The Growth and Determinants of Vertical Trade in Korea

This paper measures the volume of vertical trade in Korea and investigates its determinants. The contributions of this paper are as follow. First, the measurement method in this paper is related to Hummels et al. (2001), but it improves upon their method in that it uses information on intermediate goods trade as well as the input-output tables of trading countries. Second, this paper derives a functional form for the determinants of vertical trade from a monopolistic competition model of trade and multinational production.

The empirical results show that Korea's trade has been becoming more vertically specialized over last ten years. In particular, vertical exports to China have grown rapidly since the early 2000's, and thus the surplus on vertical trade has widened dramatically in recent years. The empirical estimation with 32 trading partners during the period of 1995-2003 provides evidences that the determinants of Korea's vertical trade are broadly consistent with the theoretical predictions: it has been affected by relative labor costs and productivity, as well as by the gravity-related variables such as trade cost and market accessibility. Korea's vertical trade was also indirectly affected by relative fixed costs through the change in the stock of FDI.

Based on these results, it can be said that, for the last ten years, the growth of Korea's trade has been largely attributed to the expansion of international production fragmentation accompanied with intermediate goods trade, and also that a monopolistic competition model of trade and production accounts quite well for the pattern of vertical trade in Korea.

Keywords: Vertical Specialization, Intermediates Trade, Production Fragmentation
JEL Classification: F14, F15, F23

I. Introduction

In recent decades, the internationalization of production has become more common as transportation costs and trade barriers have decreased, and the business environment has been increasingly competitive. Particularly when the production process consists of various separable stages which require different factor intensities, production chains are sliced thinner into many stages in different locations where the production cost is relatively low. The production of a finished good thus involves a participation of many countries, specializing in different stages of vertical production. International trade is then increasingly dominated by vertical trade, which is defined as a trade in intermediate goods that are part of an international production network[1]. According to Hummels, Ishii and Yi (hereinafter HIY, 2001), the growth rate of vertical trade has outpaced that of traditional international trade flow and current vertical trade consists of around one-third of world trade.

Increase of vertical trade affects the way in which trade flows and their major

[1] Hummels, Rapoport and Yi (HRY, 1998) defined three conditions for vertical trade to occur:
 A good is produced in two or more sequential stages.
 Two or more countries provide value-added during the production of the good.
⑶ At least one country must use inputs in its stage of the production process, and some of the resulting output must be exported.

Under this definition, vertical trade is similar to processing trade, but different from outsourcing or border-crossing trade. The cited paper provides an example which illustrates the distinction between vertical trade and outsourcing. Suppose a firm relocates production of components to another country and imports these components from that country. If the firm completes the production of the final goods and does not export, outsourcing occurs. If the country does, however, export the final goods, both outsourcing and vertical trade occurs. Vertical trade is also different from border-crossing trade of goods that are merely shipments in transit, e.g., Chinese goods going through Hong Kong's port on their way to the third countries.

determinants interact. For example, cross-border production sharing pushes specialization from the level of products to that of components. The traditional laws of comparative advantage continue to work here: labor-abundant countries would be expected to specialize in labor-intensive components and assembly, while capital- and skill-rich countries have comparative advantages in capital- and skill-intensive components and assembly (Arndt and Huemer, 2005). Cross-border production sharing also alters the response of trade to changes in trade costs. The response of vertical trade to trade costs is likely very sensitive due to the high incidences of trade costs. HIY (2001) suggested that a relatively small reduction in trade barriers since the mid 1980s was able to bring about a rapid growth in trade due to the convex response of vertical trade to decreases in trade costs. On the other hand, there is the traditional debate as to whether trade and foreign direct investment (FDI) are complements or substitutes. In a global situation characterized by growing production fragmentation, it is plausible that we should be able to observe simultaneously an increase in FDI and an increase in trade (Carpenter, 2005).

As vertical trade has expanded, the question of how to analyze this phenomenon has come to be an important subject in the recent literature on international trade. However, because data on the production process and direction of trade flow for every production stage are impossible to obtain, a number of studies have been undertaken to measure the vertical trade indirectly either by one-way trade of parts and components (Kimura et al. 2005, Athukorala and Yamashita 2006) or by the index of intra-industry trade (Fukao et al. 2003, Okubo 2004, Lee and Byun 2005). Furthermore, these studies lean heavily on the gravity model and could not provide an explanation consistent with theory for the relation between the explanatory variables and the vertical trade.

The aim of this paper is to investigate the pattern and determinants of vertical trade in Korea, where the expansion of export related to production sharing is far faster than in other countries. The contributions of this paper are as follow. First, it measures vertical trade using data on trade and production of trading countries. This method is related to HIY (2001), but it improves upon their method in that it uses information on the intermediate goods trade as well as input-output tables. In this way, we can estimate vertical trade not only by industry but also by trading partner. Second, this research provides an explicit functional form for the determinants of vertical trade, which is derived from a monopolistic competition model of trade and multinational production. It shows that vertical trade is affected by the comparative advantage in labor costs and productivity as well as the geographical advantage measured by trade costs and market accessibility. Relative fixed costs also play an important role in determining vertical trade via the change in the stock of FDI.

The empirical results presented below show that Korea's trade has been becoming more vertically specialized over last ten years. In particular, vertical exports have grown rapidly since the early 2000's, and thus the surplus on vertical trade has widened dramatically. The swift increase in vertical exports is largely attributable to the expansion of vertical exports to China, which emerged as a global production hub by attracting a large amount of foreign direct investment. On the other hand, the share of vertical imports in total imports has dropped slightly due to a slowdown of FDI inflows and intermediates imports, especially from the US and Japan. The estimation results for Korea's trade data during the 1995 to 2003 period show that increases in outward FDI, relative wage and productivity played important roles in expanding vertical exports. On the other hand, world demand and inward FDI were the main factors that determined vertical imports. In contrast to the case of vertical exports, it

appears that relative wage had no significant effect on changes in vertical imports.

The paper consists of the following sections. Section 2 describes a new method to measure the volume of vertical trade and sets out the recent characteristics of vertical trade in Korea. In Section 3, we build a simple model to examine the determinants of vertical trade, and provide the estimation results. Some conclusions and possible policy implications are put forward in Section 4.

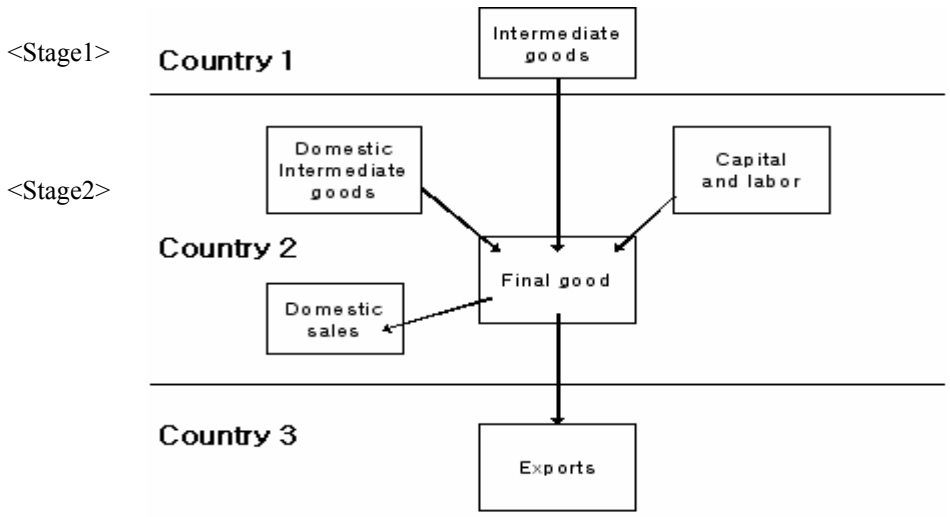
II. Vertical Trade in Korea

1. Measurement of Vertical Trade

A. The HIY measure

Vertical trade (VT) refers to the trade in intermediate goods that are part of an international production networks (HRY, 1998). Figure 1 illustrates an example of vertical trade involving three countries. Country 1 produces intermediate goods and exports them to country 2. Country1 combines the imported intermediate goods with capital, labor, and domestic intermediates to produce final goods. Finally, country 2 exports some of the final goods to country 3. Vertical trade occurs only when there are both imported intermediate goods and exports.

Figure1. Example of Vertical Trade and Stages of Production



Source: Yi (2003, p. 57).

To construct empirical measures of vertically fragmented trade, ideally we would use data on the production process and direction of trade flow for every stage of each good traded. Unfortunately, these data are impossible to obtain.

As an alternative, previous studies estimate the volume of VT using various measures such as intermediate goods trade, intra-firm trade or intra-industry trade[2]. The most popular and easy way to measure VT is to capture the one-way trade of intermediates. The main disadvantage in connection with this method, however, is that the imported intermediates data may include amounts used for the production of domestic goods[3].

[2] For intermediate goods trade and intra-industry trade in Korea, see Appendix A and B.

[3] In addition, classification schemes for intermediate goods can be somewhat arbitrary. For example, tires, flour and motherboards are intermediates when they are imported and used to make cars, bread, and computers, respectively, but they are final goods when they are purchased by households (HIY 2001, p.4).

More precise measurement of fragmentation trade requires the input-output tables of trading nations which provide data on imported intermediates and on each industry's output exported or used domestically. The general way of computing vertical trade with I/O tables was proposed by HIY (2001) as follows:

(1) $VT_{ik} = A_i^M \left[I - A_i^D\right]^{-1} x_{ik}$

where VT_{ik} is vertical trade in industry k of country i, A_i^M is the imported input matrix, $\left[I - A_i^D\right]^{-1}$ is the inverse matrix coefficients to capture the imported input used in multi-stages for the production of export goods, and x_{ik} is the export share of industry k ($= X_{ik} / X_i$).

The national I/O table, however, only provides the amount of vertical trade for the country overall. It cannot be used to calculate bilateral vertical trade because transnational I/O tables are not available for most pairs of countries[4].

B. A new measure of vertical trade: HIY2

I improve on HIY's method by using the imported intermediate inputs instead of the imported input matrix (A_i^M) on the input-output tables. The bilateral vertical export (VE) and vertical import (VI) can be calculated as a multiplication of traded intermediates by export share of each industry's output in the I/O transaction table.

[4] Recognizing the strong interdependence of the Asia-Pacific region, I.D.E and JETRO in Japan jointly published the Asian international input-output table in 1995 and 2000. They have nevertheless only released limited tables mainly focused on the final I/O tables of ten Asian countries, and the transnational I/O tables between subgroup of countries are available for only a few cases.

(2) $VE_{ij} = \sum_k IE_{ijk} B_{jk}$

(3) $VI_{ij} = \sum_k IM_{ijk} B_{ik}$

where IE_{ijk} is the exported intermediate from country *i* to country *j*, B_{jk} is a share of country *j*'s production that is exported ($= \left[I - A_j^D\right]^{-1} X_{jk} / X_j$), IM_{ijk} is exported intermediates from country *j* to country *i*, B_{ik} is a share of country *i*'s production that is exported ($= \left[I - A_i^D\right]^{-1} X_{ik} / X_i$).

Production inducement coefficients and export shares of Korea are available from I/O transaction table in 1995, 1998, 2000 and 2003 and for the between years, averaged industry shares are applied. Korea's trade data in parts and components by trading partner and by industry are come from the database of Ministry of Commerce, Industry and Energy of Korea.

It is more difficult to measure vertical exports than vertical imports, because the measurement requires bilateral export data matching the input-output tables of foreign countries. I use the OECD STAN input-output database (2000) and I/O tables from China (2000), Taiwan (2001), Russia (2000) and Indonesia (2000)[5]. Yearly trends are acquired by adjusting the industry share of the 2000's with the yearly increases of total export share in real GDP. Intermediates export data are also acquired from the database of the Ministry of Commerce, Industry and Energy of Korea.

[5] For the countries whose I/O tables are not available, the share of total exports in real GDP is used.

Table1. Comparison of Measurement Methods for Vertical Trade

	Trade in Parts and Components	Production and Export Information in I/O Tables	Coverage
Intermediates Trade	○	×	Trade by country and industry
HIY	×	○	Trade by industry
HIY2	○	○	Trade by country and industry

2. Vertical Specialization in Korea's Trade

A. Rapid Growth of Vertical Trade for the Last Decade

The HIY2 method described above is employed to estimate the volume of vertical trade in Korea[6]. Table2 illustrates that vertical trade in Korea has grown rapidly over the past ten years and played a key role in driving overall trade growth. The second row of the table shows the value of vertical exports and imports of Korea for the selected years from 1995 to 2006. The value of vertical exports almost quintupled

[6] The table below shows that there are significant differences in the volume of vertical trade generated by the three methods. Since the HIY and HIY2 methods define vertical trade as the subset of intermediates trade which is used to product exports, they yield smaller values than the method of intermediates trade. The amounts of vertical trade based on HIY are bigger that those based on HIY2 because the intermediate input in I/O table is larger than import of parts and components.

Comparing Vertical Trade Calculated by the Three Methods (2006)

	Exports			Imports		
	Intermediate Goods Trade	HIY	HIY2	Intermediate Goods Trade	HIY	HIY2
Value (100mil.$)	1,490.9	1,210.2	1,129.5	1,139.8	970.4	903.0
Share in total Trade (%)	<45.8>	<37.2>	<34.7>	<36.8>	<31.4>	<29.1>

from 1995 to represent about 35% of total exports as of 2006. The value of vertical imports has more than tripled since 1995 and presently makes up some 29% of totals import. As the growth rate of vertical exports exceeded that of vertical imports, the surplus related to vertical trade has widened dramatically in recent years and represented about one and half times the overall trade surplus as of 2006.

Table 2 also provides the sectoral composition of vertical trade in Korea. It shows that vertical exports occur mostly in two key sectors: machinery and electronics. The respective shares of machinery and electronics in vertical exports surged from 9% and 54% in 1995 to 15% and 62% in 2006. In these sectors, the surplus on vertical trade account also has widened rapidly in recent years.

Table2. Trend of Vertical Trade in Korea

(100mil.$,%)

	Vertical Export			Vertical Import			Trade Balance	
	1995	2000	2006	1995	2000	2006	2000	2006
Total Export s(A)	1,250.6	1,722.7	3,254.6	1,351.2	1,604.8	3,093.8	117.9	160.8
Vertical Trade (B)	218.4	510.7	1129.5	227.8	472.5	903.0	38.2	226.5
B/A, %	<17.5>	<29.6>	<34.7>	<16.9>	<29.4>	<29.1>	<32.4>	<140.9>
Share, %	100.0	100.0	100.0	100.0	100.0	100.0	38.2	226.5
Textiles	12.7	6.9	3.4	9.9	5.2	2.7	6.4	14.1
Chemicals Rubber	13.1	9.2	9.8	16.2	10.7	12.3	6.5	-0.8
Non-metallic minerals	0.2	0.3	0.2	0.2	0.2	0.3	0.2	-0.3
Metals	8.5	5.8	6.6	12.4	8.8	12.9	-16.2	-42.4
Machinery	9.0	17.6	15.1	11.6	13.0	13.9	21.6	44.5
Electronics	54.3	58.9	61.9	40.4	58.1	53.4	10.6	213.1
Vehicles	2.3	1.5	3.1	9.3	3.9	4.5	-11.7	-5.8

B. Sharp Increase of Vertical Exports to China

Table 3 illustrates the regional composition of vertical trade in Korea. It is notable that vertical trade with China has expanded very rapidly, with its share of exports rising from 13% in 2000 to 41% in 2006 and that of imports from 9% to 20% during the same period. On the other hand, the shares of the U.S, Japan and other developing countries in Asia have been mostly decreased. This implies that the recent increase in Korea's vertical exports was mainly attributable to the expansion of vertical exports to China. It also shows that the increase of vertical imports from China was also larger.

Table3. Trend of Vertical Trade by Country

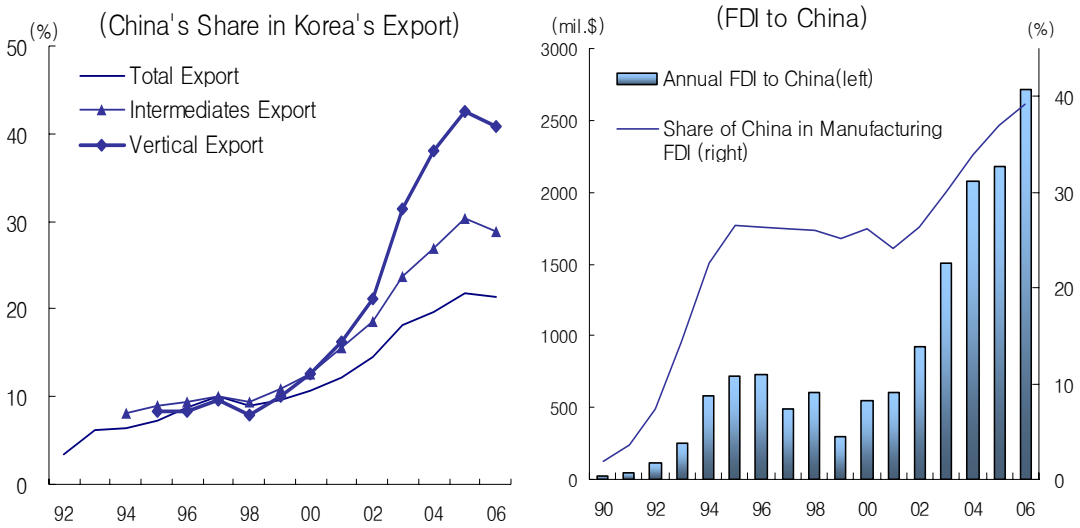
(100mil.$,%)

	Vertical Exports			Vertical Imports			Trade Balance	
	1995	2000	2006	1995	2000	2006	2000	2006
Total	100.0	100.0	100.0	100.0	100.0	100.0	38.2	226.5
Asia Developing	56.8	53.5	70.5	17.3	29.7	41.6	110.3	419.2
(China)	8.4	12.7	40.8	7.3	8.8	20.1	17.8	278.6
(Hong Kong)	17.0	9.7	10.4	1.4	1.6	1.6	36.4	103.2
(Taiwan)	8.2	10.4	5.6	3.4	6.2	7.6	18.9	-5.6
(ASEAN)	23.2	20.7	13.7	5.2	13.1	12.3	37.2	43.5
U.S.	16.5	14.0	5.0	25.4	25.3	14.6	-53.7	-75.9
Japan	8.8	8.0	6.5	34.0	28.0	23.2	-92.4	-136.6
EU	10.5	16.1	10.1	17.2	12.6	12.9	27.6	-2.9
Other countries	7.3	8.4	7.8	6.1	4.4	7.8	46.4	22.7

Through its emergence as a regional production hub, China has become the most important destination for Korea' intermediates exports and FDI. The liberalization of trade and investment in China, prompted by joining the WTO in 2001, has led to a surge of foreign direct investment into China and changes in China's role within regional and global production chains. Korean firms have been estabilishing a manufacturing base in China to take advantage of its low production costs and preferential treatment for processing trade. Since 2002, China has replaced the US as

Korea's largest destination for overseas investment, accounting for 40 percent of Korea's manufacturing outward FDI in 2006.

Figure2. Vertical Exports and FDI to China



Equation (4) divides the increase in total exports (A) into that of vertical trade (B) and other exports. Furthermore, equation (5) decomposes the change in vertical trade into two stages: a change in intermediates trade (C) and that in the production (export) of final goods (D). Table 4 shows that the increase in vertical exports explains more than 80% of the rise in Korea's export/GDP ratio during 2002 and 2006. It also provides the results of the breakdown of the changes in vertical trade with China, the U.S., and Japan into major sectors. The rise in vertical exports to China is largely attributable to the increase in China's production and export of final goods, while the rise in those to the U.S. and Japan is caused by the increase in intermediates exports themselves.

(4) $\underbrace{\Delta(EX_i / Y)}_{(A)} = \underbrace{\Delta(VE_i / Y)}_{(B)} + \Delta(EX_i - VE_i)/Y$

(5) $\Delta VE = \underbrace{\Delta IE \times B_0}_{(C)} + \underbrace{IE_t \Delta B}_{(D)}$, where *IE*: intermediates export, *B*: $\left[I - A_i^D\right]^{-1} X_{ik}$

Table4. Decomposition of Increase in Korea's Export

(Contribution to the increase in exports/GDP)

	Increase of Export/GDP(A)		Contribution Rate (%)	
	95~06	02~06	95~06	02~06
Total Export	0.125	0.069	100.0	100.0
Intermediates	0.085	0.043	68.4	62.6
Vertical Export	0.084	0.057	68.1	82.4
(China)	0.048	0.037	48.5	50.1
(ASEAN[1)])	0.015	0.004	12.1	5.2

Note: 1) including Hong Kong, Taiwan

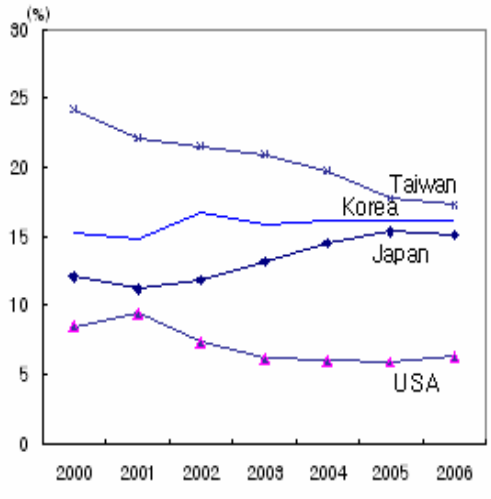
(Decomposition of increase in vertical export)

		Increase (95~06) (100mil.$)	C (%)	D (%)
China	Machinery	67.6	19.5	80.5
	Electronics	255.1	26.3	73.7
US	Machinery	8.4	99.5	0.5
	Electronics	11.2	92.9	7.1
Japan	Machinery	7.1	76.3	23.7
	Electronics	25.8	62.6	37.4

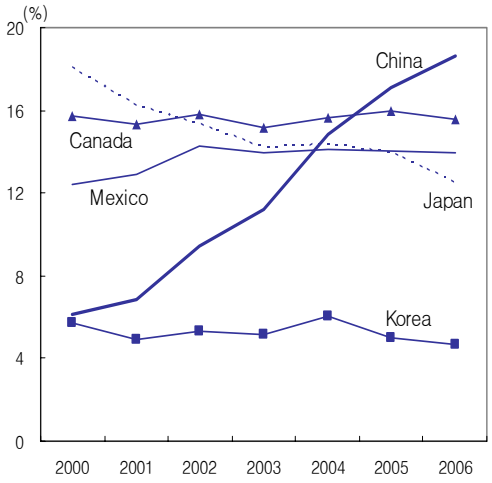
As a result of the rapid increase of intermediates exports to China, the share of Korea in total Chinese imports of intermediates also rose substantially, reaching a level slightly lower than those of Japan and Taiwan in 2006. Korea's share in the US market, however, remained flat during 2000-2006, while that of China rose sharply over the same period.

Figure3. Major Countries' Share in Intermediates Imports of China and the US

(China's Intermediates Imports by Country)



(US's Intermediates Imports by Country)



III. The Determinants of Vertical trade

1. An Overview of the Literature

The early literature on vertical trade mostly focused on vertical intra-industry trade and explained a rise in vertical trade by a widening of the gap in comparative advantage[7]. Fragmentation-based vertical trade has only recently received attention.

HIY (2001) was the first research paper to develop a comprehensive framework to analyze the phenomenon of vertical specialization. Using input-output tables from the OECD and emerging market countries, the authors estimated that vertical specialization accounts for up to the 30% of world exports. By developing an extension of the Dornbusch-Fisher-Samuelson Ricardian trade model, they showed that even small reductions in tariffs and transport costs can lead to large trade growth due to the double incidence of trade-costs in vertical trade.

By calibrating and simulating a two-stage dynamic Ricardian trade model, Yi (2003) showed that the model generates a nonlinear trade response to tariff reductions and it can explain over 50 percent of the growth of trade. He also showed that the welfare gains to tariff reductions in the vertical model are high, compared to the standard one-stage model.

Carpenter (2005) emphasized that intermediates trade occurs in combination with

[7] Falvey (1981) was the first researcher who investigated vertical intra-industry trade in final goods. He demonstrated that higher quality goods are exported by a country that has a higher capital-labor-ratio technology, while lower quality goods are exported by a low-technology country. According to him, VIIT is likely to be active when two countries have large differences in factor endowments and technology. Based on this perspective, Flam and Helpman (1987) and Grossman and Helpman (1991) presented the North-South VIIT model, in which the North (high-income countries) export high quality, high price goods and the South (low-income countries) export low quality, low price goods.

vertical FDI. Incorporating an intermediate good and endogenous multinationals into a monopolistic competition trade model, she showed that relative trade costs and fixed costs are the main factors which determine the export and location decisions of vertical firms. The solution of the model showed that under certain combination of relative trade costs and fixed costs, countries engage in both intra-industry FDI and intra-industry trade. She also developed the export function of vertical firms, but this though only covers one-way trade in intermediates.

On the other hand, the recognition of the expansion of production sharing has been far faster in East Asia than in any other region and many studies have been undertaken to analyze the magnitude and motivation of production fragmentation within it.

Ng and Yeats (1999) were the first to analyze the nature of production sharing in East Asia. By using the trade data for parts and components (SITC revision 2), they found that international production sharing in East Asia is expanding at a faster pace than in either North America or Europe. The extent of production sharing is measured by the RCA index of parts and component trade.

Fukao, Ishido and Ito (2003) empirically estimated Japan's bilateral trade with developing countries in Asia using a gravity model. They proposed that resource-seeking or export oriented FDI played the most significant role in the rapid increase in Japanese VIIT. Using the trade data between 1991 and 1999, Lee and Byun (2005) demonstrated that variations of the level of IIT in Korea are better explained by vertical IIT. The estimation results on the coefficients of independent variables supported the conventional hypotheses derived from the previous theories of the horizontal IIT and vertical IIT.

Using a standard gravity model and the recent trade data (SITC revision 3) for 36 major countries, Athukorala and Yamashita (2006) also presented the estimation result

that international production fragmentation is determined by the level of GDP, distance, relative wage differential and the formation of RTA.

Based on the gravity equation approach and disaggregated trade data, Kimura, Takahashi, and Hayakawa (2007) compared the trade patterns between East Asia and Europe, particularly trade in machinery parts and components. They argued that fragmentation theory is suitable for explaining the mechanics of international production networks in East Asia, in contrast with the traditional horizontal product differentiation model fitted for intra-industry trade in Europe.

To sum up, explaining vertical trade has been an important field in the recent literature, both theoretical and empirical. However, previous studies of vertical trade in Asia countries measured vertical trade either by one-way trade in parts and components (Ng and Yeats 1999, Kimura et al. 2005) or by the index of intra-industry trade (Fukao et al. 2003, Athukorala and Yamashita 2005, Lee and Byun 2005), which are not exactly consistent with the definition of vertical trade. Furthermore, these studies relied on gravity equations for empirical estimations and could not provide an explanation consistent with theory for the relation between the explanatory variables and the vertical trade. This paper adds to the literature by deriving the functional form of vertical trade from a monopolistic competition framework and estimating the equation using more refined measurements of vertical trade, which has been barely attempted so far.

2. Theoretical Model

To illustrate firms' decision to export vertically, we build on Carpenter (2005) which

incorporates intermediates trade and vertical FDI decisions into a monopolistic competition framework. We extend the model to include asymmetry in production costs and to predict the functional form for the dependence of vertical trade on comparative advantage, geographical advantage and FDI stock.

(Firms' maximization problem)

The representative consumer's behavior is modeled as a bilateral version of a CES ($0<\sigma<1$) utility function. The consumer in country *j* maximizes the utility function subject to the expenditure constraints:

$$(6)\ max\ \ U_j = \left[\sum_{i=1}^{N} x_{ij}^{\rho}\right]^{-\rho} \quad s.t.\ \ \sum_{i=1}^{N} p_{ij} x_{ij} = Y_j$$

where x_{ij} denotes the demand for a variety produced in country *i*, p_{ij} is the c.i.f. price, Y_j is the total expenditure in country *j* and $\rho \equiv 1/(1-\sigma)$ is the demand elasticity ($\rho > 1$). Time and industry subscripts are omitted for notational simplicity.

The constrained utility maximization yields the import demand function:

$$(7)\ \ x_{ij} = E_j p_{ij}^{-\rho}$$

where E_j is the total demand of country *j* divided by the price of all other varieties available to the consumer in that market ($E_j \equiv Y_j / P_j^{1-\rho}$).

The representative firm in country *i* produces each variety for profit maximization.

$$(8)\ max\ \ \prod_i = \sum_{j=1}^{N} (p_i - c_i) x_{ij} - F_i$$

where p_i is producer's price, c_i is a unit variable cost, and F_i is a fixed cost. Under monopolistic competition, price is a markup over the unit variable cost.

(9) $p_i = c_i / \sigma$

Then, the operating profit can be expressed as $\pi_i = \sum_j c_i^{1-\rho} A_j$ where

$A_j \equiv (1-\sigma)\sigma^{\rho-1} E_j$.

(Firms' location decision)

We now assume that production of a good comprises two stages: the first stage consists of the production of an intermediate good I and the second stage, which we denote as A, involves further processing of the intermediate good. Each stage requires its own plant. Firms can be classified into three groups by the location of production. First, there can be national firms, which produce all components and finish them in *Home*. We denote these firms as *HH-types*. Secondly, there may be firms that produce all components in *Home* and finish them at a second assembly plant in *Foreign*. We denote these firms as *HF-types*. Finally, there can be horizontal multinational firms, which produce whole products in foreign countries. We denote these firms as *FF-types.* The table below summarizes the characteristics of each type of firm.

Table5. Characteristics of each type of firm

	Type of firm	Production	Trade	FDI
HH-type	traditional and national firms	Produces all components and finishes them in Home.	**Horizontal Specialization** (Exports final good)	None
HF-type	vertically fragmented firms	Produces all components in Home; finishes them at an assembly plant in Foreign.	**Vertical Specialization** (Exports intermediates)	**Vertical FDI** (Assembly Plant)
FF-type	horizontal multinationals	Produces components and finishes them in foreign countries.	None	**Horizontal FDI** (Assembly Plant and Components Factory)

Source: Modification of Carpenter (2005, p.6)

Given that the production costs and fixed costs are different depending on where production is located, we assume that firms pick the location configuration that maximizes their profit. In an initial equilibrium, when domestic production costs are very low, there will not be an incentive for a firm to move a plant abroad. In this equilibrium, all firms are *HH-types* and there is no FDI. The number of *HH-type* firms is determined endogenously to yield zero profits for each firm only covers fixed costs.

Now imagine rising production costs at home. As the relative production costs rise, the price charged to foreign consumers for exported goods increases, foreign demand falls and firm's profits are lower. If the fixed cost of the assembly plant is relatively small and there are pure profits to be made from operating as a *HF-type*, then the firm moves the assembly plant abroad (vertical FDI) and becomes a *HF-type*.

If the production costs rise steadily, it becomes optimal for the firm to move all the production facilities including the components factory to foreign countries and become a *FF-type* (horizontal FDI). A firm would want to shift from *HF-type* to

FF-type if the increased profits from the foreign sales are more than the increase in fixed costs.

To sum up, the firm's location decision is determined mainly by the relative production cost and differences in fixed costs between the home country and foreign countries.

(Firms' Exports)

The case we are interested in is the *HF-type* firms that are engaged in both vertical trade and FDI. To derive export function of the vertical firms, we add two asymmetries. First, we allow for trade costs between countries. If τ_{ij} and t_{ij} denote iceberg transport costs (τ_{ij} >1) and ad valorem tariff (t_{ij} >1), respectively, the consumers in country *j* are charged p_{ij} for final goods from country *i* as follows.

(10) $p_{ij} = \tau_{ij} t_{ij} c_i / \sigma$

Now we consider the cost function when the production costs differ depending on where the stages of production are located. The intermediate I is manufactured by using γa units of labor, where weight, γ, reflects the importance of intermediates in the production of x. It takes one unit of I, plus further processing which requires $(1-\gamma)a$ units of labor, to produce one unit of x. The wage in home (w_i) is different from that in foreign (w_j). The variable cost for production can be expressed as a weighted combination of the costs of each stage.

(11) $c_i = (1-\gamma) a_j w_j + \gamma a_i w_i$

Now we turn to the export functions of each type of firm. From equation (7) and (10), the export function of an *HH-type* firm can be defined as the foreign demand for final goods in country *i*. What we are interested in is the export function of *HF-type* firms. The export function of affiliates in country *j* is expressed as the world demand for final goods in country *j*. Because the value of the intermediate is defined as fraction γ of the final good x, the export function of intermediates is expressed as fraction γ of demand for final goods in country *j*. For *FF-type* firms, there is no trade from the home country.

(12) *HH-type* (export of final goods): $X_{ij} = m_i p_{ij} x_{ij} = \rho m_i (\tau_{ij} t_{ij} a_i w_i)^{1-\rho} E_j$

(13) *HF-type* (export of intermediates): $I_{ij} \equiv \gamma X_{jh} = \gamma \rho m_{ij} \sum_h (\tau_{jh} t_{jh} c_i)^{1-\rho} E_h$

(14) *FF-type*: No Export

Where m_i and m_{ij} are the respective numbers of affiliates in country *i* and in the partner country and E_j and E_h measure the effective market size of country *j* ($= Y_j / P_j^{1-\rho}$) and of country *h* ($= Y_h / P_h^{1-\rho}$), respectively.

3. Empirical Estimation

A. Model and Variables

From equation (13), we can see that vertical exports (VE) from country *i* to country *j* are determined mainly by the share of intermediates in production, the number of country *i*'s affiliates in country *j*, the market access of country *j* and relative

production costs. The relative fixed costs indirectly affect the amount of vertical trade via the change in the number of affiliates. The foreign country's market access, $\sum_h (\tau_{jh} t_{jh})^{1-\rho} E_h$, can be decomposed as $(\tau_{ji} t_{ji})^{1-\rho} E_i + \sum_{h \neq i} (\tau_{jh} t_{jh})^{1-\rho} E_h$. The first term is the demand size of the home country discounted by bilateral trade costs and the second term is country *j*'s ability to access the world market. In the estimation of VE, we linearize equation (13) to illustrate more directly the impact of explanatory variables on vertical exports.

The VI of country *i* from country *j* can be defined in a similar way. VI is expressed as a linear function of number of affiliates, relative wages, bilateral and multilateral trade costs and world market access of country *i*.

(15) $$VE_{ijt} = \beta_1 \gamma_{it} + \beta_2 m_{ijt} + \beta_3 D_{ij} + \beta_4 \ln t_{ijt} + \beta_5 \ln Y_{it} + \beta_6 D_{\omega} + \beta_7 t_{\omega t} + \beta_8 Y_{\omega t} + \beta_9 \omega_{ijt} + \beta_{10} a_{ijt} + \varepsilon_{jt}$$

(16) $$VI_{ijt} = \beta_1 \gamma_{jt} + \beta_2 m_{jit} + \beta_3 D_{ij} + \beta_4 \ln t_{ijt} + \beta_5 \ln Y_{jt} + \beta_6 t_{\omega t} + \beta_7 Y_{\omega t} + \beta_8 \omega_{ijt} + \beta_9 a_{ijt} + \varepsilon_{jt}$$

Next, we take into account the endogeneity of the number of affiliates. The determinants of vertical trade and FDI are possibly correlated and this may cause the effects of FDI on vertical trade to be biased. I adjust for the endogeneity of FDI by using an instrumental variable.

In the first-stage, we estimate m_{ij} and m_{ji} on instrument variables. The relative fixed costs for building a plant at home and those for building a plant abroad are used as instrument variables. To capture the fixed cost of establishing a plant in a foreign

country, we use the *Doing Business Index* (DBI) of the World Bank[8]. We consider three of the ten areas of the DBI that are closely related to the entry of new firms: starting a business, registering property and protecting investors. We average rankings of the ease of doing business of three areas and take the inverse of the average for a proxy of fixed costs.

The empirical estimation draws data from various sources. International comparable data on wages come from WDI and UNIDO. The calculation of the TFP index follows Caves et al. (1982). Data on value added, labor input, and capital input are acquired from the INSTAT database of UNIDO, which provides value-added, gross fixed capital formation and number of employees according to ISIC revision 2 at three-digit manufacturing level.

For each pair of countries, the distance measure is calculated as a great circle distance between the countries' capitals, which is given by Haveman's website (www.eiit.org). Trade barriers are evaluated by applied MFN tariffs. The trade-weighted MFN tariffs are taken from the United Nations Conference on Trade and Development's Trade Analysis & Information System (TRAINS). To measure market size, constant GDP from WDI is used.

The stock of FDI is used as a proxy for number of affiliates. The outward FDI data are taken from the database of the Export-Import Bank of Korea, and the inward FDI data from the database of Ministry of Commerce, Industry and Energy of Korea.

[8] DBI has some limitations as a proxy for fixed costs: it covers only business regulations. For example, it does not account for the quality of infrastructure services, the transparency of government procurement, or the underlying strength of institutions.

Table6. Definition and Sources of Variables

Variables	Notation	Expected Signs		Source
		VE	VI	
Relative wages	w_{ij}	+/-	+/-	WDI, UNIDO
Relative productivity	a_{ij}	+/-	+/-	value added, capital stock, employment from UNIDO
Share of intermediates	γ_i, γ_j	+	+	I/O tables from OECD, country home page
Home GDP	Y_i, Y_j	+	+	WDI
World GDP	Y_w	+	+	WDI
Bilateral Distance	D_{ij}	-	-	Haveman: www.eiit.org
Weighted Distance	D_w	-		Haveman, PWI 6.1
Bilateral tariff	t_{ij}	+/-	+/-	WITS based on TRAINS
World tariff	t_w	-	-	WITS based on TRAINS
Outward FDI	outFDI	+		EXIM Bank of Korea
Inward FDI	inFDI		+	MCIE of Korea
Fixed costs	F_{ij}	+	-	World Bank's DBI index

B. Estimation Results

The equations (15) and (16) are estimated with bilateral trade data with 32 trading partners for the 1995 to 2003 period. The dependent variables are the level of vertical trade and intermediates trade. The explanatory variables are categorized into four groups. The first consists of the comparative advantage measured by relative wage and technology, the second includes gravity-related variables such as distance, trade barriers and importer's demand measured by real GDP, the third is the stock of FDI and the fourth is the input share of intermediates. Two different methods of estimation are employed. First, I estimate with two stage least squares (2SLS) to solve the possible endogeneity problem. I also apply a generalized method of moment (GMM) to get the approximate consistency and efficiency of estimates.

Table 7 presents the estimation results where the dependent variables are vertical exports and intermediates exports. It uses time-series and cross-sectional information for a panel of 32 trading partners. Robust standard errors are reported in parentheses.

The first and second columns report the estimation results where the dependent variable is vertical exports. According to the theory, the sign of the coefficient on the relative comparative advantage can be either positive or negative. In the short run, production costs are increasing in conjunction with the rises in both home and foreign wages, and thus the sign of the coefficient is indeterminate. In the long run, the relative wage's effects on the firm's decision on FDI become to overwhelm, and under certain conditions, it should be positively correlated with vertical exports. There is also no *a priori* expectation on the coefficient of the relative productivity, because the short-run and long-run effects of relative productivity are also different.

The regression results show that coefficients on relative wages in columns 1 and 2 are positive and statistically significant at the ten percent level. The next row of the table show that coefficients on the productivity of the exporter country also have positive signs and that they are statistically significant at the ten percent level. These results imply that the larger share of Korea's vertical exports takes place with low-productivity countries and labor abundant countries.

The third to eighth rows of the table indicate that gravity-related variables are generally appropriate to explain Korean vertical exports. Bilateral distance as well as the weighted distance to the world market turns to be negatively correlated with vertical exports, as the theory suggests. The parameters of world demand are also found to be all positive and statistically significant at the one percent level.

The coefficients on bilateral tariffs can be either positive or negative because vertical trades are two-way trades. The results on bilateral tariffs are all negative and

statistically significant. The results on the production share of intermediates of exporter country are consistent with the theory. The coefficients show positive signs, even though some of them are not statistically significant.

Turning to the effects of FDI on vertical trade, the estimation results display overall consistency with the theory. The parameters of FDI are found to be all positive and statistically significant at the one percent level.

The model was re-estimated using intermediates export as a dependent variable (columns 3 and 4). The results are similar overall to those obtained when vertical exports were used, but they are less significant.

Table 8 reports the same regression as in Table 7, except that the dependent variables are now panel data of vertical imports and intermediates imports. The second row of the table show that relative wage are negatively correlated with vertical imports but do not have statistically significant effects. The coefficients on relative TFP's are negative and statistically significant.

Again, the country-pair gravity variables are found to be very plausible in explaining vertical imports. The parameters for distance are all negative and statistically significant. The coefficients on world and exporter's GDPs are correctly signed, even though some of them are not statistically significant. The signs of coefficients on the production share of intermediates of the exporting country are the opposite of what was expected. The coefficients show negative signs, even though they are not statistically significant. The coefficients of FDI also are found to be all positive and statistically significant at the one percent level.

Table7. Estimation Results on Vertical Exports: Panel Data by Country and Industry

Dependent Variable:			Vertical Exports		Intermediates Exports	
notation	explanation	Mean (Std. Dev.)	2SLS	GMM	2SLS	GMM
w_i / w_j	Relative wage	4.55 (0.77)	0.065* (0.036)	0.340** (0.162)	0.045* (0.029)	0.021* (0.011)
a_i / a_j	Relative productivity	4.42 (0.45)	0.378* (0.311)	0.967* (0.530)	0.134 (0.274)	0.021 (0.040)
D_{ij}	Bilateral distance	8.73 (0.68)	-0.383* (0.239)	-0.601** (0.276)	-0.348 (0.341)	0.142 (0.340)
t_{ik} / t_{jk}	Relative tariff	2.26 (0.18)	-0.574*** (0.048)	-0.319* (0.163)	-0.645*** (0.039)	-0.058 (0.143)
Y_i	Korea's GDP	8.53 (0.14)	-1.770** (0.672)	-0.870 (0.879)	0.705 (0.933)	0.212 (0.191)
D_w	GDP-weighted distance to major markets	26.5 (1.33)	-0.621* (0.432)	-0.622 (1.103)	0.467 (1.569)	-0.372 (1.322)
t_w	World tariff	1.97 (0.18)	-0.821** (0.346)	-0.964*** (0.329)	0.429 (0.292)	-0.336 (0.217)
Y_w	World GDP	12.66 (0.09)	1.364 (2.033)	1.394 (1.601)	1.657* (1.811)	1.213 (2.096)
γ_{ik}	Intermediates input ratio	4.24 (0.07)	0.634* (0.345)	0.408* (0.228)	0.278 (0.314)	0.223 (0.404)
Outward FDI	outward FDI	11.13 (2.15)	3.821** (1.521)	4.450*** (1.460)	3.345** (1.401)	4.068*** (1.189)
R-squared			0.31	0.22	0.22	0.21
Observations			1,724	1,724	1,724	1,724

Table8. Estimation Results on Vertical Import: Panel Data by Country and Industry

Dependent Variable:			Vertical Imports		Intermediates Imports	
notation	explanation	Mean (Std. Dev.)	2SLS	GMM	2SLS	GMM
w_i / w_j	Relative wage	4.55 (0.77)	-0.231 (0.214)	-0.072 (0.130)	-0.121 (0.132)	-0.124 (0.313)
a_i / a_j	Relative productivity	4.42 (0.45)	-0.311*** (0.103)	-0.242* (0.149)	-0.352*** (0.131)	-0.101 (0.221)
D_{ij}	Bilateral distance	8.73 (0.68)	-0.211* (0.121)	-0.192* (0.101)	-0.231* (0.118)	-0.311** (0.131)
t_{ik} / t_{jk}	Relative tariff	2.26 (0.18)	-0.532** (0.210)	-0.914* (0.476)	-0.126** (0.043)	-0.032 (0.062)
Y_j	Korea's GDP	8.05 (1.33)	0.121** (0.052)	0.532* (0.317)	0.049 (0.231)	0.121 (0.085)
t_w	World tariff	1.97 (0.18)	0.091 (0.232)	0.104 (0.191)	-0.131 (0.121)	-0.093 (0.131)
Y_w	World GDP	12.66 (0.09)	2.121* (1.091)	2.426* (1.473)	-1.232 (1.452)	-1.421 (1.163)
γ_{jk}	Intermediates Input ratio	4.22 (0.07)	-0.832 (1.313)	-1.457 (2.542)	-1.642 (2.315)	-1.894 (1.453)
Inward FDI	inward FDI	11.02 (3.45)	0.321*** (0.092)	0.334*** (0.089)	0.231** (0.095)	0.451*** (0.052)
R-squared			0.53	0.22	0.43	0.23
Observations			1,721	1,721	1,721	1,721

IV. Conclusion

While Korea's vertical trade, fostered by foreign direct investment, has been growing rapidly, it has been left unexamined until recently. This paper provided the improved measurement based on HIY (2001) and quantified the vertical trade in Korea by trading partner and by industry. The empirical results show that Korea's trade has been more vertically specialized over the last ten years. In particular, vertical exports to China have grown rapidly since the early 2000's, and thus the surplus on vertical trade has widened dramatically in recent years.

This paper also derives a functional form for the determinants of vertical trade from a monopolistic competition model of trade and multinational production. The empirical estimation with 32 trading partners during the period of 1995-2003 provides evidence that the Korea's vertical trade has been affected by the relative comparative advantage as well as by the geographical advantage. Vertical trade is also indirectly affected by relative fixed costs through the change in the stock of FDI.

The evidence presented here suggests some policy implications. As international production fragmentation and vertical trade have expanded rapidly, it is becoming more important for firms to have a comparative advantage in "stages" with high value added and to focus on the production of parts and components in those stages. It can be said that, until recently, Korea has been successful in establishing its regional production network and remaining a major supplier of intermediate goods for processing trade to developing countries in Asia. Despite the strong performance of vertical exports, however, concerns about their sustainability have recently been raised. Korea is perceived by some as being "sandwiched" between China, which is catching

up rapidly in terms of product technology, and Japan, which is still technologically more advanced. In particular, the domestic production capacity of China has increased substantially in recent years, which has enabled increased local content in its processing trade and weakened the demand for intermediate goods from Korea[9]. Vertical import of intermediate goods from China is also increasing, while the dependency on Japan for high-tech intermediate imports is still high. To cope with these challenges, the government and firms in Korea need to put more effort into continuing to move its manufacturing sector up the value chain.

[9] As the traditionally tight link between exports and imports has weakened, China's trade surplus has expanded sharply in recent years. During 2003-2006, the trade surplus grew over five -fold in dollar terms and more than tripled as a percentage of GDP. As of 2006, the trade surplus was more than 8 percent of GDP. The rapid widening of the trade surplus has mainly been driven by a significant slowdown in imports. Imports of intermediate goods slowed the most, with parts and components and semi-finished goods accounting for almost half of the slowdown in import growth between 2003 and 2006 (Cui and Syed, 2007)

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Appendix A. Intermediates Trade in Korea

Over the past ten years, the volume of intermediates traded in Korea has increased rapidly. The table below shows that the proportion of vertical exports to total exports increased from 34% to 45% during the period 1995-2006, while that of vertical imports to total imports increased from 34% to 37% over the same period. As the growth rate of intermediate exports exceeded that of intermediate imports, the surplus on the intermediates account has widened in recent years.

The sectoral composition of intermediates trade in Korea has also changed: the share of machinery and electronics has increased rapidly while that of textiles has declined substantially. When we see the regional composition, it is notable that intermediates trade with China has expanded quite rapidly, with the country increasing its share of intermediates exports from 12.6% in 2000 to 28.8% in 2006 and that of intermediate imports from 8.0% to 21.3% during the same period. On the other hand, the shares of the U.S, Japan and other developing countries in Asia have mostly decreased.

Trend of Intermediates Trade in Korea

(100mil.$,%)

	Intermediates Export			Intermediates Import			Trade Balance	
	1995	2000	2006	1995	2000	2006	2000	2006
Total Exports (A)	1,250.6	1,722.7	3,254.6	1,351.2	1,604.8	3,093.8	117.9	160.8
Intermediates Trade (B)	425.2	799.2	1,490.9	464.8	705.7	1,139.8	93.5	351.2
B/A, %	<34.0>	<46.4>	<45.8>	<34.4>	<44.0>	<36.8>	<79.3>	<218.4>
Industry Share, %	100.0	100.0	100.0	100.0	100.0	100.0	93.5	351.2
Textile	13.4	8.2	3.1	5.2	3.3	2.3	41.7	20.8
Chemicals·Rubber	22.5	17.7	19.2	21.8	15.2	16.1	34.0	103.4
Metal	13.4	10.3	13.1	20.7	15.0	20.0	-24.1	-32.9
Machinery	7.3	15.0	11.8	18.1	17.5	16.9	-3.2	-16.8
Electronics	38.9	44.8	44.4	23.6	43.9	38.2	48.6	226.9
Vehicles	4.0	3.3	7.7	8.7	4.0	4.4	-1.7	64.1
Country Share, %	100.0	100.0	100.0	100.0	100.0	100.0	93.5	351.2
China	9.0	12.6	28.8	5.4	8.0	21.3	44.4	198.6
ASEAN	18.4	15.8	11.5	4.0	11.7	9.5	33.1	49.1
U.S.	17.1	19.6	10.6	23.2	22.5	14.7	-2.8	-1.5
Japan	12.4	13.0	10.3	31.5	28.0	26.9	-117.3	-155.8
EU	9.5	12.5	7.8	19.0	14.3	14.4	6.2	-4.6

Appendix B. Intra-industry Trade in Korea

Grubel and Lioyd (1975) defined intra-industry trade as "the value of exports of an industry which are exactly matched by the imports of the same industry" and developed a GL index. Trade products are considered to be vertically differentiated if the relative unit value (RUV) exceeds the limits of the interval [$1/1+\alpha, 1+\alpha$] and horizontally differentiated otherwise. The arbitrary value of the parameter is set at 0.25.

Vertical intra-industry trade (VIIT) is further divided into higher VIIT (HVIIT) and lower VIIT (LVIIT) based on relative unit value (RUV). If RUV is larger than the upper limit (RUV>1.25), we classify this case as HVIIT. On the other hand, if RUV is smaller than the lower limit (RUV<1/1.25), we classify this case as LVIIT.

Definition of Vertical Intra-industry Trade

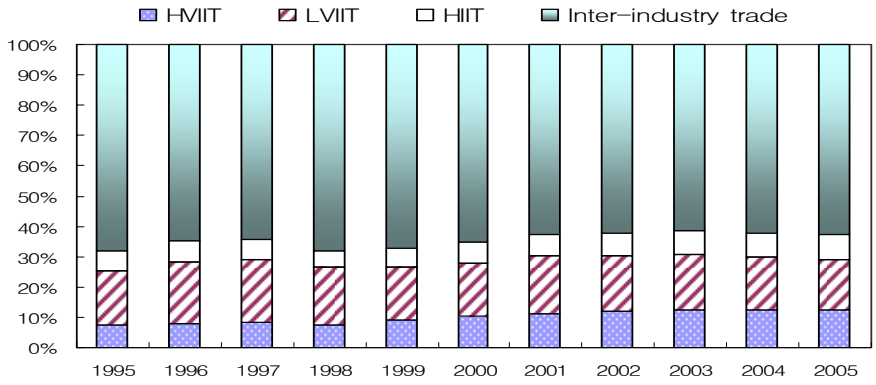
		degree of trade overlap	disparity of unit value
Horizontal Intra-industry trade		$\left\{1-\frac{\sum_n \lvert X_{ijkn}-M_{ijkn}\rvert}{\sum_n \lvert X_{ijkn}+M_{ijkn}\rvert}\right\}$	$\frac{1}{1.25} \le \frac{UVX_{ijk}}{UVM_{ijk}} \le 1.25$
Vertical IIT	HVIIT		$1.25 < UVX_{ijk}/UVM_{ijk}$
	LVIIT		$UVX_{ijk}/UVM_{ijk} < 1/1.25$

Korea's VIIT indexes are calculated at six-digit HS level and aggregated at two-digit SITC level. Data for trade volume and unit value are acquired from UNIDO. Korea's unit values are provided per weight, and thus, the unit values are assumed to be positively correlated with the value of exported goods. In Korea, though inter-industry trade still account for the majority, vertical intra-industry trade has showed a rapid increase recently, mainly in the form of HVIIT. The HVIIT share of total trade increased from 7.4% in 1995 to 12.4% in 2005, while the LVIIT share of total trade decreased from 18.0% to 16.7% during the same period.

Intra-industry Trade in Korea

	1995(A)	1997	2000	2002	2005(B)	B-A,%p
Inter-industry Trade	68.2	65.3	65.2	62.1	62.8	-5.4
Intra-industry Trade	31.8	34.7	34.8	37.9	37.2	5.3
Horizontal	6.4	6.6	7.0	7.7	8.1	1.7
Vertical	25.4	28.2	27.8	30.2	29.1	3.7
HVIIT	7.4	8.3	10.2	11.9	12.4	4.9
LVIIT	18.0	19.8	17.6	18.3	16.7	-1.3

Intra-industry Trade in Korea



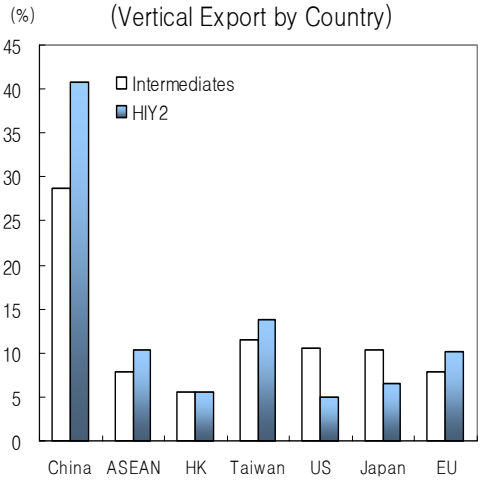
The regional composition of vertical trade in Korea shows that HVIIT with China, the largest trading partner, has increased rapidly, while VIIT with US and Japan have increased only moderately.

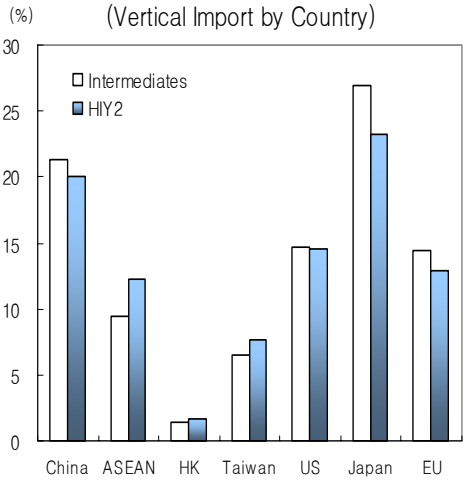
Intra-industry trade with major trading partners

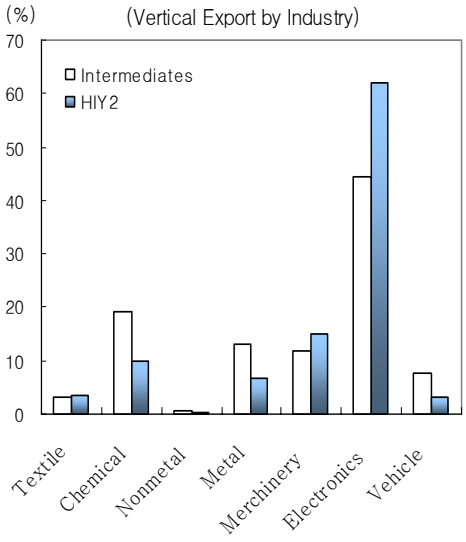
	1995 (A)				2005 (B)				B-A, %p	
	Inter industry	Intra-industry			Inter industry	Intra-industry			LVIIT	HVIIT
		HIIT	LVIIT	HVIIT		HIIT	LVIIT	HVIIT		
US	77.4	3.5	13.6	5.5	70.7	5.0	17.6	6.7	4.0	1.2
China	78.6	4.1	6.3	10.9	65.9	6.4	11.1	16.6	4.8	5.7
Japan	75.6	3.3	17.0	4.2	68.1	4.9	19.5	7.4	2.5	3.2

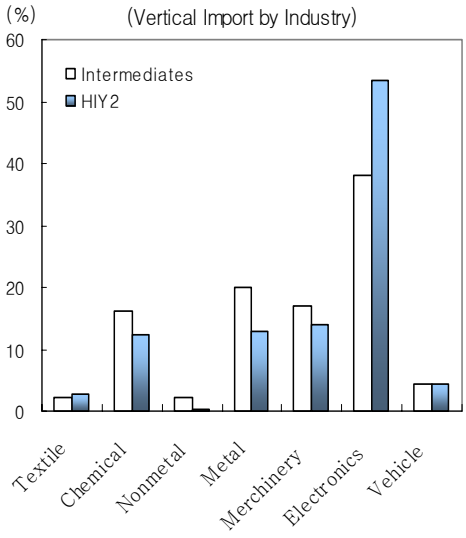
Appendix C. Comparisons between Intermediates and Vertical Trade

Figures below provide comparisons between values of the regional and sectoral shares of intermediates trade and those of vertical trade calculated by HIY2. Since the HIY2 method counts that proportion of imported intermediates, it generally yields shares that are more (less) than the intermediates method in countries or sectors where export shares are high (low).









Appendix D. Estimation Results on Vertical Trade: Panel Data by Country

Estimation Results on Vertical Exports

	Vertical Exports		Intermediates Exports	
Variables	2SLS	GMM	2SLS	GMM
w_i / w_j	0.251** (0.113)	0.254* (0.134)	0.003 (0.094)	-0.075 (0.266)
a_i / a_j	0.340* (0.177)	0.656 (0.434)	-0.183 (0.200)	0.075 (0.619)
D_{ij}	-0.583*** (0.125)	-0.655** (0.324)	0.070 (0.120)	0.106 (0.270)
t_{ik} / t_{jk}	-2.478*** (0.553)	-2.938** (1.153)	0.108 (0.344)	-0.081 (1.851)
Y_i	1.618 (1.621)	1.761 (1.683)	-0.220 (0.933)	-0.212 (1.947)
D_w	-0.772 (0.482)	-0.914 (0.897)	-1.591*** (0.465)	-1.902 (1.822)
t_w	-1.364* (0.776)	-1.514* (0.792)	0.429 (0.440)	-0.256 (0.954)
Y_w	7.316** (3.369)	8.084 (5.679)	1.657* (1.076)	3.196* (1.872)
γ_{ik}	-2.650 (2.127)	-3.387 (2.870)	3.343 (2.043)	1.378 (3.665)
Outward FDI	0.697*** (0.084)	0.702*** (0.172)	0.278** (0.850)	0.283 (0.361)
R-squared	0.52	0.21	0.32	0.22
Observations	341	341	341	341

Estimation Results on Vertical Imports

	Vertical Imports		Intermediates Imports	
Variables	2SLS	GMM	2SLS	GMM
w_i / w_j	-0.243 (0.224)	-0.375 (0.334)	-0.922* (0.538)	-0.424 (0.344)
a_i / a_j	-0.841*** (0.308)	-0.537* (0.307)	-0.936*** (0.326)	-0.501 (0.420)
D_{ij}	-0.634* (0.389)	-0.548*** (0.184)	-0.436 (0.422)	-0.512*** (0.182)
t_{ik} / t_{jk}	-1.398*** (0.415)	-1.306** (0.595)	-0.976** (0.441)	-0.784 (0.611)
Y_j	0.380 (0.276)	0.418*** (0.122)	0.485 (0.299)	0.424*** (0.124)
t_w	0.100 (0.451)	0.225 (0.391)	-0.423 (0.477)	-0.394 (0.362)
Y_w	5.681* (3.108)	5.765** (2.271)	-7.726** (3.351)	-6.856*** (2.167)
γ_{jk}	-1.689 (5.220)	-1.691 (2.792)	-2.846 (5.676)	-2.719 (2.989)
Inward FDI	0.514*** (0.197)	0.544*** (0.095)	0.540** (0.214)	0.526*** (0.094)
R-squared	0.81	0.43	0.78	0.54
Observations	341	341	341	341

<Abstract in Korean>

세계적인 무역·투자 자유화 진전과 운송·통신비용 하락에 힘입어 국가간 생산단계별 분업화(production fragmentation)가 확산되고 있다. 이에 따라 세계무역흐름에 있어 국가간 생산분절을 연결하는 중간재 무역, 즉 수직적 무역(vertical trade)의 중요성이 커졌다. 그러나 생산단계별 무역흐름의 직접적 측정이 어려워 기존연구들은 중간재 무역, 산업내 무역 및 기업내 무역 등의 간접적 방법을 이용하여 수직적 무역규모를 추정하여 왔다.

본고는 수직적 무역을 중간재 무역중 수입국에서 가공조립되어 제3국으로 수출되는 부분으로 정의하고, 산업연관표를 이용한 Hummels et al.(2001)의 방법을 보완하여 우리나라의 수직적 무역규모를 추정하였다. 국가별 · 산업별 부품소재 무역통계와 산업연관표를 결합하여 추정한 결과, 수직적 무역은 1995~2006년중 전기전자, 기계류 등을 중심으로 전체 무역보다 크게 늘어나 총수출입에서 차지하는 비중이 상승한 것으로 나타났다(수출: 18%→35%, 수입: 17%→29%). 특히 2000년대 들어 중국을 중심으로 수직적 수출이 대폭 확대된 반면 일본 미국으로부터 수직적 수입 증가세가 둔화됨에 따라 수직적 무역 흑자가 크게 확대되었다(2006년 전체 무역흑자의 1.4배).

또한 수직적 무역이 전통적인 비교우위요소와 국가간 거래비용 이외에 국내외 직접투자와 밀접한 연관성을 가지는 점을 고려하여 수정된 독점적 경쟁모형으로부터 수직적 무역함수를 도출하였다. 과거 10년간(1995~2005) 32개국, 6개 제조업종 패널자료를 이용하여 실증분석한 결과 수직적 수출입 모두 국내외 직접투자규모와 세계수요에 비례하고 교역국간 거리 및 관세장벽에 반비례하는 것으로 나타났다. 특히 수직적 수출의 경우 우리나라의 상대노동비용이 클수록, 상대 생산성이 높을수록 증가하는 것으로 나타났다.

이상의 분석결과에 비추어 볼 때 우리나라가 앞으로 수출확대와 무역흑자를 도모하기 위하여는 고기술 부품소재의 기술우위를 바탕으로 중국 등 아시아 개도국과의 수직적 분업체계를 유지·확대하는 것이 중요하다고 할 수 있다.