The Growth of Intermediate Goods Trade in East Asia

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Abstract

This paper examines what contributes to the trade growth of intermediate machinery goods in East Asia in the 1990s. To this end, this paper regresses the allocation equation to obtain the estimator of border barriers in each country, and then, by using the estimators, the first-difference logarithmic form of the gravity equation is regressed. Our empirical results suggest that border barrier reduction and the production and expenditure growth of intermediate goods are important factors which contribute to the rapid growth of trade in machinery parts in East Asia.

Keywords: East Asia; Gravity equation; Agglomeration; Fragmentation

JEL Classification: D23; F15; R12; R15

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1 Introduction

Why has trade in machinery parts and components in East Asia grown rapidly? The value of machinery parts and components exports by East Asian countries increased by more than 500% during the period of 1987-2003. In 2003, East Asia occupies 36% out of the world total exports, almost equivalent to the exports by European countries. While the value of finished machinery exports by East Asia remains lower than that of Europe, it exports as much machinery parts as Europe.[1]

The dramatic reduction of trade costs leads to the formation of "fragmentation-type agglomeration", resulting in an explosive increase of the trade in intermediate goods. Amiti (2005) explores a two-factor Hecksher-Ohlin model with vertically linked industries. In her model, the gap in factor prices encourages location based on comparative advantage as in the fragmentation literature (see, for example, Jones and Kierzkowski, 1990), while the vertical linkages between upstream and downstream firms give rise to demand and cost linkages, resulting in the concentration of upstream and downstream firms in one country. The balance between these forces depends on the level of trade costs. Particularly at a low level of trade costs, downstream firms and upstream firms separately concentrate in different countries. In this paper, we call such a type of concentration "fragmentation type-agglomeration". The development of the fragmentation-type agglomeration gives rise to the growth on downstream firms' demand on intermediate goods and upstream firms' production on intermediate goods. Such growth on the demand and

[1]The statistics in this paragraph are drawn from Kimura, Takahashi, and Hayakawa (2007).

production of intermediate goods dramatically increases the trade in intermediate goods.

Indeed, in East Asia, trade costs are remarkably reduced. JETRO (2002) shows that ocean shipping costs in East Asian countries have decreased. Gill et al. (2007) report that Asia has the lowest freight costs among all developing regions though the levels are still higher in Asia than they are in developed countries. Kimura et al. (2007) show that trade-weighted averages of MFN tariff rates on machinery have declined steadily since the late 1980s. The extensive use of the duty-drawback system, i.e., tariff rebates for imported intermediate inputs used in the production of exported products, helped further push down trade barriers.

Furthermore, the agglomeration like the fragmentation-type agglomeration also can be observed in East Asia. There are a large number of agglomerations. Xinzhu in Taiwan, Jurong industrial park in Singapore, Samut Prakan and the Eastern Seaboard in Thailand, and Penang and Shah Alam in Malaysia are such examples. Although these agglomerations are not the concentration of either only downstream firms or only upstream firms, the agglomeration in developed and developing countries is the upstream firms-centered agglomeration and the downstream firms-centered agglomeration, respectively. As a result, the formation of such agglomerations seems to contribute largely to the explosive increase of intermediate goods trade in East Asia.

The purpose of this paper is to empirically investigate what contributes to the growth of trade in intermediate goods in East Asia in the 1990s. As noted above, the reduction of trade costs not only directly increases intermediate goods trade but also indirectly does though the development of fragmentation type-agglomeration. To examine such an indirect effect of trade costs reduction as well as its direct effect, we investigate the contribution of not only trade costs reduction but also the growth of importer's demand on intermediate goods and that of exporter's output on intermediate goods.

Although there are many papers that regress trade growth equations, e.g., Baier and Bergstrand (2001), the methodologies employed in those papers can not be automatically applied in the context of East Asian trade. Baier and Bergstrand examine the empirical contribution of transport-cost reductions, trade liberalization, income convergence, and income growth to the expansion of bilateral trade flow among OECD countries in the post WWII period. They use a ratio of c.i.f-valued imports to f.o.b-valued imports as a proxy for transport cost, and calculate average bilateral tariff rates. In this paper, however, we cannot adopt the same methodology to obtain these data. This is because the ratio is too noisy[2] and because nominal tariff rates on machinery are not appropriate signal for the actual tariff burden due to the active use of duty drawback system.

This paper adopts the following methodology. We regress two equations obtained from Amiti (2005), which analyzes fragmentation type-agglomeration. In the first stage, we regress an allocation equation, which relates the decision of finished goods producers in a country on how to allocate expenditure between home-made and foreign-made intermediate goods.[3] By regressing this equation,

[2]Particularly in developing countries, the ratio often becomes less than unity.
[3]This methodology is basically the same as in Hayakawa (2007).

we can obtain the predicted value of border barriers in each East Asian country. The border barriers in this paper basically incorporate all kinds of trade costs. Next, by using such predicted values, the first difference logarithmic form of a gravity equation is regressed to examine the contribution of the border barriers reduction, the growth of importer's expenditure on machinery parts, and that of exporter's production on machinery parts to trade growth.

The rest of this paper is organized as follows. In section 2, we present theoretical model underlying on our empirical equations, and our empirical methodology is provided in section 3. Section 4 discusses empirical issues. The regression results are reported in section 5. Section 6 concludes.

2 Theoretical Model

This section provides the theoretical model underlying our empirical analysis.

2.1 Settings

In this paper, we follow the model explored by Amiti (2005). In her model, the market structure in both finished and intermediate goods sectors is assumed to be Chamberlinian monopolistic competition. The finished goods producer of each country combines a composite index aggregated across varieties of intermediate inputs and primary productive factors, e.g., labor and physical capital, with Cobb-Douglas manner. The composite enters the production function for each producer through a CES aggregator. On the other hand, the producer of each intermediate variety employs primary productive factors. In both sectors, we assume identical technology across countries but that the endowment of productive factors is different across countries.

Import demand in country r for each intermediate variety produced in country j, $z_{r,j}$, is given by:

$$z_{r,j} = t_{r,j}^{1-\sigma} q_j^{-\sigma} \Pi_r^{\sigma-1} E_r, \tag{1}$$

where σ, q_j, and Π_r denote the elasticity of substitution among the varieties (assumed to be greater than unity), the price of each variety produced in country j, and the price index in country r, respectively. E_r is total expenditure on intermediate inputs in country r. Transactions on intermediate goods between countries r and s is modeled as facing Samuelsonian iceberg costs, $t_{r,s}$.

Amiti (2005) specifies factor endowments to produce a full general equilibrium solution. Supposing that intermediate goods are capital-intensive goods while finished goods are labor-intensive goods, at a low level of trade costs, upstream and downstream firms are likely to concentrate their production activities in capital-abundant and labor-abundant country, respectively.

In this paper, however, for simplicity, we assume that total production value of finished goods (X) in each country is exogenous. This assumption implies that total expenditure on intermediate goods is also exogenous since $E_r = \alpha X_r$, where α is Cobb-Douglas expenditure share on intermediate varieties of finished goods producers. Given the locations of expenditure, we investigate what elements contribute to increasing trade in intermediate goods.

2.2 Allocation Equation

To obtain the predicted values of border barriers in each country, we employ the same method as in Head and Mayer (2000). From equation (1), we obtain a ratio of total input values in country r for the goods produced in country j to the values for the goods produced domestically as

$$\frac{Z_{r,j}}{Z_{r,r}} \equiv \frac{q_j m_j z_{r,j}}{q_r m_r z_{r,r}} = \left(\frac{m_j}{m_r}\right) \left(\frac{t_{r,j}}{t_{r,r}}\right)^{1-\sigma} \left(\frac{q_j}{q_r}\right)^{1-\sigma}. \tag{2}$$

m_i is the number of intermediate goods firms. This formulation relates the decision of finished goods producers in country r on how to allocate expenditure between home-made and foreign-made intermediate goods.[4]

For the purpose of estimation, as in Head and Mayer (2000), we eliminate the firm number variables, on which data are unavailable in intermediate goods sector, from equation (2) by using the following relationship. Recall that we assume identical technology across firms and countries. Denoting the quantity produced by each firm in intermediate goods sector as $\bar{z}$, we obtain $M_r = \bar{z} q_r m_r$. Substitut-

[4]The derivation here is called the method of "log odds ratios", which is employed in Head and Mayer (2000). This formulation enables us to cancel out the variables related to the total expenditure and the price index. Due to the unavailability of appropriate data on price index in intermediate goods, we employ this allocation equation approach.

ing this relationship into equation (2), the equation is re-written as:

$$\frac{Z_{r,j}}{Z_{r,r}} = \left(\frac{M_j}{M_r}\right)\left(\frac{t_{r,j}}{t_{r,r}}\right)^{1-\sigma}\left(\frac{q_j}{q_r}\right)^{-\sigma}.$$

Furthermore, there is a close relationship between $Z_{r,j}$ and M_j. In order to avoid a simultaneity problem between them, following Head and Mayer (2000), we move M_j to the LHS of the equation.

$$\left(\frac{Z_{r,j}/Z_{r,r}}{M_j/M_r}\right) = \left(\frac{t_{r,j}}{t_{r,r}}\right)^{1-\sigma}\left(\frac{q_j}{q_r}\right)^{-\sigma}. \tag{3}$$

2.3 Gravity Equation

Following Anderson and van Wincoop (2003), we can derive a gravity-like equation. Using equation (1) and market clearing condition, we get:

$$M_j = \sum_{r=1}^{R} Z_{r,j} = m_j q_j \bar{z} = m_j q_j \sum_{r=1}^{R} z_{r,j} = m_j q_j^{1-\sigma} \sum_{r=1}^{R}\left(\frac{t_{r,j}}{\Pi_r}\right)^{1-\sigma} E_r.$$

Substituting this into equation (1) yields the following gravity-like equation:

$$Z_{r,j} = E_r M_j \left(\frac{t_{r,j}}{\Pi_r P_j}\right)^{1-\sigma}, \tag{4}$$

where

$$P_j = \left(\sum_{r=1}^{R}\left(\frac{t_{r,j}}{\Pi_r}\right)^{1-\sigma} E_r\right)^{\frac{1}{1-\sigma}},\ \ \Pi_r = \left(\sum_{j=1}^{R}\left(\frac{t_{r,j}}{P_j}\right)^{1-\sigma} E_j\right)^{\frac{1}{1-\sigma}}.$$

The indices Π_j and P_j can be solved as a function of trade costs and total expenditure on intermediate goods.

It is worth noting that the fragmentation-type agglomeration serves to increase trade in intermediate goods greatly. In countries with downstream concentration, demand for intermediate goods expands remarkably, while the production value of intermediate goods increases in countries with upstream concentration. Equation (4) claims that the rise of both importer's E_r and exporter's M_j increases intermediate goods trade between them dramatically ($Z_{r,j}$).

3 Empirical Methodology

We estimate the first difference logarithmic form of gravity equation (4) by a two-stage procedure. In the first stage, we estimate the allocation equation (3) and get the estimators of border barriers for intermediate goods transactions in each country. In the second stage, the estimators of the border barriers in the first stage are used as regressors.

3.1 Allocation Equation

We assume that trade costs are specified as follows. For $r \neq j$,

$$\ln t_{r,j} = \ln B_r + \phi_1 Lang_{r,j} + \phi_2 Contig_{r,j} + \phi_3 \ln d_{r,j}.$$

$Lang_{r,j}$ takes unity if the same language is spoken by at least 9% of the population in both countries and zero otherwise. $Contig_{r,j}$ is a binary variable taking unity if the two countries are contiguous and zero otherwise. $d_{r,j}$ is geographical distance between countries r and j and is measured by greater circle between their respective capital cities. B_r is border barriers and consists of all the trade impediments other than the costs captured by the variables $Lang_{r,j}$, $Contig_{r,j}$, and $d_{r,j}$. For $r = j$, it is simply assumed that:

$$\ln t_{r,r} = \phi_3 \ln d_{r,r}.$$

$d_{r,r}$ is intra-national distance, of which the most appropriate definition remains unsettled in the literature, and is calculated as a radius of surface area[5] in country r. Specifically, $d_{r,r} \equiv \sqrt{surface\ area_r/\pi}$. As a result, relative trade costs are given by:

$$\ln\left(\frac{t_{r,j}}{t_{r,r}}\right) = \ln B_r + \phi_1 Lang_{r,j} + \phi_2 Contig_{r,j} + \phi_3 \ln\left(\frac{d_{r,j}}{d_{r,r}}\right).$$

We define $d_{r,j}/d_{r,r}$ as "$\mathrm{Relative\ distance}_{r,j}$".

Taking a log of equation (3) and substituting the relative trade costs function yield:

$$\ln\left(\frac{Z_{r,j}/Z_{r,r}}{M_j/M_r}\right) = \iota_0 + \iota_{1r} D_r + \iota_2 Lang_{r,j} + \iota_3 Contig_{r,j}$$

[5]The data on surface area are drawn from World Factbook (Central Intelligence Agency).

$$+\iota_4 \ln\left(\frac{d_{r,j}}{d_{r,r}}\right) + \iota_5 \ln\left(\frac{q_j}{q_r}\right) + \varepsilon_{r,j}, \tag{5}$$

where $\varepsilon_{r,j}$ denotes a normally distributed random error in the equation. D_r, for which the coefficient represents border barriers in country r, is an importer dummy variable. To avoid dummy trap, one importer dummy must be excluded. Denoting the border barriers in such an importer (reference country) as B_{ref}, since $\hat{\iota}_0 = (1-\sigma)\ln B_{ref}$, we can express the border barriers in country r as:

$$\ln B_r = \ln B_{ref} + \frac{\hat{\iota}_{1r}}{1-\sigma} \text{ or } \ln B_r = \frac{\hat{\iota}_0 + \hat{\iota}_{1r}}{1-\sigma}. \tag{6}$$

3.2 Gravity Equation

Taking a log of equation (4), we get:

$$\ln Z_{r,j} = \ln E_r + \ln M_j + (1-\sigma)\ln t_{r,j} - (1-\sigma)\ln \Pi_r - (1-\sigma)\ln P_j.$$

Using equation (6) and the definition of trade costs function, we obtain:

$$\ln Z_{r,j} = \ln E_r + \ln M_j + Barriers_r + (1-\sigma)\phi_1 Lang_{r,j} + (1-\sigma)\phi_2 Contig_{r,j}$$
$$+(1-\sigma)\phi_3 \ln d_{r,j} - (1-\sigma)\ln \Pi_r - (1-\sigma)\ln P_j,$$

where $Barriers_r \equiv (1-\sigma)\ln B_r = \hat{\iota}_0 + \hat{\iota}_{1r}$.

As in Baier and Bergstrand (2001), taking a log difference in the equation above, we obtain the first-difference logarithmic form of gravity equation:

$$\Delta \ln Z_{r,j} = \delta_1 \Delta \ln E_r + \delta_2 \Delta \ln M_j + \delta_3 \Delta Barriers_r + \delta_4 Lang_{r,j} \\ + \delta_5 Contig_{r,j} + \delta_6 \ln d_{r,j} + \delta_r \nu_r + \delta_j \nu_j + \epsilon_{r,j}, \quad (7)$$

where:

$$\delta_1 = \delta_2 = \delta_3 = 1, \;\; \delta_4 = (1-\sigma)\Delta\phi_1, \;\; \delta_5 = (1-\sigma)\Delta\phi_2, \\ \delta_6 = (1-\sigma)\Delta\phi_3, \;\; \delta_r = (1-\sigma)\Delta \ln \Pi_r, \;\; \delta_j = (1-\sigma)\Delta \ln P_j.$$

$\epsilon_{r,j}$ denotes a normally distributed random error. ν_r and ν_j are importer and exporter dummy variables, respectively, for which the coefficients as well as the other coefficients are assumed to be time-invariant simply for the save of degree of freedom. Although δ_1, δ_2, and δ_3 should be unity from the theoretical point of view, we estimate these coefficients in order to know the actual degree of contribution of the expenditure growth, the production growth, and the border barriers reduction on trade growth.

4 Empirical Issues

We focus on the transaction of intermediate goods among East Asian countries in machinery sector since this has played the most important role in the development of international fragmentation (see Ando and Kimura, 2005). Our sample consists of nine East Asian countries (China, Indonesia, Japan, Malaysia, Republic of Korea, the Philippines, Singapore, Taiwan, and Thailand) in 1990, 1995, and 2000. Since a reference country must be excluded from the sample in the second-step estimation, i.e., (7), we incorporate the U.S. in the sample in the first-step estimation, i.e., (5), as the reference country. The choice of the U.S. seems to be plausible because the U.S. is the most important player of East Asian international fragmentation in non-East Asian countries.

The data sources are as follows. Data on the transactions of intermediate goods are obtained from Asian International Input-Output Table (1990, 1995, 2000 versions) published by the Institute of Developing Economies.[6][7] The transactions on intermediate goods, total production value, and total expenditure are deflated by wholesale price index of the U.S., which is obtained from World Development Indicator. The source of $Lang_{r,j}$ and $Contig_{r,j}$ is CEPII website.[8]

In equation (5), the relative product price, q_j/q_r, embodies the difference in productive factor prices between countries r and j based on the differences in factor endowments between them. In this paper, we use relative GDP per capita, which is drawn from the World Development Indicator, as a proxy for relative wages to capture some of the variations in countries' relative price levels of intermediate goods.

There are two econometric issues. The first is the simultaneity problem be-

[6]Since the import values in some pairs, e.g., import values of Taiwan and Korea from China, are not reported, we exclude those pairs from our sample.

[7]This international input-output table gives us the input-output data comparable across East Asian countries (and the U.S.) and years. As for more details, see http://www.ide.go.jp/English/Publish/Books/Sds/material.html.

[8]See http://www.cepii.fr/anglaisgraph/bdd/distances.htm#.

tween bilateral trade values and total production value. If we perform ordinary least squares (OLS), a correlation between the production value and the error term would emerge. In order to address such a problem and to assure the robustness of our empirical results, we perform a generalized method of moment (GMM). We use the total production growth of finished goods and the 5-year lagged production growth of finished and intermediate goods as instruments. The choice of the total production value on finished goods seems to be appropriate because it has a weak correlation with bilateral trade value in intermediate goods[9] but it has a strong correlation with the total production value on intermediate goods due to the demand and cost linkage between downstream and upstream firms.

The second is the problems accompanied with using a generated regressor. The bias in estimators and the invalidity of estimated standard errors in the second step estimation by OLS and GMM are such examples. To avoid such problems, we assume that an error component in the estimated border barriers of each country is time-invariant. Thus the error disappears by taking the one-period difference on the estimators of border barriers in each country.

5 Empirical Results

This section reports the regression results of the allocation equation (5) and then the results of the gravity equation (7). Some other estimation results are also presented.

[9]Due to such a weak correlation, the assumption of exogeneity of total expenditure in the theoretical part seems to be plausible.

5.1 The 1st Step: Allocation Equation

This subsection provides the regression results of allocation equation. The OLS regression results of equation (5) are reported in Table 1. There are four points to be noted.

== Table 1 ==

First, the coefficient for relative GDP per capita and that for relative distance have been positively and negatively estimated, respectively. This result indicates that the larger the wages of exporters are[10], or the closer the distance between countries is, the larger the transactions between them are. On the other hand, most of the coefficients for the other trade costs, i.e., $Lang_{r,j}$ and $Contig_{r,j}$, are insignificant.

Second, in almost all the countries, the absolute value of the importer dummy coefficients has decreased since 1990. This result indicates that the barriers in East Asia have been reduced much more rapidly than those in the U.S. The reduction on the barriers particularly in developing countries must be due to the distinctive investment liberalization.

Third, the coefficients for Singapore are positively estimated. These positive coefficients imply that barriers in Singapore have been lower than those in the U.S. However, the magnitude of the coefficients declines over time and ends up with being insignificant in 2000. This indicates that the barriers in Singapore are reduced less rapidly than those in the U.S.

[10]We speculate that this result is because GDP per capita embodies partially labors' skill.

Fourth, among developing countries, the low barriers in Malaysia are outstanding. The coefficients in Malaysia have been insignificant in 2000, so that barriers in Malaysia have been as low as those in the U.S. The significant negative coefficients in Japan and Korea imply that barriers in Malaysia have been lower than those in Japan and Korea.

5.2 The 2nd Step: Gravity Equation

The second step is the estimation of equation (7) by using predicted values of importer's barriers. The reference country is dropped from our sample in the second regression. The basic statistics are shown in Table 2. The estimation results of the equation (7) by OLS and GMM are reported in column of (I) in Table 3.

== Table 2 & Table 3 ==

Before reporting the results, it is worth noting that $\iota_{i+1} = (1 + \iota_5)\phi_i$ and $\delta_{i+3} = (1 - \iota_5)\Delta\phi_i$ for $i \in \{1, 2, 3\}$. These restrictions should be imposed on coefficients in the first regression, i.e., (5), and the second regression, i.e., (7). As in usual results in home-bias studies, however, since our result of ι_5 has unreasonable value (see footnote 11), we do not impose such restrictions and again estimate the coefficients particularly for δ_i for $i \in \{4, 5, 6\}$.

The following points are to be noted in the table. A coefficient for international distance is positively estimated at 1% significance level, while the coefficients for language commonality and contingency are insignificant. The positive coefficients for international distance may indicate that transport costs in East Asia have declined, as shown in JETRO (2002).[11]

Coefficients for "Border barriers reduction", "Production growth", and "Expenditure growth" are positively significant. The significance of the border barriers coefficient indicates that the reduction of border barriers leads to the rapid growth of intra-East Asian trade. The positive effect of production growth on trade implies that the more parts a country produces, the larger its export value is. In East Asia, such an increase of parts production may be caused by the formation of agglomeration on upstream firms, as argued in the introductory section. The significantly positive effect of expenditure growth indicates that the more the demand for intermediate goods in a country is, the more intermediate goods the country imports. Since fragmentation raises demand for intermediate goods, this result may show that the development of fragmentation contributes to the growth of parts trade in East Asia.

5.3 Other Estimation

We perform two kinds of estimation to check the robustness of contribution of border barriers reduction on trade growth. First, three cultural variables are introduced into the first-step estimation to partly control the difference in preferences among countries. That is, as usual, we assume a CES (sub-) production function with preference weight parameters (a) for finished goods producers. Then, the

[11]Remember that $\delta_6 = (1-\sigma)\Delta\phi_3$. Thus, the positive coefficient implies that $\Delta\phi_3 < 0$ due to the assumption $\sigma > 1$.

equation (2) is rewritten as:

$$\frac{Z_{r,j}}{Z_{r,r}} = \left(\frac{a_{r,j}}{a_{r,r}}\right)\left(\frac{m_j}{m_r}\right)\left(\frac{t_{r,j}}{t_{r,r}}\right)^{1-\sigma}\left(\frac{q_j}{q_r}\right)^{-\sigma}.$$

We specify a log of the relative preference as:

$$\ln\left(\frac{a_{r,j}}{a_{r,r}}\right) = \xi_0 + \xi_1 Colony_{r,j} + \xi_2 Comcol_{r,j} + \xi_3 Religion_{r,j}.$$

$Colony$ takes unity if the two countries have ever had a colonial link and zero otherwise. $Comcol$ takes one if trading partners had a common colonizer and zero otherwise. $Religion$ is a binary variable which takes one if trading partners have a representative religion and zero otherwise.[12]

Assuming such preference structure, we again regress the allocation equation and obtain the estimators of border barriers in each country. Since adding preference parameters into the CES function does not change the formulation of our gravity equation, as demonstrated in Anderson and van Wincoop (2003), the gravity equation of the same formulation as before, i.e., equation (7), is regressed.

Second, technological differences are controlled in the first-step estimation. Our model in section 2 assumes identical technology across countries. However, this assumption seems to be unrealistic because our sample consists of the countries with quite different development stages. In order to control the technological differences to some extent, we introduce the relative labor productivity into the

[12]The source of colonial variables is CEPII website. Religion is constructed based on World Factbook (CIA).

allocation equation.[13]

The results in the first step are shown in Table 4, and columns (Ⅱ) and (Ⅲ) in Table 3 report the second step estimation results using the new estimators of border barriers. In the second step, the results by GMM are reported. From these tables, we can see that the results are qualitatively unchanged: the reduction in border barriers, production growth in intermediate goods, and growth of expenditure on intermediate goods contribute significantly to the growth of intermediate goods trade.

== Table 4 ==

6 Concluding Remarks

This paper examines what contributes to the trade growth of intermediate goods in East Asia in the 1990s. As a result, we confirm the significant contribution of border barriers reduction, the growth of importer's demand on intermediate goods, and that of exporter's output on intermediate goods. Such demand and output growth in East Asia may be caused by the development of fragmentation and the formation of agglomeration of intermediate goods producers, respectively. If this is the case, our empirical results imply that the further penetration into and sophistication of international fragmentation lead to the growth of intra-regional trade. International fragmentation in East Asia has expanded and has deepened in terms

[13]The value added and the number of employment in machinery sector are drawn from UNIDO database.

of covering a large number of countries and of sophistication in the combination of intra-firm and arm's length (inter-firm) transactions. The developing countries have achieved economic development by getting engaged in active intra-regional trade in international fragmentation to some extent. Therefore, the development of international fragmentation would lead to the further economic development.

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Table 1: Results of Allocation Equations

	1990	1995	2000
Relative distance	-0.95***	-0.58***	-0.43***
	(0.18)	(0.13)	(0.12)
Lang	0.51	0.34	0.11
	(0.35)	(0.27)	(0.24)
Contig	-0.52	0.11	0.70**
	(0.60)	(0.39)	(0.33)
Relative GDP per capita	0.65***	0.38***	0.07
	(0.12)	(0.08)	(0.07)
China	-8.37***	-4.87***	-2.30***
	(0.88)	(0.55)	(0.44)
Indonesia	-6.70***	-4.99***	-4.01***
	(0.74)	(0.46)	(0.41)
Japan	-0.36	-0.41	-0.92**
	(0.62)	(0.41)	(0.40)
Korea	-1.99***	-1.59***	-1.23**
	(0.72)	(0.46)	(0.46)
Malaysia	-2.86***	-0.96*	-0.23
	(0.83)	(0.53)	(0.46)
Philippines	-6.39***	-4.35***	-0.14
	(1.19)	(0.63)	(0.57)
Thailand	-3.19***	-2.08***	-1.24***
	(0.73)	(0.61)	(0.41)
Taiwan	-1.04	-0.68	-0.34
	(0.72)	(0.54)	(0.46)
Singapore	2.28**	1.39*	0.05
	(0.97)	(0.70)	(0.63)
constant	1.13	0.07	-0.37
	(0.70)	(0.45)	(0.38)
R-sq	0.6865	0.7125	0.6769
Obs.	87	89	90

$Notes$: Regional names represent importer dummy variables. ***, **, and * show 1 %, 5 %, and 10% significant, respectively. The inside of a parenthesis is a heteroskedasticity-robust standard error.

Table 2: Basic Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth of exports	138	-0.36	1.13	-3.07	3.08
Border barriers reduction	138	0.25	1.37	-1.85	3.77
Production growth	138	-1.10	0.46	-1.98	-0.18
Expendigure growth	138	-1.11	0.44	-1.85	-0.28
International distance	138	7.84	0.64	5.76	8.66
Lang	138	0.30	0.46	0	1
Contig	138	0.09	0.28	0	1

Table 3: Results of Gravity Equations

Equation	(I)	(I)	(II)	(III)
Method	OLS	GMM	GMM	GMM
Border barriers reduction	0.12	0.28**	0.31**	0.27**
	(0.69)	(2.09)	(2.18)	(2.02)
Production growth	0.51**	0.71***	0.69***	0.62***
	(2.38)	(3.46)	(3.45)	(3.06)
Expenditure growth	1.30***	1.12***	1.06***	1.15***
	(6.33)	(6.01)	(5.55)	(5.92)
International distance	0.25***	0.25***	0.24***	0.24***
	(6.55)	(7.13)	(6.90)	(7.00)
Contig	0.56***	0.57***	0.55***	0.55***
	(2.73)	(3.19)	(3.05)	(3.03)
Lang	-0.05	-0.02	-0.02	-0.02
	(0.33)	(0.15)	(0.14)	(0.14)
importer dum.	yes	yes	yes	yes
exporter dum.	yes	yes	yes	yes
Chi-sq		0.1031	0.1165	0.1423
R-sq	0.7429	0.7089	0.7099	0.7109
Obs.	138	138	138	138

Notes: ***, **, and * show 1 %, 5 %, and 10% significant, respectively. The inside of a parenthesis is a heteroskedasticity-robust t-value. The Chi-Square test statistic (p value) is for a test of overidentifying restrictions on instruments. Column (I) reports the results of gravity equations using the estimators of border barriers in Table 1. The results using the estimators in “Preference” and “Preference + Productivity” in Table 4 are provided in columns (II) and (III), respectively.

Table 4: Allocation Equations with Control Variables

	Preference			Preference + Productivity		
	1990	1995	2000	1990	1995	2000
Relative distance	-1.08***	-0.67***	-0.48***	-1.01***	-0.65***	-0.50***
	(0.26)	(0.19)	(0.15)	(0.26)	(0.19)	(0.14)
Lang	0.49	0.36	0.16	0.91**	0.60**	0.43*
	(0.36)	(0.27)	(0.25)	(0.39)	(0.25)	(0.24)
Contig	-0.44	0.12	0.64*	-0.60	0.00	0.42
	(0.59)	(0.36)	(0.32)	(0.60)	(0.37)	(0.32)
Relative GDP per capita	0.70***	0.41***	0.09	0.19	0.04	-0.12*
	(0.13)	(0.09)	(0.07)	(0.22)	(0.15)	(0.06)
Relative productivity				0.72***	0.51***	0.36***
				(0.26)	(0.16)	(0.08)
Colony	-0.06	0.22	0.30	0.00	0.28	0.52
	(0.87)	(0.59)	(0.41)	(0.80)	(0.55)	(0.41)
Comcol	-0.71	-0.34	0.02	-0.30	-0.14	0.21
	(0.52)	(0.39)	(0.31)	(0.55)	(0.40)	(0.33)
Religion	-0.32	-0.42	-0.43*	-0.34	-0.43*	-0.56***
	(0.31)	(0.25)	(0.21)	(0.29)	(0.23)	(0.21)
China	-8.59***	-4.88***	-2.23***	-9.44***	-5.37***	-2.75***
	(0.98)	(0.65)	(0.50)	(1.08)	(0.66)	(0.49)
Indonesia	-6.95***	-5.12***	-4.08***	-6.89***	-5.09***	-4.30***
	(0.79)	(0.51)	(0.44)	(0.84)	(0.54)	(0.41)
Japan	-0.16	-0.21	-0.75*	-0.13	-0.29	-0.90**
	(0.73)	(0.49)	(0.43)	(0.68)	(0.45)	(0.42)
Korea	-1.72**	-1.32**	-1.04**	-1.87**	-1.18**	-1.03**
	(0.82)	(0.54)	(0.49)	(0.82)	(0.50)	(0.45)
Malaysia	-2.90***	-0.96*	-0.24	-3.45***	-1.27**	-0.64
	(0.84)	(0.54)	(0.47)	(0.87)	(0.51)	(0.49)
Philippines	-6.52***	-4.43***	-0.21	-6.40***	-4.33***	-0.44
	(1.23)	(0.67)	(0.58)	(1.17)	(0.66)	(0.52)
Thailand	-3.19***	-1.94***	-1.07**	-2.36***	-1.31*	-0.12
	(0.77)	(0.64)	(0.41)	(0.82)	(0.71)	(0.46)
Taiwan	-0.72	-0.38	-0.12	-1.56*	-0.93	-0.63
	(0.85)	(0.63)	(0.49)	(0.92)	(0.61)	(0.49)
Singapore	2.88**	1.89**	0.40	2.03	1.56*	0.31
	(1.27)	(0.92)	(0.76)	(1.28)	(0.83)	(0.71)
constant	1.52*	0.31	-0.22	1.45*	0.29	-0.09
	(0.85)	(0.60)	(0.45)	(0.86)	(0.59)	(0.43)
R-sq	0.6936	0.7245	0.6930	0.7197	0.7519	0.7457
Obs.	87	89	90	87	89	90

$Note$: See notes in Table 1.