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FDI and Vertical Intra-Industry Trade between Korea and China*

Kwangsuk Han** · Jaeho Lee***

This study is to examine the impact of Korean firms' FDI to China on the development of vertical intra-industry trade between two countries. The increase of Korean firms' investment in China's industry demonstrated strongly positive effect in the intensification of vertical intra-industry trade. Additionally, this study finds that the other components such as factor endowments as well as size of the industry in proportion to the total size of its economy are also important determinants of the development of vertical intra-industry trade between two countries.

JEL Classification: F14, F21, F23, O53
Keywords: horizontal intra-industry trade, vertical intra-industry trade, foreign direct investment, China, Korea

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** Author for correspondence, KDI, Tel: +82-2-958-4188, E-mail: kshan512@naver.com
*** First Author, KDI, Tel: +82-2-958-4309, E-mail: jaeholee@kdi.re.kr

1. INTRODUCTION

There have been various studies explaining whether it is theoretically possible for foreign direct investment (hereafter FDI) to promote or to restrict the trade with other countries, and therefore FDI and international trade are either substitutes or complements. Mundell (1957) argues that FDI and international trade are perfect substitutes, if the traditional Hecksher-Ohlin theory which emphasizes the difference in factor endowments or factor prices is applied. However, Markusen (1983) challenges that FDI and international trade can be complements if the assumptions underlying the standard Hecksher-Ohlin theory are relaxed. For instance, if there is a technology gap between two countries which is not a factor of the Hecksher-Ohlin theory, FDI and international trade can be complements.

Many scholars have explored these issues. Among others, Brainard (1997), Carr *et al*. (1998), and Lipsey *et al*. (2000) argue that FDI and international trade are complements because multinational corporations' FDI pursuing market access advantages increase the sales of their subsidiary companies and also increase the sales and international trade by promoting intermediate material transactions between the head offices and subsidiaries.

Regardless of such theoretical debates, most of the recent empirical studies reveal that FDI does not become a substitute for export, rather become a complement which increases international trade.[1)] These studies commonly emphasize that the result is mainly caused by the active intra-industry trade (hereafter IIT) which is the intermediate materials trade between the local subsidiaries invested by FDI in foreign countries and the head office or associated enterprises**.** While researches on IIT have been active and advanced in Europe, East Asian countries have paid relatively little attention to IIT. In recent years, however, IIT has become an important factor for international trade in East Asia. Various studies place FDI as the most important determinant of IIT in most cases.[2)]

[1)] See OECD (1999, 2007), Lee (2002), Joshua and Ilan (2005) for more information on the complementary role of FDI in international trade.

[2)] Refer to Hu and Ma (1999), Fukao *et al*. (2003), Ando (2006), Xing (2007) and Cho (2008).

Previous studies argue that the proportion of IIT in the international trade of Japan and Korea with China and ASEAN has increased because FDI flows have been one of the important determinants of increasing IIT. Furthermore, they argue that FDI of Japan and Korea to East Asia has the characteristic of process division which induces active intermediate goods trade. If this hypothesis is correct, it would indicate that the characteristics of IIT in East Asia are quite different from the horizontal intra-industry trade (hereafter HIIT) in Europe which is targeting for differentiating the products based on various preferences in similar income levels within the same industry. That is, IIT in East Asia reflects the fact that advanced East Asian countries including Japan and Korea have been performing intermediate goods trade, so-called vertical intra-industry trade (hereafter VIIT) by FDI for the purpose of process division in order to enjoy the lower cost benefits of overseas production. Falvey (1981) also points out that the ratios of input are likely to vary if there is a difference in quality even though goods belong to the same industrial classification. Accordingly, the effect on demand or price of production elements will be different in case of active IIT between two countries.[3)]

Previous studies mainly focus on determinants of IIT and the relationship between the growth and IIT at macro level without distinguishing between the HIIT and VIIT. Moreover, they only discuss the issue at the entire industrial level without classifying major industries in detail. On the other hand, this paper attempts empirical analysis about the impacts of Korea's FDI to China in major industries on VIIT between two countries by subdividing HIIT and VIIT by major industrial levels.

The paper is organized as follows. In section 2, the previous studies about the relationship between FDI and VIIT are briefly reviewed. Section 3 explains the method of IIT measurement, empirical analysis model and data. Section 4 shows current situation of IIT and FDI in major industries between China and Korea and empirically investigates how Korea's FDI to China

[3)] For example, when korea and Japan export capital intensive high quality goods and import unskilled low quality goods from developing countries, the effect on demand or price of production element will be different in two countries.

affects IIT between two countries. Section 5 concludes this study.

2. LITERATURE REVIEW

It is quite difficult to find previous studies which have focused on the relationship between FDI and VIIT, even though various theoretical and empirical researches regarding IIT patterns have been steadily advanced since Grubel and Lloyd (1971). Most previous researches have been focusing on the studies of determinant factors of IIT pattern in order to explain why the traditional international trade theory based on the Hecksher-Ohlin theory have difficulties in explaining an actual phenomenon — "trade occurrence and increase between countries with similar degree for factor endowments". Various empirical studies regarding VIIT patterns have been advanced in mid 1990s after Falvey (1981) introduced the neo-Hecksher-Ohlin-Samuelson model, which is different from the previous HIIT, and developed a new international trade theory based on vertical product differentiation. For instance, Greenway *et al*. (1995), Hu and Ma (1999), Ando and Kimura (2003), Ando (2006), Oh and Ju (2000), Park and Choi (2000), Kim *et al*. (2000), Choi (2002) and Hwang (2007) analyze determinant factors of IIT by distinguishing VIIT from HIIT.[4)]

The main objects of these studies were to analyze the determinant factors of each international trade pattern, and to verify the HIIT patterns as the traditional IIT concept which is essentially different from the VIIT patterns because the character of the VIIT patterns is based on the qualitative difference in products. These studies assert that HIIT is determined by various factors including levels of GDP per capita, GDP scale of trading partners, ratio of manufacturing industry trade to total trade, horizontal product differentiation, market size, and so on, while VIIT is determined by the difference in GDP per capita between trade partners, FDI amount,

4) Arndt (2010) suggests that vertical intra-industry trade changes the behavior of the trade balance relative to traditional patterns involving inter- and horizontal intra-industry trade.

endowment ratio of human capital and so on.

Along with these studies analyzing the determinant factors of IIT, new studies focusing on new interpretations of the roles of IIT patterns and the roles as the variables affecting growth have been steadily advancing. One of such studies is the research on the roles of IIT patterns in the economic growth of each country. The others are the research on the roles of IIT patterns in the substantial growth of international trade. These studies commonly emphasize the roles of IIT patterns as a main functional parameter influencing international trade and industrial structure changes. At first, Krugman (1981) analyzes the roles of IIT patterns in the economic growth of each country. Since then Lundberg and Hansson (1986), Backus and Kehoe (1992), Menon (1997), Menon and Dixon (2000), Leaderman and Maloney (2003) and Lee and Wang (2004) also study on the roles of IIT patterns in the economic growth of each country. However, these studies have some limitations of microscopic analysis — simplified criteria for the interpretation to evaluate the overall level of IIT patterns in each country and a failure to classify IIT patterns in each country in accordance with its unique characters, and a lack of industry analysis in details.

In order to complement such limitations of these studies, some scholars in East Asia including Japan and Korea have recently been advancing the studies focusing on the specific roles of VIIT patterns. Fukao *et al*. (2003) indicates the problems of previous studies on IIT patterns as a whole because each IIT pattern has its own characteristic in accordance with different determining factors. Further, they pay attention to the roles of FDl, how FDI contributes the development of VIIT patterns. Ando and Kimura (2003) and Ando (2006) also consider IIT patterns, mainly VIIT patterns as an important path to the growth of each country, and further assert that this kind of international trade patterns promote the differentiation of production networks from the viewpoint of industrial organization. Also Xing (2007) analyzes the roles of FDI and the changes of China’s IIT with its major trading partners, Japan and the US, and further investigates to what extent FDI promoted IIT. The empirical results show that Japanese FDI in China

performed a significant role in enhancing IIT between Japan and China on the one hand, there was no evidence that the US FDI in China contributed to the growth of the bilateral IIT between the two countries on the other. In Korea, Cho (2008) analyzes the relationship of IIT and FDI between China and Korea in the machine and transportation equipment industry sectors. The empirical results show that Korean FDI to China has a negative impact on IIT. Cho (2008) asserts that such results are probably caused by the special case where Korea simply exports the machinery and transport equipments of large volumes to China.

As explained in the above, previous studies regarding IIT patterns have been mainly advanced to identify determinant factors of IIT patterns, even though such researches have also contributed to identify the characteristics of IIT patterns. In recent years, however, only a few studies divide IIT into HIIT and VIIT, and approach specific industries in details from micro-economic viewpoints. In this regard, this study will observe international trade between China and Korea, classify the manufacturing industry as the representative of the whole specific industries, and divide IIT into HIIT and VIIT in order to examine the effects of FDI on VIIT and to complement such limitations.

The reason why this study pays attention to the relationship between VIIT and FDI is as follows. As suggested by previous studies, if VIIT is the phenomenon caused by the difference in factor endowments, it is expected that VIIT between developing countries and advanced countries will be actively promoted. However, it would be very unusual for a developing country to either possess the required technology or produce goods of the same level as the developed countries do for the exports. Further, it is well acknowledged that the most important path to obtain advanced technologies is FDI flow from advanced countries, and consequently most cases of VIIT between advanced countries and developing countries are probably a part of international division of labor in the production activities by enterprises. In this regard, this empirical study will verify whether such discussion is actually applicable to international trade between China and Korea.

3. EMPIRICAL ANALYSIS AND DATA DESCRIPTION

3.1. Methods of IIT Measurement

Since Grubel and Lloyd (1971) suggested a method to measure IIT for the first time, Grubel-Lloyd Index (hereafter GL Index) has been traditionally a convenient tool to measure IIT. This study also employs GL Index as a tool of analysis. GL Index is expressed as follows.

$$GL = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} = 1 - \frac{|X_i - M_i|}{(X_i + M_i)}. \quad (1)$$

X_i represents export of *i* industry, and M_i represents income of *i* industry. $(X_i + M_i) - |X_i + M_i|$ shows the amount of IIT, which is subtracting $(X_i - M_i)$ showing the trade size of industry *i* from $(X_i + M_i)$ showing the total trade amount of industry *i*. Consequently, GL Index is the IIT friction of total trade in the industry. GL Index is 0 in case where there is no IIT — specialization of IIT, but 1 in case where only IIT is accomplished.[5)]

Since Abd-el-Rahman (1991) introduces a method to measure IIT by dividing into VIIT and HIIT for the first time, Greenway *et al*. (1995) and Fontagne *et al*. (1997) employ the same method as well. This method is based on the assumption that the difference in unit cost of export and import reflects the quality difference in goods of export and import between trading partners. In this regard, if the export-import ratio of unit cost is within the scope of a critical range, the goods is regarded as VIIT goods. On the other hand, if the export-import ratio of unit cost is beyond the critical range, it is regarded as HIIT goods.

Let UV^{ex} and UV^{im} be export price and import price, respectively. We then consider a commodities group as HIIT if 1) $1-\alpha \leq$

[5)] GL Index also has a limitation. GL Index varies with the specificity — of industrial classification e.g., the more specific it is, the smaller the index.

$(UV^{ex}/UV^{im}) \leq 1+\alpha$, and as VIIT if 2) $(UV^{ex}/UV^{im}) < 1-\alpha$ or 3) $(UV^{ex}/UV^{im}) > 1+\alpha$. VIIT is further classified as low-quality vertical intra-industry Trade (LQVIIT) pattern in case of 2) and as high-quality vertical intra-industry trade (HQVIIT) pattern in case of 3).

Most studies including Abd-el-Rahman (1991), Greenaway *et al*. (1995) and Fontagne *et al*. (1997) use critical value α (15%) as a standard for drawing a distinction between HIIT and VIIT. However, we use 25% as a critical value because there is a possibility of excessive estimation when we use SITC 5-digit commodities that include more different characteristic commodities comparing with HS 8-digit commodities using by Fontagne *et al*. (1997).[6)]

3.2. Model of Empirical Analysis

As mentioned the above, the basic theoretical assumption of the relationship between FDI and VIIT is that FDI and the difference in factor endowments are important factors promoting VIIT. Consequently, the hypotheses in this study are tested using the following equation.

$$VIITSH_{jt} = \alpha_0 + \alpha_1 FDICNR_{jt} + \alpha_2 CNINDSH_{jt} + \alpha_3 SIZED_{jt} + \alpha_4 GDPD_i + \varepsilon_{jt}.$$

$VIITSH_{jt}$ represents the shares of VIIT between China and Korea, and subscripts j and t denote a targeted individual industry j and a year t, respectively. The variable $FDICNR_{jt}$ is defined as the ratio of j industry of the sales by Korean-affiliated enterprises in China to the total amount of Korea's FDI to China. As explained above, it is introduced to verify the theoretical assumption that the active activities of production and sales by foreign affiliated enterprises will increase VIIT of the two countries. Although Fukao *et al*. (2003) employs the total sales of Japanese affiliated

6) Previous studies that divided IIT into VIIT and HIIT mostly use 15% or 25% as a critical value. For example, Greenaway *et al*. (1995) use 15% for advanced countries, 25% for developing countries as a standard index and Fontagne *et al*. (1997) use 15%.

enterprises in China by industry, there is no such data for Korea. Therefore, this study employs the amount of Korean FDI in China by industry.[7)]

The variable $CNINDSH_{jt}$ is defined as the ratio of production volume of the target individual industry to the total industries of China. It is introduced to verify the theoretical assumption that the expansion of international trade between the two countries in the specific industry is associated with an increase in the size of the same industry in China. The variable $SIZED_{jt}$ is defined as the difference in industrial size between China and Korea in the target industry. This variable is included in the regression in order to observe the effects of the difference in size of the specific industry on VIIT.

On the other hand, the variable $GDPD_t$ is defined as the absolute value of the difference in GDP per capita between the two countries. As vertical differentiation is explicitly modeled as differences in quality between similar products, it is assumed that the higher quality variety of the differentiated good is produced using relatively capital-intensive techniques in the case where two countries have differential endowments of capital and labor. According to this assumption, relatively capital-abundant country with high income specializes in relatively high-quality manufactures, while relatively labor-abundant country with low income specializes in low-quality manufactures. In this regard, $GDPD_t$, which is defined as the absolute value of the difference in GDP per capita or factor endowments between the two countries, has the character of a substitutive variable.[8)] Considering the difference in GDP per capita and non-linearity relationship with VIIT, some additional models which include $GDPD_t$ squared as an explanatory variable will be also presumed.

[7)] It is assumed that the higher the proportion of investment, the more product and sales activities within the industry.

[8)] The methodology of Xing (2007) is employed in this study in order to obtain the values of variables *SIZED* and *GDPD* ranging from 0 to 1, where $SIZED = 1 + [\{\omega \ln(\omega) + (1-\omega)\ln(1-\omega)\} / \ln 2]$. Therefore, the value should be 0, if there are no differences in industrial size between China and Korea in the industry. In the above formula, ω represents (the product amount of a specific industry in China) / (the product amount of a specific industry in Korea). The value of GDPD follows the same methodology.

3.3. Data

In order to analyze the share of VIIT in total trade (*VIITSH*) between China and Korea, trade data taken from Comtrade of UN are used in this study. Trade data used in this analysis are based on SITC (Standard International Trade Classification) 5-digit Code, and include the amount and volume of the items of export and import. It will be possible to get a unit cost of each export and import items, and consequently to be able to produce the index of HIIT and VIIT.

On the other hand, industrial statistics on FDI flows from Korea to China are taken from 'Current FDI Statistics by Manufacturing Industry Classification' published by the Korea Eximbank. Such FDI statistics include the amounts for investment approvals and the actual investment amounts in accordance with each industry at the KSIC (Korean Standard Industrial Classification). In order to link between trade and FDl, the following 'SITC-KSIC' Code table (table 1), which re-classifies trade statistics with the SITC 5-digit code under the industry classification of KSIC, is prepared. In this regard, this study will analyze the following six industries which are major industries in Korea: 1) Textiles, apparel, shoes 2) Chemistry 3) Basic metals, non-metallic 4) Fabricated metal, machinery, 5) Electronics (including Precision instruments) 6) Motor Vehicles, other Transport equipment. These six industries cover most of the Korea's export and FDI to China. An annual average share of six industries in Korea's export and FDI to China is 84.7% and 88.1% during 1992-2006, respectively.

GDPD represents the difference in GDP per capita based on PPP (purchasing power parity) and is obtained from the World Bank. Further, the production amounts by each manufacturing industry sector in Korea are taken from 'mining and manufacturing industries statistical surveys' published by the Statistics Korea (former Korea National Statistics Office). The production amounts by each manufacturing industry sector in China are taken from the date published by National Bureau of Statistics of China

Table 1 Major Industry and KSIC-SITC Code Matching

Major Industry	KSIC Industry	SITC 3-digit Industry
Textiles, Apparel, Footwear (incl. Fur and Leather)	D17 (Textiles) D18 (Sewn Wearing Apparel, Fur Articles) D19 (Leather, Luggage, Footwear)	611, 612, 613, 651, 652, 653, 654, 655, 656, 657, 658, 659, 831, 841, 842, 843, 844, 845, 846, 848, 851
Chemistry (incl. Rubber and Plastic)	D24 (Chemicals, Chemical Products) D25 (Rubber, Plastic Products)	511, 512, 513, 514, 515, 516, 522, 523, 524, 525, 531, 532, 533, 541, 542, 551, 553, 554, 562, 571, 572, 573, 574, 575, 579, 581, 582, 583, 591, 592, 593, 597, 598, 621, 625, 629
Non-metallic, Basic Metals	D26 (Non-metallic Mineral Products) D27 (Basic Metals)	661, 662, 663, 664, 665, 666, 667, 671, 672, 673, 674, 675, 676, 677, 678, 679, 682, 684, 685, 686, 687, 681, 683, 689
Fabricated Metal, Machinery and Equipment	D28 (Fabricated Metal Products) D29 (Other Machinery and Equipment)	691, 692, 693, 694, 695, 696, 697, 699, 711, 712, 713, 714, 716, 718, 721, 722, 723, 724, 725, 726, 727, 728, 731, 733, 735, 737, 741, 742, 743, 744, 745, 746, 747, 748, 749
Electronics industry (incl. Precision Instruments)	D30 (Computers and Office Machinery) D31 (Electrical Machinery and Apparatuses) D32 (Electronic Components, Radio, Television and Communication Equipment and Apparatuses) D33 (Medical, Precision and Optical Instruments, Watches and Clocks)	751, 752, 759, 761, 762, 763, 764, 771, 772, 773, 774, 775, 776, 778, 812, 813, 871, 872, 873, 874, 881, 882, 883, 884, 885
Motor Vehicles, Other Transport Equipment	D34 (Motor Vehicles, Trailers) D35 (Other Transport Equipment)	781, 782, 783, 784, 785, 786, 791, 792, 793

(www.stats.gov.cn). The period of this analysis is between 1992 and 2006.[9)]

[9)] Only the period between 1992 and 2006 was taken into account for the analysis due to an extensive revision of KSIC (Korea Standard Industry Classification) done in 2007, which complicated matching of the two codes.

4. RESULTS FROM EMPIRICAL ANALYSIS

4.1. Preliminary Review: IIT Pattern between China and Korea

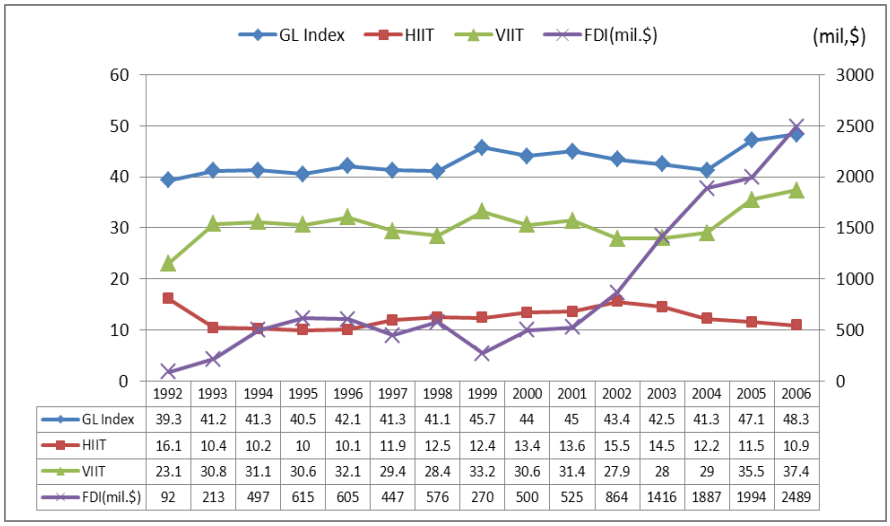
Both table 2 and figure 1 show IIT patterns between China and Korea in six industrial sectors. Observing patterns as a whole, GL Index patterns and VIIT patterns are almost identical and there is a possibility that IIT between China and Korea is reflecting VIIT patterns between the two countries.

Table 2 Trend of IIT and FDI between China and Korea (Total of 6 Industries)

Year	GL Index	HIIT	VIIT	HQVIIT	LQVIIT	GDP per Capita[1] ($)			FDI (Million $)
						China(A)	Korea(B)	(B-A)	
1992	38.8	5.0	22.6	16.9	5.7	1,976	11,160	9,184	92
1993	27.1	4.8	14.1	7.7	6.4	2,227	11,739	9,512	213
1994	29.9	5.5	15.9	11.2	4.8	2,490	12,627	10,137	497
1995	28.2	3.4	19.9	16.3	3.6	2,731	13,589	10,858	615
1996	31.1	4.2	22.4	17.9	4.5	2,973	14,402	11,429	605
1997	39.1	6.1	30.8	27.3	3.5	3,217	14,932	11,715	447
1998	30.9	8.2	18.5	15.7	2.8	3,435	13,808	10,374	576
1999	38.4	4.6	30.5	22.8	7.7	3,661	15,011	11,350	270
2000	42.3	6.4	34.7	28.8	5.9	3,940	16,149	12,209	500
2001	43.6	13.4	27.5	21.9	5.7	4,236	16,647	12,410	525
2002	44.3	8.0	35.9	28.0	7.9	4,591	17,709	13,118	864
2003	39.7	8.5	30.2	23.6	6.6	5,019	18,168	13,149	1,416
2004	43.4	8.9	34.1	29.9	4.3	5,493	18,935	13,443	1,887
2005	53.7	12.0	40.8	37.7	3.1	6,014	19,644	13,629	1,994
2006	50.7	6.9	43.4	38.3	5.1	6,621	20,572	13,951	2,489

Note: 1) PPP (constant 2000 international $), World Bank.

Figure 1 Trend of IIT and FDI between China and Korea (Total of 6 Industries)



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	39.3	41.2	41.3	40.5	42.1	41.3	41.1	45.7	44	45	43.4	42.5	41.3	47.1	48.3
HIIT	16.1	10.4	10.2	10	10.1	11.9	12.5	12.4	13.4	13.6	15.5	14.5	12.2	11.5	10.9
VIIT	23.1	30.8	31.1	30.6	32.1	29.4	28.4	33.2	30.6	31.4	27.9	28	29	35.5	37.4
FDI(mil.$)	92	213	497	615	605	447	576	270	500	525	864	1416	1887	1994	2489

The IIT/Trade ratio between China and Korea has been between 40% and 50% since 1992. The detailed observation shows such trends that the ratio was steady around 40% between the period of early and mid 1990s, suddenly reaching the pick around 50% in 1999, then slowly decreasing until 2004, and recently slowly increasing again. The whole analysis of IIT also shows that the shares of VIIT are always much higher than that of HIIT, and subsequently VIIT between China and Korea leads IIT between two countries.

On the other hand, FDI from Korea to China slowly increased from early 90s until 1998, then suddenly dropped in 1999, and again has rapidly been increasing since 2000.[10] The study pays attention to the tendency that VIIT has been increasing since 2002 in accordance to recovery and increase of FDI since 2002, while HIIT has been decreasing after the peak (15.5%) in 2002. This tendency suggests the fact that an increase in FDI is closely associated

[10] Rapid decrease of FDI in 1999 seems to be related with financial crisis in 1997. Temporary reduction in direct investment reflected that many companies were restructured after the financial crisis and survival companies also confronted financial restructuring.

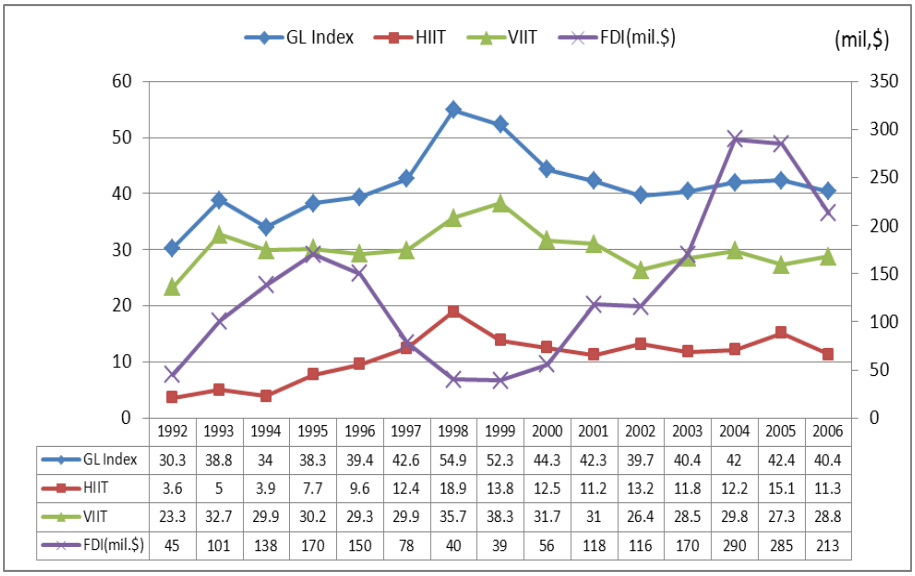
with an increase in VIIT. Although it is difficult to observe these features in 90s, there is a possibility to confirm the relationship between FDI and VIIT by way of empirical analysis.

The figures from figure 2 to figure 7 show the changing tendency of IIT and FDI in six industry sectors. Considering the shares of VIIT and HIIT in six industry sectors, VIIT has a higher position than HIIT in all industries except non-metallic and basic metals industry. However, unlike total of these six industrial sectors, some sectors show no such clear indication or tendency of decreasing HIIT and increasing VIIT since 2000 as this study shows. For instance, the chemistry sector shows that there is a clear tendency of increasing HIIT and decreasing VIIT since 2000. Further, the non-metallic and basic metals industry sector also shows that HIIT has been steadily increasing since 2000, except only 2006. On the other hand, other industrial sectors including textiles industry, fabricated metal and machinery industry, and electronics sector show that there is a tendency of increasing VIIT and decreasing HIIT.

In the case of the electronics sector, there was no big fluctuation of HIIT until the end of 90s. However, HIIT has been rapidly decreasing, while VIIT has been rapidly increasing since 2000. This tendency suggests that the vertical difference in electronics industry has been substantially advancing since 2000. Further, in case of the motor vehicles and other transport equipment industry, as VIIT occupies the most of IIT, both IIT and VIIT have almost the same pattern. Considering the above, the trends and patterns of IIT and FDI between China and Korea are different from industry to industry and reflect its own characters of each industry.[11] In this regard, without empirical analysis of FDI and VIIT between China and Korea, it would be difficult to predict in advance the impact of FDI on VIIT between overall Korean and Chinese industries.

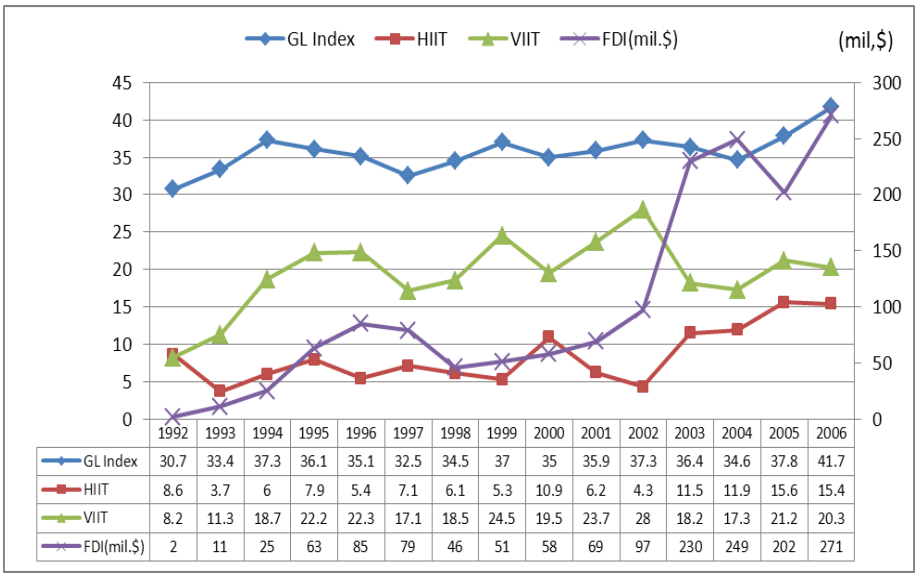
[11] Greenaway *et al*. (1995) show that the scale of VIIT and HIIT depend on the characteristic of individual industry using the U.K. data.

Figure 2 Trend of IIT and FDI between China and Korea (Textiles)



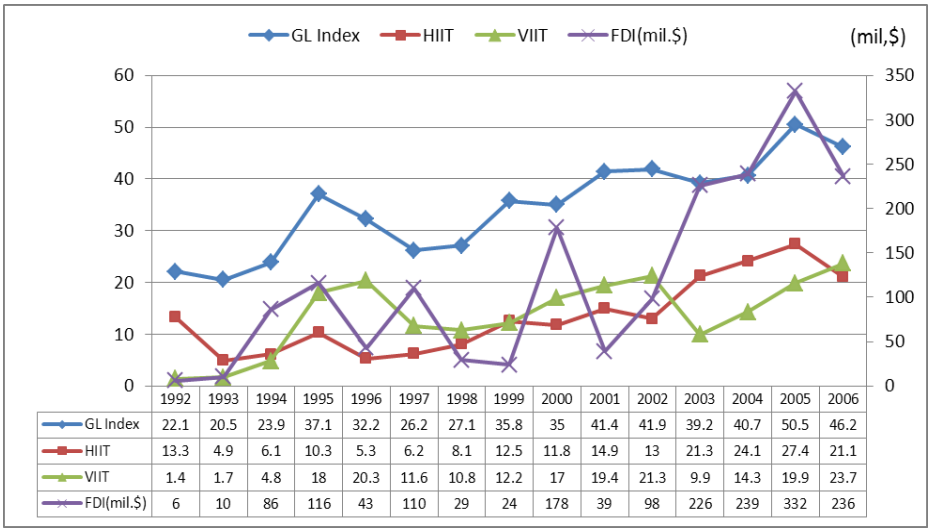
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	30.3	38.8	34	38.3	39.4	42.6	54.9	52.3	44.3	42.3	39.7	40.4	42	42.4	40.4
HIIT	3.6	5	3.9	7.7	9.6	12.4	18.9	13.8	12.5	11.2	13.2	11.8	12.2	15.1	11.3
VIIT	23.3	32.7	29.9	30.2	29.3	29.9	35.7	38.3	31.7	31	26.4	28.5	29.8	27.3	28.8
FDI(mil.$)	45	101	138	170	150	78	40	39	56	118	116	170	290	285	213

Figure 3 Trend of IIT and FDI between China and Korea (Chemistry)



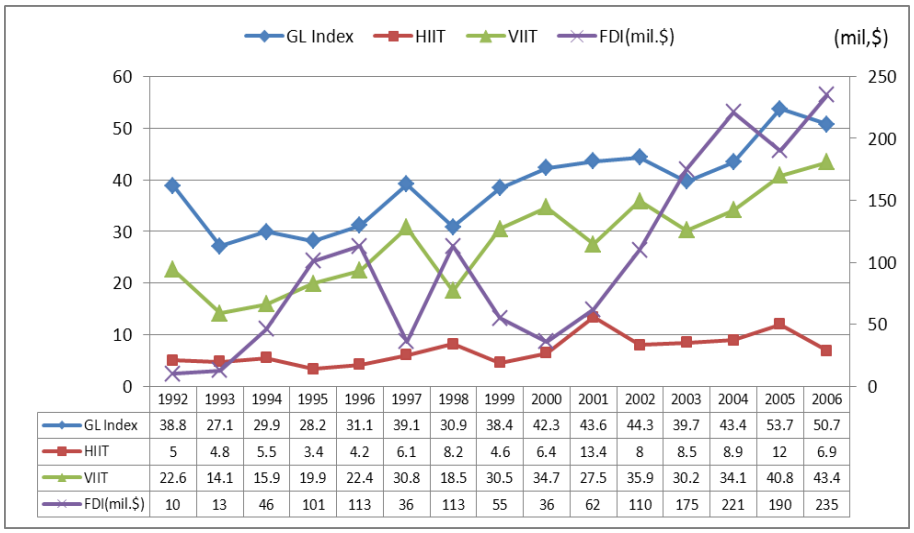
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	30.7	33.4	37.3	36.1	35.1	32.5	34.5	37	35	35.9	37.3	36.4	34.6	37.8	41.7
HIIT	8.6	3.7	6	7.9	5.4	7.1	6.1	5.3	10.9	6.2	4.3	11.5	11.9	15.6	15.4
VIIT	8.2	11.3	18.7	22.2	22.3	17.1	18.5	24.5	19.5	23.7	28	18.2	17.3	21.2	20.3
FDI(mil.$)	2	11	25	63	85	79	46	51	58	69	97	230	249	202	271

Figure 4 Trend of IIT and FDI between China and Korea (Non-metallic, Basic Metals)



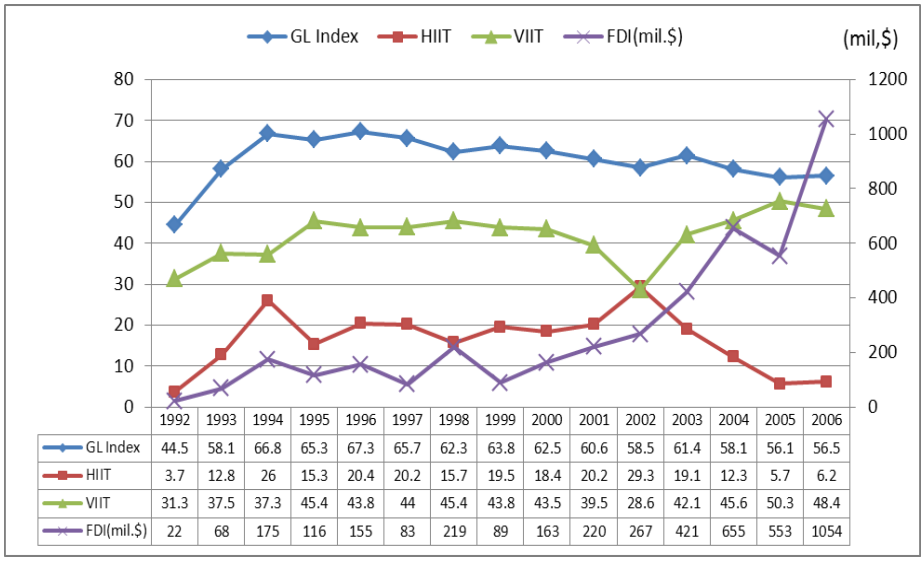
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	22.1	20.5	23.9	37.1	32.2	26.2	27.1	35.8	35	41.4	41.9	39.2	40.7	50.5	46.2
HIIT	13.3	4.9	6.1	10.3	5.3	6.2	8.1	12.5	11.8	14.9	13	21.3	24.1	27.4	21.1
VIIT	1.4	1.7	4.8	18	20.3	11.6	10.8	12.2	17	19.4	21.3	9.9	14.3	19.9	23.7
FDI(mil.$)	6	10	86	116	43	110	29	24	178	39	98	226	239	332	236

Figure 5 Trend of IIT and FDI between China and Korea (Fabricated Metal, Machinery)



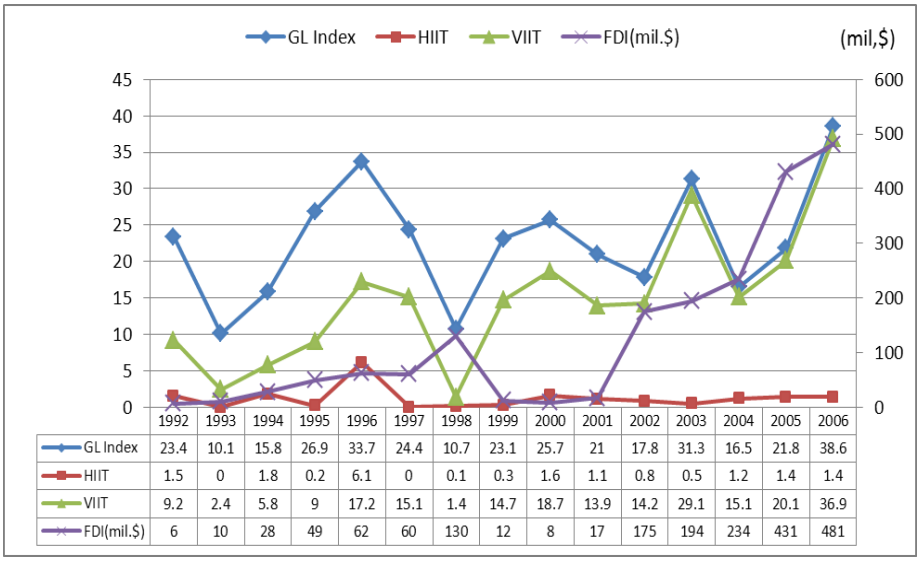
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	38.8	27.1	29.9	28.2	31.1	39.1	30.9	38.4	42.3	43.6	44.3	39.7	43.4	53.7	50.7
HIIT	5	4.8	5.5	3.4	4.2	6.1	8.2	4.6	6.4	13.4	8	8.5	8.9	12	6.9
VIIT	22.6	14.1	15.9	19.9	22.4	30.8	18.5	30.5	34.7	27.5	35.9	30.2	34.1	40.8	43.4
FDI(mil.$)	10	13	46	101	113	36	113	55	36	62	110	175	221	190	235

Figure 6 Trend of IIT and FDI between China and Korea (Electronics)



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	44.5	58.1	66.8	65.3	67.3	65.7	62.3	63.8	62.5	60.6	58.5	61.4	58.1	56.1	56.5
HIIT	3.7	12.8	26	15.3	20.4	20.2	15.7	19.5	18.4	20.2	29.3	19.1	12.3	5.7	6.2
VIIT	31.3	37.5	37.3	45.4	43.8	44	45.4	43.8	43.5	39.5	28.6	42.1	45.6	50.3	48.4
FDI(mil.$)	22	68	175	116	155	83	219	89	163	220	267	421	655	553	1054

Figure 7 Trend of IIT and FDI between China and Korea (Motor Vehicles, Transport Equipment)



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GL Index	23.4	10.1	15.8	26.9	33.7	24.4	10.7	23.1	25.7	21	17.8	31.3	16.5	21.8	38.6
HIIT	1.5	0	1.8	0.2	6.1	0	0.1	0.3	1.6	1.1	0.8	0.5	1.2	1.4	1.4
VIIT	9.2	2.4	5.8	9	17.2	15.1	1.4	14.7	18.7	13.9	14.2	29.1	15.1	20.1	36.9
FDI(mil.$)	6	10	28	49	62	60	130	12	8	17	175	194	234	431	481

4.2. Results of Empirical Analysis

Table 3 and 4 show that the results of panel analysis for six industries. In accordance with the results from empirical analysis, *FDICNR*, *CNINDSH* and *SIZED* have a positive relationship with *VIITSH* and the relationship becomes statistically significant at the 1% level. On the other hand, *GDPD* representing the difference in GDP per capita (namely, the difference in factor endowments) has a negative relationship with VIIT at the level of 5% statistical significance. This result conflicts with the assumption of this study that an increase of the difference in GDP per capita is associated with an increase of the ratio of VIIT. We next consider the quadratic form of *GDPD* to capture a possible non-linear relationship. The coefficient of $GRDP^2$ is negative and significant at the 1% level, implying that beyond a certain level of *GDPD* there exists a positive relationship between the difference in GDP per capita and the ratio of VIIT.

Although above results are identical with those of Fukao *et al*. (2003) but they are not in line with the results of Fontagne *et al*. (1997) who analyze the EC market. Further, Fukao *et al*. (2003) predicts that GDP per capita difference between two trading nations bears no positive relationship with VIIT when the difference is below $10,000 (with PPP applied), although it does positively affect the significance of VIIT in terms of nations' total trade in case where the difference is above $10,000 (with PPP applied). However, the assumption of Fukao *et al*. (2003) is not necessarily applicable to this study because the empirical analysis effectively shows that the difference in GDP per capita has a negative relationship with VIIT, albeit the GDP per capita difference between China and Korea has been over $10,000 since 1994. Although difficult to affirm, such a negative relationship is probably caused by using the difference in GDP per capita, which is entirely irrelevant to the characters of each industrial sector, as an alternative macroscopic variable presenting the difference in factor endowments in each industrial sector. In theory, the difference in capital intensity of each industrial sector is required to reflect the difference in factor endowments for each industrial sector but

Table 3 Estimation Result of Panel Data

Variables	Coefficient	Std. Error	*t*-Statistics	Prob.	R^2
FDICNR	0.0931	0.3133	(2.9737)***	0.0038	0.16
CNINDSH	0.6990	19.2968	(3.6225)***	0.0005	
SIZED	0.4793	15.8751	(3.0195)***	0.0033	
GDPD	–0.7255	30.9244	(2.3461)**	0.0213	

Notes: 1) ***, **, *: significant at the 1%, 5%, and 10% level, respectively. 2) *t*-Statistics are in absolute value.

Table 4 Estimation Result of Panel Data with GDPD Squared

Variables	Coefficient	Std. Error	*t*-Statistics	Prob.	R^2
FDICNR	0.0083	0.0031	(2.7308)***	0.0077	0.21
CNINDSH	0.5686	0.1609	(3.5324)***	0.0007	
SIZED	0.3917	0.0930	(4.2089)***	0.0001	
$GDPD^2$	–1.1317	0.3450	(3.2796)***	0.0015	

Notes: 1) ***, **, *: significant at the 1%, 5%, and 10% level, respectively. 2) *t*-Statistics are in absolute value.

such data are not available in China. As the results from the previous studies also report the relationship between the GDP per capita difference and VIIT to be either negative or positive without much consistency, more researches in this field are expected in the future.

After considering all the factors above, it is possible to reach the following conclusions: Namely, 1) in the case of international trade and investment between China and Korea, the ratio of the production volume in China to China's inward FDI from Korea in the specific industry sector will become higher, the greater VIIT in the corresponding industry sector. 2) there is a tendency that an increase in the size of the corresponding industry in the investment local country (China) is also associated with an increase of VIIT. Further, 3) there is a tendency that the growth of the difference in the

corresponding industry between China and Korea will increase the difference in VIIT. The above conclusions from empirical analysis are identical with the hypothesis of this study. However, 4) the results from this empirical study cannot support the hypothesis that there is a tendency where the growth of the difference in GDP per capita, namely the difference in factor endowments is associated with an increase in IIT with qualitative difference (namely, VIIT).

5. CONCLUSIONS

Recent trend is that IIT becomes a new pattern of international trade in various countries around the world. IIT especially plays a more important role in the specific regions including the EC, where international trade within a corresponding industrial sector increases as the economic integration pursues. These interests are reflected in the recent studies, mainly in the EU, which have actively developed to focus on HIIT on the grounds of various preferences on the similar income levels and the differentiated products with different characters. However, IIT and especially VIIT, where there is the qualitative difference in trade products, have been recently attracting attention due to the trend of increasing volumes of FDI along with the globalization.

As most of FDI by multinational corporations plays a key role in the fragmentation of production processes, it is likely to be a background on the increase of VIIT. Over the past few decades, FDI from developed countries including Korea and Japan into East Asian developing countries has been rapidly increasing, and subsequently IIT, especially VIIT has also been rapidly increasing in East Asia. However, most researches regarding IIT patterns have focused on the basis of how to identify determining factors of IIT patterns mainly in the regional trade of the EU. Although a few Japanese scholars recently have divided IIT into HIIT and VIIT and analyzed a targeted individual industrial sector from the microscopic perspective, their

studies are limited to some specific industries only.

This study conducted empirical analysis in order to supplement such limitations. This study targeted international trade between China and Korea, classified manufacturing industry into typical individual industries, and divided IIT into HIIT and VIIT. This study also analyzed how several factors including FDI from Korea to China, industrial scale of China, industrial gap between the two countries, and difference in factor endowments (difference in GDP per capita) affect VIIT.

This study attempted empirical analysis of panel data on six manufacturing industries of textiles, chemistry, basic metals, machinery, electrics, and auto industry. The estimation results confirm that VIIT between China and Korea increases, in cases where (1) the ratio of FDI from Korea to production volume of corresponding industry in China is higher; (2) industrial scale of corresponding industries in China is larger; or (3) industrial gap between China and Korea is greater. However, contrary to the prediction of this study, the difference in GDP per capita (namely difference in factor endowments) has a negative impact on VIIT according to statistics. Further studies on such relationships are necessary since the previous studies also have documented the conflicting empirical results.

Finally, data constraints limited this study to exclude numbers of variables influencing VIIT — e.g., sales of investment companies in China, accumulating level of human capital between the two countries etc. Further studies complementing such limitations are expected in the future.

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