

Policy Brief

Fragmentation and Changes in the Asian Trade Network

1. Structural changes in the Asian trade network
2. Fragmentation and global supply chain: A further look
3. Conclusions and policy implications

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The Asian trade network is increasingly fragmented, resulting in higher dependence on supplies of goods and services from neighbouring countries. The update OECD Input-Output and Bilateral Trade Databases allow us to examine the recent evolution of international trade networks involving ASEAN and East Asian countries at the 2-digit industry level. Using several globalization indicators, this Policy Brief highlights major changes in the pattern of Asia's trade in intermediate goods and services since the mid-1990s. It concludes by discussing implications for Asia's regional integration.

1. Structural changes in the Asian trade network

The Asian trade network has undergone a significant transformation since the mid-1990s. An important indication of this is revealed as major changes in export shares between 1995 and 2006 in the leading industries in the Asia-Pacific region (Table 1). The significance of this transformation becomes clear when it is contrasted with the composition of sector shares of world merchandise exports which remained largely stable during the period at the 2 digit level of ISIC (International Standard Industry Classification)¹.

Furthermore, looking more closely at the composition of the leading export sectors, the extent of differentiation and specialisation in the manufacturing sector is very high in the broad category of machinery and equipment, and in particular, office, accounting and computing machinery in China, Malaysia and the Philippines, radio, television and communication equipment in China, Chinese Taipei, Korea, the Philippines, Singapore and Thailand, and motor vehicles in Japan. The similar pattern is also observed for petrochemical products in India and Singapore. On the other hand, many Asian countries (except for Viet Nam) have significantly reduced export shares in the labour-intensive products, such as textiles, leather and footwear.

It should also be noted that the share of mining products remain dominant in Australia and to a lesser extent in Indonesia, and so does the share of food products in New Zealand.

Another major indication of the rapidly-evolving Asian trade network is the rise of China as the dominant supplier to both regional and global markets. In Table 2, we counted the number of partner countries in which individual supplier country accounts for more than 15% of total merchandise imports. For instance, the number of partner countries in which China's exports exceed 15% of the partner's total merchandise imports in office, accounting and computing machinery jumped from 1 in 1995 to 11 in 2006 within the Asia-Pacific region and

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Table 1. Leading export sectors in the Asia Pacific Region

(1995 and 2006, percentage of total exports)

ISIC Rev.3	Sector	1995	2006	ISIC Rev.3	Sector	1995	2006
Australia				Philippines			
10-14	Mining and Quarrying	28%	43%	15-16	Food products, Beverages and Tobacco	10%	3%
15-16	Food products, Beverages and Tobacco	15%	12%	17-19	Textiles, Leather and Footwear	15%	5%
27	Basic Metals	22%	18%	30	Office, Accounting and Computing Machinery	10%	15%
China				32	Radio, Television and Communication Equipment	30%	49%
17-19	Textiles, Leather and Footwear	34%	17%	Singapore			
30	Office, Accounting and Computing Machinery	4%	15%	23	Coke, Refined Petroleum Products	11%	19%
32	Radio, Television and Communication Equipment	9%	19%	24	Chemicals and Chemical Products	6%	17%
36-37	Other Manufacturing	12%	9%	30	Office, Accounting and Computing Machinery	32%	15%
Chinese Taipei				32	Radio, Television and Communication Equipment	26%	26%
17-19	Textiles, Leather and Footwear	13%	4%	Thailand			
24	Chemicals and Chemical Products	9%	11%	15-16	Food products, Beverages and Tobacco	17%	9%
30	Office, Accounting and Computing Machinery	16%	8%	17-19	Textiles, Leather and Footwear	12%	6%
32	Radio, Television and Communication Equipment	15%	37%	30	Office, Accounting and Computing Machinery	16%	14%
India				32	Radio, Television and Communication Equipment	14%	17%
17-19	Textiles, Leather and Footwear	35%	21%	Viet Nam			
24	Chemicals and Chemical Products	7%	12%	01-05	Agriculture, Forestry and Fishing	19%	7%
36-37	Other Manufacturing	20%	15%	10-14	Mining and Quarrying	21%	23%
Indonesia				15-16	Food products, Beverages and Tobacco	17%	10%
10-14	Mining and Quarrying	26%	27%	17-19	Textiles, Leather and Footwear	32%	31%
17-19	Textiles, Leather and Footwear	18%	10%	World			
20	Wood and Products of Wood and Cork	13%	3%	01-05	Agriculture, Forestry and Fishing	4%	2%
Japan				10-14	Mining and Quarrying	6%	11%
24	Chemicals and Chemical Products	9%	10%	15-16	Food products, Beverages and Tobacco	6%	5%
29	Machinery and Equipment, n.e.c	16%	16%	17-19	Textiles, Leather and Footwear	8%	6%
32	Radio, Television and Communication Equipment	19%	15%	23	Coke, Refined Petroleum Products	2%	4%
34	Motor Vehicles	17%	19%	24	Chemicals and Chemical Products	10%	11%
Korea				25	Rubber and Plastics Products	2%	2%
17-19	Textiles, Leather and Footwear	16%	3%	26	Other Non-Metallic Mineral products	1%	1%
32	Radio, Television and Communication Equipment	27%	31%	27-28	Basic Metals and Fabricated Metal Products	6%	6%
34	Motor Vehicles	6%	10%	29	Machinery and Equipment, n.e.c	9%	8%
Malaysia				30	Office, Accounting and Computing Machinery	5%	5%
30	Office, Accounting and Computing Machinery	12%	19%	31	Electrical Machinery	4%	4%
32	Radio, Television and Communication Equipment	38%	36%	32	Radio, Television and Communication Equipment	8%	10%
New Zealand				33	Medical, Precision and Optical Instruments	3%	3%
01-05	Agriculture, Forestry and Fishing	15%	12%	34-35	Transport equipment	12%	11%
15-16	Food products, Beverages and Tobacco	38%	44%	20-22,36-37	Other Manufacturing	7%	6%

Note: Export shares were calculated from import-based bilateral trade statistics.*Source:* OECD Bilateral Trade Databases, March 2010.**Table 2. Dominant suppliers and sectors in the Asia-Pacific region**

(Number of partners in which the country listed accounts for more than 15% of total goods imports)

Country	ISIC Rev.3	Sector	1995		2006	
			Asia-Pacific	TOTAL	Asia-Pacific	TOTAL
China	17-19	Textiles, Leather and Footwear	7	11	12	35
	30	Office, accounting & computing machinery	1	1	11	34
	32	Radio, Television and Communication Equipment	1	1	8	26
	36-37	Other Manufacturing	3	8	9	34
Japan	29	Machinery and Equipment, n.e.c	9	10	9	10
	30	Office, Accounting and Computing Machinery	8	11	1	1
	32	Radio, Television and Communication Equipment	10	13	3	4
	34	Motor Vehicles	11	16	11	18
Korea	17-19	Textiles, Leather and Footwear	2	2	1	1
	32	Radio, Television and Communication Equipment	1	2	2	5
United States	01-05	Agriculture, Forestry and Fishing	10	17	8	13
	24	Chemicals and Chemical Products	9	15	4	10
	29	Machinery and Equipment, n.e.c	6	14	7	13
	33	Medical, Precision and Optical Instruments	11	28	11	32
	35	Other Transport Equipments	9	29	9	32

Note: The maximum number of partner countries is 12 for the Asia-Pacific and 46 for total.*Source:* OECD Bilateral Trade Databases, March 2010.

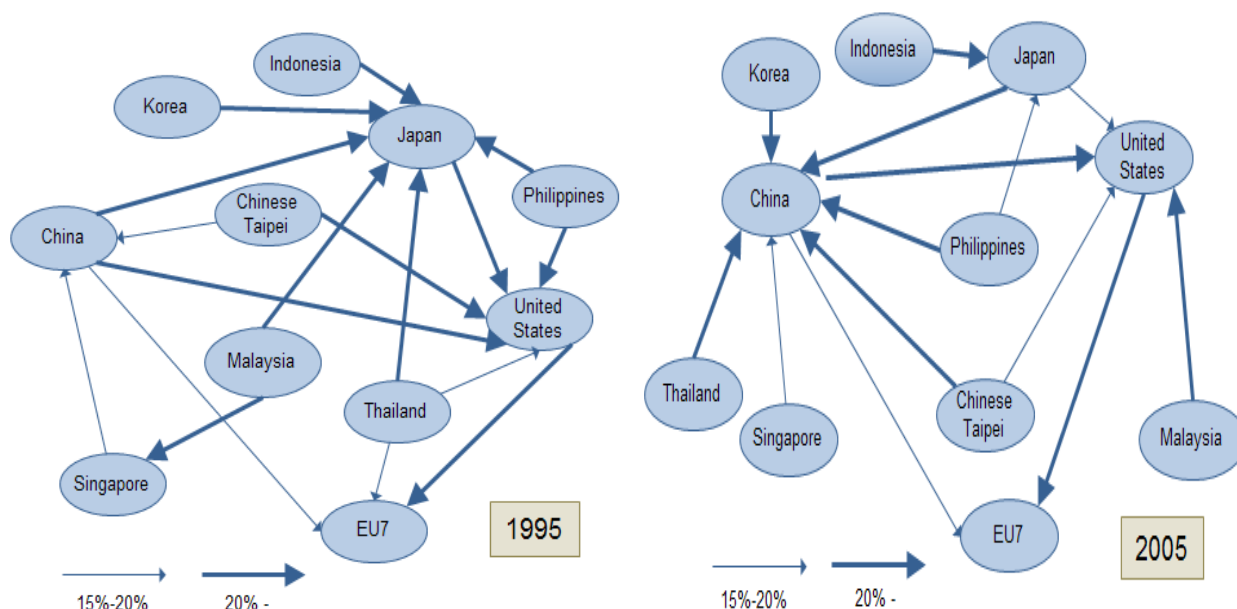
even to 34 if it is counted globally. Although using a different threshold alters the total number of partner countries listed in Table 2², the broad picture arising from this simple exercise remains intact: China has come to the fore as Asia's dominant supplier in wide-ranging manufacturing industries for both the Asia-Pacific region and the rest of the world.

Similarly, the rapidly-evolving Asian production network can also be highlighted by counting the "dominant links" of trade flows. If a country's intermediate exports (in both goods and services) to a particular partner country exceed a given threshold percentage of total exports (15% or 20% in our exercise), we consider such trade node as a dominant link (Figure 1). Examining the bilateral intermediate trade data for 46 countries across the world, China, Japan, United States and some European countries (such as Germany and France) are clearly identified as the world's leading demand centres in our dataset. In general, larger industrialised economies are expected to be identified as dominant trade partners for smaller ones in respective regions, as differentiation and specialisation take place around these larger

economies. Figure 1 illustrates major production networks from the Asian perspective. It is clear from this illustration that the emergence of China has significantly transformed the pattern of international production sharing over the past decade. Behind this transformation, there was an increased export share of machinery and equipment which requires a wide variety of goods and services as intermediate inputs.

In order to cast more light on the relative importance of production networks in Asia as opposed to North America and Europe, we calculated the inter- and intra-regional shares of intermediate trade in goods and services between 1995 and 2005. Table 3 presents the results of this work. During the decade concerned, the share of *intra*-Asian (including both ASEAN and East Asia) trade in goods and services increased, while the shares of *intra*-regional flows within North America and Europe fell. This reflects a growing importance of the Asian production network in the world economy as captured by intermediate trade in goods and services. In 2005 the amount of intra-Asian intermediate trade is estimated at about 15 % of world intermediate trade,

Figure 1. Major trade partners for Asia's intermediate exports in goods and services



Notes: EU7 is Belgium, Germany, France, Italy, Netherlands, Spain and United Kingdom. Each arrow indicates that a partner's share of a country's total exports is greater than 15%.
Source: OECD Input-Output Database, March 2010; IDE-JETRO Asian International Input-Output Database 2006; OECD Bilateral Trade Database, March 2010; OECD Trade in Services, January 2010.

Table 3. Inter- and intra-regional intermediate trade in goods and services, 1995 and 2005

(% shares of total intermediate trade, exports and imports)

Origin		Destination						
		Asia-Pacific				NAFTA	Europe	RoW
		ASEAN	East Asia	Other Asia Pacific	Total			
ASEAN	1995	1.1%	1.9%	0.2%	3.2%	0.8%	0.8%	0.1%
	2005	1.2%	2.6%	0.3%	4.1%	0.9%	0.7%	0.2%
East ASIA	1995	2.6%	4.5%	0.4%	7.5%	3.6%	2.5%	0.4%
	2005	2.1%	6.8%	0.4%	9.3%	4.4%	2.9%	0.5%
Other Asia Pacific	1995	0.4%	1.0%	0.2%	1.6%	0.2%	0.4%	0.1%
	2005	0.3%	1.2%	0.1%	1.6%	0.3%	0.4%	0.1%
Total Asia	1995	4.0%	7.5%	0.7%	12.2%	4.7%	3.7%	0.5%
	2005	3.6%	10.5%	0.9%	15.1%	5.6%	4.1%	0.8%
NAFTA	1995	1.0%	4.2%	0.4%	5.7%	9.1%	4.9%	1.0%
	2005	0.7%	2.7%	0.3%	3.7%	7.5%	3.6%	0.5%
Europe	1995	1.2%	2.5%	0.6%	4.3%	3.6%	30.0%	1.9%
	2005	1.0%	2.5%	0.5%	4.0%	3.7%	28.4%	1.7%
RoW	1995	0.8%	3.7%	0.5%	4.9%	2.4%	9.7%	1.4%
	2005	0.9%	5.3%	0.8%	6.9%	4.3%	8.8%	1.4%

Notes: Intermediate bilateral trade flows are estimated using the framework of multi-regional input-output model (see Box2). ASEAN refers to Indonesia, Malaysia, the Philippines, Singapore and Thailand; East Asia includes China, Chinese Taipei, Japan, and Korea; Other Asia Pacific includes Australia, India and New Zealand; NAFTA is Canada, Mexico and United States; and Europe includes 22 EU countries plus Norway and Switzerland.

Source: OECD Input-Output Database March 2010; IDE-JETRO Asian International Input-Output Database 2006; OECD Bilateral Trade Database March 2010; OECD Trade in Services January 2010.

compared with 7.5 % in North America and 28.4 % in Europe. However, intra-ASEAN trade in intermediate goods and services stayed almost unchanged at 1.2 %.

2. Fragmentation and global supply chain:

A further look

The above measures of international dependence on imported intermediate goods and services indicate that significant structural changes are underway in the Asian production network. Fragmentation and its impact on the global supply chain are further examined by using the harmonised input-output tables for Asian economies. The nature of OECD Input-Output and Bilateral Trade Databases are briefly described in Box 1, along with the methodological note regarding three indicators of trade fragmentation. Box 2 also explains briefly the framework for inter-country input-output analysis.

First, we calculated widely-used Hummels-Ishii-Yi's indicator of vertical specialisation, which measures the import contents of exports (Hummels *et al.*, 2001). This indicator captures an important aspect of a country's involvement in international production networks, by calculating the total amount of

imported inputs used for producing a good that is subsequently exported (ICE in Figure 2).

Table 4 reports the measurement results of this indicator (ICE) for (1) total products, (2) higher and lower technology-intensive manufactured products and (3) services with respect to 12 selected Asia-Pacific economies. It shows that the import contents shares to the total exports increased between 1995 and 2005 in most of these countries (except for Australia and New Zealand). The significant increases are observed in Chinese Taipei, Malaysia, the Philippines and Thailand and to a lesser extent in China, Japan and Korea. Note, however, that the country order of this indicator may have been affected by the size of economic activities.

Looking at the manufacturing sector, the estimated ICE values for the two different types of products (higher and lower technology-intensive) show that the higher technology-intensive products contained higher import contents of exports in most countries (except for Japan and Singapore). On the other hand, the ICE values for services sectors are found smaller than the manufacturing sectors in all countries, and significantly so in some countries. This may reflect differences in the extent of trade liberalisation in goods and services and across

Figure 2. Three indicators of trade fragmentation

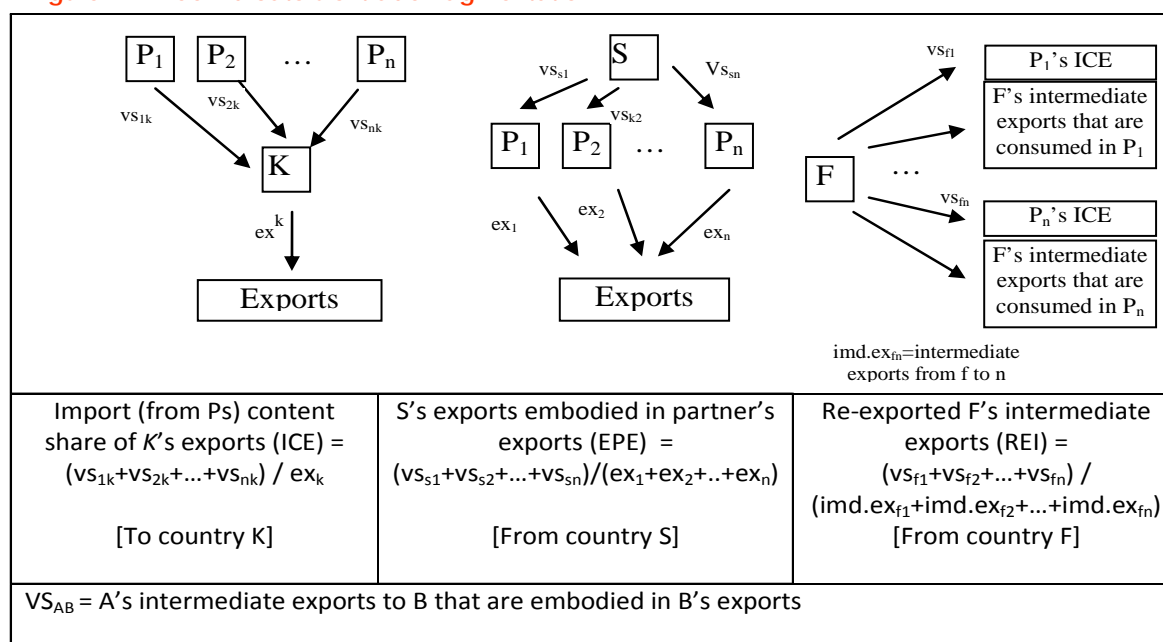


Table 4. Import contents share of exports by industry group (ICE, 1995 and 2005)

	Total		Manufacturing				Services	
	1995	2005	Higher technology manuf.		Lower technology manuf.		1995	2005
	1995	2005	1995	2005	1995	2005	1995	2005
Australia	14%	14%	28%	25%	16%	20%	10%	11%
China	16%	25%	22%	34%	15%	20%	10%	14%
Chinese Taipei	35%	48%	45%	55%	34%	53%	14%	19%
India	10%	13%	16%	21%	12%	18%	8%	6%
Indonesia	15%	18%	40%	36%	20%	21%	9%	13%
Japan	8%	15%	9%	16%	12%	22%	4%	7%
Korea	30%	39%	32%	41%	34%	42%	19%	23%
Malaysia	39%	52%	49%	65%	40%	45%	13%	31%
New Zealand	18%	18%	27%	26%	20%	19%	15%	14%
Philippines	32%	42%	56%	60%	45%	35%	17%	16%
Singapore	56%	59%	69%	71%	68%	78%	24%	30%
Thailand	33%	50%	57%	67%	29%	47%	13%	22%

Notes: Higher technology-intensive manufacturing group is defined as ISIC Rev.3 24, 29-35; lower technology-intensive manufacturing group is defined as ISIC Rev.3 15-23, 25-28, 36-37; services sector is ISIC Rev.3 50-95.

Sources: OECD Input-Output Database, March 2010; IDE-JETRO Asian International Input-Output Database, 2005; OECD Bilateral Trade Database, March 2010; OECD Trade in Services, January 2010.

economies.

Second, the phenomenon of international fragmentation is also captured from an individual supplier's perspective. Here, we propose two alternative indicators. One is to measure the share of vertical specialization in a particular country relative to world exports in goods and services (EPE in Figure 2). Another is to measure the share of re-exported intermediate inputs relative to total intermediate exports in goods and services originally supplied by a particular

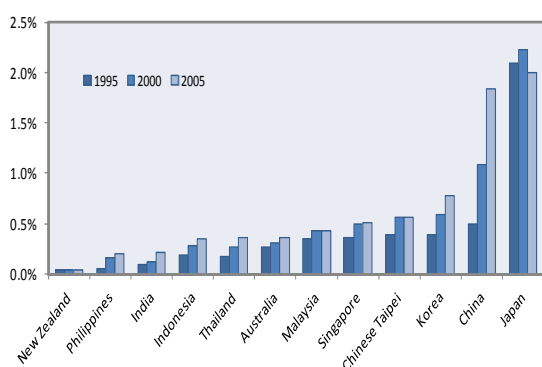
country (REI in Figure 2). The OECD databases for harmonised input-output tables and bilateral trade flows in goods and services enable us to calculate these two indicators (See Box 1 for the measurement details). The measurement results for selected Asia-Pacific economies are presented in Figures 3 and 4 below.

In Figure 3, the indicator of intermediate exports induced by partner's exports (EPE) is expressed as percentage of world exports in goods and services. This represents the

backward impacts of marginal changes in world exports in goods and services. Japan and China are those who have the highest export elasticities in this respect. Large increases in EPE were observed for China and to a lesser extent for Korea between 1995 and 2005, while Japan experienced a small decline. For the former countries, the changes in industry composition may have raised the elasticity of intermediate exports.

Figure 3. Induced intermediate exports by partners's exports (EPE)

(Percentage of worlds exports in goods and services)

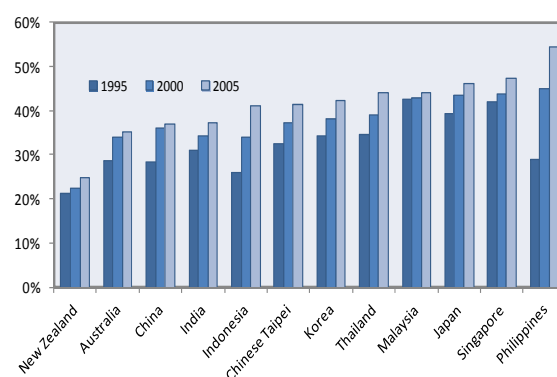


Sources: OECD Input-Output Database, March 2010; IDE-JETRO Asian International Input-Output Database, 2005; OECD Bilateral Trade Database, March 2010; OECD Trade in Services, January 2010.

In contrast to the measurement of ICE and EPE, the country size seems to be neutral to the measurement of REI (Figure 4). Rather the position of a country in the global supply chain is represented in this indicator. In other words, the value of REI becomes high, if a country provides the parts and components used in the assembly factors of the trade partners where most of the final products are sold abroad. The indicator value, on the other hand, becomes smaller, if the country's main exports are provided as the intermediate inputs of domestically consumed goods. The former example is the Japanese electronic parts and machinery sold to trade partners in Asian assemblers and the latter example is the Australian agricultural products consumed in Japanese and Korean food manufactures.

Figure 4. Re-exported intermediate exports (REI)

(Percentage of a country's total Intermediate exports in goods and services)



Sources: OECD Input-Output Database, March 2010; IDE-JETRO Asian International Input-Output Database, 2005; OECD Bilateral Trade Database, March 2010; OECD Trade in Services, January 2010.

Seeing from this angle, it is interesting to note two additional observations. One is that the lower value of China indicates that the exported intermediate goods are consumed in the later stage of the global production network. Another important point is the relatively higher value of REI for several ASEAN countries, such as the Philippines, Singapore, Malaysia and Thailand. This suggests that they became suppliers to the earlier stage of the global supply chain between 1995 and 2005.

3. Conclusions and Policy Implications

This Policy Brief analysed the contribution to and engagement in the global supply chain of Asia-Pacific countries by measuring several globalisation indicators based on the harmonised input-output and bilateral trade databases developed by the OECD. It focused analysis on major structural changes in the Asian trade network from the perspective of fragmentation in the global supply chain.

Major findings include:

- While the European supply chain structure is relatively stable, some big change in production networks was observed in the Asia-Pacific region. The partner shares of East Asia have significantly increased as China has emerged as a dominant supplier.
- The shift of major export sectors in China and other Asian emerging economies from labour-intensive products to machinery and equipment and the greater import contents of final export products in these economies

have induced a significant transformation in the Asian trade network. This reflects the fact that the machinery production requires a wider variety of domestic and imported intermediate goods and services.

- Increased engagement of ASEAN and East Asian economies as suppliers of intermediate products to global production networks was evident in the period between 1995 and 2005. Four East Asia economies (China, Chinese Taipei, Japan and Korea) supplied about 17 % of world intermediate trade in goods and services in 2005, while ASEAN 5 countries accounted for about 6 % (Table 3). During this period, ASEAN countries increased the share of intermediate exports to East Asia, but not vice versa. For ASEAN, intra-regional intermediate trade remained almost unchanged in relative terms.
- Another related point is the relatively higher value of REI for several ASEAN countries. This indicator measures the share of re-exported intermediate components relative to total intermediate exports originally supplied by a particular country, so that higher values for ASEAN countries imply that they tend to be engaged in the earlier stage of global supply chains.

These findings have important implications for regional economic integration. ASEAN countries need to think the strategy for deeper integration from the perspective of the whole East Asian region and not just ASEAN *per se*.

It should be recalled in this conjunction that ASEAN Leaders decided in October 2003 to establish an ASEAN Economic Community (AEC) by 2020 as the end goal of regional economic integration (the Bali Concord II). Subsequently, they agreed in January 2007 to accelerate the AEC establishment by 5 years to 2015 (the Cebu Declaration) and adopted in November the ASEAN Economic Community Blueprint. Implementing the AEC according to its blueprint is critical to enhancing ASEAN's position within the global supply chain.

A recent study, based on CGE (Computable General Equilibrium) model simulations, concludes that the AEC is likely to increase ASEAN real income by 5.3 per cent or \$69 billion relative to the baseline scenario – more than six

times the estimated effect of completing the ASEAN Free Trade Area (AFTA), even under conservative assumptions (Plummer and Chia, eds., 2009). At the same time, considerably larger gains would be generated should the AEC be extended to include ASEAN's East Asian partners. Indeed, the AEC envisions ASEAN as a region distinct from most other regional groupings by its focus on outward orientation. As seen in this brief, ASEAN countries have indeed developed extensive trade links with East Asian partners.

A key challenge for ASEAN policy makers, therefore, is to “keep the AEC open” in the run-up to 2015 and strengthen the ASEAN's position as the hub of free trade agreements with outside partners. In this way ASEAN countries can foster overall trade growth and dynamism in the emerging post-crisis world.

¹ This study has consistently used the import statistics of the OECD Bilateral Trade Database to deal with the statistical shortcomings arising from re-exports and unclassified export items (see Guo *et al.*, 2009)

² The number of partner countries in which China's exports of office, accounting and computing machinery exceed 20% of the partner's total merchandise imports increased from 1 in 1995 to 31 in 2006.

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Box 1: Globalisation Indicators Using OECD Input-Output and Bilateral Trade Databases

The OECD has been updating its harmonised Input-Output tables since the mid-1990s (Yamano and Ahmad, 2006). The current edition (March 2010) has increased the country coverage to 30 OECD countries and 16 non-member economies including most of the Asia-Pacific economies. Due to the limited availability of benchmark Input-Output tables for the mid-2000s, the extrapolated data is estimated using annual supply-use tables and national accounts data sources for some countries.

Following the similar methodology of earlier publications (Hummels *et al.*, 2001, De Backer and Yamano, 2007), the import contents of k 's export* of product i is defined as

$$vs_i^k = u \mathbf{A}_m^k (I - \mathbf{A}_d^k)^{-1} \mathbf{EX}_i^k$$

where u is a unity vector which consists of value 1. \mathbf{A}_d^k and \mathbf{A}_m^k are the input coefficient matrices of domestically procured inputs and imported goods and services, respectively, from the national input-output tables. \mathbf{EX}_i^k is a vector of export which only has a value of sector i such as

$$\mathbf{EX}_i^k = [0, \dots, 0, \text{export}_i^k, 0, \dots, 0].$$

This vertical specialization is then separated to each route slice of vertical specialization by trade partners using bilateral trade database in goods and services. The country k 's import contents originated in country p (vs_i^{pk}) is estimated as

$$vs_i^{pk} = u \mathbf{A}_m^{pk} (I - \mathbf{A}_d^k)^{-1} \mathbf{EX}_i^k \text{ where } \mathbf{A}_m^{pk} = \text{diag}(ts_1 \dots ts_n) \mathbf{A}_m^k$$

$\text{diag}(ts_1^p \dots ts_n^p)$ is a diagonal matrix which the elements are partner p 's share to total imports of product 1 to product n . Therefore, $ts_1^p = \text{imports of product 1 from country } p / \text{total imports of product 1}$.

The indicators of cross-border fragmentation processes are then given as

- Import content share of exports for country a (ICE) = $\sum_p vs^{pa} / EX^a$,
- Induced country b 's exports by partner p 's exports (EPE) = $\sum_p vs^{bp} / \sum_p EX^p$, and
- Re-exported intermediate exports of country c (REI) = $\sum_p vs_i^{cp} / \sum_p IMD.EX^{cp}$.

Box 2: Framework for the Inter-Country Input-Output Model

The analytical framework of multi-regional input-output model is useful to examine the inter-country indirect effects, i.e. feedback effects and triangular trade effects. The derived inter-country input coefficient (A^*) directly gives the intermediate bilateral trade flows as

$$\text{Inter-country intermediate transaction} = A^* X$$

where X is the output vector and A^* is the inter-country input coefficient which is estimated from the each country's domestic (\mathbf{A}_d) and the import input coefficients (\mathbf{A}_m^{pk}) separated by partners¹⁾.

$$A^* = \begin{bmatrix} A_d^1 & \dots & A_m^{1,N} \\ \vdots & \ddots & \vdots \\ A_m^{N,1} & \dots & A_d^N \end{bmatrix} \text{ and } N \text{ is number of target countries.}$$

¹⁾ See Box 1 for the import input coefficients by partner.