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The United States' Direct Investment and Intra-Industry Trade with Japan, the Four Tigers, and China

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Abstract

The United States, the world’s center for trade, is the most highly developed country and holds the largest foreign direct investment in the world. East Asia, one of the top trade partners with the United States, is the region with the most rapidly growth in the world over the last 30 years. In this paper, we analyze the differences in intra-industry trade patterns between the United States and Japan, China, and the Four Tigers: Korea, Singapore, Hong Kong, and Taiwan. The estimated IIT indices show U.S.–Japan trade with the highest level of IIT, and U.S.–China trade with the most rapid growth in IIT. Moreover, U.S.–Japan and U.S.–China show the highest levels of their intra-industry trade in the chemical industry, but U.S.–Four Tigers trade shares the largest proportion of IIT in the electrical industry. This paper explores the role that United States foreign direct investment plays and its impact on intra-industry trade between the U.S. and the three country groups—Japan, the Four Tigers, and China—from 1996 to 2009. The empirical data shows that U.S. direct investment enhanced its intra-industry trade with East Asia countries as a whole and with Japan, the Four Tigers and China separately, but the effects of U.S. FDI on IIT for the three groups are diverse.

Keywords: Intra-industry Trade, Foreign Direct Investment (FDI)

1. Introduction

As a leader in the world economy, the United States is one of the largest trading nations in the world. Currently, American trade of goods and services totals 13% of world trade volume. Thus, U.S. trade plays an essential role in influencing the world trade environment. During the 1980s, the United States was in a process of industrial structure adjustment to accelerate its foreign trade, especially intra-industry trade. Meanwhile，The United States also holds the largest foreign direct investment (FDI) abroad, in every country of the world. The importance of East Asian countries as trading partners with the U.S. has increased due to significant economic expansion in most East Asian regions since the 1980s. Trade between the United States and East Asia has substantially increased, and direct investment from the United States to the East Asian region has grown rapidly to make East Asia one of the largest trade partners for the U.S. In 2007, China, Japan, and South Korea were among the top ten trade partners for the U.S. In most East Asian countries, the main source of advanced technology in recent years—especially in developing countries—has been inward direct investment.

In this paper, we analyze the changes in intra-industry trade patterns between the United States and its six East-Asian trading partners, and explore the relationship between U.S. direct investment abroad and its intra-industry trade. The empirical data shows that U.S. direct investment enhanced its intra-industry trade with East Asia countries as a whole and with Japan, the Four Tigers and China separately, but the effects on the three groups are diverse.

This paper is unique in that it distinguishes the different IIT patterns of the United States with countries at three economic stages and determines the distinct influence of U.S. FDI in the development of IIT in these countries. Trade theory, as addressed by Helpman and Krugman (1985), predicts that a high degree of similarity in income level, factor endowment, and country size leads to a higher level of IIT. Thus, We have chosen six countries—Japan, Korea, Singapore, Hong Kong, Taiwan, and China—to represent three different economic stages in the East Asian region., which can be approved by the index of GDP per capita. Japan is the most developed country in East Asia, its GDP per capita closed to 40,000USD in 2009. The Four Tigers—Korea, Singapore, Hong Kong, and Taiwan—are considered as Newly Industrialized

Countries(NICs), the average GDP per capita of them was about 25,000USD in 2009. However, though China has experienced steady and rapid economic growth for thirty years, its GDP per capita was not more than 4,000USD in 2009, which showed it is a developing country. We expect to give an explanation to the influence of FDI on intra-industry trade between countries with similarity or disparity in income level.

The paper is organized as follows. Section 2 reviews study on the relationship between FDI and intra-industry trade. Section 3 describes the features of U.S. FDI and IIT with East Asia partners from 1996 to 2009. Section 4 empirically analyzes the impact of U.S. FDI on its IIT with the three country groups. This section also provides detailed explanations of the different relationships between U.S. FDI and its intra-industry trade with its various trading partners. The last section offers conclusions regarding the major findings of this paper.

2. Literature Review

2.1 The overall effect of FDI on IIT

Verdoorm's (1960) study of inter-block trade in the Benelux Economic Union is the first reference to the concept of intra-industry trade, which observed that simultaneous exports and imports of commodities within industries are traded between countries with similar development levels. This finding challenged traditional international trade theory which was based on the comparative advantage, and initiated a new direction in trade theory. Intra-industry trade, however, increase sharply between both developed countries, and between developed and developing countries since 2000s. Therefore, similar economic development levels are far from explaining the cause of recent IIT. Since the late twentieth century，a few papers mention the relationship between intra-industry trade and foreign direct investment.

Some studies supported that FDI activated IIT, such as, Wakasugi (1997), Fukao (2003), and Zhang, Witteloostuijin, and Zhao (2005). Wakasugi(1997), further exploring the mechanism for FDI promoting IIT, considered that FDI introduced advanced technology and specific capital from the parent country into the host country and built the transaction network between two trade partners, which promoted production capacities and increased production varieties in FDI host countries, And the reduced technology gap and the improvement in product varieties and production capacities consequently promoted intra-industry trade.

Others, however, considered FDI was negatively or insignificantly related to IIT. Djankov and Hoekman's (1996) research on intra-industry trade in Eastern European countries suggests that FDI cannot be treated as a major force for the growth of intra-industry trade. Based on Sharma's (2000) empirical research, the coefficient of foreign direct investment is significantly negative to IIT in the pre-liberalization period because of the investment in the import-substitution industries.

2.2 The effect of FDI on IIT at the national or industrial level

From the perspective of national or industrial level, the effect of FDI on IIT between developed countries, and between developed and developing countries seems to be different in terms of extant literature. Andressso-O'Callaghan and Bassino (2001) analyzed how Japanese FDI contributed to intra-industry trade between the European Union (EU) and Association of South East Asian Nations (ASEAN) countries at the industrial level. The results showed that Japanese direct investment best explains the growth of intra-industry trade between EU and ASEAN in the electrical, machinery, and transportation equipment industries. Fukao, Ishido, and Ito (2003) showed that Japan's bilateral trade in the electrical industry suggested that FDI had a strongly positive impact on vertical IIT, and the vertical IIT would be promoted if the cost of

FDI and trade were lower. Xing’s (2007) investigation on the extent of FDI from the United States and Japan affecting their intra-industry trade with China shows Japanese direct investment playing a significant role in promoting intra-industry trade, but no evidence proves that the United States’ direct investment enhances its intra-industry trade with China. In addition, Xing uses lag values of FDI stock and flow for panel estimation in his research. Therefore, the impact of FDI on different modes of IIT is uncertain.

2.3 The mechanism of FDI to IIT

FDI can affect intra-industry trade in two ways. First, advanced technology and specific capital transferred via FDI increases the product varieties and production capacities of host countries. Foreign direct investment (FDI) introduces advanced technology and specific capital from the parent country into the host country and builds the transaction network between two trade partners. Therefore, foreign direct investment facilitates technology progress and capital transition, consequently promoting production capacities and increasing production varieties in FDI host countries (Xing, 2007 and Wakasugi, 1997). The reduced technology gap and the improvement in product varieties and production capacities promote further intra-industry trade. Therefore, FDI plays an essential role in the development of intra-industry trade. Second, FDI helps to build the transaction network between parent firms and their affiliates to expand intra-firm trade, which is regarded as one of the major factors driving intra-industry trade growth.

3. U.S. FDI and Intra-Industry Trade with China, Japan, and the Four Tigers

3.1 Measurement of intra-industry trade: the Grubel-Lloyd Intra-Industry Trade Index

The Grubel-Lloyd Intra-Industry Trade Index (G-L Index) was first introduced by Grubel-Lloyd in 1975, and is the most widely used method to measure intra-industry trade. At an “industry” or micro level, the G-L Index can be defined as follows:

错误！未定义书签。错误！未定义书签。GLi ： $IIT_i = (1 - \frac{|X_i - M_i|}{X_i + M_i}) \times 100$

(1)

Xi and *Mi* represent the export and import value of goods in the industry *i*. The value of IIT falls in the range between 0 and 100, where 0 suggests only inter-industry trade and 100 indicates all intra-industry trade for a particular industry. The value of index IIT_i refers to the share of intra-industry trade for industry *i* in its total trade. However, in most empirical studies, IIT is measured by production group or across industries. At the aggregate or micro level, Grubel-Lloyd further suggest that a weighted average of G-L indices can be defined as

G-L: **错误！未定义书签。** $\sum \{[(X_i + M_i)/(X + M)] * G - L_i\}$

where *i* indicates the industry category.

Xing (2007) suggests a modified formula of IIT at a given level of aggregation level is defined as

$$IIT_i = \frac{\sum_{t=1}^{n}(X_{it} + M_{it}) - \sum_{t=1}^{n}|X_{it} - M_{it}|}{\sum_{t=1}^{n}(X_{it} + M_{it})} \times 100 \qquad \textbf{(2)}$$

Where t denotes a sub-industry of industry i, and n is the total number of sub-industries. The value of index IIT_i refers to the share of intra-industry trade for industry i in its total trade. In view of convenience ,we calculate the aggregate IIT by using formula (1), at the same time, For better measuring IIT across industries at a given level aggregation, we choose formula (2) to calculate IIT by industry.

3.2 Data source

Based on the formula defined in Equation 2, export and import values are needed to calculate intra-industry trade indices for the United States with China, Japan, Korea, Singapore, Hong Kong, and Taiwan. The data used to calculate IIT is based on the three digits Standard International Trade Classification (SITC). We calculated the IIT indices for all traded commodities and manufacturing goods separately, from 1989 to 2009, where all commodities belong to SITC 0-9, and manufacturing goods belong to SITC 0 and SITC 5-8. The calculated IIT index indicates the share of overall trade.

3.3 Dynamic Changes in Intra-Industry Trade (IIT) and FDI

3.3.1 IIT Trend

The United States' annual IIT for all traded commodities and manufacturing commodities with Four Tigers (Korea, Singapore, Hong Kong, Taiwan), Japan, and China is illustrated in Figure 1 and Figure 2. Figure 1 shows that the annual IIT index for all commodities between the United States and the Four Tigers ranged between 20% and 47% from 1996 to 2009. Meanwhile, the U.S. and Japan's intra-industry trade, however, only made up 32% to 40% of its total trade with the United States, which was little higher than Hong Kong but obviously lower than Korea, Singapore and Taiwan. The annual intra-industry trade values between the United States and China varied from

12 to 16, which indicated a small share of intra-industry trade relative to overall trade with the U.S. Although its share was increasing, the value of China's IIT was still the lowest of all trade partners. Figure 2 tells us that the IIT values of manufacturing goods for the Four Tigers, Japan, and China are similar with that of total goods. That may imply that most intra-industry trade between the United States and these trading countries occurred within the manufacturing sector.

Figure 1: U.S. Annual IIT with six East Asia countries (1996-2009)

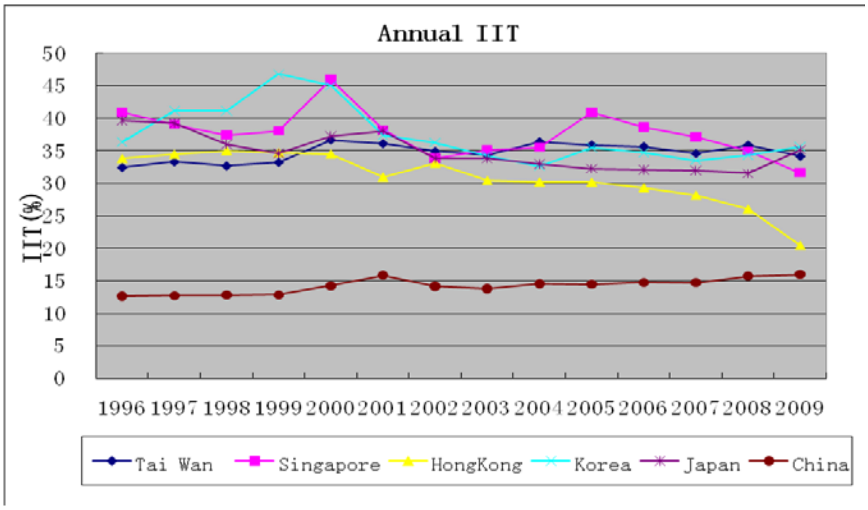
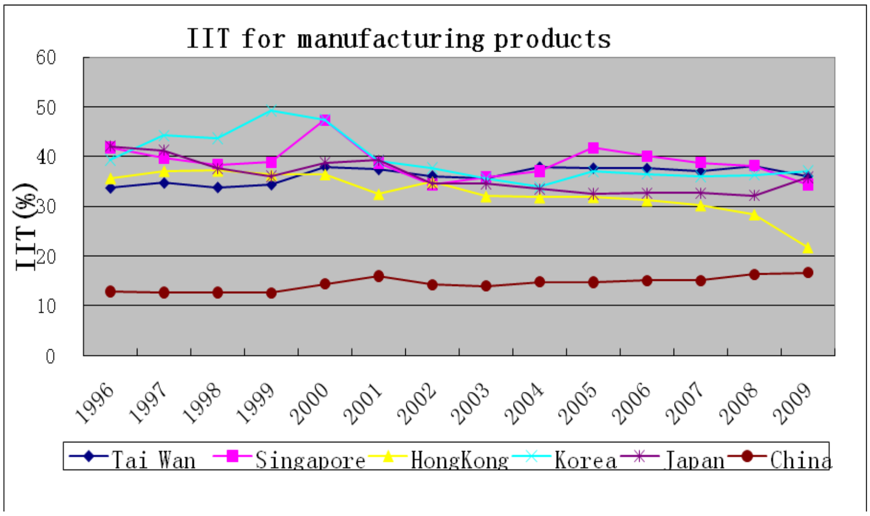


Figure 2 : U.S. IIT for manufacturing products with six East Asia countries (1996-2009)



Moreover, we use six manufacturing sectors to compute an industrial IIT index (Xing, 2007): food, chemicals, metals, machinery, electrical, and transportation[1]. Table 1 summarizes the industrial IIT values for six industries in selected years. For intra-industry trade between the U.S. and all Four Tiger countries, the electrical industry was highest, the machinery industry second highest, and transportation the lowest in value. IIT between U.S. and Japan scored relatively high for all traded commodities and in each industry, especially in the chemical industry. The chemical industry was reported as the largest IIT between the U.S. and Japan, where the IIT value reached 60%. Meanwhile, U.S.–Four Tigers trade shared the largest proportion of IIT in the electrical industry, the value of IIT between them ranged from 60% to 80%. Among all of these trading partners, China showed the highest degree of income disparity and the least developed level of IIT with the United States. Meanwhile, we also observe that intra-industry trade between the U.S. and China had the most rapid growth rate for all traded commodities and industry levels and the chemical, with its IIT values rising from 26% in 1996 to 50% in 2009.

3.3.2 U.S. FDI in Japan, the Four Tigers, and China

United States holds the largest direct investments abroad. Within the manufacturing sector, investment in the machinery, electric, and transportation industries grew more rapidly (Jackson, 2008). As one of the largest investors in the East Asian region, the United States' investment goes into almost every industry. In this paper, we use the FDI data of the *U.S.* Investment Position Abroad on a Historical-Cost Basis, provided by the U.S. Bureau of Economic Analysis. This investment position can be treated as stock, which is the net book values of U.S. parent company's equity in, and outstanding loans to, their affiliates abroad (Jackson, 2005).

[1] The food sector belongs to SITC001-098; the chemical sector belongs to SITC 511-598; the metal sector belongs to 671-699; the machinery sector belongs SITC 711-764; and the transportation sector belongs to SITC 781-793.

Table 2 summarizes U.S FDI in major industries in Japan, the Four Tigers, and China, for the selected years 1996, 2000, 2005, and 2009. Among all six trade partners, Japan received the most of U.S. investments, although it experienced a steady trend of decreasing in recent years. Meanwhile, other East Asian countries were opening to foreign countries as well as implementing many policies to provide a better investment environment for foreign investors. Since the mid 1990s, U.S. rapidly transferred FDI in manufacturing industries from Japan to the other countries in East Asia.

Four Tiger countries showed different patterns of the United States' investments. For Korea, U.S. investments increased in every industry from 1996-2009. For Singapore, U.S. investments increased in the chemical, machinery, electrical and transportation industries from 1996-2009 except the food industry decreasing and metal industry fluctuating a lot. For Hong Kong, U.S. investments grew in the machinery, electrical and transportation industry but decreased in other three industries. For Taiwan, the United States decreased its investment to most industries except the metal and electrical industry from 1996 to 2009.

Unlike Japan and the Four Tigers, China started opening its market in the early 1980s and the investment from the U.S. to China was relatively small in 1996. However, following China's steadily toward openness and development, U.S. investments increased rapidly in every industry over time, especially for the chemical industry with $4,987 million and electrical industry with $5,745 million by the end of 2009. This growth was much faster than with the other five trade partners, and showed a trend of continual increase.

4. Testing on the Relationship of FDI and IIT

4.1 Theory and hypothesis

According to the literature review discussed previously, most of scholars believe FDI has positive effects on IIT between FDI host and source countries. Generally speaking, the effects can be concluded in the following aspects.

From the view of overall level, FDI brings a technology spillover effect on host countries. The introducing of FDI does not only mean importing of capital but also technologies, which usually be regarded as technology spillover effect. Apparently, technology transferring will benefit to accelerating technological progress of enterprises in host countries, improving their international competitiveness and boosting the growth of IIT between FDI host and source countries. Moreover, FDI helps to build the transaction network between parent firms and their affiliates to expand intra-firm trade, which is regarded as the other important factors driving intra-industry trade growth. Therefore,

Hypothesis 1: FDI has a significant and positive effect on IIT between host and source countries.

From the perspective of country level, on one hand, the technology spillover effects of FDI on host countries of different economic stages are not the same. The spillover effects among countries of similar levels of economic development may be stronger than countries with large economic disparities, because the huge gulf of enterprises' technology level between them will not be helpful for technology communication and improvement, and ultimately prevent IIT increase between FDI host and source countries. On the other hand, FDI produces trade network enlarging effect. As is known to all, FDI is dominated by MNEs in possession of global trade network, thus introducing of FDI usually leads to enlargement of trade network, which can increase the trade chances of enterprises betwent two countries, strengthen their international trade relations and promote the IIT between them. In fact, developed countries usually have a broader trade network than developing countries, thus the marginal utility of trade network enlarging effect arisen by FDI to the latter can be much stronger than the former. As a result, from the perspective of trade network enlarging effect, the influence of FDI on IIT for countries of similar economic development stage may be weaker than for countries with large economic disparities. Therefore,

Hypothesis 2: The influence of FDI on IIT is uncertain when host and source countries are in various economic development levels.

4.2 Data and methodology

In this section, based on the theoretical and empirical literature we reviewed previously, we develop a model of IIT to explore the FDI impact on variations of intra-industry trade. To examine the contribution of the United States' FDI in Japan, the Four Tigers and China, the regression model is as follow:

$$\log(IIT_{i,t}) = \beta_1 \log(FDI_{i,t-1}) + \beta_2 \log(FDI_{m,t-1}) + \beta_4 \log(OPEN_t) + \varepsilon_{i,t} \quad (3)$$

IIT_{it} denotes the G-L Index of intra-industry trade in industry *i* at time *t*. As we mentioned in Section 4, the IIT index is calculated based on the three-digit Standard International Trade Classification (SITC).

$FDI_{i,t-1}$ denotes the net book value of U.S. investment abroad for industry *i* at time *t-1*, as provided by the U.S. Bureau of Economic Analysis. Here, we use the lag value of FDI to avoid the correlation problems between FDI and IIT at time *t*. In this paper, we will test how U.S. FDI last year impacted its intra-industry trade this year. It is common to expect a positive link between FDI and the growth of intra-industry trade, but it is possible to argue whether the motive behind FDI is to promote inter-industry trade or intra-industry trade (Sharma, 2002).

$FDI_{m,t-1}$ denotes the net book values of U.S. investment abroad in all manufacturing industries except industry *i* at time *t-1*. Manufacturing industries may be interdependent with each other, so FDI in one industry may cause spillover effects in other industries (Andreosso-O’Callaghan and Bassino, 2001). Therefore, the sign $FDI_{m,t-1}$ is ambiguous, since it depends on whether spillover effects exist or not.

OPEN denotes the level of trade liberalization in a partner country.. Trade barriers restrict the development of international trade, and since it is possible to lower the level of intra-industry trade, increasing the degree of an economy’s openness of an economy can be hypothesized to promote the level of IIT. Many empirical studies, such as Balassa (1986) and Xing (2007), show that reduced tariffs or high levels of openness promote growth in intra-industry trade.
The estimation used in this paper is based on panel data covering six industries from 1996 to 2009. My first estimation, based on Equations 3 for the United States with all six partners, illustrates an overall effect. Next, according to the level of development, we divide the six countries into three groups: Japan (developed country); the Four Tigers—Korea, Singapore, Hong Kong, and Taiwan—(developing countries with higher development levels); and China (developing country with lower development level). we then re-estimate Equations 3 separately for the three country groups.

4.3 Estimation results

As we know, unobserved and time-invariant variables most likely exist in most panel models. These variables can cause heterogeneity, or individual effects, which make ordinary least square estimation biased.[①] We conducted pooled regression model, variable-coefficient model and variable-intercept models separately, than according to the Sum squared resid(S_1, S_2, S_3) to calculate the F-value, which showed we should choose pooled regression model. Therefore, we estimated Equations 3 by using pooled regression model. Table 3 shows the estimation results of U.S—six trade partners; U.S.—Japan; U.S.—Four Tigers; and U.S.—China.

4.3.1 Overall effects of U.S. FDI on the six trade partners

In Table 3, the results show a positive and significant coefficient for the United States FDI at a 1% level of significance, which indicates a positive relationship between the U.S. FDI and its IIT with East Asia. An increase of 1% in FDI results in a 0.32% increase in IIT between the U.S. and East Asia. The empirical results support the hypothesis as described previously, that the United States' direct investment in six East Asian countries has enhanced its intra-industry trade between the two regions. The second independent variable, FDI in other industry, is significant and negative, which means there is a negative spillover effect on the United States' direct investment in the six East Asian countries. Again, OPEN is another independent variable, which is insignificant. This estimation result indicates that the openness levels of the six East Asian countries do not lead to a higher level of intra-industry trade.

[①] If those unobserved variables are correlated with any of variables in the model, then fixed effect will be used to make the estimation correct and efficient; otherwise, random effect will be appropriated for models without correlation (Greene, 2003; Xing, 2007).

4.3.2 U.S. FDI and U.S.—Japan intra-industry trade

From the estimation results shown in Table 3, U.S. FDI is an essential determinant in promoting the growth of intra-industry trade between the U.S. and Japan. The correlation coefficient between FDI and IIT is 0.19, which means an increase of 1% in FDI results in a 0.19% increase in IIT between U.S. and Japan. Meanwhile, U.S. investment in other industries ($FDI_{m,t-1}$) is negatively related to intra-industry trade between two countries, and significant at a level of 5%. In addition, Variable OPEN is insignificant as expected, and indicates that the level of openness plays an unimportant role in expanding intra-industry trade between the U.S. and Japan. This is because that Japan has been a country of high openness level, so keeping exoteric almost can not affect the IIT.

4.3.3 U.S. FDI and U.S.—Four Tigers intra-industry trade

Korea, Singapore, Hong Kong, and Taiwan form the Four Tiger country group because they are all new industrial countries in the East Asia region. The coefficient of the United States' direct investment is significantly positive. The correlation coefficient between FDI and IIT is 0.28. This indicates that a 1% increase in U.S. direct investment in the Four Tigers will promote the IIT between the U.S. and the Four Tigers by 0.28% on average. Variable $FDI_{m,t-1}$ was negatively related to IIT between the U.S. and the Four Tigers, and is significant at a level of 5%. U.S. investment has a negative spillover effect on its intra-industry trade with the Four Tigers. In addition, the coefficient of OPEN is also significant at a 1% significant level, and indicates that restriction on trade has no positive impact on the development of intra-industry trade between the U.S. and the Four Tigers.

4.3.4 U.S. FDI and U.S.—China intra-industry trade

China has the lowest development level of all three country groups, so intra-industry trade between the United States and China has the lowest value. The significance of FDI demonstrates that direct investment from the U.S. also makes contributions to intra-industry trade growing between the United States and China, though the value of correlation coefficient is very small(0.05). There is no spillover effect existing in U.S. investment since direct investment in other industries is insignificant. Moreover, the level of openness is significant at a 1% significant level, and the correlation coefficient is positive(0.18), so the United States' intra-industry trade is positively affected by the level of liberalization in China.

4.4 Comparison of the impact of FDI on IIT for the three country groups

U.S. FDI has not only a significant and positive effect on IIT with East Asia countries overall, but also on IIT with Japan, four tigers and China separately. However, The United States' direct investment has a different impact on its intra-industry trade with each of the three trade groups because they each have different economic conditions and development levels. The estimation results reported in Table 3 provide evidence to support the hypothesis 1 and hypothesis 2 put forward ahead.

After Comparison of the impact of U.S. FDI on IIT for the three country groups, we found the effect of U.S. FDI on IIT with Four tigers is the strongest among them, the value of correlation coefficient is 0.28. This is because that the gap of income level between the Four tigers and U.S. is not too large, and the economic development of Four tigers kept energetic in the latest two decades as a whole.

The effect of U.S. FDI on IIT with China is the weakest, the value of correlation coefficient is only 0.05. This is mainly because inter-industry trade dominates bilateral trade between the U.S. and China. Unlike Japan, the large gap between technology and development levels makes FDI function well as a transmission for advanced technology. However, United States' FDI in China is oriented to the domestic market. This investment is treated as a substitution of the U.S. exports to China and does not greatly promote the development of IIT (Xing, 2007).

The impact of U.S. FDI on IIT with Japan is in a middle level, which has a correlation coefficient of 0.19 obviously lower than that of U.S. with Four tigers. This can be explained as follows. First, since the 1990s, Japan's economy has reached a plateau, and its average growth rate is only 1.75%—which lags far behind the Four Tigers—so this economy stagnation may prevent the growth of trade. Second, compared to the other two country groups, Japan holds a very large investment in the United States, which also contributes to the growth of IIT. Since only the U.S.' direct investment in Japan is involved in this model, the effect of FDI on IIT cannot be totally embodied.

5. Conclusion

This paper demonstrates the level of intra-industry trade between the United States and six East Asian countries—Japan, Korea, Singapore, Hong Kong, Taiwan, and China—and focuses on the role played by U.S. FDI in its intra-industry trade with Japan, the Four Tigers, and China. This role is important for two reasons. First, economic patterns have changed over the last 20 years. The United States is still the economic leader, but some newly industrialized countries are catching up. Because the levels of intra-industry trade indicate a development and technology gap between two trade partners, the differences between developed-developed country IIT and developed-developing country IIT are interesting to explore. Second, in accordance with the hypothesis presented here, direct investment should promote intra-industry trade, although this relationship is disputable. To examine the relationship between FDI and IIT for countries at different economy stages is also very interesting.

Based on the G-L Index, this paper estimates the IIT index based on the three-digit SITC for the United States with its trade partners Japan, Korea, Singapore, Hong Kong, Taiwan, and China. Calculated IIT indices are consistent with the Helpman and Krugman (1985) hypothesis: the more similarity in factor endowment and income level between trade partners, the higher the value of IIT. Japan has the highest level of IIT with the United States, and China has the lowest level of IIT for overall commodities and manufacturing commodities. At the industry level, China ranks as the fastest growing country, whose intra-industry trade with the United States is growing in every industry. Unlike China, the IIT value of the Four Tigers—Korea, Singapore, Hong Kong, and Taiwan—fluctuates over time. The electrical industry is strongest for all four member countries, with the IIT share in this industry totaling more than 60% on average. In addition, Japan's IIT level tends to be consistent from 1996 to 2009 in each industry, with a fairly insignificant increase and decrease rate at the industrial level. Intra-industry trade in the chemical industry, which is the number one industry for Japan, shares more than 50% of total trade.

Economic investigation is needed on the extent to which FDI from the United States contributes to the growth of U.S.' intra-industry trade with Japan, the Four Tigers, and China. The empirical results vary for the different trade partners of the United States. Generally speaking, United States' FDI promotes its intra-industry trade with these six East Asian countries. According to economic patterns, we divided the six countries into three groups, and the separate estimation results are different. United States' FDI plays an important role in its intra-industry trade with the East Asia courtiers as a whole and with the three group counties separately. The effect of U.S. FDI on IIT with Four tigers is the strongest, the effect of U.S. FDI on IIT with China is the weakest and the effect of U.S. FDI on IIT with Japan is in a middle level.

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Appendix

Table 1: Calculated IIT Indices for Japan, Korea, Singapore, Hong Kong, Taiwan, and China in the Food, Chemical, Metal, Machinery, Electrical, and Transportation Industries for Selected Years

country	year	Category					
		Food	**Chemical**	**Mental**	**Machinery**	**Electrical**	**Trans.**
Japan	1996	5.003	65.928	33.577	43.324	56.139	25.747
	2000	7.813	59.887	34.511	42.074	54.804	15.029
	2005	10.709	61.051	34.862	32.824	56.911	9.147
	2009	9.929	67.813	34.455	36.823	51.855	15.569
korea	1996	7.240	26.613	36.099	43.646	61.328	61.328
	2000	12.427	39.479	23.375	46.460	84.604	84.604
	2005	20.688	44.406	26.460	35.245	72.295	72.295
	2009	13.762	46.125	40.467	31.675	74.781	74.781
Singapore	1996	13.105	14.689	23.550	32.880	85.650	12.672
	2000	14.739	19.631	26.869	35.840	87.708	28.886
	2005	17.352	35.656	29.961	43.482	66.333	6.490
	2009	12.683	21.181	18.020	38.711	57.636	7.704
HongKong	1996	14.663	6.015	38.122	40.738	74.755	3.124
	2000	15.703	5.515	48.670	33.124	62.830	8.497
	2005	20.034	7.092	50.170	44.430	21.303	12.189
	2009	6.658	4.012	35.723	35.670	12.567	1.928
Taiwan	1996	15.089	21.473	13.564	30.907	80.537	5.753
	2000	18.440	34.051	13.433	33.211	77.917	13.309
	2005	15.785	37.831	13.124	31.852	83.204	12.764
	2009	13.462	39.588	14.303	22.609	79.495	14.102
China	1996	14.95	25.94	20.69	27.86	22.29	9.80
	2000	37.54	38.49	12.57	25.18	26.92	9.00
	2005	36.59	52.62	16.53	15.21	27.96	16.75
	2009	38.37	50.13	21.10	16.37	27.93	14.92

Notes:

1. IIT was calculated based on the G-L index and derived from the following formula:

$$IIT_i = \frac{\sum_{t=1}^{n}(X_{it} + M_{it}) - \sum_{t=1}^{n} \left| X_{it} - M_{it} \right|}{\sum_{t=1}^{n}(X_{it} + M_{it})} \times 100$$

2. The Exports and Imports values used are based on the three-digit Standard International Trade Classification (SITC).

3. The food industry belongs to SITC 001-098; the chemical industry belongs to STIC 511-598; the metal industry belongs to SITC 671-699; the machinery industry belongs to 711-764; the electrical industry belongs to SITC771-778; and the transportation industry belongs to SITC 781-793 (Xing 2007).

4. The value of IIT means its share of total trade in one industry, and the values calculated are on a percentage basis.

Table 2: The United States' Direct Investment Position in Japan, Korea, Hong Kong, Singapore, Taiwan, and China at the Industrial Level

country	year	Category					
		Food	**Chemical**	**Mental**	**Machinery**	**Electrical**	**Trans.**
Japan	1996	559	2,572	358	4,765	4,374	2,453
	2000	228	3,352	306	1,060	3,642	1,900
	2005	213	3,564	219	535	3,067	2,053
	2009	226	2,555	228	998	2,717	1,394
Korea	1996	265	486	35	105	1,785	148
	2000	352	763	71	203	1,901	456
	2005	622	1,478	NA	232	2,469	810
	2009	NA	1,152	392	155	2,253	1,121
Singapore	1996	NA	304	190	932	6,162	50
	2000	10	554	227	265	10,515	568
	2005	2	1,172	19	909	6,340	862
	2009	-1	477	132	1,421	6,473	833
Hong Kong	1996	10	342	204	201	971	35
	2000	4	204	NA	121	1,586	25
	2005	-1	118	136	31	805	27
	2009	-2	235	77	636	2,495	39
Taiwan	1996	95	1,301	44	174	935	NA
	2000	46	1,217	57	102	1,188	52
	2005	78	883	59	124	1,643	116
	2009	79	601	86	134	2,862	71
China	1996	186	297	122	174	684	NA
	2000	286	1,122	157	218	3,500	652
	2005	402	2,335	432	386	1,689	1,501
	2009	2,874	4,987	691	1,186	5,745	2,736

Notes:

1. FDI data at the industrial level is from the U.S. Investment Position Value Abroad on a Historical-Cost Basis, which is provided by the U.S. Bureau of Economic Analysis website.
2. The values are in million dollars.

Table 3: Estimation Results for FDI and U.S.-East Asia partners' IIT

variable	Overall	Japan	Four tigers	China
	Equation(1)	Equation(2)	Equation(3)	Equation(4)
C	4.121884***	4.946223***	3.021263***	3.373974***
	(8.349357)	(3.561832)	(4.928579)	(10.11069)
$\log(FDI_{i,t-1})$	0.319002***	0.192340***	0.275911***	0.055051**
	(30.31131)	(9.787974)	(23.43280)	(2.095490)
$\log(FDI_{m,t-1})$	-0.318269***	-0.298539**	-0.179028***	-0.01723
	(-9.006710)	(-2.302105)	(-4.992112)	(-0.513035)
$\log(OPEN_t)$	-0.007279	-0.096516	-0.107091***	0.182634***
	(-0.157916)	(-0.396450)	(-4.992112)	(3.137699)
R^2	0.958460	0.755327	0.981055	0.872590
Adj. R^2	0.956776	0.745408	0.980287	0.857818
F-test	569.1450	76.14822	1277.337	59.06982
# of Obs.	78	78	78	78

Notes:

1. ***, ** and * indicate significance level at 1%, 5% and 10% respectively; numbers in parentheses are t-values.

2. The estimation results are based on pooled regression models.

3. The observed objects are relatively not too many, which may affect the precision of regression results to some extent.