Chapter 7

Structural Changes in the Electronics Industry and Intra-industry Trade in East Asia

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Introduction

As is widely documented, the explosive growth of trade in East Asia during the past quarter century has been accompanied by a rapid spread of intra-industry trade (IIT). Existing literature stresses the role of international production sharing ("fragmentation"), and attendant trade in intermediate goods, as the engine of IIT in East Asia. According to this literature, the growing IIT among the regional economies is an inherently "good" phenomenon that mirrors deepening integration of their production structures (Wakasugi 2007).

One salient -- yet often neglected -- feature of IIT in East Asia is its heavy concentration in a relatively narrow range of electronic products. As will be discussed in this chapter, the rapid spread of IIT in the region during the 1980-1990s was driven primarily by fragmentation trade in information and communication technology (ICT) products and related semiconductor devices, with comparatively limited contributions from other industries. Moreover, this trend of increasing cross-border fragmentation of electronics production has recently reversed, due mainly but not solely to the accelerating growth of China's ICT hardware output. To the extent that this is the case, there is no guarantee that East Asia's fragmentation-driven economic integration will be sustained in the future. This chapter analyzes the dynamics of IIT in East Asia and assesses its prospects in the near future.

1. Measurement and data issues

This chapter relies heavily on the Grubel-Lloyd (GL) index, a simple and routinely used indicator of the prevalence of IIT (Grubel and Lloyd 1971). A small innovation of this paper is to use this index as a regional rather than national indicator and to analyze its time-series behavior along several dimensions.

At the most detailed level, the GL index is defined as

$$IIT_{ij}^{k} = \frac{2\min\left[X_{ij}^{k}, M_{ij}^{k}\right]}{X_{ij}^{k} + M_{ij}^{k}}, \tag{1-1}$$

where X_{ij}^{k} and M_{ij}^{k} denote exports and imports by country i to (from) country j, respectively, of goods produced in industry k. This index simply measures the share of the overlap in trade between two countries within a specific industry.

The GL index in (1-1) can be aggregated in a number of ways. By summing its numerator and denominator across industries $k = 1, 2, \ldots$, we obtain

$$IIT_{ij} = \frac{2\sum_{k}\min\left[X_{ij}^{k}, M_{ij}^{k}\right]}{\sum_{k}\left(X_{ij}^{k} + M_{ij}^{k}\right)} = \sum_{k} w_{ij}^{k} IIT_{ij}^{k}, \tag{1-2}$$

where $w_{ij}^k = \frac{X_{ij}^k + M_{ij}^k}{\sum_k \left(X_{ij}^k + M_{ij}^k \right)} = \frac{X_{ij}^k + M_{ij}^k}{X_{ij} + M_{ij}}$ is the share of industry k in total bilateral trade between countries i and j. The index in (1-2) can be further aggregated as follows:

$$IIT_i = \sum_j w_{ij} IIT_{ij}$$

(1-3)

$$\text{where } w_{ij} = \frac{X_{ij} + M_{ij}}{\sum_j \left(X_{ij} + M_{ij} \right)} = \frac{X_{ij} + M_{ij}}{X_i + M_i},$$

and

$$IIT = \sum_i w_i IIT_i,$$

(1-4)

$$\text{where } w_i = \frac{X_i + M_i}{\sum_i \left(X_i + M_i \right)}.$$

If we apply the summations in (1-3) and (1-4) to countries in East Asia only,[1] the aggregated GL index in (1-4) shows how much of trade within East Asia is accounted for by IIT. The following sections focus on this index and examine how and why its value has changed over time.

Computing the above index requires detailed bilateral trade statistics. Although most existing studies rely on UN Comtrade, this database has several problems that are particularly pertinent to East Asian countries.[2] This chapter instead employs two datasets complied by Centre d'Études Prospectives et d'Informations Internationales (CEPII), a French research institution. These datasets, *Comptes Harmonisés sur les Echanges et l'Economie Mondiale* (CHELEM) and *Base pour l'Analyse du Commerce International* (BACI), rely on Comtrade as its original data source but adjust for its shortcomings with additional statistics and a series of adjustment that involves sophisticated econometric techniques. These datasets are largely complementary for our purposes, with CHELEM providing long time-series data for relatively broad industry categories, and BACI being a highly disaggregated dataset covering only 1995-2005.

2. A first look

The upper panel of **Figure 1** presents three time series of IIT that are computed from data at different levels of industry (product) aggregation.[3] All series exhibit a clear upward trend, although there have been two temporary downturns in the early 1990s and 2001-2002. Among these, the first setback was due mainly to widening trade imbalances among major countries, whereas the second downturn was caused by a temporary drop in electronics trade after the collapse of the US tech bubble (see the lower panel of Figure 1 and Sections 3 and 4).

Although Figure 1 gives us an impression that the rising share of IIT is a long-standing feature of trade in East Asia that will not be reversed any time soon, a simple sectoral analysis suggests that this is not necessarily the case. Letting ϕ_m, $m = 1, 2, \ldots$ denote a broad industrial sector (e.g., transport equipment), we can express regional GL index as a weighted average of sectoral rather than country GL indices:

$$IIT = \sum_m w(\phi_m) IIT(\phi_m)$$

(2-1)

$$\text{where } w(\phi_m) = \frac{\sum_i \sum_{k \in \phi_m} \left(X_i^k + M_i^k \right)}{\sum_i \left(X_i + M_i \right)}.$$

By evaluating (2-1) at two points in time, taking their difference and collecting terms, we obtain

(2-2)

$$\Delta IIT_t = \sum_m \left[\Delta w_t(\phi_m) IIT_s^*(\phi_m) + w_s(\phi_m) \Delta IIT_t(\phi_m) + \Delta w_t(\phi_m) \Delta IIT_t(\phi_m) \right]$$

where $IIT_t^*(\phi_m) = IIT_t(\phi_m) - IIT_t$ and subscripts now refer to time ($t > s$). By using (2-2), we can decompose a change in *IIT* between years *s* and *t*, into contributions from individual sectors, though the terms on the right hand side of (2-2) are not mutually independent and should be interpreted carefully.

According to the above decomposition, the

electronic and electrical (EE) machinery sector has been the main driving force behind the dynamics of the regional GL index during the past quarter century. As is shown in **Table 1** and **Figure 2**, the share of EE machinery in total manufacturing trade nearly doubled between 1985 and 2000, during which its own sectoral GL index also rose progressively. Between 2000 and 2005, however, the share of EE machinery in regional trade remained largely unchanged while its GL index fell sharply. Accordingly, the effect of EE machinery on the dynamics of the aggregate GL index has turned from positive to negative, denting the latter's growth significantly.

3. Changing IIT dynamics and the electronics industry

What has changed the relationship between the EE machinery sector and IIT? The primary reason for the stagnating trade of and the falling GL index for EE machinery during the 2000s has been the decelerating growth of IIT in intermediate ICT products and active electronic components (**Table 2**). The falling GL indices for ICT intermediates and active components in turn reflect a changing vertical division of labor among the regional economies, regarding in particular the production of computer and office equipment for which Southeast Asia used to host intricate networks of foreign and local producers. In the late 1990s, however, the center of gravity for ICT hardware production started to shift to China, playing havoc with the existing international value chains in the region (**Table 3**).

The impact of the changing vertical division of labor on regional IIT can be assessed using a dynamic decomposition similar to (2-2). Here we focus on the EE machinery sector only and let ϕ^1 and ϕ^2 stand for the final and intermediate EE machinery sectors, respectively. The temporal change in the regional GL indices for sectors ϕ^1 and ϕ^2 can be expressed as the sum of contributions from individual countries:

$$\begin{aligned}\Delta IIT_t\left(\phi^m\right) = \sum_{i=1}^{11}\Big[& \Delta w_{i,t}\left(\phi^m\right) IIT^*_{i,s}\left(\phi^m\right) \\ & + w_{i,s}\left(\phi^m\right)\Delta IIT_{i,t}\left(\phi^m\right) \\ & + \Delta w_{i,t}\left(\phi^m\right)\Delta IIT_{i,t}\left(\phi^m\right)\Big],\end{aligned} \tag{3-1}$$

where $IIT^*_{i,s}(\phi^m) = IIT_{i,s}(\phi^m) - IIT_s(\phi^m)$ and $m = 1$, 2. The result of this decomposition, shown in **Table 4**, highlights the decisive role of China in the falling regional GL index for intermediate EE products since the late 1990s. While China incurs large trade deficits vis-à-vis other East Asian countries in all major intermediate categories, its excess imports are most salient in active electronic components.

4. Future prospects

How will the structure of East Asia's cross-border production sharing and IIT evolve in the future? There has recently been much talk about "triangular trade," whereby China imports intermediate production inputs from other East Asian countries and exports final products to countries outside the region. Although triangular trade implies that China and other Asian countries are "comrades" whose exports continue growing together (Ahearne et al. 2006), this optimistic view is belied by a closer look at recent statistics. While the existing structure of regional trade is not inconsistent with triangular trade, China is rapidly expanding its production into upstream segments of the electronics industry. During the past few years, China's global trade balance has swung from a deficit to a surplus in a number of electronic products, including parts and components, with the notable exception of electronic integration circuits (ICs) (**Tables 5** and **6**).

The ongoing agglomeration of ICT production in China suggests that the EE machinery sector is unlikely to regain its role as the driver of East Asia's regional

fragmentation and IIT in the near future. Can other industries fill in this role? Although cross-border production sharing is observed in other sectors as well, **Table 7** reveals that IIT in non-EE manufacturing industries still remains modest. This is particularly the case in final products for which trade liberalization often remains limited, suggesting that policy does matter for the configuration of regional trade structure. This inference is supported by **Table 8**, which compares the regional GL indices for East Asia with those for North America and Europe: the index for East Asia is at a roughly comparable level with those of North America and Europe in the EE machinery sector but remains embarrassingly low in other industries.

Conclusions

Although existing literature hails growing IIT in East Asia as evidence of market-driven integration of the regional economies, our analysis suggests that the reality is more sobering, not least because the region's IIT is heavily concentrated in a subset of electronics whose producers are particularly foot-loose. The previous process of increasing vertical divisions of production and international fragmentation in the ICT hardware sector has recently reversed, thanks to the rise of China as a global electronics powerhouse and the gradual maturation of the world ICT market. These observations suggest that the fragmentation-driven integration of the East Asian economies is now at an important crossroads.

According to our analysis, non-EE industries should be able to take up the role which the electronics industry played during the 1980-1990s and to lead the next round of market-driven regional integration. That this will actually happen is not guaranteed, however, not least because vested interests and protectionism still abound in these traditional industries. It remains to be seen if East Asia's policy-makers can extricate themselves from domestic protectionist pressures and take up the challenge of creating a truly liberal trading area in the region.

Notes

1 In this chapter, East Asia refers to China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand and Vietnam.

2 See the Japanese text for further discussions.

3 Due to the limitation of space, all figures and tables are shown only in the Japanese-language chapter. The English translation of the figures and tables is available on request.

References

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