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How Does Industrialization Affect the Structure of International Trade? The Japanese Experience in the Pacific Basin, 1975-85

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Abstract

This paper provides a theoretical model to address the issue of how industrialization affects the structure of international trade. Considering both horizontal and vertical product differentiation, the model shows that intra-industry trade increases when product quality improvement emerges in a developing country and when a difference in relative factor endowments between a developed and a developing countries shrinks. To promote understanding of the conclusions of the model, the paper also uses actual trade data between Japan and Indonesia and between Japan and Korea.

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Contents

Summary

Over the years, a great deal of research has focused on the expansion of intra-industry trade among the member countries of the European Union. Traditional international trade theories based on assumptions of constant returns to scale and perfect competition (e.g., the Hecksher-Ohlin model and the Ricardian model of comparative advantage) have been modified to explain this phenomenon (e.g., Helpman and Krugman, 1985). More recently, intra-industry trade has expanded between industrialized and newly industrializing countries, such as between Japan and Pacific Basin countries. In this context, international trade theories must again be modified to take into account the influence of industrialization.

Japan's intra-industry trade is more extensive with Singapore, Korea, and Thailand than with Indonesia, Malaysia, and the Philippines because, like Japan, the countries in the first group are relatively rich in skilled labor and capital, whereas those in the second group are relatively rich in natural resources. However, although Japan has maintained large-scale, inter- industry trade with the latter group, it has also expanded intra-industry trade by increasing manufactured imports as these countries have progressed toward industrialization. Intra-industry trade among all six countries has expanded since Japan's foreign direct investment in these countries increased owing to the sharp appreciation of the yen after 1985. As each country has become more specialized in certain manufactured products, Japan has formed production networks with them. This industrialization process is closely related to an increase in the variety of manufactured products (horizontal product differentiation) as well as an improvement in their quality (vertical product differentiation).

This paper provides a theoretical model to explain how industrialization affects the structure of international trade. Using conventional economic concepts such as economies of scale and monopolistic competition and considering both horizontal and vertical product differentiation, the model explicitly focuses on industrialization and its impact on the volume and share of intra- and inter-industry trade. The paper considers two processes: one that increases the quality of manufactured products and one that shifts labor from the agricultural to the manufacturing sector. The model shows that the volume and share of intra-industry trade increase when the quality of products in a developing country improves and when the difference in relative factor endowments between an industrial and a developing country shrinks. It also suggests that the faster a developing country industrializes, the faster intra-industry trade increases.

This paper investigates empirically the structural changes in Japan's international trade with Indonesia and Korea for 1975 and 1985. These countries were chosen because they differ in their relative factor endowments and technology.

I. Introduction

The rapid industrialization that has taken place in Asian countries in the past two decades has brought about substantial changes in the structure of international trade with Japan. Industrialization has not only expanded the share of manufacturing in GNP of these countries, but has also upgraded their industries from labor-intensive to capital-intensive. Consequently, Japan has increased its dependence on imports of manufactured products and thus has stimulated two-way flows of products with other Asian countries. This shift is particularly evident in capital-intensive industries. For example, between 1975 and 1985, Japan's imports of manufactured metal products from six Asian countries (Indonesia, Malaysia, the Philippines, Singapore, South Korea and Thailand) soared from $0.2 billion to $1.3 billion, while its exports increased only from $1.5 billion to $3 billion. By contrast, the increase in two-way flows of products in labor-intensive industries has been on a much smaller scale. For example, between 1975 and 1985, Japan's imports of manufactured textile products increased from $478 million to $997 million, while its exports increased from $443 million to $895 million.

These examples suggest that the composition of international trade is shifting toward products experiencing rapid technological evolution and toward heterogeneous products rather than homogeneous products (Bergsten and Noland (1993)). These trends are closely related to an expansion of two-way flows of manufactured products, or intra-industry trade. A large expansion of intra-industry trade has been observed among the member countries of the European Union and much research has focused on this phenomenon (Caves (1981), Gray (1973), and Pagoulatos and Sorensen (1975)). As a result of these developments, traditional international trade theories based on assumptions of constant returns to scale and perfect competition (e.g., the Heckscher-Ohlin model and the Ricardian model of comparative advantage) have had to be modified and a large body of literature has emerged to explain the new phenomenon of intra-industry trade (e.g., Helpman and Krugman (1985)). In recent years, the expansion of intra-industry trade has become pronounced between industrialized and industrializing countries, such as between Japan and other Asian countries. Consequently, international trade theories need to add the influence of industrialization in order to explain intra-industry trade between these countries.

Japan's intra-industry trade is more evident with Singapore, South Korea, and Thailand than with Indonesia, Malaysia, and the Philippines. This difference can be attributed to the fact that like Japan, the former countries are relatively rich in skilled labor and capital, whereas the latter group of countries are relatively rich in natural resources. However, although Japan has still maintained large-scale, inter-industry trade with the latter countries, it has also expanded intra-industry trade by increasing manufactured imports as industrialization has progressed in these countries. The tendency toward intra-industry trade among all six countries has become more pronounced since Japan's foreign direct investment expanded in these countries due to the sharp appreciation of the yen after 1985. Consequently, as each country has increasingly specialized in certain

manufactured products, Japan has formed international production networks with them.

This industrialization process is closely related to an increase in the variety of manufactured products as well as an upgrading of these products. A growing body of literature points out that increasing the variety of manufactured products and improving their quality expands intra-industry trade. According to this literature, the varietal change is related to horizontal product differentiation while the change in quality is related to vertical product differentiation. Horizontal product differentiation refers to the existence of innovative products, which serve new functions, thereby expanding the variety of products available for consumption (Lancaster (1980), Dixit and Norman (1980), Helpman (1981), and Krugman and Helpman (1986)). Vertical product differentiation refers to the emergence of innovative products that provide functions similar to those of existing products but are of higher quality (Flam and Helpman (1987), and Helpman and Krugman (1985)).

With the concepts of product differentiation, increasing returns to scale and imperfect competition, the so-called "new trade theory" provides an alternative explanation for the fact that nearly half of world commerce consists of trade among developed and newly developed countries with similar relative factor endowments. This new trade theory, however, does not satisfactorily explain how industrialization affects the international trade structure, including the combination of horizontally and vertically differentiated products. This phenomenon was first documented in the classic work undertaken by Chenery and Hughes (1971), which remains unexplained due to the absence of a satisfactory theoretical foundation.

This paper provides an alternative theoretical model to address the issue of how industrialization affects the structure of international trade. Using conventional economic concepts such as economies of scale and monopolistic competition, this model explicitly focuses on the dynamic process of industrialization and its impact on the volume and share of intra- and inter-industry trade. Also, we investigate empirically the implications of the model. We first develop a two-country, two-product, two-factor model. The two countries produce a homogeneous agricultural product and a differentiated manufactured product with many varieties. We assume that due to the technology gap, one country produces a higher-quality manufactured product than the other country. Thus, this model combines horizontal product differentiation within a country with vertical product differentiation between countries. We refer to a country that produces a high-quality manufactured product as a developed country and a country producing a low-quality manufactured product as a developing country.

This model focuses on a preference for variety as the driving force for intra-industry trade and thus, differs from that of Flam and Helpman (1987) which sees an overlap of income distribution between rich and poor countries as the main factor. Our model also considers both horizontal and vertical product differentiation while their model focuses solely on vertical product

differentiation. Our model takes advantage of the recent literature that successfully explains how endogenous innovation, quality improvement and human capital formation affect economic growth and international trade (e.g., Grossman and Helpman (1990) and (1991a)). To make the model tractable and to put more emphasis on the structural change in international trade, our model treats innovation, quality improvement, and human capital formation as exogenously given and examines how changes in such exogenous variables affect the international trade structure. The structure of our model is somewhat similar to that of Krugman ((1991a) and (1991b)), although his model focuses on the geographic distribution of particular manufacturing sectors.

We study the impact of industrialization on the change in the structure of international trade. Suppose large differences in the relative factor endowments and technology exist between a developed country and a developing country in the early stage of industrialization. Then inter-industry trade dominates intra-industry trade, and traditional international trade theories prevail. We consider two industrialization processes: one that increases the quality of the manufactured product (or equivalently, reduces the technology gap) and another that shifts labor from the agricultural to the manufacturing sector (or equivalently, changes the relative factor endowments). We find that intra-industry trade increases and inter-industry trade declines when the quality of the manufactured product improves or the technology gap shrinks as a result of industrialization in a developing country. We also find that a transfer of the labor force from the agricultural sector to the manufacturing sector in a developing country increases the variety of the differentiated manufactured product and thus, increases intra-industry trade. 1/

How quickly a developing country industrializes determines the change in the international trade structure. For instance, a developing country undergoing rapid industrialization may experience a swift expansion as well as an upgrading of intra-industry trade by improving the quality of manufactured products. By contrast, a developing country undergoing slow industrialization may experience a smaller increase in inter-industry trade.

The initial conditions, such as differences in the relative factor endowments and technology, may significantly change the international trade structure. Suppose product quality improves in a developing country. We show that its total trade volume with a developed country is likely to increase more when the two countries differ significantly in their initial conditions. Furthermore, we also show that the total volume is likely to increase more when the developing country is in the early stage of industrialization than when it is in the later stage.

1/ One can consider, for example, a case in which the government expands expenditure on education and vocational training to increase the skills of the labor force.

This paper consists of four sections. Section II begins with a basic theoretical model. We first consider the impact of the quality improvement and a shift in the relative factor endowments on the volumes of inter- and intra-industry trade. Then, the impacts of these variables on the total trade volume and the share of intra-industry trade (or the share of inter-industry trade) are examined. Section III investigates empirically the structural changes in Japan's international trade with Indonesia and South Korea between 1975 and 1985. These two developing countries have been chosen because they differ significantly in their relative factor endowments. Section IV contains concluding remarks.

II. The Theoretical Model

1. The basic model

We consider a model of two countries, country I and country II. There are two kinds of products, an agricultural product and a manufactures aggregate (hereafter called manufactures). The manufactures produced in each country are horizontally differentiated with many varieties. Furthermore, we assume that the manufactures produced within one country are vertically differentiated from those of the other country because of a difference in quality. The two countries produce a homogeneous agricultural product with a constant returns to scale technology. The two countries also produce the differentiated manufactures with an increasing returns to scale technology, and producers operate under monopolistic competition, following the Dixit and Stiglitz (1977) approach.

All individuals in the two countries are assumed to have the same utility function. We specify this by the following Cobb-Douglas function, which increases with the consumption of the manufactures and the agricultural product (Krugman (1991a) and (1991b)):

$$U = C_M^{\mu} C_A^{1-\mu} \tag{1}$$

where C_M is consumption of the manufactures and C_A is consumption of the agricultural product. Given this functional form, μ is the share of expenditure that falls on the manufactures and $1-\mu$ is the share of expenditure that falls on the agricultural product. The consumption of the manufactures is in turn specified by the following Constant Elasticity of Substitution (CES) function:

$$C_M = \left(\sum_i^{N1} c_{1i}^{\frac{(\sigma-1)}{\sigma}} + \sum_j^{N2} (hc_{2j})^{\frac{(\sigma-1)}{\sigma}} \right)^{\frac{\sigma}{(1-\sigma)}} \tag{2}$$

where c_{1i} is consumption of variety i of the manufactures produced in country I, and c_{2j} is consumption of variety j of the manufactures produced in country II. Also, σ refers to the elasticity of substitution between

any varieties of the manufactures. We assume that σ is larger than one. The term N_1 is the number of varieties of the manufactures produced in country I and N_2 is the number of varieties of the manufactures produced in country II. Later, these numbers are endogenously determined. We assume that country I is able to produce a higher quality of manufactures than country II, with the assumption of $0 \leq h \leq 1$. When h is zero, consumers would not want to consume the manufactures produced in country II because of their substantially lower quality. In this case, no production of manufactures takes place in country II. When h is one, consumers regard manufactures produced in country II as having the same quality as those in country I. Due to a preference for variety, they consume all varieties that are available. With a sufficiently large number of varieties, this functional form ensures that σ is the elasticity of demand for any of the varieties of the manufactures.

We assume two factors of production, each of which is specific to a particular sector (Krugman (1991a), (1991b), and (1994)). The term M refers to a labor force that is specific to the agricultural sector (farmers), and L refers to a labor force that is specific to the manufacturing sector (workers). We assume country I is endowed with M_1 farmers and L_1 workers and country II is endowed with M_2 farmers and L_2 workers.

The price of the agricultural product should be the same in the two countries if free trade is assumed. As farmers in the two countries produce the homogeneous agricultural product under constant returns to scale, the wage is equal to the price. Throughout this section, we treat the price of the agricultural product or the wage of farmers as the numerare. The production of variety i (or variety j) of the manufactures requires a fixed cost and constant marginal cost under increasing returns to scale. Under the economies of scale, the average cost of producing variety i (or variety j) is a decreasing function of its volume. We assume the following linear cost function:

$$l_i = \alpha + \beta \cdot x_i \tag{3}$$

where l_i (or l_j) is the number of workers used to produce variety i (or variety j) of the manufactures and x_i (or x_j) is production of variety i (or variety j). Under monopolistic competition, each manufacturer produces a different variety to gain some limited market power. We assume that if a given factor of production produces x units of variety i of the manufactures, then the same factor of production will produce x units of every other possible variety of the manufactures. This assumption is necessary to assure the possibility of a symmetrical equilibrium for varieties of manufactures produced in a country. A manufacturer in each country maximizes his profit from producing a variety and the following profit maximizing conditions are obtained:

$$p_1 = (\sigma \cdot \beta \cdot w_1) / (\sigma - 1) \tag{4a}$$
$$p_2 = (\sigma \cdot \beta \cdot w_2) / (\sigma - 1) \tag{4b}$$

where p_1 is the price of a variety of manufactures produced in country I, and p_2 represents that of country II. Also, w_1 is the wage of workers in country I, and w_2 is that for country II. Thus, the profit-maximizing price is a constant mark-up over the marginal cost or the wage. Assuming free entry, each manufacturer's profit is competed away at the equilibrium. Thus, we obtain the following equations:

$$(p_1 - \beta \cdot w_1) \cdot x_1 = \alpha \cdot w_1 \quad (5a)$$
$$(p_2 - \beta \cdot w_2) \cdot x_2 = \alpha \cdot w_2 \quad (5b)$$

From the profit-maximizing conditions (4a) and (4b) and the free-entry conditions (5a) and (5b), the equilibrium output of a manufacturer in each country is as follows:

$$x_1 = \alpha \cdot (\sigma - 1) / \beta \quad (6a)$$
$$x_2 = \alpha \cdot (\sigma - 1) / \beta \quad (6b)$$

As x_1 and x_2 depend on the same parameters of cost functions and utility functions, a manufacturer in country I produces the same amount of the representative variety as a manufacturer in country II. The total number of workers used in the manufacturing sector of country I is $L_1 = N_1 \cdot l_1$ and $L_2 = N_2 \cdot l_2$ is that of country II. From equation (3), the following equations can be derived:

$$N_1 = L_1 / \alpha \cdot \sigma \quad (7a)$$
$$N_2 = L_2 / \alpha \cdot \sigma \quad (7b)$$

From the utility-maximizing conditions for c_1 and c_2, we derive the following relationship, which is the same in both countries:

$$\frac{c_1}{c_2} = \left(\frac{p_1}{p_2}\right)^{-\sigma} \left(\frac{1}{h}\right)^{\sigma-1} = \left(\frac{w_1}{w_2}\right)^{-\sigma} \left(\frac{1}{h}\right)^{\sigma-1} \quad (8)$$

Suppose Z is the ratio of expenditure spent on varieties of the manufactures produced in country I to that of country II. The ratio Z turns out to be the same for both countries.

$$Z = \frac{N_1 p_1 c_1}{N_2 p_2 c_2} = \left(\frac{N_1 p_1}{N_2 p_2}\right)\left(\frac{p_1}{p_2}\right)^{-\sigma} \left(\frac{1}{h}\right)^{\sigma-1} = \left(\frac{L_1}{L_2}\right)\left(\frac{p_1 h}{p_2}\right)^{-(\sigma-1)} = \left(\frac{L_1}{L_2}\right)\left(\frac{w_1 h}{w_2}\right)^{-(\sigma-1)} \quad (9)$$

Let Y_1 be the total income of country I and Y_2 that of country II. The total expenditure spent on all varieties of the manufactures produced in the two countries is given by $\mu \cdot (Y_1 + Y_2)$. Of this total, a proportion $Z/(1+Z)$ is spent on varieties of the manufactures produced in country I and a proportion $1/(1+Z)$ is spent on what country II produces. As the value of total supply for the manufactures produced within a country is equal to the

expenditure for the manufactures (or, the value of demand for them) in equilibrium, we obtain the following equations:

$$w_1 L_1 = \mu \frac{Z}{1+Z}(Y_1 + Y_2) \tag{10}$$

$$w_2 L_2 = \mu \frac{1}{1+Z}(Y_1 + Y_2) \tag{11}$$

From equations (10) and (11), we obtain the wage ratio between the manufacturing sectors in country I and country II.

$$\frac{w_1}{w_2} = h^{-\frac{\sigma-1}{\sigma}} \tag{12}$$

The ratio depends only on the quality level of the manufactures produced in country II and the elasticity of demand. As σ is larger than one, the wage in the manufacturing sector in country I is larger than in country II if h is lower than one. Differentiation of the ratio with respect to h yields a negative sign. Namely, as the quality difference declines between the two countries, the wage difference between the manufacturing sectors of each country declines.

$$\frac{d\frac{w_1}{w_2}}{dh} < 0 \tag{13}$$

Substituting equation (12) into equation (9), equation (9) is rewritten as:

$$Z = \frac{L_1}{L_2} h^{-\frac{\sigma-1}{\sigma}} \tag{9}'$$

By definition, the total income in a country is equal to the labor incomes that are obtained in the agricultural and manufacturing sectors. Thus, $Y_1 = M_1 + w_1 \cdot L_1$ and $Y_2 = M_2 + w_2 \cdot L_2$. Substituting these equations into (10) and (11), we obtain (10)' and (11)'.

$$w_1 L_1 = \mu \frac{Z}{1+Z}(M_1 + w_1 L_1 + M_2 + w_2 L_2) \tag{10}'$$

$$w_2 L_2 = \mu \frac{1}{1+Z}(M_1 + w_1 L_1 + M_2 + w_2 L_2) \tag{11}'$$

Substituting (9)' into (10)' and (11)', we obtain wages for the manufacturing sectors.

$$w_1 = \frac{\mu}{1-\mu} \frac{M_1+M_2}{L_1+L_2 h^{\frac{\sigma-1}{\sigma}}} \tag{14a}$$

$$w_2 = \frac{\mu}{1-\mu} \frac{M_1+M_2}{L_2+L_1 h^{\frac{-(\sigma-1)}{\sigma}}} \tag{14b}$$

Equations (14a) and (14b) show that w_1 and w_2 are increasing functions of the share of expenditure that falls on manufactures or μ. From equations (4a) and (4b), p_1 and p_2 are increasing functions of μ. Equations (14a) and (14b) also suggest that an increase in h reduces w_1 and p_1 while it increases w_2 and p_2.

2. The volume of intra-industry and inter-industry trade

We now focus on the volume of intra-industry trade and inter-industry trade. We begin with a situation in which each country is able to supply an agricultural product in a quantity that just meets domestic demand, and thus, no agricultural trade takes place. In other words, no inter-industry trade takes place in this case. We already know that a portion of income $(1-\mu)$ is spent on an agricultural product in each country. Thus, the expenditure on the agricultural product (or, the value of total demand for the agricultural product) is $(1-\mu)\cdot Y_1 = (1-\mu)\cdot(M_1+w_1\cdot L_1)$ for country I and $(1-\mu)\cdot Y_2 = (1-\mu)\cdot(M_2+w_2\cdot L_2)$ for country II. As the agricultural product in each country is produced under constant returns to scale, the value of output is equal to the value of the labor cost.

$$M_1 = (1-\mu)\cdot(M_1 + w_1\cdot L_1) \tag{15a}$$
$$M_2 = (1-\mu)\cdot(M_2 + w_2\cdot L_2) \tag{15b}$$

From equations (15a) and (15b), we obtain the ratio of the number of farmers in country I and country II. Substituting equation (12) into equations (15a) and (15b), the condition for no inter-industry trade is derived as follows:

$$\frac{M_1}{M_2} = \frac{w_1}{w_2}\frac{L_1}{L_2} = h^{-\frac{\sigma-1}{\sigma}}\frac{L_1}{L_2} \tag{16}$$

If the left-hand side of equation (16) is larger than its right-hand side, country I is an exporter of the agricultural product while country II

is an importer. Similarly, if the right-hand side of equation (16) is larger than its left-hand side, country II is an exporter while country I is an importer of the agricultural product. Equation (16) suggests that the ratio depends on the relative number of workers in the manufacturing sector in country I and country II. When country I has a larger number of workers than country II, country I is likely to be an importer of the agricultural product. The ratio also depends on the quality of the manufactures produced in country II. Differentiation of the right-hand side with respect to h yields a negative sign.

$$\frac{d\dfrac{w_1L_1}{w_2L_2}}{dh}<0 \tag{17}$$

Equation (17) indicates that when a large quality difference exists between the two countries, country I is likely to be the importer of the agricultural product and country II the exporter. As country II is able to produce the higher quality manufactures, the right-hand side of equation (16) becomes smaller. As h converges to one, the right-hand side of equation (16) depends only on the relative number of workers between the two countries.

Throughout this section, we consider a case in which country I is the importer of the agricultural product and country II the exporter.

We assume that:

$$\frac{M_1}{M_2}<\frac{w_1}{w_2}\frac{L_1}{L2}=\frac{L_1}{L_2h^{\frac{(\sigma-1)}{\sigma}}} \tag{18}$$

With this assumption, the volume of inter-industry trade is obtained by the difference between the value of supply for the agricultural product and the value of demand for the product in country II, or $N_2 - (1-\mu)\cdot Y_2$, multiplied by two. Using the definition $Y_2 = M_2 + w_2\cdot L_2$ and equation (14b), the volume of inter-industry trade is obtained as follows:

$$2[M_2-(1-\mu)Y_2]=2\mu\left(\frac{M_2L_1h^{\frac{-(\sigma-1)}{\sigma}}-M_1L_2}{L_2+L_1h^{\frac{-(\sigma-1)}{\sigma}}}\right) \tag{19}$$

Proposition 1: The volume of inter-industry trade is obtained from equation (19).

(i) The volume of inter-industry trade decreases when the quality of manufactures produced in country II, h, improves (or, when the technology difference shrinks).
(ii) The volume of inter-industry trade decreases when the total number of farmers in country I, M_1, increases, or when that in country II, M_2, decreases.
(iii) The volume of inter-industry trade increases when the total number of workers in country I, L_1, increases, or when that in country II, L_2, decreases.

Proof for this proposition is apparent from equation (19). Proposition 1 is easily understood by looking at equation (18). Equation (18) indicates the relation between the share of the total number of farmers in country I and country II and the share of the total number of workers in country I and country II. It may be considered that the number of workers in country II is adjusted by $h^{(\sigma-1)/\sigma}$. If we move L_1 and M_2 to the other side, the share is equivalent to the relative factor endowments. Other variables held constant, an increase in h lowers the right-hand side of equation (18). In other words, the smaller the quality difference between the manufactures produced by the two countries, the smaller is the difference in their relative factor endowments. Thus, the volume of inter-industry trade declines. This result is similar to that of the Heckscher-Ohlin model.

When the total number of farmers in country I increases, the difference in the relative factor endowments of the two countries becomes smaller. As the left-hand side of the relation given in equation (18) increases, the inequality of the equation becomes smaller. Thus, the volume of inter-industry trade declines. However, when the total number of farmers in country II increases, the difference in the relative factor endowments of the two countries widens. Thus, the volume of inter-industry trade expands.

When the total number of workers in country I increases, the difference in the relative factor endowments of the two countries increases because country I has a relatively large number of workers compared with farmers. As a result, the volume of inter-industry trade increases. When the total number of workers in country II increases, the difference in the relative factor endowments of the two countries become smaller since country II has a relatively larger number of workers compared with farmers. Thus, inter-industry trade declines.

The volume of intra-industry trade is obtained by the expenditure of country I on varieties of the manufactures produced in country II, multiplied by two. Let $p_2C_2^I$ be the expenditure, where C_2^I refers to consumption of country I on the varieties of manufactures produced in country II. Then, $p_2C_2^I$ is derived by multiplication of the income of country I spent on the manufactures, μY_I, and a $1/(1+Z)$ proportion of

the expenditure spent on the varieties of manufactures produced in country II, $1/(1+Z)$.

Substituting equation (9)' and $Y_1 = N_1 + w_1 \cdot L_1$ into $p_2 \cdot C_2^I$, the volume of intra-industry trade is obtained as follows:

$$2p_2C_2^I = 2\mu L_2 \left[\frac{1}{L_2 + L_1 h^{\frac{-(\sigma-1)}{\sigma}}} \right] \left[M_1 + \frac{\mu L_1}{1-\mu} \frac{M_1 + M_2}{L_2 h^{\frac{(\sigma-1)}{\sigma}} + L_1} \right] \tag{20}$$

Let us assume $M^1 = M^2 = 1$ to simplify the analysis. Then the volume of intra-industry trade can be written as follows:

$$2p_2C_2^I = \frac{2\mu L_2}{1-\mu} \left[\frac{(1-\mu)L_2 + L_1 h^{\frac{-(\sigma-1)}{\sigma}} (1+\mu)}{\left(L_2 + L_1 h^{\frac{-(\sigma-1)}{\sigma}} \right)^2} \right] \tag{20}'$$

Proposition 2: The volume of intra-industry trade is defined by (20)'.

(i) The volume of intra-industry trade increases when the quality of manufactures produced in country II, h, improves (or, when the technology gap shrinks).
(ii) The volume of intra-industry trade decreases when the total number of workers, L_1, increases.
(iii) The volume of intra-industry trade increases when the total number of workers, L_2, increases.

The proof of Proposition 2 is obtained by differentiating (20)' with respect to h, L_1, and L_2. When the quality of manufactures produced in country II, h, improves, the volume of intra-industry trade increases through two counteracting effects. One effect is to decrease the total income of country I, Y_1, by lowering the price of its manufactures. Thus, country I reduces its expenditure on the varieties of manufactures produced in country II, $p_2 \cdot C_2^I$. The other effect is to increase the proportion of expenditure spent on the varieties of manufactures produced in country II, $1/(1+Z)$, which increases the expenditure, $p_2 \cdot C_2^I$. The second effect dominates the first effect.

When the total number of workers in country I, L_1, increases, the volume of intra-industry trade declines through three effects: two affect volume positively while the third affects it negatively. The first effect is to increase the ratio of expenditure of country I on the manufactures it produces to what it spends on those produced in country II, Z. This effect takes place because total output of the manufactures produced in country I

increases. The second effect is to increase the total income of country I by increasing L_1. The third effect is to lower the wage of workers in country I, w_1. This situation occurs because by increasing varieties of manufactures produced in country I, N_1, the total world output of the manufactures increases, and therefore, the price of the manufactures declines relative to that of the agricultural product. It is shown that the third effect dominates the first two effects.

When the total number of workers in country II, L_2, increases, the volume of intra-industry trade increases through two counteracting effects. One effect is to increase the proportion, $1/(1+Z)$. This effect takes place because the total output of manufactures produced in country II increases as a result of the increase in the number of varieties, N_2. The other effect is to reduce Y_1 by reducing w_1 as a result of the increase in the total world output of the manufactures. It is shown that the first effect dominates the second effect.

From Propositions 1 and 2, we can conclude that as the difference in the quality of manufactures produced by the two countries becomes smaller, the smaller is the difference between their total income. That is, by increasing the total income of country I, Y_1, and decreasing the total income of country II, Y_2, the difference between incomes narrows. As a result, the expenditure of country II on the agricultural product increases. Therefore, the volume of inter-industry trade decreases. Meanwhile, the quality upgrading improves the terms of trade for the manufactures from the viewpoint of country II. Thus, it increases the purchasing power of country II on the manufactures produced in country I, thereby expanding the volume of intra-industry trade.

From these propositions, we also conclude that the larger is the difference in the relative factor endowments between the two countries, the larger is the volume of inter-industry trade and the smaller is the volume of intra-industry trade.

3. Total trade volume

Let us now consider total trade volume, which is the sum of the volumes of inter-industry and intra-industry trade. Assuming balanced trade, the total trade volume is $2 \cdot p_1 \cdot C_1^{II}$. We can obtain $p_1 \cdot C_1^{II}$ from (19) and (20)'. Also, $p_1 \cdot C_1^{II}$ is derived by the definition $\mu Y_2 Z/(1+Z)$.

$$2p_1C_1^{II} = \frac{2\mu L_1 h^{\frac{-(\sigma-1)}{\sigma}}}{(1-\mu)} \frac{(1-\mu)L_1 h^{\frac{-(\sigma-1)}{\sigma}} + (1+\mu)L_2}{\left(L_2 + L_1 h^{\frac{-(\sigma-1)}{\sigma}}\right)^2} \tag{21}$$

After differentiating the total trade volume given in (21) with respect to h, we consider the following condition for achieving the positive sign of $\partial p_1 \cdot C_1^{II} / \partial h$:

$$\frac{L_1}{L_2 h^{\frac{(\sigma-1)}{\sigma}}} > \frac{1+\mu}{3\mu-1} \tag{22}$$

The result of differentiation suggests that the share of expenditures that falls on the manufactures, μ, must be larger than one third. From Propositions 1 and 2, we know that an increase in h reduces inter-industry trade and increases intra-industry trade. When approximately more than 60 percent of total income is spent on the agricultural product, the decline in inter-industry trade is likely to exceed the increase in intra-industry trade. Therefore, the total trade volume declines when the quality improves. This situation takes place whenever μ is less than one third, regardless of the size of endowments, L_1 and L_2, and the degree of the quality, h. This situation is very unlikely for countries that are in the later stage of industrialization. Therefore, we only consider the case of $\mu < 1/3$.

We assume that:

$$\mu > 1/3 \tag{23}$$

The condition given in (22) indicates that with the assumption given in equation (23), three situations are necessary to maintain the condition. Those are: (a) h is low; (b) L_1 / L_2 is large; and (c) μ is high.

Proposition 3: As the quality of the manufactures produced in country II improves (or, the technology difference shrinks), the total trade volume increases when the assumption given in (23) and the following three conditions are met:

(i) the quality of the manufactures produced in country II, h, is low (or, the technology gap is large);
(ii) the difference in the relative factor endowments is large; and
(iii) the share of expenditures that fall on the manufactures, μ, is high.

The left-hand side of the condition given in (22) increases when h becomes lower, L_1/L_2 becomes larger, and μ becomes higher. Proposition 3 leads to Lemmas 1 and 2. Consider a situation in which a developed country trades with two kinds of developing countries. We assume that the developed country (country I) has a large number of workers, L_1. One developing country (country IIa) has relative factor endowments similar to those of country I, so that $L_{2,a}$ is closer to L_1. Also, country IIa can produce a relatively high quality of the manufactures, so that h is high. The other developing country has relative factor endowments that are significantly

different from those of country I, so that $L_{2,b}$ is much smaller than L_1. Also, country IIb produces a relatively low quality of the manufactures, so that h is low. Proposition 3 implies that when the quality improves in country II, an increase in total trade volume is larger between country I and country IIb than that between country I and country IIa, given that μ is the same.

Lemma 1: Suppose the quality improves in a developing country, or that the technology gap shrinks between a developed and a developing country. Other things being equal, an increase in the total trade volume is larger when differences in technology and relative factor endowments are large than when they are small.

Alternatively, we can consider a situation in which a developed country trades with one developing country that undergoes industrialization. In the early stage of industrialization, the two countries may have large differences in their relative factor endowments and technology. In this stage, a given growth rate of quality improvement that takes place in the developing country leads to the larger increase in the total trade volume compared with the volume obtained in the later stage of industrialization.

Lemma 2: Suppose a developing country undergoes industrialization. Other things being equal, the given growth of quality improvement increases the total trade volume between the developing country and the developed country faster in the early stage of industrialization than in the later stage.

Proposition 4: An increase in the number of workers in country I decreases the total trade volume when the assumption given in (23) and the following conditions are met:

(i) the quality of the manufactures produced in country II, h, is low (or, the technology gap is large);
(ii) the difference in the relative factor endowments is large; and
(iii) the share of expenditures that falls on the manufactures μ is high.

From differentiation of the total trade volume given in (20) with respect to the number of workers in country I, L_1, we conclude that under the three conditions given in Proposition 3, total trade volume declines when L_1, increases. Intuitively, from Propositions 1 and 2, we know that L_1 increases inter-industry trade and decreases intra-industry trade. As the decline in intra-industry trade exceeds the increase in inter-industry trade, total trade volume declines.

Lemma 3: Suppose the number of workers increases in a developed country. Other things being equal, a decline in total trade volume is likely to be larger when countries have large differences in relative factor endowments and technology.

Lemma 4: Suppose the number of workers increases in a developed country. Other things being equal, a decline in total trade volume is likely to be larger in the early stage of industrialization than in the later stage.

Proposition 5: An increase in the number of workers in country II expands the total trade volume when the assumption given in (23) and the conditions given in Proposition 3 hold.

From differentiation of the total trade volume given in (21) with respect to the number of workers in country II, L_2, we conclude that under the conditions given in Proposition 3, increasing L_2 expands the total trade volume.

Lemma 5: Suppose a developing country experiences an increase in the number of workers. Other things being equal, an increase in the total trade volume is likely to be larger when the two countries have large differences in technology and relative factor endowments.

Lemma 6: Suppose a developing country experiences an increase in the number of workers. Other things being equal, an increase in the total trade volume is likely to be larger in the early stage of industrialization than in the later stage.

4. Share of intra-industry trade

When countries are significantly different in size, it is often difficult to examine the volumes of intra- and inter-industry trade or the total trade volume. This subsection, therefore, considers the share of intra-industry (or inter-industry) trade. The share of intra-industry trade is defined by the volume of intra-industry trade divided by total trade volume. As $p_2 \cdot C_2^I = \mu Y_1/(1+Z)$ and $p_1 \cdot C_1^{II} = \mu Y_2 Z / (1+Z)$, the share of intra-industry trade, $p_2 \cdot C_2^I / p_1 \cdot C_1^{II} = Z \cdot Y_1 / Y_2$. Using (20)' and (21), the share of intra-industry trade takes the following form:

$$\frac{p_2 C_2^I}{p_1 C_1^{II}} = \frac{(1-\mu)L_2^2 + (1+\mu)L_1 L_2 h^{\frac{-(\sigma-1)}{\sigma}}}{(1-\mu)\left(L_1 h^{\frac{-(\sigma-1)}{\sigma}}\right)^2 + (1+\mu)L_1 L_2 h^{\frac{-(\sigma-1)}{\sigma}}} \tag{24}$$

We now analyze the impact of quality improvement, and the increase in the number of workers in countries I and II on the share of intra-industry trade. We first differentiate the share of intra-industry trade given in (24) with respect to h. Differentiation always yields a positive sign.

Proposition 6: The share of intra-industry trade increases when the quality of the manufactures produced in country II improves (or, when the technology difference between the two countries shrinks).

From Proposition 2, we know that improving the quality of manufactures produced in country II increases the volume of intra-industry trade. From Proposition 3, total trade volume increases or decreases depending on the initial conditions and the proportion of expenditure spent on the manufactures. Differentiation of (24) with respect to h provides a positive sign. It suggests that a change in the volume of intra-industry trade as a result of quality improvement exceeds the change in the total trade volume. Therefore, improving the quality always increases the share of intra-industry trade and decreases that of inter-industry trade.

We now differentiate the share of intra-industry trade given in (24) with respect to the number of workers in country I, Ll. Differentiation yields a negative sign.

Proposition 7: The share of intra-industry trade declines when the number of workers in country I increases.

From Proposition 2, we know that the volume of intra-industry trade declines when L_1 increases. From Proposition 4, the total trade volume may increase or decrease depending on initial conditions and the proportion of expenditure spent on the manufactures. The negative sign of the differentiation indicates that a change in the volume of intra-industry trade exceeds a change in the total trade volume. Thus, increasing the number of workers in country I reduces the share of intra-industry trade and increases that of inter-industry trade.

Finally, we differentiate the share of intra-industry trade given in (22) with respect to the number of workers in country II, L_2. The differentiation takes a positive sign.

Proposition 8: The share of intra-industry trade increases when the number of workers in country II increases.

From Proposition 2, we know that increasing L_2 expands the volume of intra-industry trade. From Proposition 5, the total trade volume increases or decreases depending on the initial size of the factor endowments, the scale of the technology gap, and the proportion of expenditure on the manufactures. The positive sign of differentiation suggests that a change in the volume of intra-industry trade exceeds a change in the total trade volume. Therefore, increasing the number of workers in country II expands the share of intra-industry trade and decreases the share of inter-industry trade.

From Propositions 6, 7 and 8, the share of intra-industry trade increases when the quality of manufactures produced in country II improves, when the number of workers in country I declines, and when the number of workers in country II increases. Furthermore, these propositions provide

results similar to Helpman (1987)--that a larger difference in relative factor endowments and in quality is associated with a smaller share of intra-industry trade.

III. Empirical Analysis

1. An overview

The "East Asian Miracle," or the remarkable economic success of countries in the Pacific Basin, has become apparent over the past two decades. High economic growth has been achieved particularly by the Newly Industrializing Economies (NIEs), which includes Korea, Taiwan Province of China, Hong Kong, and Singapore. Their economies grew at a rate of 8 percent per year in the 1960s, accelerated to 9 percent per year in the early 1980s, and have still maintained a rate of over 6 percent per year since the late 1980s (Bank of Japan (1993)). Following the NIEs, the 4 counties, which are Thailand, Indonesia, Malaysia, and the Philippines (we shall refer to them as the "TIMP" group), have experienced high economic growth since the 1970s, maintaining a rate of over 4 percent per year (Bank of Japan (1993)). The economies of these Pacific Basin countries have consistently grown faster than the world average.

The countries in the Pacific Basin have been undergoing a process of rapid industrialization during the post-war period, although the speed of this process has varied among countries. Generally, industrialization has progressed more rapidly in the NIEs than in the TIMP group, which can be seen by the difference in the growth rate of income per capita (see Table 1). The NIEs began to specialize in labor-intensive manufacturing products at an earlier stage than the TIMP group. Due to the relatively small domestic markets, the NIEs adopted an export-oriented industrialization policy. By contrast, the TIMP group countries began to specialize in manufactured products at a later stage. Because of their relatively large domestic markets, these countries initially undertook an import-substitution industrialization policy, before adopting an export-oriented industrialization policy.

The difference in the speed of industrialization between the NIEs and TIMP countries can be explained partly by the difference in their relative factor endowments. The NIEs, which lack natural resources, have emphasized industrialization and had the primary goal of export promotion since the 1950s. By contrast, the TIMP countries, which are rich in natural resources, have maintained a large agricultural sector and therefore, have specialized in manufacturing at a later stage of economic development. Therefore, compared with the former countries, the latter groups shifted their economies gradually into labor-intensive manufacturing sectors, which delayed the technology catch-up or the quality improvement. Table 2 shows that the NIEs have more human capital per capita but a smaller labor force, less arable land, and mineral resources than the TIMP countries.

For illustrative purposes, to compare the industrialization process of the two groups, this paper selects Korea as a representative of the NIEs

Table 1. Basic Economic Data for the Countries in the Pacific Basin

Country	Land Area 1/	Population 2/		Per Capita Income 3/	
		1963-65	1987-88	1963	1988
NICs	136	44.2	70.2	974	5,162
Hong Kong	1	3.6	5.7	2,247	11,952
Singapore	1	1.8	2.7	1,777	11,693
Taiwan	36	19.9	19.9	980	4,607
Korea	98	26.9	42.0	747	4,094
TIMP	3,049	167.2	305.8	606	1,546
Malaysia	330	8.8	16.9	1,233	3,643
Thailand	514	28.5	54.5	537	1,627
Philippines	300	29.9	58.7	965	1,460
Indonesia	1,905	99.9	175.6	463	1,348
Japan	378	96.8	122.6	2,931	10,568

Source: Noland, M., (1990), Table 1, p. 4.

1/ 1,000s square kilometers.
2/ Millions.
3/ 1980 PPP U.S. dollars.

Table 2. Factor Endowments for the Countries in the Pacific Basin

	Hong Kong	Singapore	Taiwan Prov. of China	Korea
Arable land 1/				
1968	13.0	12.0	535.0	2,319.0
1988	7.0	4.0	495.0	2,135.2
Capital stock 2/				
1968	7,141	9,770	13,687	21,121
1988	77,670	52,982	119,942	303,380
Labor force 3/				
1968	1.6	0.7	4.1	9.8
1988	2.7	1.2	8.2	16.4
Oil reserves 4/				
1968	0.0	0.0	18.8	0.0
1988	0.0	0.0	4.7	0.0
Psacharopoulos indexes 5/				
1968	1,172.0	1,024.0	1,097.0	1,013.0
1988	2,119.4	2,213.0	2,043.3	2,410.9

	Malaysia	Thailand	Philippines	Indonesia
Arable land 1/				
1968	5,533.0	13,300.0	6,992.0	15,050.0
1988	4,337.3	18,459.4	8,061.0	21,378.1
Capital stock 2/				
1968	15,785	28,441	28,176	27,190
1988	123,496	127,567	92,850	301,662
Labor force 3/				
1968	3.1	16.2	11.8	38.3
1988	6.1	30.8	23.3	78.9
Oil reserves 4/				
1968	500.0	0.2	0.0	8,850.0
1988	2,941.8	82.2	15.6	8,169.2
Psacharopoulos indexes 5/				
1968	563.0	213.0	1,030.0	296.0
1988	1,227.8	1,026.4	2,030.8	925.8

Source: Norland, M., (1990), Table A.2 and A.3, pp. 199-204.

1/ Thousands of hectares.
2/ Millions of 1980 PPP dollars.
3/ Millions.
4/ Millions of barrels.
5/ Defined as the average per capita expenditure on education embodied in the labor force and regarded as a proxy for human capital.

and Indonesia from the TIMP group. Korea experienced rapid industrialization in the post-war period. For example, its share of manufacturing in output increased from 14.7 percent to 30.3 percent between 1963 and 1987, while its share of agriculture declined from 43.4 percent to 11.4 percent over the same period. With the export-oriented industrial policy, Korea increased its export share in GNP from 4.8 percent to 42.0 percent between 1963 and 1987. By contrast, Indonesia concentrated its exports on crude oil and petroleum products, which accounted for nearly half of total exports. Thus, its share of manufacturing in output increased only from 7.4 percent to 13.9 percent between 1963 and 1987. Over 70 percent of the Indonesian population live in rural areas and the agricultural sector directly provides employment to nearly 60 percent of the population (Noland (1990)).

This difference in the speed of industrialization affected the international trade structure. In the case of Korea, between 1967 and 1987, the share of manufacturing exports in total exports increased from 46.6 percent to 91.9 percent, while that of nonfuel primary exports declined from 50 percent to 6.1 percent. In the case of Indonesia, between 1963 and 1987, the share of manufacturing exports in total exports increased from 0.3 percent to 25.0 percent, while that of nonfuel primary exports declined from 61.2 percent to 26.0 percent. Indonesia's share of fuel primary exports increased from 38.5 percent to 48.9 percent over the same period.

Between 1975 and 1985, Japan increased intra-industry trade with Korea and maintained large-scale inter-industry trade with Indonesia. With respect to trade between Japan and Korea, Japan increased the import share of manufacturing in total imports from Korea from 62 percent to 82 percent between 1975 and 1985, and decreased that of agriculture and mining from 15 percent to 9 percent (Table 3). Japan's export share of manufacturing in total exports to Korea increased from 88 percent to 91 percent, while its export share in agriculture and mining remained at nearly zero during the decade. Thus, the share of two-way trade flows in manufacturing in total trade volume increased over the same period.

By contrast, between 1975 and 1985, Japan's import share in manufacturing in total imports from Indonesia increased from only 9.7 percent to 13.9 percent and decreased in agriculture and mining slightly, from 84 percent to 82 percent. Japan maintained the export share in manufacturing in total exports to Indonesia at over 90 percent during the same period. Therefore, although it increased to some extent, the share of two-way trade flows in manufacturing remained small. The major share of trade between the two countries came from flows of primary products from Indonesia to Japan and from flows of manufactured products from Japan to Indonesia.

2. Structural change in intra-industry trade

In this subsection, we consider structural change in intra-industry trade in manufacturing. We utilize the following intra-industry trade (IIT)

Table 3. Japan: Export and Import Shares with Indonesia and Korea, 1975 and 1985

(In percent)

	Indonesia		Korea	
	1975	1985	1975	1985
The export share				
Agriculture	0.0001	0.0005	0.002	0.004
Mining	0.0009	0.001	0.001	0.004
Manufacturing	0.944	0.93	0.88	0.91
Trade	0.053	0.068	0.12	0.07
Services	0.003	0.001	0.003	0.005
The import share				
Agriculture	0.08	0.025	0.14	0.08
Mining	0.76	0.80	0.02	0.01
Manufacturing	0.10	0.14	0.62	0.82
Trade	0.057	0.04	0.07	0.08
Services	0.001	0.001	0.15	0.01

Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Note: Japan's export share with Indonesia (or Korea) is defined by its exports to Indonesia (or Korea) in each sector divided by its total exports to Indonesia (Korea). Japan's import share with Indonesia (or Korea) is defined by its imports from Indonesia (or Korea) in each sector divided by its total imports from Indonesia (Korea).

index for a commodity or industry i, which is developed by Grubel and Lloyd (1971): 1/

$$IIT_i = 1 - |X_i - M_i| / (X_i + M_i)$$

where X_i refers to exports of commodity or industry i, and M_i refers to imports of commodity or industry i. The index varies between zero and one. When commodity i is exported but not imported, or when commodity i is imported but not exported, the index takes zero. When exports of commodity i is equal to imports, the index takes one. The index is measured as one minus the absolute value of net exports of commodity i as a percentage of total trade volume of the commodity. We can also obtain the average intra-industry trade index by taking weighted average of these indexes.

Table 4 shows Japan's IIT indexes with Korea and Indonesia for twelve manufacturing sectors over the period of 1975-85. For both countries, the average IIT index increased: between Japan and Korea it rose from 0.356 to 0.459, and between Japan and Indonesia it grew from 0.07 to 0.229. In other words, in 1985 two-way trade in manufacturing between Japan and Korea accounted for approximately 50 percent of total manufactures trade, while between Japan and Indonesia it accounted for approximately 20 percent. Between Japan and Indonesia, flows of manufactured products were rather one way--from Japan to Indonesia in exchange for primary products (Table 5), but nevertheless the increase in the average IIT index was remarkable for the two countries.

Wide variation in Japan's IIT indexes exists with both Korea and Indonesia. In 1975, the indexes with Korea ranged from 0.173 for the transport equipment manufacturing sector to 0.997 for other manufacturing sector. The wide variation continued in 1985, although the index for the transport equipment manufacturing sector increased to 0.029 and that for other manufacturing sector declined to 0.948. The indexes with Indonesia in 1975 ranged from zero for the transport equipment manufacturing sector to 0.872 for the rubber manufacturing sector. In 1985, the range declined because the index for the transport equipment manufacturing sector increased to 0.0002 and that for rubber declined to 0.765.

In 1975, for the manufacturing sectors in which Japan had a comparative advantage relative to Indonesia and Korea--chemical, metal, machinery, and transport equipment--the IIT indexes were low. In 1985, by expanding imports to Japan, especially those coming from Korea, the IIT indices of some sectors improved, the chemical and metal sectors in particular.

1/ The intra-industry trade index is biased in the presence of a trade imbalance (Aquino, 1978). The bias caused by trade imbalance varies depending on the source, which makes the adjustment a difficult task. As there is no satisfactory way to deal with the bias, the conventional intra-industry index is utilized for empirical estimates.

Table 4. Japan: Intra-industry Trade Indexes in Manufacturing with Korea and Indonesia, 1975 and 1985

	Korea		Indonesia	
	1975	1985	1975	1985
Manufacturing				
Food	0.173	0.20	0.470	0.429
Textile	0.617	0.625	0.083	0.445
Lumber	0.038	0.166	0.691	0.006
Pulp	0.252	0.218	0.0003	0.117
Chemical	0.111	0.260	0.026	0.056
Petroleum	0.637	0.500	0.089	0.038
Rubber	0.174	0.804	0.872	0.765
Non-metallic mineral	0.439	0.894	0.0001	0.010
Metal	0.166	0.557	0.140	0.738
Machinery	0.383	0.355	0.001	0.001
Transport equipment	0.017	0.029	0.000	0.0002
Other manufacturing	0.997	0.948	0.043	0.171
Average	0.356	0.459	0.07	0.229

Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Note: The IIT index was calculated using the following formula:

$$IIT_i = 1 - |X_i - M_i| / (X_i + M_i).$$

The average IIT index was calculated using the following formula:

$$IIT = \Sigma [IIT_i \cdot (X_i + M_i) / \Sigma(X_i + M_i)]$$

Table 5. Japan: Ratios of Net Exports in Total Trade Volume with Korea and Indonesia, 1975 and 1985

	Korea		Indonesia	
	1975	1985	1975	1985
Manufacturing				
Food	-0.827	-0.800	-0.530	-0.571
Textile	-0.383	-0.375	0.917	0.555
Lumber	-0.962	-0.835	-0.309	-0.994
Pulp	0.748	0.782	0.100	0.883
Chemical	0.889	0.740	0.974	0.944
Petroleum	0.363	-0.500	-0.911	-0.962
Rubber	0.827	0.196	0.128	-0.235
Non-metallic mineral	0.561	0.106	1.000	0.990
Metal	0.834	0.443	0.860	0.263
Machinery	0.617	0.645	0.999	0.999
Transport equipment	0.983	0.971	1.000	1.000
Other manufacturing	-0.003	0.052	0.957	0.829
Average	0.382	0.270	0.671	0.274

Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Note: The ratio was derived by net exports divided by the total trade volume. The negative ratio indicates net imports.

Japan's IIT indexes with Korea increased substantially for the rubber, non-metallic mineral, and metal manufacturing industries (see Figure 1). For the rubber manufacturing sector, Japan's IIT index increased because Japan's imports from Korea increased. Japan's IIT indexes for the non-metallic mineral and metal manufacturing sectors increased because Japan's imports from Korea increased. These sectors produce intermediate industrial inputs, which are consumed largely by capital-intensive manufacturing sectors such as machinery and transport equipment. The large expansion of these indices indicates that industrialization progressed in Korea during the decade. For the machinery and transport equipment manufacturing sectors, the IIT indices remained constant between 1975 and 1985. In particular, the index for the transport equipment manufacturing sector remained constant at nearly zero, which suggests that Japan remained a substantial net exporter for both years (Table 5).

Japan's IIT indexes with Indonesia increased significantly for the textile and metal manufacturing industries while it dropped considerably for the lumber manufacturing sector (Figure 2). The increase in the IIT indexes of the textile and metal manufacturing sectors is due to an increase in Japan's imports from Indonesia, which exceeded that of its exports to Indonesia. The increase in the index for the textile manufacturing sector indicates that Indonesia had begun to industrialize in the labor-intensive manufacturing sector, following the pattern of relatively advanced countries such as Korea. The increase in the index for the metal manufacturing sector can be attributed to the industrialization policy of the Indonesian government. The decline in the lumber manufacturing sector index occurred because Japan's imports increased significantly from Indonesia compared with its exports.

Comparing Figure 1 with Figure 2, relative to Korea, the Indonesian textile manufacturing sector achieved remarkable progress. Figure 3 shows that in 1975, Japan's IIT index for the textile sector was substantially lower with Indonesia at 44.5 while with Korea it was around 60. In 1985, however, the difference in the indexes between Korea and Indonesia declined significantly (Figure 4). This is probably because Korea, which had begun to industrialize its economy in the labor-intensive manufacturing sector in an earlier period, gradually shifted its economy into the capital-intensive manufacturing sector. As a consequence, Korea no longer showed much progress in the labor-intensive sector although it remained a net exporter of textiles (Table 5). Korea's share of textile production in total manufacturing production declined from 21 percent to 15 percent between 1975 and 1985 (Table 6).

For most manufacturing sectors, between 1975 and 1985, Japan's IIT indexes remained higher with Korea than with Indonesia. In other wards, two-way flows of products were more evident between Japan and Korea than between Japan and Indonesia. Tables 1 and 2 show that the Japanese economy is closer to the Korean economy than to Indonesian largely because of the similarity in relative factor endowments. Also, the fact that Korea began to industrialize in an earlier period explains why Japan relies more heavily

Table 6. Japan: Production Share of Each Manufacturing Sector in Total Manufacturing Output with Korea and Indonesia, 1975 and 1985

(In percent)

	Korea		Indonesia	
	1975	1985	1975	1985
Manufacturing				
Food	0.28	0.18	0.54	0.40
Textile	0.21	0.15	0.09	0.07
Lumber	0.02	0.02	0.03	0.05
Pulp	0.03	0.04	0.02	0.02
Chemical	0.09	0.10	0.03	0.05
Petroleum	0.09	0.09	0.05	0.13
Rubber	0.02	0.02	0.03	0.03
Non-metallic mineral	0.03	0.04	0.02	0.03
Metal	0.09	0.13	0.04	0.06
Machinery	0.07	0.14	0.03	0.04
Transport equipment	0.04	0.06	0.11	0.10
Other manufacturing	0.04	0.04	0.01	0.02

Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Figure 1. Japan: Comparison of Intra-industry Indexes in Manufacturing with Korea, 1975 and 1985

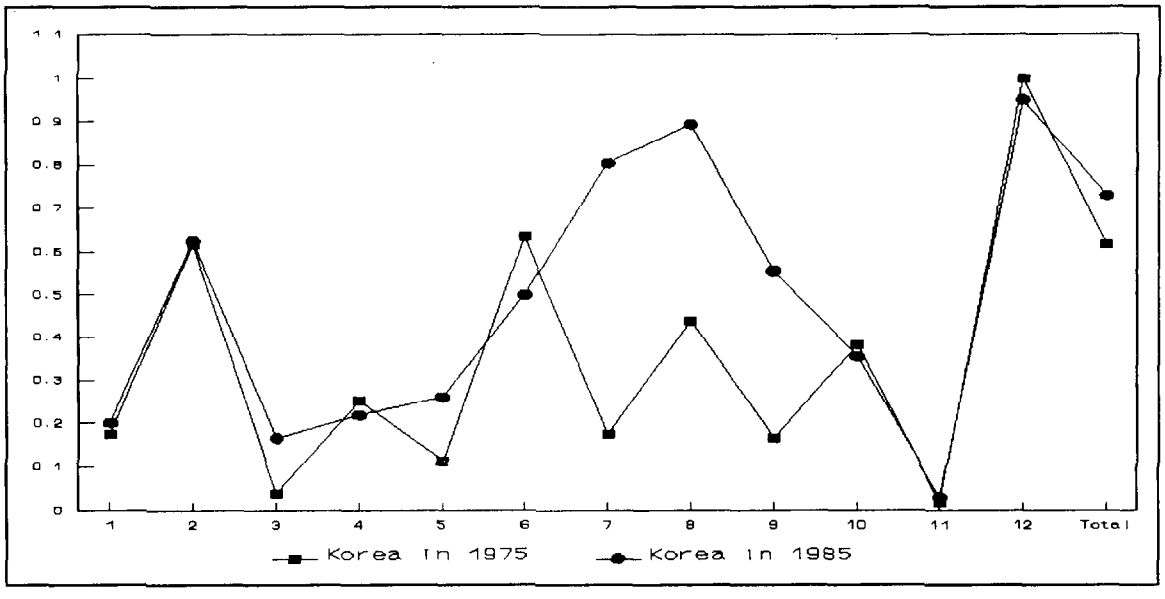
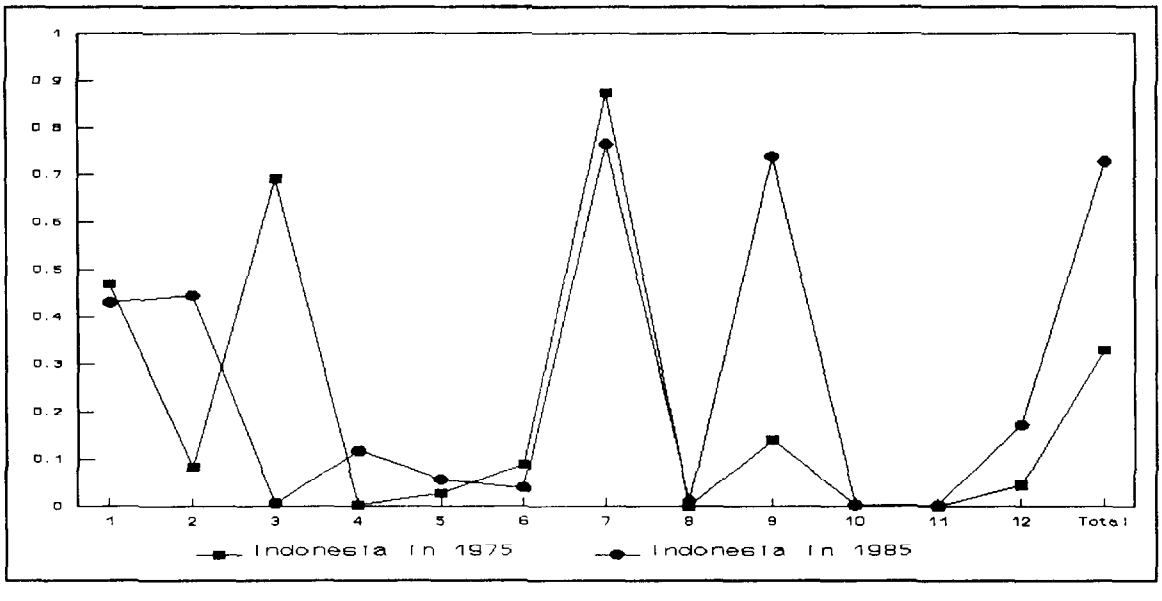


Figure 2. Japan: Comparison of Intra-industry Indexes in Manufacturing with Indonesia, 1975 and 1985



Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Note: The twelve manufacturing sectors are (1) Food, (2) Textile, (3) Lumber, (4) Pulp, (5) Chemical, (6) Petroleum, (7) Rubber, (8) Non-metallic mineral, (9) Metal, (10) Machinery, (11) Transport equipment, and (12) Other manufacturing.

Figure 3. Japan: Comparison of Intra-industry Indexes in Manufacturing with Indonesia and Korea, 1975

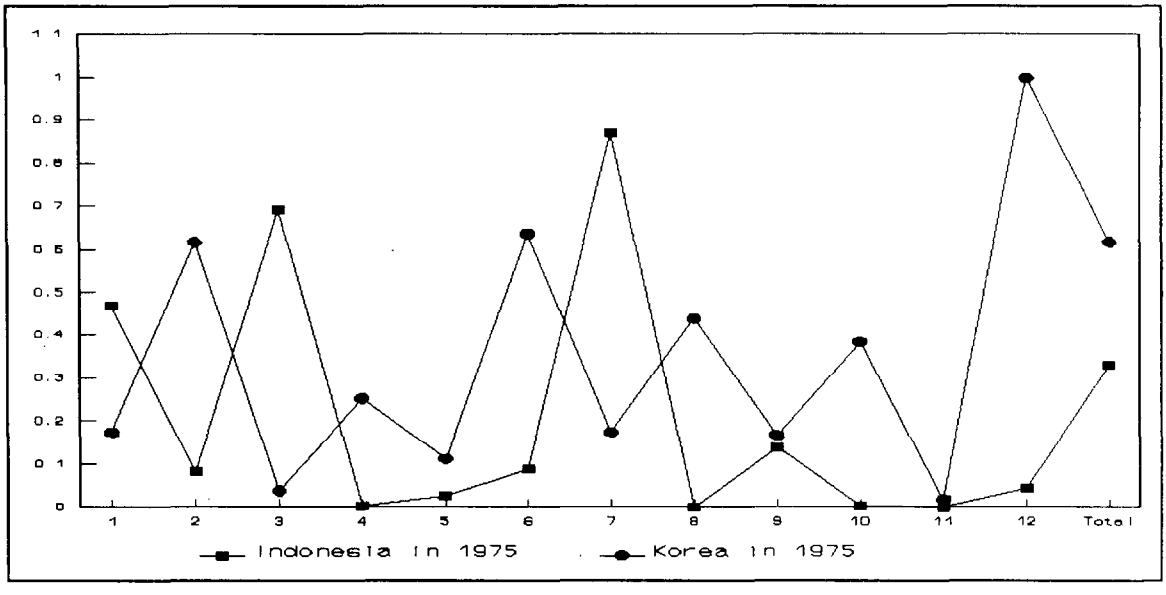
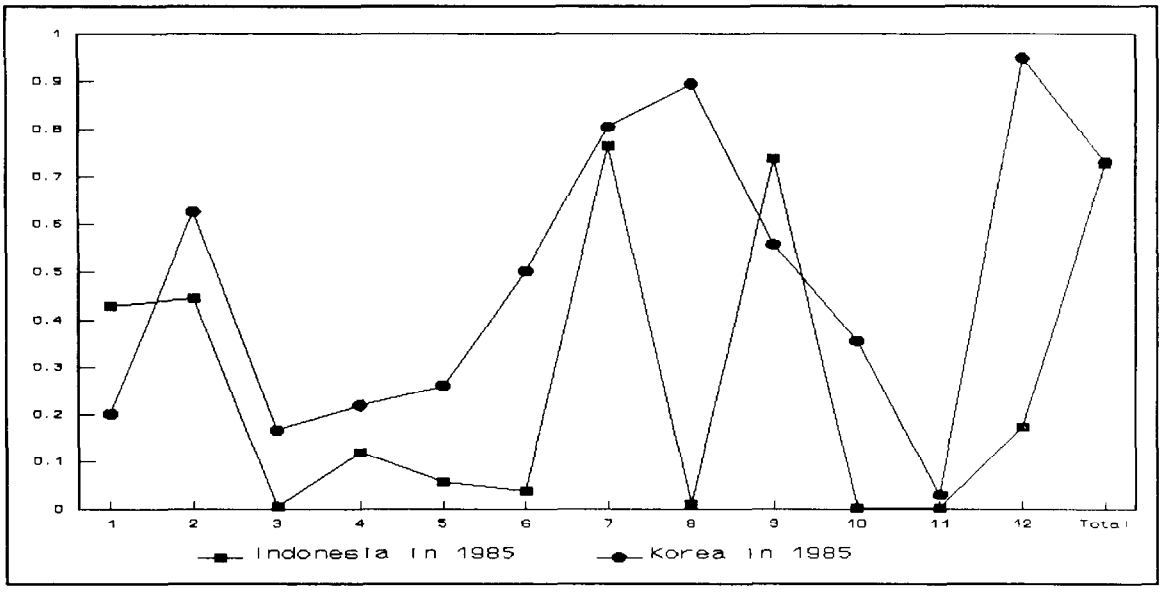


Figure 4. Japan: Comparison of Intra-industry Indexes with Indonesia and Korea, 1985



Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992.

Note: The twelve manufacturing sectors are: (1) Food, (2) Textile, (3) Lumber, (4) Pulp, (5) Chemical, (6) Petroleum, (7) Rubber, (8) Non-metallic mineral, (9) Metal, (10) Machinery, (11) Transport equipment, and (12) Other manufacturing.

on its manufactured products than those produced in Indonesia. Table 6 suggests that manufacturing production in Korea had diversified into several capital-intensive sectors between 1975 and 1985 while Indonesia continued to concentrate its production in the food and petroleum sectors.

The results obtained in this subsection are consistent with those derived in Section II. Consider Japan to be a developed country and Korea and Indonesia as developing countries. First, as suggested in Propositions 2 and 6, the aggregate IIT indexes increased as industrialization progressed in Korea and Indonesia. Second, the higher aggregate IIT indexes for Korea than for Indonesia in 1975 suggests that Korea had a factor intensity that was more similar to that of Japan than to Indonesia, which is consistent with the results of Propositions 2 and 8. Third, Table 3 indicates that inter-industry trade is more prevalent between Japan and Indonesia than between Japan and Korea due to the large difference in factor endowments (Tables 1 and 2). This result is also consistent with Proposition 1.

3. Empirical estimates

Utilizing the analytical framework of the model developed in Section II, this subsection attempts with actual data to promote understanding of the factors that effect change in the international trade structure. The model analyzes the change in the international trade structure or in intra-industry trade as a result of quality improvement. We use the change in the IIT indexes based on Grubel and Lloyd. Other things being equal, conclusions of the model are presented as follows:

(i) The IIT indexes increase when factor endowments specific to the manufacturing sector expand relative to those of the nonmanufacturing sector in a developing country.

(ii) The IIT indexes decrease when factor endowments specific to the manufacturing sector expand relative to those of the nonmanufacturing sector in a developed country. (Combining conclusions 1 and 2, the IIT indexes increase when the difference in the relative factor endowments between a developed and a developing countries becomes smaller).

(iii) The IIT indexes increase when quality improvement takes place in a developing country (or, when the technology gap shrinks).

(iv) The IIT indexes increase when the manufacturing sector grows in a developing country.

(v) The IIT indexes decrease when the manufacturing sector grows in a developed country. (From conclusions 3, 4 and 5, the IIT indexes increase when the growth rate of the manufacturing sector in a developing country is larger than in a developed country.)

We use the data of the international input-output tables to test the above conclusions. This is because the sector-based data, such as exports, imports, outputs, wage payments and payments for depreciation, are available for Indonesia, Japan, and Korea so that we do not have to consider the issue of data inconsistency.

The shortcoming of using this data is that they are available only for the years 1975 and 1985, and the manufacturing sector is decomposed only up to the twelve sectors. Generally, IIT indexes are calculated using the Standard International Trade Classification (SITC) system at a chosen level of aggregation. In the SITC system, each industry category is comprised of a number of subclasses of products, which are similar, but nonetheless not perfectly homogenous (Pagoulatos and Sorensen (1975)). As the use of more detailed systems of classification may still include an industry with dissimilar products, the problem may not be solved by disaggregation. Also, too detailed a system of disaggregation may exclude commodities that are close substitutes in consumption. Since there is no agreement about the appropriate level of disaggregation (Balassa (1979)), we use the highly aggregated data obtained from the input-output tables.

As the data is reported at nominal prices, we adjusted the 1975 data using the GDP deflator, which is obtained from the International Financial Statistics complied by the International Monetary Fund. The price-adjusted data is used when the output growth rate is calculated.

The dependent variable is the change in the intra-industry trade index between 1975 and 1985. As calculated in the previous subsection, we use Japan's intra-industry indexes of the twelve manufacturing sectors with Indonesia and Korea.

To see whether the data is consistent with the above conclusions, we have selected the following independent variables: (a) the absolute difference of the change in the wage-depreciation ratio (W/D) between Indonesia and Japan, and between Korea and Japan, (b) the output growth rate of Indonesia, and that of Korea ($Growth^D$), (c) the output growth rate of Japan ($Growth^J$), and (d) the dummy variable which distinguishes Indonesia from Korea (Dummy).

Variable (a) indicates the difference in the relative factor endowments between Indonesia and Japan, and that between Korea and Japan. Considering conclusion 1 and conclusion 2, we use variable (a). The smaller value of variable (a) implies that between 1975 and 1985, the difference in the relative factor endowments between the two countries shrank, and consequently intra-industry trade index increased. Therefore, we expect variable (a) to have a negative sign.

Variable (b) and variable (c) indicate that if the value of (b) is larger than (c), quality improvement took place or the technology gap shrank in the developing country, assuming that Japan's overall technology standard was substantially high in manufacturing. Considering conclusions 4, 5 and

6, we use variables (b) and (c). Thus, we expect variable (b) to have a positive sign and variable (c) to have a negative sign.

Variable (d) is a dummy variable capturing the country differences between Indonesia and Korea that can not be controlled by variables (a), (b) or (c). It includes the difference in relative factor endowments, technology gap, speed of industrialization, and size of the economy.

We have estimated the following equation:

$$\Delta IIT_i^{J,D} = a + b \cdot \log\left|\Delta(W_i^D/D_i^D) - \Delta(W_i^J/D_i^J)\right| + c \cdot Growth_i^D + d \cdot Growth_i^J + e \cdot Dummy$$

where i refers to a sector, J to Japan and D to a developing country (Indonesia and Korea). IIT refers to the intra-industry trade index following Grubel and Lloyd.

The regression result is presented as follows:

$$\Delta IIT_i^{J,D} = \underset{(0.966)}{0.169} - \underset{(-0.998)}{0.190} \cdot \log\left|\Delta(W_i^D/D_i^D) - \Delta(W_i^J/D_i^J)\right| + \underset{(0.067)}{0.01} \cdot Growth_i^D - \underset{(-0.141)}{0.023} \cdot Growth_i^J + \underset{(0.414)}{0.058} \cdot Dummy$$

$$R^2 = 0.088$$

where t-values are given in parenthesis.

The coefficients presented above show the signs that are expected from our model, although the effect of the output growth rate of Japan and appears to be rather weak. The coefficient for the absolute difference in the relative factor endowments between Indonesia (and Korea) and Japan displays the expected positive sign. It suggests that between 1975 and 1985, the difference between Indonesia (and Korea) and Japan became smaller, which resulted in an increase in intra-industry trade.

The coefficient for the output growth rate of Indonesia and Korea shows the expected positive sign. It indicates that the rapidly growing manufacturing sectors in Indonesia and Korea promoted intra-industry trade between 1975 and 1985. The coefficient for the output growth rate of Japan presents the expected negative sign. It means that the growing manufacturing sector in Japan made it less attractive to import manufactured products from Indonesia and Korea, which resulted in a decline in intra-industry trade between 1975 and 1985. Figure 5 shows the sector-based output growth rates for Indonesia, Japan, and Korea. The figure suggests that most of the growth rates of Japan were higher than those of Indonesia, which resulted in smaller intra-industry trade. Finally, the coefficient for the dummy variable shows a positive sign.

In summary, all the conclusions derived in the model find support in the evidence for international trade between Japan and Indonesia, and Japan and Korea between 1975 and 1985.

IV. Concluding Comments

This paper has presented a theoretical model that explains how industrialization affects the international trade structure. More specifically, the model shows that intra-industry trade increases when product quality improvement emerges in a developing country and when the difference in relative factor endowments of a developed and a developing country shrinks. The model also suggests that a rapidly industrializing developing country increases intra-industry trade faster than a slowly industrializing developing country.

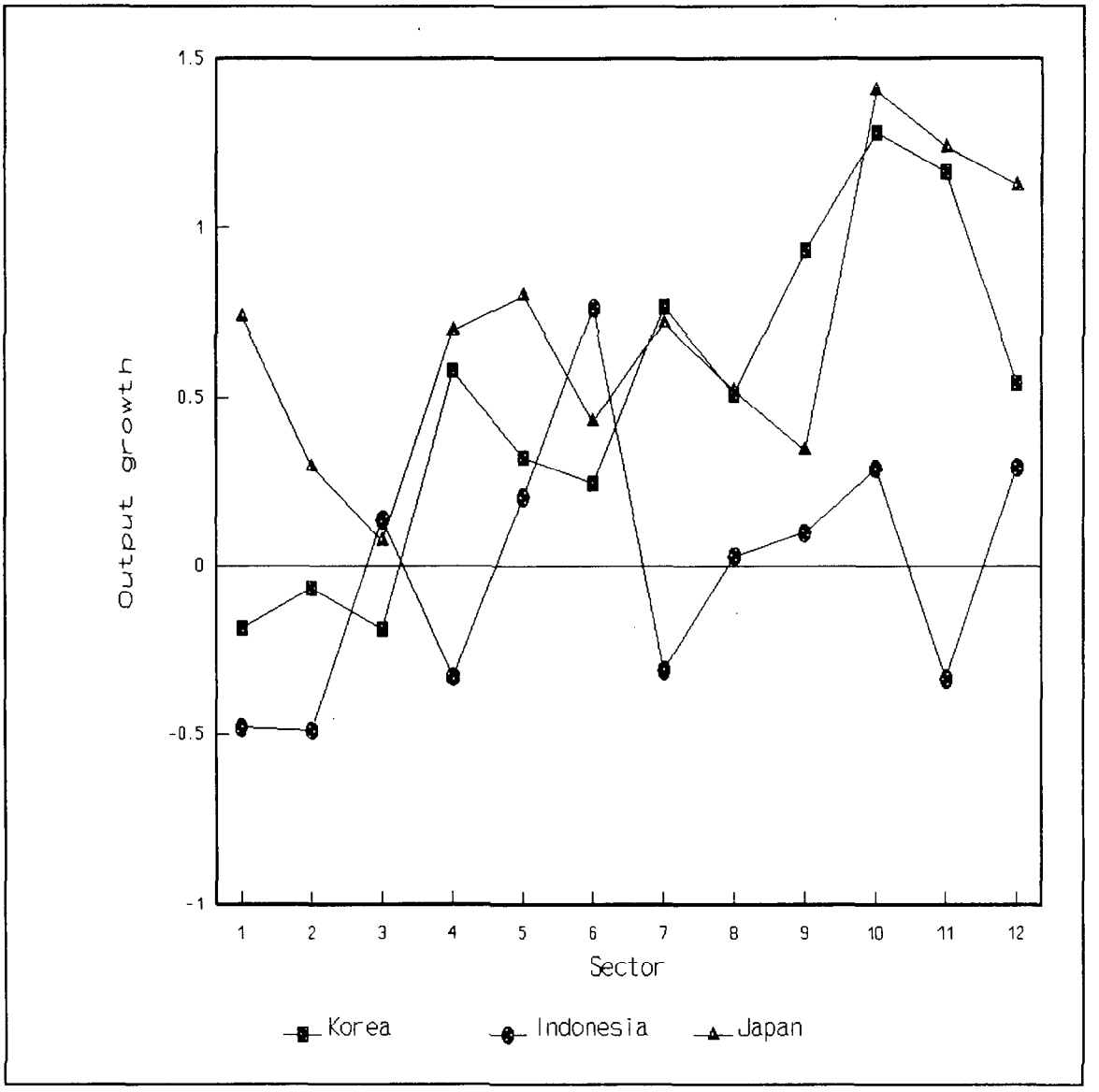
To promote understanding of the conclusions of the model, we used the actual data. As a representative of a developed country, we selected Japan and for the two developing countries, Indonesia and Korea were chosen to illustrate the country differences such as relative factor endowments and technology gaps. All conclusions derived in the theoretical model have found in the evidence for international trade between Japan and Indonesia, and between Japan and Korea for the years 1975 and 1985.

The increase in intra-industry trade was a phenomenon that was observed mainly between developed countries, particularly in the European Union in response to their post-war trade liberalization. In recent years, this phenomenon has also been observed between developed and developing countries, such as between Japan and other Asian countries. As industrialization has progressed in the developing countries, this phenomenon has become more pronounced. We have also seen that countries, such as Korea, have achieved larger intra-industry trade than others, such as Indonesia. This country difference may come from initial conditions including the technology gap and the difference in the relative factor endowments.

Finally, we refer to limitations of this paper. This paper does not cover several issues such as how high rates of protection in both developing and developed countries affect the structure of international trade and why the share of intra-industry trade in total trade is lower in Japan than in other developed countries. These topical issues will be a subject for future research.

Figure 5. The Output Growth Rate of Indonesia, Japan, and Korea in Manufacturing between 1975 and 1985

(In percent)



Source: International Input-Output Table for Asian Countries, Institute of Developing Economies, 1982 and 1992; (for GDP deflator, 1985=100) International Finance Statistics, International Monetary Fund.

Note: The twelve manufacturing sectors are (1) Food, (2) Textile, (3) Lumber, (4) Pulp, (5) Chemical, (6) Petroleum, (7) Rubber, (8) Non-metallic mineral, (9) Metal, (10) Machinery, (11) Transport equipment, and (12) Other manufacturing.

References

Aquino, A., (1978), "Intra-industry Trade and Inter-industry Specialization as Concurrent Sources of International Trade in Manufactures," Weltwirtschaftliches Archiv, Vol. 114, pp. 756-62.

Bank of Japan, (1993), "Higashi Asia no Keizai Geicho to Chokusetsu Toshi no Yakuwari," Nihon Ginko Gepppo, No. 12.

Balassa, B., (1979), "Intra-industry Trade and the Integration of Developing Countries in the World Economy," in H. Giersch (ed.), On the Economics of Intra-Industry Trade, J.C.B. Mohr (Paul Siebeck), Tubingen, pp. 245-70.

Caves, Richard E., (1981), "Intra-industry Trade and Market Structure in the Industrial Countries," Oxford Economic Papers, Vol.33, pp. 203-23.

Dixit, Avinash, and Victor D. Norman, (1980), *Theory of International Trade*, London/New York: Cambridge Univ. Press.

Flam, Harry and Elphanan Helpman, (1987), "Vertical Product Differentiation and North-South Trade," *American Economic Review*, Vol. 77, No. 5, pp. 810-22.

Glay, Peter H., (1973), "Two-way International Trade in Manufacturers: A Theoretical Underpinning," Weltswirtschaftliches Archiv, pp. 19-39.

Grossman, Gene M. and Elhanan Helpman, "The "NEW" Growth Theory: Trade, Innovation, and Growth," American Economic Review Papers and Proceedings, Vol. 80, No.2, pp. 86-91.

——— and ———, (1991a), *Innovation and Growth in the Global Economy*, Cambridge: MIT Press.

——— and ———, (1991b), "Quality Ladders in the Theory of Growth," Review of Economic Studies, Vol. 58, pp. 43-61.

Grubel, Herbert G. and P. J. Lloyd, (1971), "The Empirical measurement of Intra-industry Trade," The Economic Record, Vol. 47.

Helpman, Elhanan, (1981), "International Trade in the Presence of Product Differentiation, Economies of Scale and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin approach," Journal of International Economics, Vol. 11, pp. 305-40.

———, (1987), "Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries," Journal of the Japanese and International Economics, Vol. 1, pp. 62-81.

Helpman, Elhanan and Paul Krugman, (1985), *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*, Cambridge: MIT Press.

Krugman, Paul, (1991a), *Geography and Trade*, Cambridge: MIT Press.

———, (1991b), "Increasing Returns and Economic Geography," Journal of Political Economy, Vol. 99, No. 3, pp. 483-99.

———, (1994), "Fluctuations, Instability, and Agglomeration," NBER Working Paper Series No. 4614, Cambridge, MA.

Lancaster, Kelvin, (1980), "Intra-Industry Trade under Perfect Monopolistic Competition," Journal of International Economics, Vol. 10, pp. 151-75.

Linder, Stefan B., (1961), *An Essay on Trade and Transformation*, New York: John Wiley and Sons.

Noland, Marcus, (1990), *Pacific Basin Developing Countries: Prospects for the Future*, Washington, DC: Institute for International Economics.

Pagoulatos, E. and R. Sorensen, (1975), "Two-way International Trade: An Econometric Analysis," Weltswirtschaftliches Archiv, pp. 454-65.

Sazanami, Yoko, (1985), *Kokusai Bungyo to Nihon Keizai*, Toyo Keizai Shinpo ya.