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A Gravity Model Analysis of the Benefits of Economic Integration in the Pacific Rim

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Abstract

A modified gravity model of international trade is used to evaluate determinants of flows of commodities most often traded in the Pacific Rim. It is shown that the gravity model can be reparameterized effectively by using time series and cross section data rather than using cross section data alone. Documented evidence indicates that all independent variables including income, export and

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import unit values, exchange rates, and membership in regional trade groups are major determinants of trade flows in the Pacific Rim. Specifically, membership in the ASEAN significantly increased trade creation among members as well as fostered trade diversion from members to nonmembers. However, the impact of membership in the NAFTA on trade flows in the Pacific Rim is limited and appears to be commodity specific. (**JEL Classifications**: F15, F14, F02) <**Key Words** : pacific rim, economic integration, generalized gravity model, ASEAN, NAFTA>

I. Introduction

The potential for regional economic integrations to increase trade among partners has been long recognized in the international trade literature. For instance, Aiken [1973] and Balassa [1975] showed that European economic integrations under both the European Community (EC) and the European Free Trade Agreement (EFTA) significantly increased inter-member trade flows. Brown *et al.* [1990] analyzed and documented the effects of a more recent North American economic integration, *i.e.* the North American Free Trade Agreement (NAFTA). Karemera and Koo [1994] empirically evaluated the trade expansion effects of the US-Canada free trade agreement. However, only a few studies have been devoted to the empirical examination of the trade benefits of an economic integration in the Pacific Rim, especially the Asian members of the region. Yamazawa [1992] offers an excellent survey of Pacific Rim's subregional groupings that seem to operate in a loose form of trade arrangements. His survey, however, does not provide a well defined empirical analysis of the benefits of a free trade agreement among the countries of the Asian Pacific Rim, and does not bring a needed focus on the Asian members of the region. It is on account of this vacuum that the current study has specific relevance. This study uses the gravity model of international trade to provide a quantitative assessment of the benefits of free trade agreements in the Pacific Rim.

Formal theoretical foundations for the gravity model are provided in Anderson [1979] and Bergstrand [1985, 1989]. Bergstrand provides a sound theoretical foundation for the gravity model and generalizes the conventional model. The traditional gravity model contains the following three variable components:

1. Economic factors affecting trade flows in the exporting country
2. Economic factors affecting trade flows in the importing country
3. Natural or artificial factors enhancing or restricting trade flows between trading partners.

The gravity model has been used to evaluate aggregate bilateral trade flows between pairs of countries (Linneman [1966]; Anderson [1979]; Bergstrand [1985, 1989] and Summary [1989]). We modified this model further to permit an examination of the benefits and determinants of trade flows in an economically integrating Pacific Rim. In this study, the gravity model is specified and reparameterized into a time series and cross-sectional framework. This modified model is then used to evaluate trade flow effects of the most often traded commodities among the Pacific Rim countries. Furthermore, the effects of subregional groups on Pacific Rim trade are examined.

The rest of the paper is organized as follows: Section II highlights the importance of integration in the Pacific Rim. Section III provides a review of gravity models while section IV presents the particular empirical methodology used in this study. Section V presents a review of procedures and data sources. Section VI discusses the estimated results and the relative benefits to specific industries. The last section summarizes the results and concludes the paper.

II. The Importance of Economic Integration in the Pacific Rim.

The Pacific Rim comprises the world's largest and fastest growing internal markets (Eichengreen and Frankel [1995]). It currently has both countries with the largest per capita income growth and potential growth in purchasing power. As the trend towards regional trade groupings continues, negotiations for an Asian Pacific Economic Cooperation or APEC-wide free trade agreement are under way. At the APEC summit in Bogor, Indonesia, the APEC countries expressed commitment to the creation of a free trade zone by the year 2020. That commitment was first discussed during the APEC meeting in Seattle, Washington in November of 1993. It is now routinely reiterated in subsequent association meetings. The most advanced nations in the region are expected to provide the lead and pursue free movements of

Table 1
1993 Profiles of Countries of the Asia-Pacific Economic Cooperation (APEC)

Country	Population (Mil.)	Per Capita GDP (Mil. of U.S. $)	Merchandise Trade		Subregional Trade Group[1]
			Imports (Mil. of U.S. $)	Exports (Mil. of U.S. $)	
Australia	17.66	15.87	45,577.0	42,723.0	Australia-New Zealand TA
Canada	28.94	18.57	139,035.0	145,178.0	NAFTA, U.S.-Canada FTA
China	1,196.40	0.45	103,088.0	90,970.0	
Hong Kong	5.92	18.53	138,658.0	135,248.4	
Indonesia	189.14	0.83	28,327.8	36,823.0	ASEAN
Japan	124.70	33.41	241,624.0	362,244.0	
Malaysia	19.25	3.14	45,657.1	47,121.7	ASEAN
Mexico	91.21	3.98	50,147.3	30,241.4	NAFTA
New Zealand	3.46	13.06	9,636.2	10,536.7	Australia-New Zealand TA
Philippines	65.65	0.81	18,754.4	11,088.7	ASEAN
Singapore	2.87	20.01	85,234.0	74,011.6	ASEAN
South Korea	44.06	7.50	83,800.0	82,236.0	
Thailand	58.58	2.12	46,208.0	37,168.0	ASEAN
Taiwan	20.84	10.68	n.a.	n.a.	
United States	258.12	24.58	603,438.0	464,773.0	NAFTA, U.S.-Canada FTA

[1] TA designates trade agreement, and FTA designates free trade agreement, and n.a. stands for not available.
Source: International Financial Statistics in Various Issues

goods and services in the APEC countries by the year 2010. The APEC countries included in the analysis are shown in Table 1 below.

As is reported in Table 1, the APEC member countries are Australia, Canada, China, Hong Kong, Indonesia, Japan, Malaysia, Mexico, New Zealand, Philippines, Singapore, South Korea, Thailand, Taiwan, and the United States. Of particular interest in this study are the subregional trade groups in the larger Pacific Rim region. These subregional groups are NAFTA, which comprises Canada, Mexico, and United States; and the Association of South East Asian Nations, ASEAN, which comprises Indonesia, Malaysia, Philippines, Singapore, and Thailand. The descriptive statistics in Table 1 provide

Table 2
Sample of Bilateral Trade Flows for Selected Pacific Rim Countries (000's omitted)

	Average	Year		
		1993	1992	1991
5811: Plastic Materials				
United States imports from Canada	609,801	681,502	596,947	550,953
Japan imports from Canada	266,623	325,208	245,449	229,213
Taiwan imports from Canada	36,787	39,291	35,899	35,172
5812: Refined Plastic Materials				
United States imports from Japan	346,892	350,521	328,418	361,737
Japan imports from South Korea	301,642	321,324	295,941	287,661
Taiwan imports from Japan	82,279	82,361	75,960	88,517
6516: Synthetic Fiber Blends				
United States imports from Canada	214,644	231,748	215,386	196,797
China imports from Hon	242,459	213,942	253,803	259,633
South Korea imports form Japan	45,362	40,756	49,502	45,827
6822: Worked Copper Alloys				
China imports from Hong Kong	116,908	112,714	117,396	120,614
Malaysia imports from Singapore	69,060	99,392	55,814	51,974
United States imports from Japan	32,772	30,298	32,316	35,703
7231: Civil Engineering Equipment				
United States imports from Mexico	871,238	1,349,302	1,163,300	101,111
Malaysia imports from Singapore	109,002	132,233	98,251	96,523
South Korea imports from Japan	32,126	30,683	30,844	34,851
7143: Reaction Engines				
United States imports from Hong Kong	111,991*	n.a.	n.a.	n.a.
South Korea imports from United States	484,593*	n.a.	n.a.	n.a.
Singapore imports from United States	275,609*	n.a.	n.a.	n.a.

* : averages used for year 86-88.
n.a.: not consistent over time and country.

insights into the absorption capacity of the region regarding merchandise flows. Population and GDP figures are provided as a gauge of the markets and sizes involved.

Table 2 provides selected bilateral flows of specific commodities that are most often traded in the region. As can be seen in Table 2, trade flows in the Pacific Rim region seem to be product-specific. For example, Japanese imports of Refined Plastic Materials from Korea increased by 11.70% from 1991 to 1993. In the same period, Malaysia's imports of Civil Engineering Equipment from an ASEAN partner, Singapore, increased by 36.99%. However, in the other groups such as Worked Copper Alloys, imports and exports exhibit trade fluctuations over the sample period.

In summary, this study examines and evaluates trade determinants for the Pacific Rim region. It also examines the implications of the subregional trade arrangements for the entire Pacific Rim trade. The commodity groups included in the analysis are those that are most frequently traded among the APEC member countries during the study period. More specifically, particular attention is paid to the trade group' s effects on the group's members and nonmembers in the context of the Pacific Rim.

III. Development of a Gravity Model

The theoretical derivation of a gravity model follows the standard procedure outlined in the international trade literature. According to Linneman [1966] and Bergstrand [1985, 1989], a gravity model is a reduced-form equation of a general equilibrium of demand and supply systems. The model of trade demand for each country is derived by maximizing a constant elasticity of substitution (CES) utility function subject to income constraints in importing countries. The model of trade supply is derived from the firms' profit maximization procedure in the exporting country, with resource allocation determined by the constant elasticity of transformation. The gravity model of trade flows is then obtained under market equilibrium conditions, where demand for trade flows equals supply of the flows. It follows:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} C_{ij}^{\beta_3} T_{ij}^{\beta_4} P_i^{\beta_5} P_j^{\beta_6} E_{ij}^{\beta_7} I_i^{\beta_8} I_j^{\beta_9} e_{ij} \quad (1)$$

$$i = 1, \ldots, N_1 \quad \text{and} \quad j = 1, \ldots, N_2$$

where

X_{ij} = the dollar volume of trade flows between country i and country j;
$Y_i(Y_j)$ = the national income of country i (j);
C_{ij} = the transportation cost (CIF/FOB) between i and j;
T_{ij} = the other factors either aiding or restricting trade between i and j;
$P_i(P_j)$ = the unit value of export (imports);
E_{ij} = the spot exchange rate (country j's currency in terms of country i's currency);
$I_i(I_j)$ = the inflation in each respective country;
e_{ij} = the error term; and
β = parameters of the model.

The Mathematical derivation of Equation (1) is explained in Bergstrand [1985, 1989]. A brief summary of the derivation is provided as an appendix in Koo and Karemera <[1991], pp. 443-335>.

Gravity models hypothesize that an exporting country's income represents the country's production and supply capacity while an importing country's income represents the country's purchasing power or its absorption capacity. Trade flows are expected to be positively related to the exporting and importing countries' income. Transportation costs and tariffs, which are trade barriers, should be negatively related to the volume of trade flows. The prices of a particular commodity in both exporting and importing countries are important in determining trade flows such as when a commodity moves from a country where prices are low to a country where prices are high. Trade flows are hypothesized to be positively related to changes in export prices and negatively related to changes in import prices.

Exchange rates are one of the most important macroeconomic factors affecting trade flows. Exchange rates used in the analysis are defined as changes in the prices of importing countries' currencies in terms of exporting countries' currencies. An appreciation of a country's currency reduces its exports and increases its imports. A currency depreciation, on the other hand, will elicit the opposite effects.

IV. An Empirical Gravity Model of the Pacific Rim Trade Flows

Traditional gravity models generally employ aggregate goods trade data, and they evaluate trade flows at a specific time period as demonstrated in Bergstrand [1985, 1989], Anderson [1979], and Lineman [1966]. We depart somewhat from the traditional model by reparameterizing equation (1) into a combined time series and cross-section model. The modified model is then used to analyze the effects of other factors (besides those suggested by the traditional gravity model) which enhance or impede trade between importing and exporting countries. That is, in addition to trade factors common to the traditional gravity model, our model includes variables representing, for instance, environmental or socioeconomic factors affecting trade flows among trade partners, and free trade variables.

The Pacific Rim includes members of subregional trade groups. The subgroups are engaged in cooperative trade arrangements. Dummy variables representing trade flows from specific groupings are included in the modified model. Specifically, a dummy variable representing trade flows among the Association of South East Asian Nations (ASEAN) is included to identify the extent to which membership of two countries in ASEAN (AS_2) enhanced trade in the Pacific Rim. Another dummy variable representing trade flows among members and non-ASEAN members (AS_n) is included to identify trade diversion. Likewise, a dummy variable representing trade between two NAFTA countries (NA_2)is included to evaluate NAFTA's effects on trade in the region. Similarly, another dummy variable representing trade between a NAFTA country and a non-NAFTA country (NA_n) is used to identify the extent of trade diversion from the North American free trade area. It is hypothesized that economic integration or trade arrangement under NAFTA and/or ASEAN would enhance trade flows among member countries. That is, there will be a trade creation effect. However, a trade between a beneficiary and nonbeneficiary will yield a trade diversion effect as well.

Finally, two variables representing environmental factors were included to examine both the effects of cultural similarity and level of development on trade in the Pacific Rim region. Such factors show the effects of specific subgroups on the inter- and intra-group trade. The pertinent factors are the specific distance between integrating countries (ND_{ij}) and integrating members' levels of development ($Pinc_{ij}$). The hypothesis is that trade group member countries close to each other are more likely to have similar cultures or cultural heritages, similar patterns of consumption and production, and high incentives for trade with each other. A relatively short distance between specific integrating countries will enhance trade more than a relatively long distance between member countries. While the interpretation has the features similar to that of the traditional distance variable, the variable representing distance among the integrating countries focuses on the effects of distance between countries under a free trade treaty.

Brada and Mendez [1985] provide a computational definition of the level of development variable as $Pinc_{ij} = (Y_i / N_i)(Y_j / N_j)$. The per capita income has been often used to reflect a country's level of development. The level of development among integrating members should have a positive impact on trade among beneficiaries because there is more trade among countries with similar per capita incomes as demonstrated by Pagoulatos and Sorensen [1975].

The traditional adjacency dummy variable is retained in the empirical model because, in addition to characteristics identified for countries with close proximity, it is assumed that there is even more trade between countries with common borders than countries without common borders. Therefore, the expanded empirical model of the Pacific Rim trade is specified as follows:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} D_{ij}^{\beta_3} P_i^{\beta_4} P_j^{\beta_5} E_{ij}^{\beta_6} I_i^{\beta_7} I_j^{\beta_8} Nd_{ij}^{\beta_9} Pinc_{ij}^{\beta_{10}} e^{\beta_{11} AD_{ij}} e^{\beta_{12} NA_2} e^{\beta_{13} NA_n} e^{\beta_{14} AS_2} e^{\beta_{15} AS_n} \upsilon \qquad (2)$$

where

D_{ij}	=	distance between exporting country i and importing country j;
AD_{ij}	=	dummy variable representing countries with common border;
NA_2	=	dummy variable identifying trade flows between 2 NAFTA countries;
NA_n	=	dummy variable indicating a trade flow between a NAFTA and non-NAFTA country;
AS_2	=	dummy variable indicating trade flows between 2 ASEAN countries;

AS_n = dummy variable indicating a trade flow between an ASEAN member and a non-ASEAN member;

$P_i(P_j)$ = export (import) unit price for exporting country i (importing country j);

Nd_{ij} = distance between integrating countries i and j;

$Pinc_{ij}$ = level of development of integrating member countries i an j;

All other variables have been previously defined.

V. Econometric Procedure and Source of Data

As noted earlier, classical gravity models use cross-section data to estimate trade effects and relationships for a particular time period (*e.g.*, one year). However, in real life, cross-section data observed over several years provide more useful information than cross-section data alone. Therefore, in the empirical implementation of model (2), we reparameterize the traditional model into a time series and cross-sectional framework with a study time period that ranges from 1984 to 1993.

Financial data, such as gross domestic product, exchange rates, domestic whole sales price indices, and population data, were obtained from the International Financial Statistics published by the International Monetary Fund. The dollar volume of trade flows and corresponding quantities were obtained from the United Nations Statistics Division Office. Import and export unit values were simply computed by dividing the dollar volume of trade by the respective quantity of each commodity category.

For the distance measure, ocean freight rates were not readily available. The distance between country i and j (D_{ij}) is used as a proxy for transportation costs and geographical factors impeding trade flows. This formulation has been commonplace in the literature (*e.g.*, see Bergstrand [1985] and [1989]; Geraci and Prewo [1979]; and Linneman [1966]). The distances were obtained from the oceanographic maps published by the U.S. Navy. Exporting and importing countries engaged in sporadic trade were excluded from the analysis in order to obtain a data set consistent with the time series and cross section framework. Since the number of countries in the Pacific Rim that were consistently engaged in trade over the selected sample period is small and the time span short relative to the number of estimated parameters, serial correlation problems may be negligible, and, according to Judge *et al.* ([1985], p. 515), it may be better to treat coefficients as fixed. A dummy variable identifying free trade flows between countries with common borders such as the US and Canada is also identical to the adjacency dummy variable. Therefore, one variable was used to avoid multicollinearity problems. Likewise, the variable representing specific distance among integrating countries such the distance between NAFTA countries or ASEAN countries were later eliminated to avoid multicollinearity problems. The model was then estimated using the heteroskedasticity consistent covariance estimator proposed by White [1985].

VI. Results

The problems associated with pooling techniques have been extensively discussed in literature, including Hausman [1978], Judge *et al.* [1985], and Hsiao [1986]. For clarity and notational simplification, we use the symbols used by Judge *et al.*([1985], p. 516). Similar notations can be seen in Koo and Karemera ([1991], p. 446). Equation (2), in time series and cross section framework, can be written as:

$$X_{ijt} = Z_{ijt}\beta + \mu_{ijt} \tag{3}$$

where:

X_{ijt} = trade observation from country i to country j at time t ($t = 1,\ldots\ldots, T$);

Z_{ijt} = a corresponding trade determinant vector;

β = a response coefficient vector; and

μ_{ijt} = the trade effect associated with the country pair.

Equation 3 indicates that all response coefficients are constant and the error term is assumed to capture effects over time and cross section units. The specification is plausible because the number of time series units or cross section units alone is small and less than the number of model parameters. Therefore, the specific time and cross section effects are assumed negligible and the disturbance term will capture differences over time and individual countries. The reader is referred to Koo and Karemera ([1991] p. 446) for a summary of methods of estimation of alternative model effects.

A. Specification Tests

Traditional gravity models do not have variable augmentation as specified in equation (2). The generalized gravity model represented by equation (2) includes both gravitational variables and the variables representing the free trade, economic, and cultural development characteristics associated with both the exporting and importing countries. Equation (2) was subjected to specification tests. An F-test statistic developed by Godfrey [1986] for model specification indicated, at the 1% significance level, that model (3) should be used in the trade flow analysis. Among the six commodity groups analyzed, the smallest statistic recorded is F=36.10, which significantly exceeds the critical value of $F(5, 13) = 4.86$ at the 1% level. Alternatively, given that model (1) is nested in model (2), the likelihood ratio test for specifications (Kmenta, [1986], p. 593) gives a likelihood ratio λ=36.19, which exceeds $\chi^2 = 15.09$ at the 1% significance level and 5 degrees of freedom. It also rejects the null hypothesis of no social or economic variable augmentation. These results suggest that in modeling international trade flows in the Pacific Rim, social, economic and environmental factors should be considered and be subjected to econometric specification tests.

The parameter estimates of the models are presented in Table 3. The dependent variable in all regressions is the dollar volume of trade (*i.e.*, the sum of dollar value of imports and exports). The estimated coefficients for most gravitational variables (*i.e.*, income and distance) and the variable representing integration grouping (pact) are significant in most cases. For each estimated model, the adjusted R^2 indicates that included factors explain most of the variations in the respective dependent variables. The analysis of the effects of factors affecting trade flows in the Pacific Rim is based on expected coefficient signs of the gravity model variables.

Before proceeding to the result analysis, some signs of the estimated model's parameters need further explanation. The following variables have unambiguous expected signs. An increase in a country j's income or an appreciation of a country j's currency will lead to movements of trade flows from country i to country j. The existence of free trade arrangement between countries i and j will increase trade from i to j while a relatively long distance between i and j is expected to impede trade from i to j. In a detailed derivation of a generalized gravity model similar to equation (2), Bergstrand [1985, 1989] explains that an exporting country i's income, unit price, and inflation may have ambiguous signs. If the elasticity of substitution among imports is greater than unity, the exporter's income and inflation variables will have a positive and a negative sign, respectively. In addition, a relatively low elasticity of transformation among exportables and a large elasticity of substitution between production for domestic and foreign markets lead to a negative coefficient on the exporter's unit price. Further, the import unit value may have a positive sign if the elasticity of substitution among imports is greater than the elasticity of substitution between imported and domestic products. The importer's inflation coefficient will be positive if the elasticity of substitution between imports and domestic products is greater than unity; otherwise it will be negative.

B. Effects of Income, Price, and Exchange Rates

The estimated coefficients on income, prices, and exchange rates in most cases are significant and have the expected signs. An increase in the exporter's income leads to increased trade flows, while an increase in an importer's income indicates an increase in both the importer's purchasing power and ability to absorb large imports. Most of the income coefficients are significant at the 5% level (see the first two rows of Table 3). The magnitudes of income elasticities greater than 1.0 indicate that trade flows are sensitive to productive capacities in the exporting country and to the importers' internal markets and absorption capacities. However, for most commodities, the magnitudes of the income elasticities are less than 1.0, suggesting that trade flows in the Pacific Rim are sensitive to neither exporter's nor importer's income changes. The extent of sensitivity is greater in importing than exporting countries.

This behavior is commodity-specific. For example, in the groups of Reaction Engines (SITC 7143) and Worked Copper Alloys (SITC 6822), Pacific Rim trade flows are clearly more responsive to increases in the exporter's

Table 3
Estimated Gravity Models for Bilateral Trade Between Pacific Rim Countries

Four-Digit Standard International Trade Classification (SITC) Commodity Groups

Variable	7231	7143	6822	6516	5812	5811
1. Exporter's income (Y_i)	-0.220*	1.056***	0.947***	-0.627***	-0.591***	0.631***
	(-2.277)	(9.261)	(4.395)	(-5.835)	(-6.378)	(4.097)
2. Importer's income (Y_j)	7.035***	0.602***	0.619***	0.010	1.982*	0.359***
	(3.307)	(11.607)	(3.478)	(0.160)	(1.933)	(5.904)
3. Export unit price (P_i)	-0.321	-0.140	0.089	-0.752**	0.046	-0.504**
	(-1.195)	(-1.719)	(1.571)	(-2.723)	(0.794)	(-2.768)
4. Import unit price (P_j)	0.084	-0.413***	-0.361	0.856**	-0.070	0.541**
	(0.284)	(-3.963)	(1.998)	(3.055)	(-0.717)	(2.828)
5. Distance (D_{ij})	7.129**	0.754	-2.564***	-0.081	-1.172	-0.706***
	(3.197)	(1.334)	(3.847)	(-0.251)	(-1.402)	(-6.033)
6. Exchange rate (E_{ij})	-	0.091*	0.455***	0.220*	0.055***	0.277***
		(2.231)	(4.031)	(2.008)	(5.142)	(4.883)
7. Exporter's inflation (I_i)	-0.039	1.774*	1.006	0.238	-1.132***	0.335
	(-0.417)	(2.400)	(1.548)	(0.674)	(-5.124)	(0.573)
8. Importer's inflation (I_j)	1.804	1.214**	0.869	-0.080	-3.576	-0.006
	(1.196)	(2.650)	(1.296)	(0.154)	(-1.509)	(-0.085)
9. NAFTA$_2$ (NA_2)	0.140	3.398	-	-	-	0.879**
	(0.170)	(1.593)				(2.948)
10. NAFTA$_n$ (NA_n)	-	1.667**	-	-	-	-
		(2.730)				
11. ASEAN$_2$ (AS_2)	8.483*	-	0.482***	1.145***	-	-
	(2.144)		(3.238)	(6.066)		
12. ASEAN$_n$ (AS_n)	2.791*	-	0.283	0.455	1.678	-0.530
	(2.173)		(0.418)	(1.391)	(1.293)	(-1.245)
13. Level of development ($Pinc_{ij}$)	0.166***	-	-	0.015*	-	-
	(3.615)			(2.133)		
Constant	-43.690**	-11.074	14.981*	9.369**	16.785*	7.911**
	(-3.029)	(1.526)	(2.459)	(2.726)	(2.278)	(2.910)
Adjusted R^2	0.813	0.985	0.776	0.894	0.949	0.964
Number of Observations	36	32	30	36	40	36
MSE	0.360	0.147	0.200	0.159	0.100	0.095

Note: (1) Student's t statistics are presented within parentheses. * indicates statistical significance at the 5% level; **at 2.5 % level; and *** at 1% level.

(2) SITC commodity code 7231 represents Civil Engineering Equipment; 7143 represents reaction Engines; 6822 represents Worked Copper Alloys; 6516 represents Synthetic Fiber Blends; 5812 represents Refined Plastic Materials.

(3) NAFTA$_2$ and ASEAN$_2$ capture the effects that membership in the same trade group has on the bilateral trade among Pacific Rim countries. NAFTA$_n$ and ASEAN$_n$ measures the bilateral trade effect between a group member and non-member country.

production and supply capacities than to changes in importer' purchasing power while in the groups of Civil Engineering Equipment (SITC 7231) and Plastic Materials (SITC 5812), trade flows are sensitive to changes in importer's buying power. Further, for the groups of Synthetic Fiber Blends (SITC 6516) Refined Plastic Materials (SITC 5812), and Civil Engineering equipment (SITC 7231), a negative and significant coefficient on the exporter 's income suggests that the elasticity of substitution among imports is less than unity.

The estimation of import and export price elasticities has mixed results. A positive coefficient sign on import unit value is consistent with an elasticity of substitution among imports greater than the elasticity of substitution between imported and domestic products. A large substitution elasticity between home products and products from abroad and a small elasticity of transformation among exportables lead to a negative coefficient on the exporter's unit price. This finding is consistent with Bergstrand ([1985] p. 479). Thus, the similar explanation provided above may be applied to the inflation variables. The reader can judge the significance of the estimates by looking at the corresponding t-ratios. The magnitude of the price elasticities are less than 1.0 for most commodity groups suggesting that the flows are less sensitive to commodity price changes in the Pacific Rim trade. However, the magnitude of import price elasticities are slightly greater than that of the export price elasticities, suggesting that trade flows are less sensitive to changes in export prices than in import prices.

The exchange rates coefficients (reported in row 6) are positive and significant in most cases. That is, an appreciation of an importing country's currency (a depreciation of an exporting country's currency) increases trade flows from the exporting country to the importing country. These findings show that changes in exchange rates significantly affect trade flows in the Pacific Rim.

C. Effects of Subregional Trade Groups

The model includes variables representing membership in subregional trade groups. The coefficients measuring the trade effects of two member countries (NA_2 and AS_2) are significant, indicating that integration pacts enhance trade among members, especially through trade creation effects. However, for commodity groups such as Civil Engineering Equipment, there is significant evidence of trade diversion. For example, for this commodity group, the coefficient on AS_n indicates that while the ASEAN led to increased trade among members, it also promoted trade among non-ASEAN members. That is, its expansion in the Pacific Rim trade also yielded trade diversion effects. On the other hand, the commodity group of Worked Copper Alloys provides evidence that subregional groups enhanced trade among its members, and, consequently, enhanced trade in the Pacific Rim. Overall, there is evidence that subregional trade groups (*i.e.*, NAFTA and ASEAN) in the Pacific Rim contribute to increased trade flows in the region. Additionally, and in sum, the evidence indicates that more of the subregional groups' trade effects are via trade creation than via trade diversion. This finding is consistent with findings documented by Eichengreen and Frankel ([1995] p. 93) and Karamera and Ojah [1998]. Karemera and Ojah [1998] studied the trade creation and diversion effects of NAFTA. They document that NAFTA expands trade in North America through both trade creation and trade diversion and that about seventy percent of the total expansion in the commodities examined is attributable to trade creation.

D. Effects of Environmental Factors on Trade in the Pacific Rim.

According to the theory of spatial equilibrium, the quantities of a commodity traded are inversely related to distance. A relatively large distance discourages trade while a relatively short distance is more likely to stimulate trade. It is hypothesized that countries with shorter distance among themselves are more likely to be better acquainted and share similar culture than countries that are geographically farther apart. The distance among integrating countries may be subject to similar interpretation. Thus, shorter distance among integrating members reduces resistance or impediments to trade and should be associated with higher levels of trade, and vice versa. In this study, the estimated coefficients have expected negative signs except coefficients on the commodity groups of Civil Engineering Equipment and Reaction Engines. Since types and quality of these specific commodity groups produced in the exporting countries are not homogeneous and since demand is quality specific in most importing countries, the pattern of trade in these commodity groups of Civil Engineering Equipment and Reaction Engines is not determined on the basis of distances in the Pacific Rim trade.

Furthermore, it may be argued that, in the era of regional groupings, distance is not an trade impediment it used to be. Cargo ships and planes are larger and faster. Modern means of transportation including Private carriers such Federal Express and the United Parcel Service, telecommunications, and the Internet are now used to "shrink" distance as a factor resisting trade. Therefore, as technology brings the costs of overcoming distance down, the emerging of regional groupings is facilitated; which provides an impetus for more trade. Finally, the results indicate that APEC countries with common borders or in close proximity trade more than countries that are more geographically separated.

The level of development variable was included to represent another environment factor. Brada and Mendez [1985] defined the level of development as the per capita income of integrating countries. The level of development should have a positive effect on economic integration and trade flow. A high level of development is likely to be associated with a high need for exchange in both intermediate and finished goods. As Krugman and Obstfeld [1994] observed, such trades are more likely to be driven by economies of scale (intra-industry trade) than by comparative advantage (inter-industry trade). The results indicate that increases in the per capita income lead to increases in trade flows. In fact, the result here is particularly notable for the commodity groups of Civil Engineering Equipment and Synthetic Fiber Blends. However, this evidence is not documented for all the commodity groups we analyzed. Thus, more research involving larger data sets and a longer sampling period is needed. In other words, further studying the effects of the relative level of development and per capita incomes on trade in the Pacific Rim would be a fruitful agenda for future research.

VII. Concluding Remarks

A reduced-form gravity model derived from a general equilibrium model of international trade is modified to evaluate the determinants of trade flows of some selected commodity groups in the Pacific Rim. This model employs time series and cross-sectional data. We placed special emphasis on the effects of subregional pacts on the Pacific Rim trade. Additionally, we examined the effects of cultural and economic factors on integrating (trade pact members) nations.

Our study shows that gravity models can be reparameterized into a time series and cross-sectional model and used for the statistical description of trade flows and the analysis of the economic integration effects. In the case of the Pacific Rim trade, documented evidence on selected commodity groups suggests that environmental, free trade, and economic variables should be considered in the modeling of trade flows that are due to economic integration.

Our findings on the traditional gravitational variables (such as incomes of importing and exporting countries, prices of the traded commodity, and distance between trade partners) are, generally, in conformity with those documented in previous studies. Furthermore, findings on the effects of subregional trade pacts on trade flows in a larger economically integrating area, such as the Pacific Rim, seem to be highly commodity-specific. For instance, documented results show that while ASEAN enhanced trade among ASEAN members, it also increased trade among non-ASEAN members, thus stimulating both trade creation and trade diversion effects. This finding further indicates that trade pacts are beneficial to both participating and nonparticipating countries in the region. We document evidence that environmental factors such as the distance between economically integrating countries have significant and positive effects on trade flows of the integrating area. The effect of per capita income of integrating member countries on trade flow is preliminary in this study because of data limitation. However, the preliminary evidence suggests that integrating high-income countries elicit increased trade flows in the economic union.

In conclusion, our study has amply demonstrated the importance of incorporating economic, free trade, and environmental factors into the traditional gravity framework when modeling the determinants or effects of trade flows on an economically integrating area, such as the Pacific Rim. This insight is particularly important in this era of increased economic regionalism and globalization. Indeed, one can infer from our findings that economic regionalism and economic globalization are not contradictory. If subregional trade groups enhanced trade in a region, then regionalism should enhance the benefits of economic globalization. The verification of this conjecture, therefore, presents an interesting question for future research.

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