論　説

Intra-Industry Trade in East and South East Asia: Comparative Advantage and Expansion of Regional Production Network

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Abstract

This paper investigates the determinants intra-industry trade in Asia focusing on the role of FDI and comparative advantage. It is often argued that this surge in intra-industry trade within region reflects the expansion of regional production networks. Japanese corporations have played a particularly important role. Japanese companies established production sites within region, which each produce different parts and components. This was especially prominent in electronics and automotive industries. An expansion of production network has changed the determinants of international trade pattern in the region. In particular, comparative advantage became less important, while FDI increasingly became the major factors that affect the trade pattern. Our estimation shows that while comparative advantage has a significant, the most important determinant is FDI from Japan. Our finding confirms the view that FDI by Japanese corporations has created regional production network, and facilitated a surge in intra-industry trade.

Introduction

Is comparative advantage still important for determining the trade pattern in East Asia? In the past two decades, East Asia has experienced a surge in intra-regional trade and intra-industry trade. An important factor behind the increase in intra-regional and intra-industry trades in East Asia is argued to be an expansion of production network in the region. Since Plaza Accord agreement, many manufactures in automotive and electronics industries shifted their production from Japan to East Asian countries. Instead of shifting entire production process to a particular country, Japanese corporates developed the cross-

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border production networks. Production was divided and allocated across border. For example, Toyota produces body and components of engine in Thailand, while it produces suspensions in Malaysia. This type of production network has resulted in a rapid increase in intra-industry trade and intra-regional trade.

Expansion of production networks may have influenced how each country is engaged in international trade. As East Asian countries are increasingly engaged in intra-industry trade, comparative advantage may no longer be an important factor for determining trade pattern. Instead, the pattern of international trade in East Asia may have been influenced more heavily by FDI by multinationals.

This paper will examine the impact of comparative advantage and FDI on intra-industry trade in Asia. We focus on electronic industry, as the electronics industry, especially information technology-related industry has been a major industry that expanded in many Asian economies, such as Korea, Malaysia, and Taiwan. By looking at the data on 7 East and South East Asian economies from mid-1990s to early 2000s, this paper will examine which factor is the main determinant of the surge of intra-industry trade. The structure of this paper is as follows: Section 2 describes recent situation in intra-industry trade; Section 3 reviews the indicators of comparative advantage and intra-industry trade; Section 4 looks at these indicators in East and South East Asia, and Section 5 estimates the impact of comparative advantage and FDI on intra-industry trade.

Intra-industry trade in East Asia

As Bonturi and Fukasaku (1993) point out, a surge in IIT in Asia can be primarily attributed to the globalisation of corporate activities by Japan and the US. They argue that multinationals have established of assembly-line production based on imported parts and components, which takes the form of subcontracting arrangements with different East and South East Asian economies. Ota (2003, 2004) also finds the importance of multinationals in IIT in electronics industry. Ota has found that trade parts and components has surged in the region, which accounted a considerable proportion of IIT in electronics industry.

IIT in East Asia was modest until 1990s. However, it has been rapidly increasing since the 1990s. A number of studies (OECD, 2002; Fukao *et al.* 2003; Helg, 1999; Ota, 2003, 2004) on IIT show a massive expansion in IIT in Asia. For example, Bonturi and Fukasaku (1993) found that trade between Japan and East Asian economies have previously been dominant by inter-industry (and intra-firm) trade. However, recent trading pattern in Asia has increasingly shifted toward intra-industry. The recent surge in IIT in Asia demonstrates that the trading pattern in the region is more influenced by investment by multinationals. As a result, traditional comparative advantage can no longer explain the trading

pattern in the region. Instead, FDI has increasingly become main determinants of regional trading pattern.

RCA, specialisation index and G-L index

Comparative advantage can be measured by various methods. One of the popular methods is the revealed comparative advantage (RCA) index developed in Balassa (1965). The RCA index for country (a) in product (k) is derived as:

$$\mathrm{RCA}_{\mathrm{aj}} = \frac{X_{ak}/X_a}{X_{wk}/X_w}$$

X_{ak}/X_a is the share of product (k) in exports by the country (a). Likewise, X_{wk}/X_w is the share of product (k) in the world's total exports.

In different manner, specialisation index can indicate a country's position of comparative advantage. Specialisation index shows whether a country is net exporter or net importer of particular product. In this regard, specialisation index is considered an indicator of comparative advantage. The index ranges between-1 to 1. Higher value indicates that a country is specialised as exporter, and lower value means that she is specialised as importer. Specialisation index in country (i) with trading partner (j) is given as:

$$SI_{ij} = \frac{\sum_k X_{ijk} - M_{ijk}}{\sum_k (X_{ijk} + M_{ijk})}$$

By the same token, G-L index measures the overlap in exports and imports in a particular industry. G-L index ranges from 0 to 1, and higher value indicates that a reporting country is engaged in both exporting and importing a particular commodity. In turn, the overlap in export and import shows the magnitude of intra-industry trade between two countries.

The magnitude of IIT is traditionally measured using the Grublel-Lloyd (G-L) index, which measures the overlap in imports and exports. The G-L index in industry (i) with trading partner (j) is calculated as:

$$GL_{ij} = 1 - \frac{\sum_k |X_{ijk} - M_{ijk}|}{\sum_k (X_{ijk} + M_{ijk})}$$

where the subscript (k) refers to the product. The index ranges from 0 to 1, and higher value means higher IIT.

By definition, G-L index has an inverse relationship with specialisation index. Lower G-L index means that the trade between two countries in a particular industry is one-way. In other words, the reporting country is specialised as an exporter and another is specialised as an importer. In contrast, when G-L index has higher value, specialisation index approaches to zero, indicating that there exists no clear comparative advantage between reporting country and her trading partner.

Therefore, both G-L index and specialisation index can indicate whether the trading pattern between countries reflect vertical or horizontal division of labour. When horizontal division of labour is established between two countries, G-L index should be close to one, and specialisation index is close to zero.

Intra-industry trade, comparative advantage, and production network

Expansions of intra-industry trade and intra-firm region in the 1990s can indicate that a considerable shift of production / trading pattern. Since the mid the 1980s, multinationals, especially Japanese manufacturers, made FDI to establish the regional production networks. Multinational corporations, especially Japanese corporations, have been playing a central role in establishing regional production networks. The role of Japanese multinationals has been especially prominent in in electronics and automotive industries. Japanese firms strategically allocate production sites across border: For example, in Singapore, where there is a good communication infrastructure, regional headquarters / support centre are established. Likewise, in Thailand and Malaysia, where there is relatively low-cost skilled labour is available, mid-level production takes place (Natsuda and Otsuka, 2007).

Expansion of production networks in East Asia converted the division of labour from traditional vertical division to horizontal division (Natsuda and Otsuka, 2007). The trading pattern in Asia, as a result, is no longer a simple reflection of comparative advantage. It is likely that comparative advantage has decreased its importance in determining trade pattern in the region. Instead, FDI, especially by Japanese corporations, is increasingly important determinant of international trade in the region.

If the role of FDI has become a main determinant of trade pattern, then there must be a clear relationship between FDI and the magnitude of IIT within Asia. Therefore, we expect that G-L index and FDI are positively related. In addition, if the FDI by Japanese corporations has been the engine of expansion of regional production network, Japanese FDI should have a higher impact on IIT than the FDI from other countries. On the other hand, if IIT in Asia is mere reflection of comparative advantage, the impact of FDI on IIT should not be significant, or very limited.

As mentioned earlier, this study focuses on electronic industry, in which production in

the region increased dramatically in most economies. Among electronics industries, we will examine office machinery and automatic data processing industry. This industry is strongly related to information technology, which is considered as highly technology-intensive. IIT is most likely to take place in highly sophisticated industries, and therefore, this industry is the most appropriate for the present study. This industry is an appropriate industry to examine, as information technology has been a main engine of production in electronic industry in recent years in many Asian countries.

Intra-industry trade in electronics industry

Table 1 shows the average G-L index in office and machinery industry for Japan and US by destination region. The table shows that IIT is clearly influenced by physical distance-IIT by US concentrates in North America and Europe, while Japanese IIT is predominantly taken place within Asian region. IIT occurs within Asia, showing that intra-regional trade in Asia-Pacific largely reflect production network developed in the region.

On the other hand, the table also shows interesting contrast in the IIT patterns between Japan and the US. IIT by US seems to reflect proximity in factor endowment more strongly than that of Japan. That is, more IIT is taken place between the US and those countries with similar comparative advantage. IIT by US seems to have hierarchy structure depending on the stages of development. G-L index for the US is high for North America, followed by Europe, Asian NIEs, ASEAN4, and newcomers (China and Vietnam) respectively. In contrast, Japanese IIT pattern does not show such a hierarchy structure among the regions. Regardless to their developmental stages, Japanese ITTs with Asian trading partners are in similar level for all Asian economies.[1)]

Table 2 above is the correlation matrix of intra-industry trade, FDI, and RCA index in office machinery and automatic data processing equipments.[2)] Correlation between GL index and FDI is positive but very small (0.02). The correlation between GL index and RCA index, in contrast, is much higher (0.37)[3)]. Therefore, correlation coefficients may suggest that intra-industry trade between Japan and Asian countries are more strongly influenced by comparative advantages rather than FDI.

On the other hand, however, the correlation between GL index and FDI as a percentage of fixed capital formation is relatively high at 0.25. As OECD (2002) finds, intra-industry trade is prominent in the countries that has experienced massive capital accumulation from FDI. More importantly, Japanese FDI seems to be playing considerably important role in determining IIT in the region. The correlation between GL index and Japanese FDI is significantly higher (0.24) compared to global FDI (0.02). This may suggest that recent Japanese FDI is strategically directed toward the establishment of horizontal production net-

Table 1. Average GL index in office machinery industry (1997-2002)

	Office machines and automatic data processing machines		Office machines		Automatic data processing machines, n. e. s.		Parts, accessories for machines of groups	
	Japan	US	Japan	US	Japan	US	Japan	US
Europe	0.345	0.592	0.102	0.823	0.482	0.642	0.185	0.500
North America	0.554	0.923	0.114	0.848	0.605	0.880	0.577	0.918
Total Asia	0.741	0.368	0.894	0.184	0.448	0.335	0.933	0.447
ASEAN4	0.619	0.209	0.441	0.344	0.127	0.128	0.707	0.455
Asian NIEs	0.749	0.315	0.441	0.312	0.550	0.291	0.768	0.352
China and Vietnam	0.620	0.195	0.320	0.027	0.271	0.238	0.671	0.186

Source: Natsuda and Otsuka (2007)[4)]

Table 2. Correlation matrix of FDI, intra-industry trade, and RCA (ISIC 75, 1996-2002)

	GL	RCA	RCA gap	FDI	FDI % of capital formation	Japanese FDI
GL	1					
RCA	0.373887	1				
RCA gap	−0.35432	−0.99121	1			
FDI	0.029979	−0.01909	0.02035	1		
FDI % of capital formation	0.248509	0.423427	−0.40812	0.235334	1	
Japanese FDI	0.241082	0.057177	−0.01416	0.526262	0.110574	1

Source: Natsuda and Otsuka (2007)

work within Asia-Pacific region, as we predict.

Furthermore, correlation matrix reveals that FDI does not seem to be related to comparative advantage. The correlation between RCA and FDI is negative, and very small in absolute term. Likewise the correlation between RCA and Japanese FDI is also negligibly small.

Regression analysis on intra-industry trade in electronics industry

In the previous section, we have discussed that IIT in Asian region mainly reflects strategic investments by multinational corporations (especially by Japanese multinationals) rather than comparative advantage. To examine this proposition, we conduct regression analysis using the data on office machinery and automatic data processing industry.

Following the common methodology in the IIT literature (e. g. Fukao et al, 2003; Greenaway et al, 2003) we analyse the determinant of IIT with a simple linear specification:

$$IIT_{it} = \alpha_i + \beta FDI_{it} + \gamma RCA_{it} + \delta GAP + \varepsilon_{it} \quad (1)$$

The dependent variable (IIT_{it}) is the magnitude of IIT (measured with GL index) between Japan and trading partner (i) in year (t). FDI variables (FDI_{it}) is the level of FDI as a percentage of GDP in host country (i) in year (t). Likewise, (RCA_{it}) is the RCA index of trading partner (i) in year (t). Finally, the variable GAP_{it} measures the difference in endowment between Japan and each trading partner (i). This *GAP* variable is proxied by the difference in GDP per capita between Japan and each country. β_1, γ, δ are the parameters to be estimated, while α is the country-specific constant (fixed-effect). ε_{it} is the white-noise.

We include two FDI variables — Japanese FDI (*JFDI*) and rest-of-the-world FDI (WFDI). If recent IIT reflects horizontal production network developed by Japanese multinational corporations, Japanese FDI should have larger impact on IIT between Japan and Asian trading partners. Including *JFDI,* our model is specified as follows:

$$IIT_{it} = \alpha_i + \beta_1 JFDI_{it} \beta_2 WFDI_{it} + \gamma RCA_{it} + \delta GAP + \varepsilon_{it} \quad (2)$$

We estimate the equation (2) using the pooled least square estimation method with the fixed-effects. Our pooled data consists of ten major Asian trading partners including ASEAN 4 (Indonesia, Malaysia, Philippines, and Thailand), East / South East Asian NIEs (South Korea, Taiwan, and Singapore), and newcomers (China, India, and Vietnam) in the period between 1996 and 2002.

As discussed briefly above, IIT variable (i. e. GL index) and RCA index is calculated from 3 digit level ISIC data on "office machinery and automatic data processing" industry (ISIC 75). GL index is calculated with the data from OECD International Trade by Commodity database. RCA index is computed with the data from UNCTAD Statistics Handbook (2005). *JFDI* and *WFDI* are obtained from OECD International Direct Investment database and the data from UNCTAD website respectively. GDP data is obtained from UN database except for Taiwan, which we have obtained the data from National Statistics website.

Table 3 shows our regression results. The coefficient for RCA is positive and significant, suggesting that comparative advantage has some impact on IIT. The estimation results suggest that comparative advantage still plays some role in determining IIT in Asia. There can be a specialisation in production stages within the same industry.

FDI from Japan seems to be the strongest determinant of IIT in the region. *JFDI* has extremely large coefficient of 24.5, compared to that of RCA (0.79). The impact of Japanese FDI is much stronger than that of RCA. From this finding, we can conclude that IIT between Japan and Asian economies largely reflects Japanese business's strategy to establish the horizontal production network within the region.

World FDI (*WFDI*) shows a sharp contrast to Japanese FDI. Not only it is insignificant, but the coefficient for *WFDI* also has a negative sign. This suggests that vast majority of

Table 3: Regression results: Office machinery and automatic data processing

Dependent Variable: IIT			
	Coefficient	t－Statistic	Prob.
Constant	0.096	0.498	0.621
JFDI (% of GDP)	24.504	3.048	0.004**
WFDI (% of GDP)	－0.232	－0.265	0.792
RCA	0.790	13.118	0.000**
DGDP	－1.05E－05	－2.566	0.013*
Fixed Effects			
China	－0.19	Philippines	－0.80
India	0.29	Singapore	0.72
Indonesia	0.48	Thailand	0.52
Korea	－0.22	Taiwan	0.80
Malaysia	－1.94	Vietnam	0.35
Adjusted R^2	0.997		
F－statistic	1957.51		
Durbin－Watson	1.46		

*Significant at 5% confidence level: **Significant at 1% confidence level

FDI does not have much impact on IIT in Asia. Or if any, it may even have a negative impact. This result further strengthens our proposition that IIT in Asia reflects Japanese corporations' strategic move.

Our findings are consistent with the recent trends of intra-regional trade and intra-firm trade. The tendency of intensive intra-firm trade combined with a strong increase in intra-regional trade is likely to be reflection of strategic FDI to establish production network. As OECD (2002) and Bonturi and Fukasaku (1993) recognise, intra-firm trade within Asian region had previously been inter-industry nature.

Comparing Japanese FDI and FDI from the rest or the world, only FDI from Japan shows a significant impact on IIT. Our finding may indicate that FDI from Japan is the main driver of formation of regional production network. Since mid the 1980s, foreign multinationals started to invest in East and East Asian countries to establish production sites. However, that FDI from US or Europe, did not lead to an expansion of production network. As Kojima (1978, 2000) point out, there is a notable difference between FDI by Japan and FDI by US. Kojima (1978, 2000) argue that FDI from Japan is pro-trade—FDI from Japan tends to facilitate production capacity in host countries, and thus, facilitate international trade. In contrast, FDI from US does not lead to enhancement of production capacity in host countries. Therefore, FDI from US / Europe have made little impact on increasing intra-industry trade from host countries. On the other hand, Japanese corporates have strategically divided production processes and allocate different stages of production across boarder.

Conclusion

This paper has investigated the determinants of intra-industry trades by focusing on the role regional production networks and comparative advantage. While comparative advantage has a significant impact on IIT, the biggest factor to determine the level of IIT is FDI from Japan. Our estimation results indicate that Japanese FDI has formed regional production networks, and this has resulted in a surge of intra-regional and intra-industry trade. More specifically, a recent surge in intra-industry trade in East and South East Asia has been driven by the expansion of regional production networks, which have attributed to FDI by Japanese corporations.

Notes:

1) Of course, if you look closely at more disaggregated levels, each country seems to have its strength in particular commodity group (s). This is also consistent with our proposition that Asian economies are specialised according to horizontal division of labour.
2) GL-index and RCA index are computed with 2 digit level ISIC classification 75. FDI data is aggregated level by host countries.
3) In addition, the correlation between GL index and RCA gap (difference in RCA between Japan and trading partners) has large negative value. Since intra-industry trade is likely to take place among the countries with similar endowments, RCA gap is expected to be negatively related to GL index. As expected, RCA gap and GL index has a negative correlation, suggesting that proximity in comparative advantage is a determinant of intra-industry trade.
4) The original data was obtained from OECD international trade by commodity database

Bibliography

Balassa, Bela (1965) "Trade Liberalisation and Revealed Comparative Advantage", *Manchester School of Economic and Social Studies,* vol. 33, pp. 90–124.

Balassa, Bela (1977) "A Stage Approach to Comparative Advantage", *International Bank For Reconstruction and Development, Bank Staff Working Paper No. 256.*

Bonturi, Marcos and Fukasaku, Kiichiro (1993), "Globalisation and Intra-firm trade: an empirical note", *OECD Economic Studies,* No. 20, Spring, pp. 145–159

Ernst, Dieter (2000) "Evolutionary Aspect: The Asian Production Networks of Japanese Electronics Firms", in Borrus, M, Ernst, D, and Haggard, S (eds.) International Production Networks in Asia: Rivalry or Riches? London, Routledge.

Ernst, Dieter (2003) "Pathways to Innovation in the Global Network Economy: Asian Upgrading Strategies in the Electronics Industry", *East-West Working Paper* No. 58.

Fukao, Kyoji, Ishido, Hikari, and Ito, Keiko (2003), *Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia,* RIETI Discussion Paper 03-E-001, Research Institute Economy, Trade and Industry.

Greenaway, David, Hne, Rober, and Milner, Chris (1995), "Vertical and Horizontal Intra-Industry

Trade: A Cross Industry Analysis for the United Kingdom", *The Economic Journal,* Vol. 105, No. 433, pp. 1505–1518.

Helg, Rodolfo (1999) East and South East Asian Economics and the EU: Pattern of Specialisation and Intra-Industry Trade, in Suthiphand Chirathivat e Corrado Molteni (eds.), *ASEAN-EU Economic Relations: the Impact of the Asian Crisis on the European Economy and the Long-term Potential,* Nomos Publication, Baden-Baden

Kojima Kiyoshi (1978) *Japanese Direct Investment: A Model of Multinational Business Operation,* London, CROOMHELM.

Kojima Kiyoshi (2000) "The Flying Geese Model of Asian Economic Development: Origin, Theoretical Extensions, and Regional Policy Implications", *Journal of Asian Economics,* vol. 11, pp. 375–401.

Natsuda, Kaoru, Otsuka, Kozo (2007), "East Asian Industrial Development: The Flying Geese or International Production Networks ?", *Asian Profile,* Vol. 35, No. 4, pp. 293–312

OECD (2002) *OECD Economic Outlook* 71, June 2002

Ota, Tatsuyuki (2003), "Development of International Direct Investment and Changing Directions of Trade in East Asian Electornics Industry (Part I)", *Keiei Ronshu* Vol. 61, Novermber 2003.

Ota, Tatsuyuki (2004), "Development of International Direct Investment and Changing Directions of Trade in East Asian Electornics Industry (Part II)", *Keiei Ronshu* Vol. 61, Novermber 2003.