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Yuqing Xing

Foreign direct investment and China's bilateral intra-industry trade with Japan and the US

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Contents

Yuqing Xing*

Foreign direct investment and China's bilateral intra-industry trade with Japan and the US

Abstract

This paper analyzes dynamic changes of China's intra-industry trade with its major trading partners, Japan and the US, from 1980 to 2004. It also investigates to what extent foreign direct investment promoted intra-industry trade. The empirical results show that, while shares of China's intra-industry trade with both Japan and U.S rose substantially, its intra-industry trade with Japan has reached 35 per cent of the overall trade, considerably larger than 10 per cent with the US. Sino-Japan intra-industry trade concentrated in the electrical and machinery sectors accounted for 52 per cent and 46 per cent of overall trade respectively. On the other hand, it is in the chemical and food sectors where intra-industry trade represented a relatively large proportion of Sino-US trade, 50 per cent and 30 per cent accordingly in each sector. In addition, the analysis indicates that Japanese direct investment in China performed a significant role in enhancing intra-industry trade between Japan and China. However, it found no evidence that the US direct investment in China contributed to the growth of the bilateral intra-industry trade between the two countries.

JEL:F14, F23
Key Words: Intra-industry trade, FDI, China

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Yuqing Xing

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Tiivistelmä

Tässä tutkimuksessa käsitellään Kiinan sekä Japanin ja Yhdysvaltojen välisen teollisuusalojen sisäisen kaupan (intra-industry trade) kehitystä vuosina 1980–2004. Aiheena on myös, miten suorat sijoitukset ovat edistäneet teollisuusalojen sisäistä kauppaa. Kiinan teollisuusalojen sisäinen kauppa sekä Japanin että Yhdysvaltojen kanssa on kasvanut, mutta suhteessa Japaniin se on jo 35 % kokonaiskaupasta, kun taas suhteessa Yhdysvaltoihin ainoastaan 10 %. Kiinan ja Japanin välinen teollisuusalojen sisäinen kauppa on mittavinta elektroniikkateollisuudessa (52 % kokonaiskaupasta) ja koneenrakennusteollisuudessa (46 %). Kiinan ja Yhdysvaltain välillä teollisuusalojen sisäinen kauppa oli suurinta kemianteollisuudessa (50 % kokonaiskaupasta) ja elintarviketeollisuudessa (30 %). Tuloksien mukaan japanilaiset suorat sijoitukset Kiinaan ovat selvästi lisänneet teollisuusalojen sisäistä kauppaa. Yhdysvaltalaisten yritysten suorilla sijoituksilla Kiinaan ei ole ollut vastaavaa vaikutusta.

Asiasanat: teollisuusalojen sisäinen kauppa, suorat sijoitukset, Kiina

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1 Introduction

The fact that China has emerged as the largest country in making toys and exporting textile products in the world should not surprise its trading partners. The rich labor endowment and seemingly unlimited rural labors released from the agriculture sector grant China both comparative and absolute advantages in manufacturing labor intensive products. As its economy is gradually integrated with the world economy, China has naturally evolved as a major exporter in almost all of the categories of labor-intensive products, such as shoes, travel gears, clothes, toys, etc. This phenomenon is exactly what the conventional Heckscher-Ohlin theorem predicts.

If a country specialized in producing low value-added labor intensive commodities forever, free trade would be a curse rather than a blessing for the country. That is actually one of the major suspicions that developing countries have on free trade. In the case of China, the economic integration with the global economy has not only greatly expanded the utilization of its abundant human resources and augmented its specialization in labor intensive productions, but also facilitated the development of its manufacturing capacity into high value-added products, inducing fundamental changes in its trade structure.

According to reports by China's Ministry of Commerce (2005, 2003), China's exports of high-tech goods have experienced rapid growth. In 2002, China exported $67 billion high-tech goods, ranging from computers, mobile phones, biotech products, to aerospace equipments. In 2004, high-tech exports more than doubled that of 2002; jumping to $166 billion (about 28 per cent of China's total exports), representing a significant achievement in high-tech exports. A study released by the OECD (2006) on the global trade of information and communication technology (ICT) products, outlined an even more striking picture. It showed that China has not only been one of the largest ITC importing countries, but also one of the largest ICT exporters. It exported $180 billion ICT products in 2004, exceeding Japan, the European Union and United States; becoming the number one exporter of ICT products in the world.

This paper attempts to analyze the changing trade pattern of China. The analysis focuses on the growth of intra-industry trade (IIT) between China and its major trading partners Japan and US. IIT characterizes simultaneous imports and exports of goods under same industry classifications. Rising share of IIT indicates an increase in product varieties, improved economies of scales in production, and shortened technology gaps with competitors. Even if most of IIT belongs to vertical IIT (which covers simultaneous exchanges of goods in the same categories but different qualities), increased IIT in overall trade still marks the progresses in manufacturing capacity, expanded export capability, increased involvement in global production networks, and the transition in trade pattern.

Additionally, the paper examines factors contributing to the growth of IIT. Particular attention is given to foreign direct investment in China. It has been recognized that foreign invested firms are the major forces driving the fast expansion of China's exports. In 2004, they exported $339 billion, about 60 percent of China's exports (CSB, 2005). In the high-tech products category, foreign invested firms contributed even more, about 87 percent (MOF, 2006). FDI not only boosted China's export growth, but also accelerated the transition of its exports from low value-added to high value-added products. Developing countries usually do not posses the necessary technology to produce high-tech goods. It is the multinational enterprises which bring advanced technology and production know-how into developing countries by green-field FDI, consequently improving production capacities and product varieties of FDI host countries. Furthermore, technology spillovers associated with inflows of FDI also facilitate technological progresses of domestic firms, leading to improvements in production efficiency and product quality. Through alliances with MNEs, domestic firms of developing countries could take advantage of well-established global market distribution systems and recognized brands, which are critical for those firms marketing their products in the global market.

A few empirical studies explored the relationship between FDI and China’s IIT (e.g., Hu and Ma, 1999; Zhan, Witteloostuijn and Zhou, 2005). Essentially, those studies are based on aggregated FDI and cross-country analysis. Effects of FDI on IIT however, depend largely on country, as well as industry specific factors. For instance, domestic market oriented FDI usually function as substitutes of exports from FDI source to host countries. Rising inflows of domestic market oriented FDI reduce, rather than raise bilateral trade between FDI source and host countries. In other words, such FDI contribute very little to the growth of IIT. As a matter of fact, the estimates show that, while one third of trade between China and Japan belongs to IIT, intra-industry trade accounted for only 10 per cent of Sino-US trade, in spite of the fact that the US is China's largest trading partner and one of the largest FDI investors. Moreover, FDI in labor-intensive sectors such as textiles, where China has already specialized, generally intensify the specialization, thus mitigating the bilateral intra-industry trade between China and its trading partners, which are the sources of FDI in those sectors. The estimate demonstrates that only 7 percent of the bilateral trade between China and Japan in textile consisted of intra-industry trade; less than half of that in 1980, despite the fact that China's textile sector is one of Japan's largest host of FDI in the manufacturing sector.

This study investigates the development of the bilateral intra-industry trade between China and the US separately. Additionally, it looks into the issue of major manufacturing sectors and applies sectoral FDI data, rather than aggregated ones, to explore the plausible impact of FDI on IIT. The remainder of the paper proceeds as follows. Section 2 provides a brief review on FDI and China's bilateral trade with Japan and the US, while section 3 reviews the literature on the relationship between FDI and IIT. Section 4 estimates IIT indexes for overall trade; trade in manufacturing, as well as six major manufacturing subsectors from 1980 to 2004. Section 5 econometrically analyzes the impact of FDI on IIT. The analysis emphasizes the difference between Japanese and US FDI in terms of how it affects their bilateral intra-industry trade with China. The final section summarizes major findings of the paper.

2 A brief review of China's trade and FDI with Japan and the US

2.1 Sino-Japanese trade and FDI

Sino-Japan trade has risen sharply over the last few years. According to the Japan External Trade Organization (JETRO) (2006), the bilateral trade between the two countries grew 12.7 per cent and reached a new record $189 billion in 2005. Of this amount, China's imports from Japan surged by 8.9 percent to $80.4 billion, while its exports rose 15.7 percent and amounted $109 billion, toping the $100 billion mark for the first time, due to strong IT-related demand from Japan.

The growth of China's exports to Japan has no longer depended on textile related products. Instead, information technology related products have led this growth. The exports of personal computers, printers and other office equipments rose 19 percent, and digital mobile music players and other audio/visual equipment 28.7 percent. It is noteworthy to emphasize that Japan's exports to China in visual apparatuses including digital cameras and home video cameras surged 167 percent. The extensive exchanges of visual apparatuses products between China and Japan unequivocally represent a form of intra-industry trade. Similarly, the two way trade in steel product is also evident. While China's import of steel from Japan rose 15.7 percent because of its booming construction sector, its export of steel to Japan grew even higher, and jumped 27.6 percent. Japanese invested firms in China performed a critical role in promoting the two way trade. The surge of Japan's imports from China in steel, semiconductor and electronic parts and scientific/optical equipment was partially triggered by the rising "reverse imports" of Japanese affiliated manufacturers in China.

China has replaced ASEAN-4 (Indonesia, Malaysia, the Philippines and Thailand) in becoming the largest destination of Japanese FDI in Asia (Xing and Wan, 2006). In 2005, Japanese MNEs invested $6.53 billion directly in China, making Japan the third largest investor in China. Traditionally, Japan’s Asia-bound investment has concentrated in manufacturing and its investment in China is no different. Table one summarizes cumulative Japanese direct investment in China by major manufacturing sectors. The data do not include the reinvestment by existing Japanese affiliated manufacturers. The Japanese electrical industry has been the leader in engaging on FDI in Asia. It also takes the lead in China. According to Table 1, among the manufacturing sectors, Electrical ranked number one, with a cumulative investment of 617 billion Yen in China by the end of 2004. Transportation equipment is the second largest sector in terms of direct investment from Japan. Before the early 1990s, the scale of Japanese direct investment in transportations equipment was relative small. The cumulative FDI in the sector was the smallest among all manufacturing sectors. After China joined the WTO, the lucrative auto-market in China attracted a tide of FDI from Japan. Major Japanese auto makers such as Toyota, Honda, and Nissan have accelerated their expansions in China. They have substantially increased direct investment for the expansion of production capacities catering to the fast growing local market. Machinery is the third largest section with 314.8 billion Yen of cumulative investment by 2004.

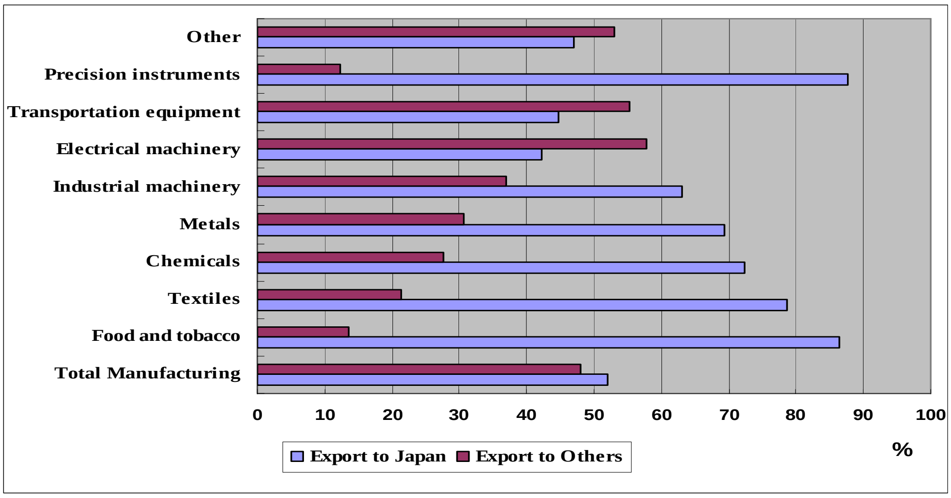
Table 1 Cumulative Japanese FDI in China (Million Dollars)

Sectors	1984	1992	2004
Food	9.6	129.8	1,300.4
Textile	1.2	263.6	2,283.0
Chemical	6.5	100.8	1,929.2
Metal	1.4	96.0	2,117.0
Machinery	1.0	213.8	3,023.3
Electrical	1.2	611.3	5,923.5
Transportation Equipment	0.6	51.7	4,609.4

Source: Calculated by the author based on inward FDI from the Japanese Ministry of Finance. The data does not include the re-investment by existing Japanese affiliated firms in China.

Using China as an export platform is one of the major motivations Japanese multinational enterprises invest in China. Investing in China, Japanese MNEs are able to strengthen their global competitiveness by combining China's low production costs together with their superior technology, brand recognition, and global distribution networks. According to a JETRO survey (2003), 61.6 percent of Japanese firms operating in China exported at least 70 percent of their products. In 2001, Japanese affiliated manufacturers in China as a whole sold 65 percent of their products in overseas markets (Xing, 2006). Another unique practice of Japanese affiliated manufacturers is their extensive involvement in "reverse imports"--exporting their products back to Japan.

Figure 1. Export destination of Japanese affiliated manufacturers in China:



Source: Calculated by the author based on the data from quarterly survey of business activities (2004), METI

Figure one breaks down overseas sales of Japanese affiliated manufacturers into the Japanese market, and non-Japanese market. According to the figure, on average, more than 50 percent of exports by Japanese subsidiaries headed for Japan. In the sector of precision instrument, almost 90 percent of the overseas sales were made in the Japanese domestic market; in the chemical sector, more than 70 percent, and in industry machinery, more than 60 percent. The significant ratios of the sales in the Japanese market suggest that serving Japanese markets is one of the major objectives for Japanese MNEs investing in China. As aforementioned, those products exported back to Japan by Japanese affiliates belong to the product categories which comprise China's major imports from Japan. Therefore, "reverse imports" contribute directly to the growth of the bilateral intra-industry trade between the two countries.

2.2 Sino-US trade and FDI

Sino-US bilateral trade soared from $7.7 billion to $284 billion from 1985 to 2005, making China the third largest trading partner of the US, just after Canada and Mexico. Meanwhile, the US has become China's largest trading partner and the largest exporting market. During the same period, China's exports to the US jumped from $3.9 billion to $243.5 billion, while US exports to China rose from $3.9 to $41.9 billion. The sharp imbalanced growth in exports and imports between the two countries gave rise to a huge trade deficit of $201.5 billion borne by the US in 2005 (US Census Bureau).

While China remains a leading exporter of apparel, footwear, and other labor-intensive products to the US, in recent years the most drastic increases in China's exports to the US have been in high-tech products, such as office machinery and electrical equipment. Between 1999 and 2004 for instance, China's exports of office and data processing machines to the US surged by 331 percent. The growth was so rapid that total exports of those products in 2004 amounted $35.3 billion; surpassing the US' entire year's exports of $34.7 billion to China. The exports of telecommunications and sound equipment, electrical machinery and appliances, and road vehicles also surged sharply, increasing 229 percent, 116 percent and 253 percent respectively (Lum & Nanto, 2006).

Table 2 Cumulative the US FDI in China (million dollar)

Sectors	1989	1992	2004
Food	10	69	593
Chemical	27	93	1,643
Metal	2	-3	149
Machinery	21	14	455
Electrical	10	13	493
Transport	na	na	1,832

Sources: Calculated by the author based on various issues of survey of current business.

Even though the US is one of the largest sources of foreign direct investment in China, compared with Japan, the scale of FDI from the US is relatively smaller. In 2005, US FDI in China amounted to $3.06 billion, less than half of the direct investment from Japan. Table 2 lists the stocks of the US FDI in China's major manufacturing sectors. Compared with the positions of Japanese MNEs summarized in Table 1, US FDI in those sectors are substantially lower. Moreover, unlike Japanese FDI, US FDI is domestic market oriented, and is a means of accessing the Chinese market rather than using it as an export platform (Gill & Tay, 2004). According to the Government Accountability Office (2003), in 2003 the US affiliates in China sold about 75 percent of their products in China, and 25 percent in overseas markets. Of the total exports, only 7 percent were exported back to the US. In 2004, the sales of US affiliates in China reached $38 billion, even larger than the total US exports to China $34.7 billion (US GAO, 2005). Hence, the contribution of the US affiliates in China to the bilateral trade is rather limited. Bottelier (2003) estimated that only 13 to 15 percent of China's exports to the US originated from the U.S firms in China, and most of the remaining share could be attributed to other Asian firms operating in China. Some authors even argued that the US exports to China might have been retarded by the outflow of US FDI, evidenced by the substantially large amount of local sales through US affiliates in China (Bottelier, 2003; Stanley, 2002).

3 Review of the literature

Intra-industry trade is traditionally considered as a phenomenon between two similar trading partners such as industrialized countries. Countries with substantial differences in factor endowments, income level, and technology, are assumed mainly to engage on inter-industry trade, which is trading different commodities. Helpman and Krugman (1985) demonstrated that the scale of IIT depends on relative factor endowment, and the size of the two trading economies. In particular, high degrees of similarity in factor endowment and a small gap in income levels facilitate the development of intra-industry trade. In the early work of Gruble and Lloyd (1975), in which the quantitative measurement of IIT was proposed, they showed that a high proportion of IIT existed between industrialized countries. Greenway and Milner (1986) also found that IIT was prevalent between countries with little variations in factor endowments and factor prices.

On the other hand, associated with an integration of the global economy, intensified FDI, and outsourcing activities by multinational enterprises, intra-industry trade between developing and developed countries have expanded extensively. Hellvin (1996) revealed that China's intra-industry trade with the OECD rose to 20 percent by the middle of 1990s, after China adopted an outward-looking development policy, and most of IIT fell into SITC 5-7 product categories. According to Clark and Stanley (1999), more than 50 percent of trade in manufactured commodities between the US and 155 developing countries and territories comprised IIT. In a study on intra-industry trade between EU and ASEAN in the high-tech industry, Andreoss-O' Callaghan and Bassino (2001) concluded that, in human capital and technology-intensive sectors, intra-industry trade between the EU and ASEAN countries have risen substantially since the 1980s. Most of the growth in the overall trade is attributed to the increase in intra-industry trade, rather than inter-industry trade.

Foreign direct investment has been the focal point in the literature investigating the proliferation of intra-industry trade between structurally different economies. Expansions of intra-firm trade associated with rising global FDI is regarded as one of the major factors driving intra-industry trade growth between FDI source and host countries. Intra-firm trade between parent firms and their foreign affiliates usually fall into same industry categories because of specific capital and technology available in both parent firms and their foreign affiliates. By analyzing US imports shipped by overseas affiliates to their U.S parents, and the US imports shipped to the US affiliates by foreign parents, Antras (2003) found that the US intra-firm imports are particulary active between the US and Latin American countries. Using Japanese MNEs as an example, Wakasugi (1997) argued that rising share of IIT within Asian countries was largely induced by Japanese FDI, by which intra-firm transaction networks between parent companies and their foreign affiliates have been built up. Japan has become a center of the fragmentation of production process in East Asia, and trade in parts and components plays an important role in Asian trade (Ng and Yeats, 2003). Furthermore, Japanese MNE affiliates in China and ASEAN-4 not only export a substantially high share of their products, but also engage on extensive "reverse imports", contributing directly to the two-way trade in commodities belonging to same categories (Xing and Zhao, 2003). Empirical evidence supporting the causal relationship between FDI and IIT can also be found in Hu and Ma (1999), Zhang et.al. (2005), etc.

Additionally, FDI actually increases the number of product varieties that host countries are able to produce. Specific technology and capital transmitted via FDI generally enlarge production capacities and product varieties of host countries. For instance, SONY's subsidiaries in China can produce SONY branded products, which can be sold in the global market and compete with products that belong to the same categories but different brands. Without outsourcing/FDI from SONY, it is impossible for China to do so. Technology spillovers, a positive externality of FDI inflows, upgrade qualities and varieties of domestic firms and enhance the competitiveness of those firms in the global market; thus augmenting intra-industry trade. Technology transfers from parent firms to their foreign affiliates mitigate technology gaps between the two, and facilitate intra-firm trade, consequently stimulating intra-industry trade between FDI host and source countries (Okubo, 2004).

Given that FDI could potentially enhance IIT, high FDI costs may prevent developed countries from conducting vertical IIT with developing countries (Fukao, et.al., 2003). In addition, a critical assumption on the causality of FDI and intra-industry trade is that FDI is export oriented, and a means of efficiency improvement production. Domestic market oriented FDI generally substitute exports and reduce trade volume between FDI source and host countries; consequently contributing little to the development of intra-industry trade.

4 The development of China's bilateral intra-industry trade with Japan and the US

This section applies numerical measures to evaluate the evolution of China's intra-industry trade with Japan and the US in major manufacturing sectors from 1980. In the empirical studies on intra-industry trade, the level of IIT in an industry is usually quantified by the

Grubel and Lloyd index (1975). We follow the same fashion in this study. The index of IIT in an industry is generally defined as

$$IIT_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \times 100 \tag{1}$$

where X_i and M_i represent exports and imports in the industry respectively. The value of the index ranges from 0 to 100, where 0 indicates complete inter-industry trade and 100 implies complete intra-industry trade. To calculate IIT across industries or product groups at a given level of aggregation, Grubel and Lloyd further suggested the following weighted average intra-industry index:

$$IIT_i = \frac{\sum_{j=1}^{n}(X_{ij} + M_{ij}) - \sum_{j=1}^{n}|X_{ij} - M_{ij}|}{\sum_{j=1}^{n}(X_{ij} + M_{ij})} \times 100 \tag{2}$$

where j denotes the sub-industry/sub-product category within industry *i* and *n* is the total number of the sub-categories.

Following the weighted IIT defined in equation (2), I first calculated China's bilateral IIT indices with Japan and the US for all traded commodities and manufacturing products as a whole, for the period between 1980 and 2004. The calculation is based on three digits standard international trade classification (SITC). Specifically, I estimated time series of IIT indexes for all traded commodities SITC 0-9 as a whole and for manufacturing products SITC 5-8 as a sub-group. Table 3 reports the indexes for selected years. According to the results, in 1980, intra-industry trade between China and Japan accounted for merely 5.6 percent, and between China and the US, 4 percent. China's intra-industry trade in manufacturing with both countries was relative high, but still lower than 10 per cent. The extremely low level of intra-industry activities suggest that the bilateral trade between China and its major trading partners was mainly in the form of exchanging different products. The trade patterns were largely determined by comparative advantages determined by the differences in factor endowments and technology gaps.

Associated with deepened economic integration between China and Japan, the intra-industry trade between the two countries developed steadily. The share of overall IIT rose to 18 percent in 1992, and further jumped to 34 percent in 2004. It is noteworthy that the share of IIT was even higher in the manufacturing industry (SITC 5-8), and rose to 36 percent in 2004. The rising weight of IIT in Sino-Japan trade indicates that the trade pattern between the two economies has experienced significant transformation, going from simply exchanging different products to exchanging more and more similar ones.

While the intra-industry trade between China and the US also grew during the period, the magnitude of the growth is much smaller compared with that of Sino-Japan trade. In 2004, the IIT between China and US accounted for merely 9 percent of the overall trade, and 15 percent of trade in manufacturing products. The US has run a trade deficit with China since 1983. The trade deficit reached 162 billion USD in 2004. Generally trade deficit causes biases in the calculation of IIT indexes and tends to inflate the indexes. Given the huge trade deficit between China and the US, the actual intra-industry trade might be even lower than showed by the estimated indexes. The small proportion of IIT in Sino-US trade implies that the trade pattern between China and the US is mainly dominated by inter-industry trade. Most of the growth in trade between the two economies during the last two and half decades was attributed to the growth of inter-industry trade. The economic integration between the two economies actually intensified the specializations between the two economies. Differences in resource endowments and technology still perform a fundamental role in shaping trade patterns between the two countries.

Table 3 China's bilateral intra-industry trade with Japan and the US

	SITC 0-9		SITC 5-9	
Sectors	Japan	US	Japan	US
1980	5.6	4.0	8.2	8.3
1992	18.0	9.9	22.3	9.7
2004	34.2	9.7	36.2	15.5

Source: Calculated by the author based on three-digit SITC level from U.N. COMTRADE

For further examining the industrial characteristics of IIT, sectoral IIT indexes were computed for six manufacturing industries: food (SITC 001-098), chemical (SITC 511-598), metal (SITC 671-699), machinery (SITC 711-764), electrical (SITC 771-778) and transportation (SITC 781-793). Table 4 summarizes the results. Unambiguously, there is a wide variation in the degree of IIT across sectors. Of the six sectors, intra-industry trade in electrical is the most extensive in Sino-Japanese trade. It is the only sector in which intra-industry trade reached 52 percent, exceeding the share of inter-industry trade by 2004. In fact, in the early 1980s, intra-industry trade did not exist in the sector, and China was a purely importer of electrical products. According to our estimates, IIT in the sector rose rapidly and it surpassed the 50 percent mark in 1992. The rapid development of intra-industry trade in the sector paralleled with the inflows of Japanese direct investment in the sector. Electrical has consistently ranked number one in terms of direct investment from Japan since China opened up to foreign investment. It is in the industry that Japanese MNEs have established extensive production networks within Asia. The IIT of machinery accounted for 46 per cent of the trade in the sector in 2004, 25 percentage points higher than that in 1992. It is also the sector where IIT did not exist at all in early 1980s. The intra-industry trade in chemical sector has been around one third of the total trade. The relative high share of IIT in chemical in the early 1980s might be due to trade in petroleum and its related products. IIT in metal and transportation sectors also experienced substantial increase from less than one percent to 35 percent and 21 percent respectively during the period.

The pattern of the bilateral intra-industry trade between China and the US differs with that of Sino-Japan trade substantially. Compared with Japan, the percentage of intra-industry trade in electrical and machinery are relatively low. For instance, intra-industry trade represents only about 27 of trade in electrical. Unlike other sectors in which IIT grew steadily, the share of IIT in machinery fluctuated during the period. It rose to 33 percent in 1992 from a mere 5 percent in 1980, but dropped to 16 percent in 2004. Chemical is the sector in which intra-industry experienced rapid growth and rose from 16 percent to 49 percent from 1980 to 2004. IIT in food accounted for 31 per cent, the second highest among all the sectors.

Table 4 China's bilateral IIT with Japan and the US in selected manufacturing sectors

	Sino-Japan			Sino-US		
Sectors	1980	1992	2004	1980	1992	2004
Food	0.49	1.69	7.54	0.06	6.07	30.6
Chemical	35.56	41.48	33.56	16.28	26.25	49.05
Metal	0.60	21.96	35.02	17.02	10.28	14.26
Machinery	0.42	21.12	45.72	4.95	33.07	16.06
Electrical	0.63	50.41	51.79	17.88	13.75	26.79
Transport	0.31	6.75	21.14	0.01	6.2	21.9

Source: Calculated by the authors based on three-digit SITC level from U.N. COMTRADE

5 FDI and China's intra-industry trade

The estimates in section 4 reveal a few important facts. While China's bilateral intra-industry trade with both Japan and the US has increased since 1980, IIT has emerged as a significant part of the overall trade between China and Japan. For Sino-US trade, the weight of IIT in the bilateral trade between the two countries remains relatively small, less than 10 percent. Inter-industry trade still dominates trade flows between the two countries. IIT of Sino-Japan and that of Sino-US concentrate in different sectors. The former concentrates in electrical and machinery, while the latter in chemical and food. All these sectors in China received the most FDI from Japan or the US. It is highly likely that FDI performed a substantial role in promoting China's bilateral intra-industry trade.

For examining the contribution of FDI, the following econometric model is employed:

$$\log(IIT_{cjt}) = \beta_0 + \beta_1 YD_{cjt} + \beta_2 \log(FDI)_{cj(t-1)} + \beta_3 \log(TB)_{cjt} + \beta_4 \log(TR)_{ct} + u \qquad (3)$$

where *IIT* denotes the intra-industry trade index, and *YD* the difference of GDP per capita. *TB* represents trade balance and *FDI* direct investment; *TR* is the average tariff level measuring the level of openness in China. *FDI* is the focal point of the analysis and the rest of independent variables serve as control variables for possible impact of other factors on IIT.

Relative size between two trading economies is considered as one of the critical factors determining IIT. Demand structures vary across countries, and the difference generally increases with the variation in income levels. Similar demand structures give rise to trade of commodities in the same categories, i.e. intra-industry trade. Some of the empirical literature on the determination of intra-industry trade (e.g, Balassa & Bauwens, 1988; Bowden, 1983; Thorpe & Zhang, 2005), employed the difference of GDP as a proxy measuring the variation in demand structures between two trading economies. The difference in GDP per capita is also used alternatively (e.g, Zhang, van Witteloostuijin and Zhou, 2005). It is suggested that the latter is a better. In this paper, the GDP per capita difference is employed to proxy the difference in income level as well as demand structures.

The GDP per capita difference is estimated as:

$$YD_{cj} = 1 + \frac{\left[w \ln(w) + (1-w)\ln(1-w) \right]}{\ln 2} \tag{4}$$

where $$w = \frac{YP_c}{YP_c + YP_j} \tag{5}$$

Equation (4) smoothes the difference of GDP per capita between the two trading economies and maps it into the range of 0 and 1, in which 0 represents no difference at all.

With an imbalance between exports and imports, IIT indexes must be less than 100 no matter what the trade pattern is, because exports cannot match imports in every single sector. In other words, even if all trade between two trading partners fall into same commodity categories, the IIT index will not equal to 100 as long as trade deficits exist. Further, IIT indexes are generally biased towards trade imbalance. The higher the trade imbalance, the lower the index is. To correct the biases, trade balance is usually included in the models of IIT determination. In equation (3), independent variable *TB* is used for the purpose. It is defined as the absolute value of trade balance divided by total trade.

International trade naturally intensifies competition in the domestic market, as more and more foreign goods compete with domestic made products. Domestic producers usually lobby for protecting what they can produce, not what they cannot. Compared with inter-industry trade, intra-industry trade might be subject to relatively more tariff and non-tariff barriers and could be easily targeted by protectionism. In other words, intra-industry trade may rise as countries gradually liberalize their domestic markets. Many studies (e.g., Balassa, 1966; Falvey, 1981; Verdoorn, 1960) showed that the proportion of IIT increases with a reduction in trade barriers. As the time series data of tariffs on different sectors are not available, the un-weighted average tariff rate is used as a proxy of trade liberalization in this study. The tariff rates are collected from Rumbangh and Blancher (2004).

Equation (3) was estimated for both Sino-Japanese and Sino-US trade. The estimation for the bilateral trade between China and Japan was based on panel data covering six manufacturing sectors from 1980 to 2004. Annual FDI flows are usually applied in the empirical literature on the relationship between FDI and intra-industry trade. With respect to standard production functions, exports of foreign invested firms are the result of capital stocks rather than flows. Thus, both FDI flows and stocks are used in estimating equation (3). Table 5 reports the estimates for the bilateral intra-industry trade between China and Japan.

Table 5. FDI and Sino-Japanese intra-industry trade

	FDI Flows		FDI Stocks	
Independent Variable	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Const.		5.50 (1.63)		-10.39 (-2.41)
YD	-10.80* (-1.65)	-10.67* (-1.64)	3.51 (0.78)	0.62 (0.16)
$FDIF_{(-1)}$	0.24*** (3.60)	0.21*** (4.42)	0.53*** (4.98)	0.44*** (4.49)
TB	-2.45*** (-7.93)	-2.86*** (-9.53)	-1.31*** (-6.11)	-1.92*** (-10.15)
TR	0.93* (1.70)	0.99* (1.87)	0.76** (2.15)	0.88*** (2.50)
Adj. R^2	0.82	0.73	0.88	0.78
# of Obs.	120	120	123	123

Note: ***, ** and * indicate significance level at 1, 5 and 10 per cent respectively; numbers in parentheses are t-values. All standard errors are estimated with the White consistent estimator.

According to Table 5, the coefficients of independent variables FDI are positive and statistically significant. When FDI is measured in annual flows, the estimated coefficient of FDI is 0.24 and statistically significant at the one percent level, indicating that a one per cent increase in Japanese FDI will raise IIT between China and Japan by 0.24 percentage points. The estimated coefficient of FDI, measured in cumulative stock value, is 0.53 and also statistically significant at one per cent. It also suggests that FDI contributed significantly to the growth of IIT between China and Japan. The estimated marginal impact showed by FDI stock is higher than FDI flows, because a one per cent increase in stock is generally much larger than that of flows. The empirical results provide evidence in supporting our hypothesis, and suggest that Japanese direct investment in China has substantially enhanced the bilateral IIT between the two countries.

Besides independent variable FDI, the coefficient of the GDP per capita difference *YD* is -10.80 and significant at ten per cent level, suggesting that the variations in income level hinder the development of the bilateral intra-industry trade. The result is consistent with the theoretical expectation that larger income differences generally lead to low small IIT. The coefficient of trade balance *TB* is -2.45 and significant at the one percent level, indicating that the value of IIT index decreases as trade imbalance increases and the trade imbalance does impose a biased impact on the calculation of IIT indexes. It is imperative to include trade imbalance as a explanatory variable. However, the coefficient of *TR* is 0.93 and significant at ten percent. The result contradicts to the expectation that low tariffs enhance intra-industry trade. The inconsistence may be due to the collinearity between *TR* and *YD*[1].

The same model was estimated for the bilateral intra-industry trade between China and the US. The estimates are also based on panel data. Due to the limit of the data availability, the panel data covers the same six manufacturing sectors but from 1990 to 2004. FDI is also measured with both flow and stock values. Table 6 reports all the estimates. Among the four different estimations, the coefficient of FDI is only positive and significant when FDI is measured in stocks and the model was estimated with random effects. However, the statistic test indicates individual effects are correlated with the regressors[2]. The random effects model is not appropriate. The estimated coefficients of FDI in all other three cases are insignificant. Therefore, it can be concluded that the US FDI in China is not a factor determining IIT between the two countries. In other words, with the given information, there exists no empirical evidence indicating that direct investment from the US contributed to the growth of IIT significantly. The insignificance of FDI in the US case can be explained as follows. Firstly, the share of IIT in manufacturing trade between China and the US is merely 15 percent, much smaller compared with that of Sino-Japan trade. Inter-industry trade remains dominant. As previously mentioned, US direct investment in China has been primarily domestic market oriented. It has substituted the US exports to China, thus failed to facilitate the bilateral IIT. Furthermore, the scale of US FDI in China is relatively small compared with cumulative FDI from Japan. Even if FDI might stimulate IIT as expected, the impact may be too small to be measured with statistic significance. Finally, the long distance between China and the US may be one of the reasons causing the low level of intra-firm trade among the US affiliates in China. High transportation costs associ-

[1] The correlation coefficient between TR and YD is 0.96.
[2] The Hasuman test statistic is negative. Tests for individual coefficient were conducted instead. The individual test indicates that the coefficients of FDI estimated by the fixed and random effects are significantly different.

ated with long distance may prevent parent firms from trading intermediates with subsidiaries.

Almost all of the previous empirical studies on FDI and intra-industry trade concluded that foreign direct investment enhanced intra-industry trade. Our results show that the conclusion is not necessarily true if country and capital specific factors are considered. Whether FDI promote intra-industry trade between two trading countries largely depends on characteristics of FDI.

In addition, the coefficients of GDP per capita difference are negative and significant in the two estimations where FDI is measured with flows. The significance of GDP per capita difference shows that gradually reduced income disparity between the two countries improved the volume of IIT. It also implies that the small scale of IIT is partially attributed to the large income gap between the two countries and different demand structures remain the barrier for exchanging goods in same categories extensively. The rest of independent variables are insignificant. Comparing with the case of Sino-Japanese trade, the overall explanatory power of the model is low for Sino-US trade as most of independent variables are insignificant. Relatively small sample size might be the reason for the low explanatory power of the model.

Table 6 FDI and Sino-US intra-industry trade

	FDI flows		FDI Stock	
Independent Variable	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Const.		18.17 (3.77)		2.12 (0.62)
YD	-20.66*** (-3.31)	-19.23*** (-3.10)	-7.91 (-1.54)	-4.56 (-0.89)
$FDIF_{(-1)}$	-0.07 (-1.02)	-0.04 (-0.70)	0.02 (0.38)	0.18*** (5.09)
TB	0.36 (0.76)	0.35 (0.77)	-0.31 (-0.75)	-0.19 (-0.64)
TR	0.43 (1.31)	0.47* (1.27)	0.08 (0.32)	0.45 (1.24)
Adj. R^2	0.58	0.41	0.48	0.20
# of Obs.	52	52	74	74

Note: ***, ** and * indicate significance level at 1, 5 and 10 per cent respectively; numbers in parentheses are t-values. All standard errors are estimated with the White consistent estimator.

6 Concluding remarks

This paper analyzed dynamic changes of the bilateral intra-industry trade between China and its two major trading partners, Japan and the US. Our estimates demonstrate that, the trade pattern between China and Japan has changed substantially, and intra-industry trade has risen to one third of the overall trade of the two countries. In electrical, IIT emerged from zero to 52 per cent of Sino-Japan trade in the sector. Similar rapid growth in IIT is also observed in machinery, in which IIT did not exist in 1980, but accounted for 46 per cent of Sino-Japanese trade in the sector in 2004. However, the bilateral intra-industry trade between China and the US has developed slowly. It accounted for 10 per cent of the overall trade and 15 per cent of trade in manufacturing between the two countries. Inter-industry trade remains the major form of the bilateral trade, except for chemical, in which IIT reached 50 per cent of trade.

Additionally, the paper investigated to what extent FDI inflows in China contributed to the development of the bilateral IIT. The empirical results vary with respect to Japan and the US. In the case of Sino-Japanese trade, the empirical analysis suggests that Japanese FDI into China is one of the significant variables determining IIT in manufacturing sectors between the two countries. In the case of Sino-US trade, however, the analysis did not find any significant evidence suggesting that the US FDI stimulated the growth of IIT between the two countries. The contrasting roles performed by FDI indicate that the impact of FDI on IIT depends on country specific factors and characteristics of FDI. Domestic market oriented FDI which substitutes exports to FDI host countries cannot improve IIT between developed and developing countries.

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