that two countries in a competitive economic relationship will trade more through intra-industry trade. To see explicitly which of the two models better explains Korea's trade patterns, we included the Trade Conformity Index, which is a more direct measure of bilateral trade structures, as another explanatory variable.[12]

The calculation of the TCI is based on the share of commodity group k in the exports of a country and the share of commodity group k in imports of its trading partner. As explained earlier[13], it takes a maximum value of "1" if the export share of a country and import share of its trading partner are equal, meaning perfect trade comlementarity and it approaches "0" as the difference between the two shares becomes greater, indicating perfect trade competition.

The TCI reflects whether two countries are complementary or competitive in their trade structures. For example, in Korea's case, its TCIs with the U.S., China and Japan are 0.642, 0.536 and 0.444, respectively, meaning that Korea maintains a relatively complementary trade relationship with the U.S., while it has relatively competitive trade relationships with Japan.[14]

The regression results of equation (3) with the TCI as an additional explanatory variable are summarized in Table 3. In this new equation, R-squared rose by 6 percent point from 0.786 to 0.845. The rise in the value of R-squared means that the equation with the TCI included better explains Korea's bilateral trade flows.

The per capita GDP variable continued to be insignificant, while the GDP and distance variables remained highly significant with only slight reductions of their coefficients to 0.727 and –0.794, respectively.

The t-statistic value of the TCI variable is 3.094, proving that it is a significant factor in determining Korea's bilateral trade flows. Its coefficient has a positive sign implying that Korea's bilateral trade flows will increase more as the degree of trade complementarity with its trading partner rises. Therefore, Korea's trade patterns are more likely to follow the H-O model, based on inter-industry trade, than the

[12] See Appendix Table 2 for data on the TCI.

[13] See Chapter III (p14) for detailed explanation of TCI.

[14] In the analysis of RCA (Revealed Comparative Advantage) between Korea and Japan, U.S. and China, give similar results. Analyzing bilateral RCA structure based on Spearmen's Rank Correlation, we can observe that the trade structure of Korea and Japan are highly competitive with a correlation index of 0.5084, while the trade structure of Korea-U.S. is relatively complementary, with a correlation index of –0.0576.

<Matrix of Spearmen's rank correlation of RCA>

	Japan	China	U.S.
Korea	0.584	0.2852	-0.0576
Japan		0.1754	0.3094
China			-0.3049

Source: Chan-Hyun Sohn (2001), "*Analysis of Economic Effects of Korea's FTAs with Japan, the U.S. and China.*"

Differentiated Products model based on intra-industry trade.

<Table 3> OLS Regression Results for Gravity Model with TCI included

Explanatory Variable	Unstandardized Coefficient		Standardized Coefficient (β-coefficient)
	Coefficient	t-statistics	
Constant	5.111** (2.275)	2.247	-
Product of GDPs	0.727*** (0.105)	6.934	0.657
Product of per capita GDPs	-0.04882 (0.130)	-0.376	-0.037
Distance	-0.794*** (0.174)	-4.574	-0.385
TCI	3.038*** (0.982)	3.094	0.271
Numbers of observation	30		
R^2	0.845		
Adjusted R^2	0.821		

Note: 1) The numbers in parenthesis are standard deviations.

2) *** and **means significant at the 99% and 95% level, respectively.

We also estimated the relative contribution of each variable in determining Korea's bilateral trade flows, using the standardized regression coefficient (ß-coefficient).[15] The ß-coefficients for the GDP, distance and TCI variables were estimated at 0.657, -0.385 and 0.271, respectively. Therefore, we can see that GDP is the most influential factor, explaining almost 50% of the variability of Korea's bilateral trade flows. The next most important is the distance variable, explaining 29% of the bilateral trade flows, followed by the TCI with 21%. The relative influence of Per capita GDP seems to be almost 0 as it proved to be an insignificant factor.

[15] The standardized coefficient (β-coefficient) is a coefficient converted into a z-score in order to compare the relative weight of explanatory variables when they are measured by different units.

2.2. Regression Analysis of Disggregated Trade by Sector

We broke down bilateral trade into 23 sectors and ran the regression on disaggregate bilateral trade flows using equation (3), the results of which are summarized in Table 4.

Among the 23 sectors, except for the primary sectors and some light industrial sectors such as paper and wood products, the R-squared value for most of the manufacturing sectors were above 0.5, implying that the gravity equation is also very efficient in explaining sectoral bilateral trade flows. The heavy and chemical sectors, in particular, have relatively higher R-squared values, above 0.85, which means that the variability of the bilateral trade flows in these sectors is much better explained by the gravity model than in other sectors. In contrast, the primary sectors and most light industrial sectors have R-squared values of less than 0.5, indicating that there may be other more important variables than those assumed by the basic gravity model.

The GDP variable is statistically highly significant and has a positive coefficient in most sectors. Of all 23 sectors, there are 6 sectors, livestock, food products, wood products, paper & printing, non-ferrous metal products and metal products, having a GDP coefficient similar to that of aggregate trade (0.728). In other sectors, the GDP coefficient exceeds that of aggregate trade. This is particularly the case for heavy and chemical products, such as steel, petroleum & coal products, automobiles, and transportation equipment, implying that these sectors are more sensitive to changes in GDP or overall market size. Therefore, they will take full advantage of economies of scales in order to expand their bilateral trade volumes.

The per capita GDP variable, which was insignificant in the regression analysis of aggregate trade, turned out to be significant in some sectors, such as agriculture, mineral products, textiles, leather products and steel, with negative coefficients. This implies that an increase in the per capita GDP of a trading partner will lead to a reduction in Korea's bilateral trade volumes in these sectors. Therefore, in order to expand Korea's bilateral trade flows in these sectors, it would be more desirable to trade with other developing countries with low and middle incomes.

The distance variable is generally significant in most sectors other than the primary sectors. The fact that the distance effect is lower in the primary sectors than it is in the manufacturing sectors is consistent with other similar studies. This is because manufactured products represent a great variety of choices and preferences and therefore, are highly affected by distance and cultural unfamiliarity, while primary products, by their relatively homogeneous nature across cultures appear less affected by distance and cultural factors.[16]

<Table 4 > OLS Regression Results for Gravity Model by Sector with TCI included

Sector	Constant	Product of GDPs	Product of per capita GDPs	Distance	TCI	R^2 (Adjusted R^2)
Agriculture	8.2038 (7.9424)	1.3166*** (0.3718)	-0.9456** (0.4436)	-0.6401 (0.614)	3.3050 (3.5349)	0.4972 (0.3966)
Livestock	-13.8709 (7.5702)	0.6782* (0.3736)	0.7674* (0.4263)	-0.7207 (0.5923)	-0.6802 (3.4207)	0.4356 (0.3168)
Forestry	-1.400 (11.6038)	0.1758 (0.5686)	-0.1972 (0.6722)	0.3686 (0.9192)	0.5257 (5.4911)	0.0136 (0.2330)
Fisheries	-3.366 (8.9258)	0.2801*** (0.4179)	0.1114 (0.4985)	-0.3609 (0.69)	1.7835 (3.9726)	0.0830 (0.1004)
Minerals	9.4667 (8.1515)	1.1410*** (0.3816)	-0.9482** (0.4552)	-0.5375 (0.6301)	3.4053 (3.6280)	0.4241 (0.3089)
Foods	2.7275 (4.6638)	0.7145*** (0.2183)	-0.1702 (0.2605)	-0.6124 (0.3605)	2.1584 (2.0757)	0.5251 (0.4301)
Beverages and Tobacco	-18.1871 (5.9581)	1.5111*** (0.2783)	0.2364 (0.3368)	-0.4598 (0.4699)	-0.0928 (2.6541)	0.7173 (0.6578)
Textiles	13.3608 (2.9162)	0.7720*** (0.1365)	-0.6175*** (0.1629)	-0.7617*** (0.2254)	0.0715 (1.2980)	0.7692 (0.7230)
Apparel	-2.6060 (4.1469)	1.0114*** (0.1941)	0.0020 (0.2316)	-0.7946** (0.3206)	0.0321 (1.846)	0.7239 (0.6687)
Leather Products	5.7391 (2.8265)	0.9033*** (0.1323)	-0.2869* (0.1579)	-0.822*** (0.2185)	-1.3141 (1.2580)	0.8102 (0.7723)
Wood Products	1.1529 (6.2755)	0.7414** (0.2938)	-0.88 (0.3505)	-0.1913* (0.4851)	3.6234 (2.7930)	0.4806 (0.3767)
Paper Products and Publishing	-0.8853 (5.1630)	0.7406*** (0.2417)	-0.0254 (0.2883)	-0.5751 (0.3991)	2.0487 (2.2979)	0.4977 (0.3973)
Petroleum and Coal Products	8.6336 (9.9929)	1.3113*** (0.4828)	-0.7951 (0.5764)	-1.5524* (0.8503)	9.0132* (4.6348)	0.5478 (0.4413)
Chemicals, Rubber & Plastics	6.5276 (2.3960)	0.7904*** (0.1122)	-0.1557 (0.1338)	-1.0471*** (0.1852)	2.1689* (1.0664)	0.8693 (0.8431)
Non Metal Minerals	3.8309 (2.8895)	0.7421*** (0.1353)	0.0129 (0.1614)	-1.4826*** (0.2234)	3.8616*** (1.2860)	0.8700 (0.8440)
Iron and Steel	7.8487 (4.1603)	1.1073*** (0.1947)	-0.4895** (0.2323)	-1.1716*** (0.3216)	4.0741** (1.8516)	0.7892 (0.7470)
Non-Ferrous Metals	0.9866 (7.5516)	0.9420*** (0.3536)	-0.1309 (0.4217)	-0.9545 (0.5838)	3.3552 (3.361)	0.4588 (0.3506)
Metal Products	1.1429 (2.0469)	0.7411*** (0.0958)	-0.0078 (0.1143)	-0.9359*** (0.1582)	3.3645*** (0.9110)	0.8996 (0.8795)
Automobiles	-5.6666 (4.1379)	0.8253*** (0.1937)	0.06819 (0.2311)	-0.0226 (0.3199)	-1.5538 (1.8417)	0.5720 (0.4864)
Other Transportation	-4.2139 (6.2384)	0.8726*** (0.2921)	0.0237 (0.3484)	-0.6447 (0.4822)	3.7650 (2.7765)	0.5128 (0.4154)
Electric and Electronic Products	-2.4572 (2.1888)	0.7701*** (0.1024)	0.0112 (0.1222)	-0.4332** (0.1692)	3.89894*** (0.9742)	0.8678 (0.8414)
Machinery	1.7059 (2.4589)	0.7793*** (0.1151)	0.0928 (0.1373)	-1.0324*** (0.19)	4.4067*** (1.0943)	0.8879 (0.8654)
Other Manufacturing	-0.3256 (2.4479)	0.9111*** (0.1146)	-0.1596 (0.1367)	-0.4918** (0.1892)	1.6052 (1.0895)	0.8405 (0.8085)

Note: 1) Number of observations in the sectoral analysis is 25.

2) ***, **, * means significant at 99%, 95% and 90% level, respectively.

Among the manufacturing sectors, the distance effect is greater on heavy and

[16] Frankel argues that the physical transport costs are not necessarily the most important component of costs associated with distance. Rather, the cost associated with transport time and cultural unfamiliarity may be greater, and, according to him, these costs are more important for manufactured goods than for agriculture.

chemical products than on light products. Petroleum & coal products, chemicals, rubber & plastic products, and steel and machinery, in particular, have higher coefficients, which means that trade volumes in these sectors are greatly dependent on distance factors such as transport costs, transport time and market access barriers. In contrast, textiles, leather products and wearing apparel have relatively lower distance effects, indicating that shipping costs and market access barriers are not as high as for other heavy and chemical products.[17] On the other hand, in the case of automobiles and transportation equipment, the distance effect proved to be insignificant, meaning that Korean companies are engaged in an active export strategy that goes beyond geographical barriers.

The TCI variable is highly significant and has a positive coefficient in the heavy and chemical sectors and was not very significant in the primary and light industrial sectors. Therefore, we can expect that Korea's heavy and chemical sectors will increase their bilateral trade volumes more by trading with those countries having complementary trade structures. Chemical products, steel, machinery, electronic & electric products and non-ferrous metal products, in particular, have higher coefficients (above 3), indicating that the trade flows in these sectors are most affected by complementary trade structures.

3. The Effect of a Regional Trading Arrangement on Korea's Bilateral Trade Flows

3.1. Regression Analysis on Aggregated Trade

While distance and cultural unfamiliarity act as resistance factors for bilateral trade flows, trade liberalization achieved by a regional trading arrangement can be a facilitating factor. International trade theories emphasize the trade creation effect of FTAs, or Customs Unions, caused by the efficient allocation of resources and economies of scale as a result the elimination of tariff and non-tariff barriers and the free movement of production factors, such as labor and capital.

Frankel (1997) and Garman (1999) tried to measure the effect of regional economic integration on bilateral trade flows econometrically. Frankel included the EU, NAFTA, APEC and Mercosur as dummy variables in his gravity equation and proved that there is a close positive correlation between bilateral trade flows and regional economic

[17] Although Korea's exports of textile and apparel products to EU and the U.S markets face import restriction under MFA (Multifiber Agreement), the level of import quota allowed to Korean products are high enough to absorb Korea's production capacity. In contrast, heavy and chemical products such as electric and electronic products and iron and steel products often suffer from high market access barriers in the form of antidumping or safeguard measures by developed countries.

arrangements. Garman also tried to estimate the positive effect of different forms of economic integration on intra-regional trade among Latin American countries.

Therefore, in this chapter, using the gravity model, we will try to empirically analyze the effect of regional trading arrangement on Korea's bilateral trade flows. As Korea is not yet a member of any regional trading blocs, we instead included the APEC bloc as a dummy variable for our gravity equation since it is a loose form of regional economic cooperation with high degree of expectation for trade liberalization. We tried to capture APEC effect, that is, the effect of regional economic arrangement on Korea's bilateral trade flows. The OLS regression results of the equation (4) are reported in Table 5.

<Table 5> Comparison of Regression Results before and after including APEC Variable

Explanatory Variables	Without APEC variable			With APEC variable		
	Unstandardized coefficient	t-statistics	Standardized Coefficient (β - coefficient)	Unstandardized coefficient	t-statistics	Standardized Coefficient (β - coefficient)
Constant	5.111** (2.275)	2.247	-	1.659 (1.857)	0.894	-
Product of GDPs	0.727*** (0.105)	6.934	0.657	0.721*** (0.078)	9.213	0.651
Product of per capita GDPs	-0.04882 (0.130)	-0.376	-0.037	0.007482 (0.098)	0.077	0.006
Distance	-0.794*** (0.174)	-4.574	-0.385	-0.492*** (0.145)	-3.390	-0.239
TCI	3.038*** (0.982)	3.094	0.271	1.933*** (0.771)	2.506	0.173
APEC	-	-	-	1.100*** (0.240)	4.576	0.330
Numbers of observation	30			30		
R^2	0.845			0.917		
Adjusted R^2	0.821			0.900		

Note: 1) The numbers in parenthesis are standard deviations.
2) *** and ** mean significant at 99% and 95% level, respectively.

In this equation, R-squared increased by 7.2 percent point, from 0.845 to 0.917, meaning that the explanatory power of the model was enhanced by including the APEC variable. The GDP variable is still highly significant but its coefficient is lower than it was in the equation without the APEC variable, suggesting a decrease in the influence of overall market size on Korea's bilateral trade flows. This is because Korea, through trade liberalization processes within APEC, is expected to diversify its trade direction, shifting from large economies, such as the U.S. and Japan, toward small and middlesized economies in Southeast Asia and Latin America.[18]

The coefficient for the distance variable dropped by more than 0.3, from –0.794 to – 0.492, compared to the estimated results of equation (3). The drastic reduction of the distance effect reflects the positive influence of the APEC bloc, that is, the effect of trade liberalization, or economic integration, on Korea' trade flows, through which the geographical distance is converted into a shortened form of economic distance.

The TCI variable is also statistically significant, however, its coefficient dropped considerably after the inclusion of the APEC variable, indicating the reduced influence of the TCI on Korea's bilateral trade. Therefore, bilateral trade flows are expected to expand further regardless of the two countries' trade structures, whether complementary or competitive, as a result of the trade ongoing liberalization processes within the APEC bloc. Unlike the results of equation (3), the calculations from equation (4) show that bilateral trade structure whether it is complementary of competitive, will no longer be a critical factor for Korea in expanding its bilateral trade flows.

The APEC variable is highly significant, with positive coefficient of 1.100, which means that if Korea's trading partner belongs to APEC, Korea's bilateral trade flows with that country will be 3 times as much as those with a non-APEC country.[19] This estimate is similar to the regression results obtained by Frankel (1997) where the APEC coefficient was estimated to be 1.2 (3.3 times).

The positive effect of the APEC variable on bilateral trade flows is especially encouraging considering the peculiarity of APEC as a regional trading bloc. Unlike the EU or NAFTA, whose members are engaged in a concrete form of free trade agreement, APEC is only a loose form of economic cooperation without any binding commitments to trade liberalization. However, even by assuming APEC is a regional trading arrangement, the negative effects of distance and competitive trade structures on bilateral trade flows are greatly reduced, thus leading to the significant expansion of bilateral trade flows. Accordingly, if Korea establishes a concrete regional trading arrangement such as an FTA with its neighbors, the trade expansion effect is expected to be still greater.

To see the relative influence of explanatory variables in this new equation, we estimated the standardized coefficient for each variable. The most influential variable is

[18] Actually, the ratio of trade with U.S. and Japan, which accounted for almost 1/2 of Korea's total trade, has been gradually decreasing since the 1990s, while the ration of trade with ASEAN countries, in Korea's total trade, increased by 6% in 1985 and by 10% in 1995, showing that Korea's trade with other developing countries is becoming more active.

[19] As the trade variable takes the form of a natural logarithm, we should interpret this as [exp(1.10)= 3.004], meaning an increase in trade flows of more than 3 times.

the GDP variable, which explains 47% of the ability to predict the variability of Korea's bilateral trade flows, followed by the APEC dummy variable with 24%. Compared to the result of equation (3), the relative influence of distance and the TCI on bilateral trade flows dropped sharply from 29% and 21% to 17% and 12%, respectively.

3.2. Regression Analysis of Disaggregated Trade by Sector

We disaggregated trade into 23 sector in order to estimate the APEC bloc effect by sector based on equation (4). R-squared has risen in most sectors when compared to equation (3). This implies that the gravity equation that includes the APEC variable is better able to provide a sectoral analysis of bilateral trade flows.

The GDP variable is also statistically highly significant in most sectors but its coefficient does shows a decreasing trend. The decrease is most outstanding in steel, chemicals, electronic & electric products, mineral products, and petroleum, implying that, in these sectors, the influence of the overall market size in determining bilateral trade flows will be particularly reduced.

<Table 6> OLS Regression Results for Gravity Model with APEC included

Sectors	Constant	Product of GDPs	Product of per capita GDPs	Distance	TCI	APEC	R^2 (Adjusted)
Agriculture	0.5569 (7.1721)	1.2412*** (0.3150)	-0.8063** (0.3774)	0.0433 (0.5660)	0.8167 (3.0973)	2.8433*** (0.9451)	0.6594 (0.5698)
Livestock	-13.7335 (8.032)	0.6780* (0.384)	0.7650* (0.441)	-0.7330 (0.661)	-0.6374 (3.6333)	-0.0510 (1.0985)	0.4356 (0.2790)
Forestry	-12.6227 (10.5473)	-0.1566 (0.4774)	-0.0395 (0.5671)	1.2050 (0.8284)	-1.3348 (4.6583)	4.0453** (1.4576)	0.3483 (0.1310)
Fisheries	-10.0942 (8.7717)	0.2137 (0.3853)	0.2404 (0.6923)	-0.4058 (3.7881)	-0.4058 (3,7881)	2.5016** (1.1559)	0.2644 (0.0708)
Minerals	0.0546 (6.5476)	1.0483*** (0.2876)	-0.7767** (0.3445)	0.3036 (0.5168)	0.3426 (2.8276)	3.4997*** (0.8628)	0.6913 (0.6101)
Foods	-1.3759 (4.3806)	0.6742*** (0.1924)	-0.0957 (0.2305)	-0.2472 (0.3457)	0.8288 (1.8918)	1.5193** (0.5773)	0.6520 (0.5603)
Beverages and Tobacco	-21.42 (6.2403)	1.4800*** (0.2722)	0.3059 (0.3320)	-0.2001 (0.4934)	-1.9062 (2.6777)	1.1690 (0.8266)	0.7256 (0.6749)
Textiles	10.9175 (2.7814)	0.7479*** (0.1222)	- 0.573*** (0.146)	-0.5433*** (0.2195)	-0.7235 (1.2012)	0.9085** (0.3665)	0.8256 (0.7797)
Apparel	-3.533 (4.5103)	1.0022*** (0.1981)	0.0369 (0.2373)	-0.7117** (0.3560)	-0.2695 (1.9478)	0.3446 (0.5944)	0.7287 (0.6573)
Leather Products	3.7132 (2.8104)	0.8834*** (0.1234)	-0.2500* (0.1479)	-0.6410*** (0.2218)	-1.9734 (1.2137)	0.7533* (0.3703)	0.8442 (0.8032)

Wood Products	-5.5387 (5.3524)	0.6755*** (0.2351)	0.0340 (0.2816)	-0.1325 (0.4224)	1.4460 (2.3115)	2.4881*** (0.7053)	0.6862 (0.6036)
Paper Products and Publishing	-5.1378 (4.8845)	0.6969*** (0.2145)	0.0554 (0.2570)	-0.1790 (0.3855)	0.6064 (2.1094)	1.6437** (0.6437)	0.6266 (0.5283)
Petroleum and Coal Products	-1.5459 (8.3698)	1.1933** (0.3821)	-0.4940 (0.4631)	-0.8186 (0.7047)	5.1363 (3.8301)	3.7964*** (1.1167)	0.7355 (0.6529)
Chemicals, Rubber & Plastic	4.0610 (2.0885)	0.7661*** (0.0917)	-0.1107 (0.2099)	-0.8267*** (0.1648)	1.3662 (0.9019)	0.9172*** (0.2752)	0.9175 (0.8958)
Non Metal Minerals	1.6153 (2.8274)	0.7203*** (0.1242)	0.0533 (0.1488)	-1.2850*** (0.2231)	3.1407** (1.2210)	0.8238** (0.3726)	0.8966 (0.8694)
Iron and Steel	4.8827 (4.1413)	1.0780*** (0.1819)	-0.4355** (0.2179)	-0.9065** (0.3268)	3.1089* (1.7885)	1.1028** (0.5457)	0.8265 (0.7809)
Non-Ferrous Metals	-7.7284 (6.0968)	0.8560** (0.2665)	0.0280 (0.3193)	-0.1756 (0.4789)	0.5194 (2.6207)	3.2404*** (0.7997)	0.7097 (0.6333)
Metal Products	-0.5943 (1.9441)	0.7240*** (0.0854)	0.0238 (0.1023)	-0.7806*** (0.1534)	2.7992*** (0.8396)	0.6459** (0.2562)	0.925 (0.905)
Automobiles	-6.6670 (4.4935)	0.8154*** (0.1974)	0.1002 (0.2364)	0.0671 (0.3546)	-1.8802 (1.9406)	0.3730 (0.5921)	0.5807 (0.4704)
Other Transportation	-4.4527 (6.8431)	0.8703*** (0.3005)	0.0280 (0.3601)	-0.6233 (0.5401)	3.6871 (2.9552)	0.0888 (0.9018)	0.5131 (0.3849)
Electric and Electronic Products	-4.5647 (1.9765)	0.7493*** (0.0868)	0.0496 (0.1040)	-0.2449 (0.1560)	3.3037*** (0.8536)	0.7836*** (0.2605)	0.9105 (0.8869)
Machinery	0.4636 (2.5752)	0.7670*** (0.1131)	0.1154 (0.1355)	-0.9214*** (0.2032)	4.0025*** (1.1121)	0.4619 (0.3394)	0.8978 (0.8709)
Other Manufacturing	-2.4553 (2.3051)	0.8901*** (0.1012)	-0.1208 (0.1213)	-0.3014 (0.1819)	0.9122 (0.9955)	0.7919** (0.3038)	0.8825 (0.8516)

Note: ***, **, * means significant at 99%, 95% and 90% level.

The influence of the APEC variable on distance is also noticeable as seen in Table 7. Before adding the APEC variable, there were 12 sectors for which the distance variable was a significant factor. However, after including the APEC variable, the distance variable lost its significance in 4 sectors (petroleum, wood product, electronic and electric products and other manufacturing) and even in the remaining 8 sectors, the distance coefficients saw drastic decreases. Therefore, with the acceleration of APEC trade liberalization, the negative effect of distance on trade is likely to be offset or reduced, resulting in the expansion of trade flows in most sectors. As seen in the regression analysis of aggregate trade, physical distance will be replaced by economic distance being shortened through the harmonization of transportation systems and trade rules, as well as by cooperation in the market access area, thus facilitating bilateral trade flows.

<Table 7> Changes in the Distance Coefficient caused by the APEC Bloc Effect

Sector	Without APEC variable	With APEC variable
Textiles	-0.717	-0.543 ↓
Apparel	-0.795	-0.712 ↓
Leather Product	-0.822	-0.641 ↓
Wood Products	-0.191	ns
Petroleum and Coal Products	-1.552	ns
Chemical, Rubber and Plastic	-1.047	-0.827 ↓
Non-Metal Mineral	-1.483	-1.285 ↓
Iron and Steel	-1.172	-0.907 ↓
Metal Products	-0.955	-0.781 ↓
Electric and Electronic products	-0.433	ns
Machinery	-1.032	-0.921 ↓
Other Manufacturing	-0.492	ns

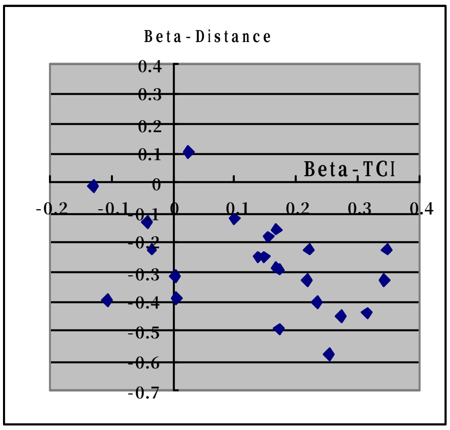
Note: ↓means the decrease in distance coefficient and "ns" means that the distance variable is not significant anymore.

The coefficient of the TCI variable also shows a decreasing trend in most sectors, particularly, in heavy industries such as steel, electronic and electric products, and metal products.

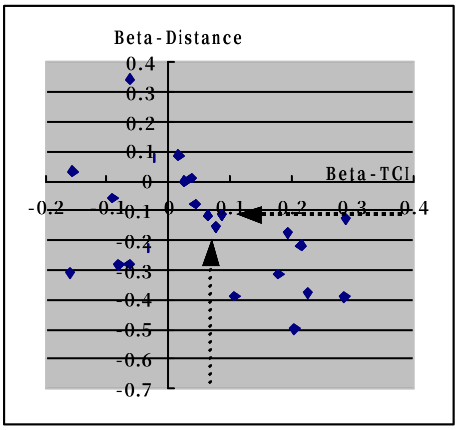
The impact of the APEC variable on distance and the TCI are clearly demonstrated in the following chart by considering the ß-coefficient for each variable.

As seen in Chart <1-a> and Chart <1-b>, the ß-coefficients for the distance variable are rising, while the ß-coefficient for the TCI variable are decreasing in most sectors after including the APEC variable. Therefore, if a deeper level of trade liberalization is achieved through APEC, the negative effect of distance and the importance of trade complementarity on bilateral trade flows will be reduced in most sectors.

<Chart 1> Changes in b -coefficients of Distance and TCI Variable



(a) Without APEC variable



(b) With APEC variable

V. Policy Implications

The gravity model analysis of Korea's trade patterns provides important implications for Korea's trade policy, in particular for Korea's FTA choice and North-South Korean trade relations. Discussed below are these two major policy implications.

1. For Korea's FTA Choice

We compared the predicted bilateral trade flows estimated by equation (4) with the actual trade flows and found the following implications.

First of all, there were 13 countries, including Indonesia, Sri Lanka, Chile, Singapore, German, Brazil, Italy, France, Malaysia, Turkey, United States, Australia and England whose actual bilateral trade flows with Korea exceeded the predicted value (over 105%), and Indonesia, Sri Lanka, Chile and Singapore, in particular, recorded actual trade flows that were more than twice as much as the predicted values. Germany and Brazil also posted actual trade flows 1.5 times greater than the predicted value. Therefore, we can infer that other factors not considered by gravity model may be facilitating Korea's bilateral trade with these countries. Korea, for example, is trading with Chile far more than predicted by gravity equation because almost half of copper products are imported from this country.

Secondly, the countries whose actual bilateral trade flows with Korea were generally consistent with the predicted values were Taiwan (101%), New Zealand (99%), Sweden (98%) and Hong Kong (96%). We can say that Korea's trade patterns with these countries are generally explained by the gravity model.

In contrast, there were 13 other countries whose actual trade flows were smaller than the predicted values (less than 95%), including China, Colombia, the Philippines, Canada, Japan and Mexico. China, Canada and Japan, even with their large economies, showed relatively lower levels of actual bilateral trade flows than predicted, corresponding to 85%, 68% and 67%, respectively. We can, therefore, assume that there exist other important trade impeding factors leading to a considerable level of "missing trade", which cannot be explained in our gravity model.

<Table 8> Actual and Predicted Trade Flows

(Unit: US$ billion, %)

Country		Actual Trade Flows(T_{ij}) (1995)	Predicted Trade Flows($\hat{}T_{ij}$)	T_{ij}/^ T_{ij} (%)
1	Indonesia	6118	2452	249
2	Sri Lanka	291	120	242
3	Chile	1583	668	237
4	Singapore	7617	3775	202
5	Germany	10897	6328	172
6	Brazil	2439	1593	153
7	Italy	4400	3293	134
8	France	5620	4271	132
9	Malaysia	5001	4105	122
10	Turkey	662	583	114
11	U.S.	50184	45845	109
12	Australia	5039	4717	107
13	England	4087	3867	106
14	Taiwan	6166	6123	101
15	New Zealand	989	1003	99
16	Sweden	1116	1137	98
17	Hong Kong	6401	6666	96
18	China	19165	22343	86
19	Columbia	262	310	85
20	Philippines	2003	2530	79
21	Denmark	668	868	77
22	Finland	723	994	73
23	Uruguay	62	86	72
24	Argentina	495	726	68
25	Canada	3830	5616	68
26	Japan	46896	70059	67
27	Thailand	3342	5231	64
28	Venezuela	190	307	62
29	Morocco	57	117	49
30	Mexico	1164	4004	29

Source: GTAP Statistics (1995).

The trade with Japan and China, in particular, possessing all the favorable conditions needed to expand trade, such as large economic size and geographical and cultural proximity, fall far short of our expectations, recording a missing trade of 15% and 33%. This contrasts to the Korea-U.S. case where actual bilateral trade flows exceeded the predicted values in spite of the large distance between the two countries. This is mainly because Korea has been maintaining a relatively competitive trade structure with both Japan and China. The stagnant bilateral trade flows between Korea and Japan may, especially, be attributed to Korea's Import Sources Diversification Program and to Japan's complicated non-trade barriers in hidden form of distribution channels and business practices.

Accordingly, in order to expand trade with China and Japan, it is necessary for Korea to seek ways by which to facilitate the bilateral trade flows while overcoming the existing trade barriers and competitive trade structures. As seen in the previous chapter, the APEC variable, which represents a loose form of a regional trading arrangement, reduces the negative effect of distance and of trade structures on bilateral trade flows, thus creating a trade expansion effect. If Korea establishes an FTA with Japan or China, it is expected to enjoy not only the benefits of trade creation effect but also the restoration of missing trade through the elimination of unnecessary trade barriers.

Therefore, it would be desirable for Korea to pursue an active regional approach, such as the formation of an FTA with Japan and China. An FTA with Japan or China is likely to bring about closer cooperation in competitive sectors, enhanced productivity and a higher level of intra-industry trade, thereby expanding bilateral trade and investments and stimulating mutual economic growth.

2. For North-South Korean Trade

Another important policy implication of gravity model analysis can be found by comparing the actual and predicted bilateral trade flows between South and North Korea. The bilateral trade, which started since 1988, has been steadily growing in the wake of the opening of political dialogue and improvement of South-North relations, posting a record high of 0.3 billion dollars in 1999. However, considering the geographical proximity and adjacency and trade complementarity, of the two, the bilateral trade falls far short of our expectation due to the peculiarity of the South-North Korea relations. Much of the trade between South and North Korea has been conducted within the unilateral assistance framework of non-commercial characteristics rather than the mutual exchange based on commercial interest. The actual trade[20] between South

[20]Actual trade means commercial trade based on the real exchange of the goods and consignment processing.

and North Korea in 1999 accounted only for 52% of the nominal trade. Moreover, 85% of the South-North trade is conducted in an indirect way through the intermediary in the third country.

We can estimate the discrepancy between the predicted and actual trade flows between North and South Korea by using the same gravity model in the previous analysis.

Due to the unavailability of data, we used GNP instead of GDP for North Korea's economic size and assumed four different scenarios where TCI with North Korea is 0.2, 0.4, 0.6, 0.8, respectively.[21] Table 9 shows the actual and predicted trade flows under the different scenarios.

<Table 9> Actual and predicted flows between South and North Korea

(Unit: US$ million)

	North Korea's APEC membership	TCI=0.2	TCI=0.4	TCI=0.6	TCI=0.8
Predicted trade flows	No	661.3	973.3	**1,432.6**	2,108.8
	Yes	1,986.4	2,923.9	**4,303.9**	6,335.1
Actual trade flows		290			

In comparing the actual and predicted bilateral trade flows, we regard that TCI=0.6 is the most appropriate value among the four TCIs assumed to describe the current bilateral trade structure. This is because the trade between South and North Korea is based on the complementary structure. Main products imported from North to South Korea are primary products and textiles, each accounting for more than 60% of the total imports from the North. Exports from the South to the North, on the other hand, are dominated by manufacturing products mainly machinery and transport equipment and textiles.

Therefore, taking TCI=0.6 as criteria and assuming that North Korea will not become a member of APEC, we can observe that the actual trade of South Korea with North Korea (US$ 290 million) is representing only one fifth of the predicted value (US$ 1.43 billion). This means that if both South and North try to exploit their trade potential by liberalizing unnecessary barriers and expanding direct bilateral trade, the trade flows

[21] Refer to Appendix Table 3 for data on North Korea.

between them could expand five times that of the actual trade level as much.

Moreover, if we assume that North Korea will join APEC in a near future, the trade flows between North and South Korea is expected to expand three times that before the APEC membership, reaching to US$ 4.3 billion.

Therefore, South Korea needs to promote closer economic relations with North Korea, while supporting North Korea's gradual opening of its economy and successful incorporation into the multilateral trading system. In this way, both countries will fully exploit their trade potential and achieve mutual economic development.

VI. Conclusions

Korea, a small economy scarcely endowed with natural resources, has emerged as a major exporter and producer in the world economy during the last few decades. Its rapid economic growth has primarily been achieved through an active trade policy aimed at the strategic development of export industries, based on comparative advantage. Recognizing the importance of international trade in the Korean economy, this study attempted to analyze Korea's trade patterns empirically, based on "the Gravity model," one of the most efficient models in explaining international trade volume and to identify the determinant factors of Korea's bilateral trade flows and effective ways to expand these flows.

According to the results of this study, Korea's bilateral trade patterns follow the basic gravity model, implying that bilateral trade flows will increase in proportion to the trading partner's GDP and decrease in proportion to the distance involved. Therefore, in order to expand bilateral trade flows, it appears to be more desirable for Korea to promote bilateral trade with countries in close proximity and having large economies. Per capita GDP, in contrast, turned out to be an insignificant factor in determining Korea's bilateral trade flows. This implies that Korea's trade patterns follow a GDP pattern, concentrating on the production and export of quantity-based products and depending on overall market size, rather than a per capita GDP pattern centering on the export of quality-based high value added products which are sensitive to the levels of income.

We also analyzed the possible impact of complementary trade structures on Korea's bilateral trade flows and found that Korea's bilateral trade flows increase in proportion to the trade complementarity (TCI). Accordingly, it seems that Korea's trade patterns are based on inter-industry trade rather than on intra-industry and Korea's bilateral flows are expected to increase more when its trading partner possesses a complementary structure rather than a competitive one. The reason why Korea trades more actively with remote countries, such as the U.S., than it does with those in close proximity, such as China and Japan can be attributed to Korea's relatively higher degree of trade complementarity with the U.S.

Finally, we estimated the effect of regional trading arrangement on Korea's bilateral trade flows and it turned out to be a facilitating factor for increasing bilateral trade flows. The positive effects of regional trading arrangement appear in various forms, one of which being the shortening of economic distance. With the formation of a regional trading arrangement, such as an FTA, the physical distance will be replaced by a reduced form of economic distance, thereby expanding trade indirectly. The second positive effect of a regional trading arrangement is the trade creation effect, which takes place in overcoming the existing trade structures. In Korea's case, where inter-industry trade is more dominant, trade complementarity acts as a crucial factor in determining bilateral trade flows. However, with the formation of an FTA, bilateral trade flows are expected to increase regardless of the trade structure, whether it is complementary or competitive.

As gains of international trade became more plausible amid the intensification of globalization, Korea is also seeking ways to reap the full benefit of trade liberalization and market opening. It is basically assumed that Korea will expand trade more with large economies in close proximity and possessing higher degrees of trade complementarity. However, by forming a regional trading arrangement, Korea could facilitate bilateral trade beyond the given constraints as a result of the trade creation effect and restoration of missing trade. Therefore, in order to expand bilateral trade and maximize the benefits of trade liberalization, it would be desirable for Korea to pursue an active regional approach, such as the formation of an FTA with countries like China and Japan, while promoting closer trade relations with North Korea.

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Appendix

< Table 1 > Data for the Gravity Model

	Country	T_{ij}	GDP_j	Per capita GDP_j	$Distance_{ij}$	TCI_j
1	Australia	5,039	363	20,090	5,160	0.542
2	New Zealand	989	60	16,959	6,205	0.460
3	Japan	46,896	5,137	41,033	716	0.444
4	Korea	-	489	10,853	-	-
5	Indonesia	6,118	201	1,038	3,278	0.320
6	Malaysia	5,011	87	4,342	2,864	0.859
7	Philippines	2,003	74	1,055	1,624	0.530
8	Singapore	7,617	85	23,590	2,900	0.821
9	Thailand	3,342	168	2,834	2,311	0.686
10	China	19,165	711	582	542	0.536
11	Sri Lanka	291	13	719	3,627	0.377
12	Canada	3,830	574	19,386	6,546	0.522
13	U.S.	50,184	7,625	27,621	6,544	0.642
14	Mexico	1,164	287	3,168	7,494	0.647
15	Colombia	262	81	2,294	9,226	0.418
16	Chile	1,583	65	4,593	11,495	0.382
17	Uruguay	62	18	5,657	12,175	0.382
18	England	4,087	1,112	18,965	5,519	0.608
19	Germany	10,897	2,414	29,562	5,348	0.564
20	Denmark	668	181	34,596	4,950	0.482
21	Sweden	1,116	231	26,194	4,631	0.515
22	Finland	723	126	24,642	4,400	0.659
23	Turkey	662	172	2,792	4,821	0.298
24	France	5,620	1,535	26,403	5,587	0.541
25	Italy	4,400	1,088	18,988	5,584	0.536
26	Taiwan	6,166	260	12,264	922	0.365
27	Argentina	495	280	8,042	12,055	0.459
28	Brazil	2,439	704	4,517	11,396	0.510
29	Hong Kong	6,401	139	22,456	1,307	0.729
30	Morocco	57	33	1,250	6,741	0.173
31	Venezuela	190	77	3,657	9,001	0.425

Note: 1) Trade value (T_{ij}) is the sum of total exports and imports between Korea(i) and its trading partner. 1 billion Dollars.
2) The unit for GDP is 1 billion U.S. dollars.
3) The unit for Per capita GDP is 1 U.S. dollar.
4) Distance means great circle distance between Seoul and the capital city of its trading partner. The unit is in miles.
5) TCI represents the degree of trade complementarity between Korean and its trading partner, $0<TCI<1$.
6) TCI_j of Sri Lanka is based on 1994 data.
7) TCI_j of Taiwan is an estimated value.

Source: Bank of Korea [National Account], 1988.
IMF [International Financial Statistics] 1999. 6.
Taiwan [Financial Statistics] 1999. 4.

<Table 2> TCI for Korean Exports

Importing Country	TCI(1995)	Importing Country	TCI(1995)
Algeria	0.219	Kenya	-
Argentina	0.459	Korea	0.598
Australia	0.542	Latvia	0.261
Austria	0.490	Lithuania	-
Bangladesh	-	Madagascar	0.187
Denmark-Luxembourg	0.347	Malawi	0.209
Bolivia	0.343	Malaysia	0.859
Brazil	0.510	Mexico	0.647
Bulgaria	-	Morocco	0.173
Cameroon	0.241	Mozambique	-
Canada	0.522	Netherlands	0.487
Central African Rep.	0.194	New Zealand	0.460
Chile	0.382	Nicaragua	0.184
China	0.536	Norway	0.493
Colombia	0.418	Pakistan	0.202
Congo	-	Panama	0.353
Costa Rica	0.326	Paraguay	0.351
Croatia	0.277	Peru	0.388
Czech Republic	0.444	Philippines	0.530
Denmark	0.482	Poland	0.394
Ecuador	0.353	Portugal	0.513
Egypt	0.198	Rumania	0.294
El Salvador	0.322	Saudi Arabia	-
Estonia	-	Singapore	0.821
Finland	0.659	Slovakia	0.326
France	0.541	Slovenia	0.442
Gabon	-	South Africa Rep.	0.360
Germany	0.564	Spain	0.394
Ghana	-	Sri Lanka	-
Greece	0.396	Sweden	0.515
Guatemala	0.328	Switzerland	0.463
Honduras	0.213	Thailand	0.686
Hong Kong	0.729	Tunisia	0.370
Hungary	0.406	Turkey	0.298
Indonesia	0.320	Unite Kingdom	0.608
Ireland	0.567	Uruguay	0.382
Israel	0.295	United States	0.642
Italy	0.536	Venezuela	0.425
Jamaica	0.327	Yugoslavia	-
Japan	0.444	Zimbabwe	0.317
Jordan	0.215		

Source: Patrick J. Gormely and John M. Morrill (1998), *Korea's International Trade in Goods: The Potential for Increased Exports to and Imports from Trade partners.*

<Table 3> Data onNorth Korea

Population	23,261 thousand
Distance	125 miles
Nominal GNP	US$ 22.3 billion
Per capita Nominal GNP	US$ 957
Trade volume with Korea (1995)	US$ 287 million

Source: KIEP (1996).

國文要約

본 연구의 목적은 '중력모형'을 토대로 우리나라의 교역패턴을 실증적으로 분석하고 양국간 교역규모를 결정하는 구체적 요인을 규명함으로써 교역규모를 더욱 확대시킬 수 있는 방안을 모색하고자 하는 것이다. 중력모형은 양국간 교역이 거리에 반비례하고 경제규모에 비례한다는 가정에 기초한 모형으로 그동안 국제무역이론에서 간과되어 왔던 거리, 인구, 인접여부 등 지리적 요인까지 고려함으로써 양국간 교역량을 설명하는 적절한 모형의 하나로 알려져 있다. 본 연구에서는 특히 중력모형의 기본설명변수인 GDP 와 거리 및 인구이외에도 무역보완도지수(TCI)와 APEC 을 새로운 설명변수로 추가하여 우리나라의 교역패턴이 헥셔올린모델과 제품차별화 모델 중 어느 모델에 더 잘 부합하는지의 여부와 지역경제권이 우리나라 교역에 미치는 영향을 살펴보고자 하였다.

본 연구에 의하면 중력모형은 우리나라의 양국간 교역규모와 패턴을 설명하는데 있어서 매우 적합한 모형인 것으로 나타났다. 즉, 우리나라는 거리가 가깝고 경제규모가 큰 국가와의 교역규모가 더 큰 것으로 확인되었다. 또한 무역보완도가 높을수록 양국간 교역규모도 증가하고 있어 우리나라의 교역패턴이 산업내 교역보다는 헥셔올린모델에 기초한 산업간 교역의 형태를 띠는 것으로 나타났다. 이와 함께 APEC 회원국들간의 교역규모가 비원국보다 더욱 큰 것으로 나타나고 있어 지역경제권의 중요성이 확인되고 있다.

중력모형에 기초한 우리나라의 교역규모에 대한 실증분석을 통해 다음과 같은 중요한 정책시사점을 발견할 수 있다.

첫째, 중력모형에 의해 예측된 양국간 교역규모와 실제교역규모를 비교해 보면 일본, 중국 등의 경우 예상교역규모 대비 실제교역규모 비율이 각각 85%, 67%로 상당한 교역미달치(missing trade)가 나타나고 있다. 이는 즉 양국간에 높은 무역장벽이 존재하고 있음을 간접적으로 시사하는 것이라고 할 수 있다.. 따라서 한국이 일본, 중국과 FTA 를 체결할 경우 FTA 자체에 따른 무역창출효과이외에도 교역장벽의 철폐 또는 완화로 인해 교역미달치(missing trade)가 바람직한 수준으로 회복되는 추가적인 효과를 기대해 볼 수 있다.

둘째, 중력모형을 남북한 교역에 적용한 결과 남북간 실제교역규모(2 억 9 천만 달러)가 중력모형에 의해 예측되는 정상교역규모(14 억 달러)의 1/5 에 불과한 것으로 나타났다. 따라서 양국이 정상적인 교역관계를 회복하고 무역

장애요인을 제거하는 경우 교역이 5 배 이상 대폭 확대될 수 있을 것으로 기대된다. 더 나아가 북한이 APEC 에 가입하여 시장개방 및 역내무역자유화를 적극 수용하는 경우 남북간 교역규모는 북한의 APEC 가입전 보다 3 배 이상 증가하여 약 43 억 달러까지 확대될 수 있을 것으로 추정된다.

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