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RECENT DEVELOPMENTS IN ASIAN ECONOMIC INTEGRATION: MEASURING TRADE INTEGRATION AND FRAGMENTATION

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ABSTRACT

This paper analyses the contribution to and engagement in global supply chains of Asian emerging economies by measuring several globalisation indicators based on the harmonised input-output and bilateral trade databases developed by the OECD. It focuses on major structural changes in the Asian trade network from the perspective of integration and fragmentation in global supply chains. It shows that greater fragmentation and higher dependence on supplies of intermediate goods and services from neighbouring countries have gone hand-in-hand and led to deepening economic integration between ASEAN and East Asia. ASEAN policy makers, therefore, need to consider their integration strategies from the perspective of the whole East Asian region and not just among ASEAN countries themselves.

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L'ÉVOLUTION RÉCENTE DE L'INTÉGRATION ÉCONOMIQUE EN ASIE : LA MESURE DE L'INTÉGRATION DES ÉCHANGES ET DE LA FRAGMENTATION

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RÉSUMÉ

Ce document analyse la contribution et la participation des économies asiatiques émergentes et en développement aux chaînes d'approvisionnement mondiales, en mesurant plusieurs indicateurs de la mondialisation établis d'après la base de données entrées-sorties et la base de données sur les échanges bilatéraux constituées par l'OCDE, après leur harmonisation. Il porte en particulier sur les évolutions structurelles majeures intervenues dans les échanges intra-asiatiques, sous l'angle de l'intégration et de la fragmentation dans les chaînes d'approvisionnement mondiales. Il démontre que l'intensification de la fragmentation et la dépendance accrue vis-à-vis des approvisionnements en biens intermédiaires et en services auprès de pays voisins sont allées de pair avec le renforcement, qu'elles ont d'ailleurs entraîné, de l'intégration économique au sein de l'ANASE et en Asie de l'Est. Les résultats présentés dans ce document, qui s'appuient sur des données concrètes, ont des répercussions significatives sur les stratégies d'intégration économique régionale mises en œuvre dans la région Asie-Pacifique. Les pays membres de l'ANASE doivent en particulier envisager leur stratégie de renforcement de l'intégration à l'échelle de l'Asie de l'Est dans son ensemble, et pas uniquement à celle de l'ANASE à proprement parler.

JEL : F14, F15, O19

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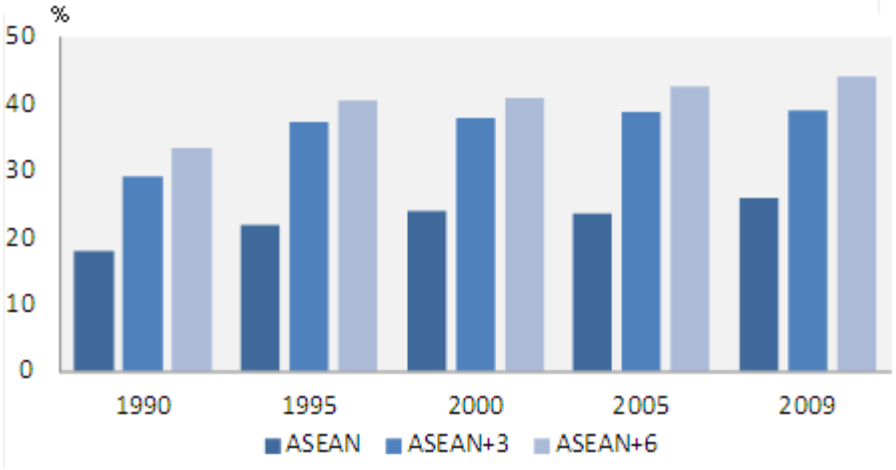
RECENT DEVELOPMENTS IN ASIAN ECONOMIC INTEGRATION: MEASURING INDICATORS OF TRADE INTEGRATION AND FRAGMENTATION

1. Introduction

Many Asian emerging and developing economies have recently shown remarkable dynamism and resilience to the global financial crisis. In particular, the region's most export-oriented economies, such as Korea, Malaysia, Singapore and Thailand, have displayed V-shape recoveries in 2010. These and other outward-oriented economies in the region have benefited considerably from China's early rebound due to their trade linkages.[1] As part of their strategic response to the need for rebalancing growth in 2011 and beyond, they are seeking to deepen regional economic integration and unleash the growth potential within the region.[2] In this paper, we propose several alternative indicators of trade integration and fragmentation to review recent developments in Asian economic integration and discuss policy implications.[3] Our goal is to expand OECD's harmonised input-output and bilateral trade databases to include 13 Asia-Pacific economies and to analyse major transformations in the region's inter-country production networks since the mid-1990s.

A key message arising from this paper is that the progress of Asian economic integration should be measured not only by standard trade integration indicators but also by applying input-output techniques to take into account the recent development of the region's inter-country production networks. This point can be well illustrated by Figure 1. Despite the tariff reductions and other market-opening measures that have taken place in the Asia-Pacific region, there have been only marginal increases over the past decade in the share of intra-regional trade relative to total merchandise trade for ASEAN 10 countries as a group. This share rose from 18% in 1990 to 24% in 2000, but afterwards it remained almost unchanged until 2005. Then the share inched up to 26% in 2009. Even if we look at ASEAN+3 or ASEAN+6 as a group and recalculate the intra- versus inter-regional trade shares for the same years, we observe a similar trend, though the size of intra-regional trade becomes larger for ASEAN+3 (39% in 2009) and ASEAN+6 (44% in 2009) relative to that of ASEAN alone.[4]

Figure 1. Share of intra-regional trade as percentage of total merchandise trade



Source: OECD (2010b)

The relative stability of intra-regional trade shares over the past decade may well be construed as an indication of Asia's overall trade growth based on outward (rather than inward) orientation. This example, however, reveals that merely monitoring intra- versus inter-regional trade shares would not tell us much about the regional integration landscape in Asia. Indeed the relative stability of intra-regional trade shares masks significant structural transformations taking place in the region's inter-country production networks. A thorough assessment of the current state of regional economic integration is thus a prerequisite for any well-crafted policy action for facilitating further integration and alleviating possible bottlenecks in the region.

In what follows, we first review major structural changes in the Asian trade network that have occurred since the mid-1990s and then discuss the region's progress towards deeper economic integration by applying the standard measure of intra-industry trade. Second, we present our indicators of trade fragmentation using OECD's harmonised input-output tables and bilateral trade databases to shed light on the linkages between trade fragmentation and regional integration. Finally, we conclude by discussing some policy implications.

2. Structural changes in the Asian trade network

2.1. Evolution of trade hubs

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. The latter remained largely stable during the period, as it can be seen by looking at the 2-digit level ISIC (International Standard Industry Classification) figures.[5]

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. A similar pattern is also observed for petrochemical products in India and Singapore. On the other hand, many Asian economies (except for Viet Nam) have significantly reduced export shares in the labour-intensive products, such as textiles, leather and footwear.[6]

Another major indication of the rapidly-evolving intra- and extra-Asian trade network is the rise of China as the dominant supplier to both regional and global markets. Table 2 shows the number of partner economies in which individual supplier country accounts for more than 15% of total merchandise imports. As can be seen, for instance, the number of partner economies in which China's export exceeds 15% of the partners' total imports in office, accounting and computing machinery jumped from 1one in 1995 to 11 in 2006 within the Asia-Pacific region and even to 34 if it is counted globally. The broad picture arising from this simple exercise remains intact also when using different thresholds. Doing so only alters the total number of partner economies listed in Table 2, but still sees China emerging as Asia's dominant supplier in a wide range of manufacturing industries for both the Asia-Pacific region and the rest of the world. For example, even if the threshold has changed to 20%, the number of partner economies in which China's exports of office, account and computing machinery has still significantly increased from 1 in 1995 to 31 in 2006.

Table 1. Leading export sectors in the Asia Pacific region (1995 and 2006, percentage of total exports)

ISIC Rev.3	Sector	1995	2006
Australia			
10-14	Mining and Quarrying	28%	43%
15-16	Food products, Beverages and Tobacco	15%	12%
27	Basic Metals	22%	18%
China			
17-19	Textiles, Textile Products, Leather and Footwear	34%	17%
30	Office, Accounting and Computing Machinery	4%	15%
32	Radio, Television and Communication Equipment	9%	19%
36-37	Manufacturing n.e.c; Recycling	12%	9%
Chinese Taipei			
17-19	Textiles, Textile Products, Leather and Footwear	13%	4%
24	Chemicals and Chemical Products	9%	11%
30	Office, Accounting and Computing Machinery	16%	8%
32	Radio, Television and Communication Equipment	15%	37%
India			
17-19	Textiles, Textile Products, Leather and Footwear	35%	21%
23	Coke, Refined Petroleum Products and Nuclear Fuel	2%	9%
24	Chemicals and Chemical Products	7%	12%
36-37	Manufacturing n.e.c; Recycling	20%	15%
Indonesia			
10-14	Mining and Quarrying	26%	27%
15-16	Food products, Beverages and Tobacco	7%	7%
17-19	Textiles, Textile Products, Leather and Footwear	18%	10%
20	Wood and Products of Wood and Cork	13%	3%
Japan			
24	Chemicals and Chemical Products	9%	10%
29	Machinery and Equipment, n.e.c	16%	16%
32	Radio, Television and Communication Equipment	19%	15%
34	Motor Vehicles, Trailers and Semi-Trailers	17%	19%
Korea			
17-19	Textiles, Textile Products, Leather and Footwear	16%	3%
24	Chemicals and Chemical Products	9%	10%
32	Radio, Television and Communication Equipment	27%	31%
34	Motor Vehicles, Trailers and Semi-Trailers	6%	10%
Malaysia			
10-14	Mining and Quarrying	5%	8%
30	Office, Accounting and Computing Machinery	12%	19%
32	Radio, Television and Communication Equipment	38%	36%

ISIC Rev.3	Sector	1995	2006
New Zealand			
01-05	Agriculture, Hunting, Forestry and Fishing	15%	12%
10-14	Mining and Quarrying	2%	3%
15-16	Food products, Beverages and Tobacco	38%	44%
Philippines			
15-16	Food products, Beverages and Tobacco	10%	3%
17-19	Textiles, Textile Products, Leather and Footwear	15%	5%
30	Office, Accounting and Computing Machinery	10%	15%
32	Radio, Television and Communication Equipment	30%	49%
Singapore			
23	Coke, Refined Petroleum Products and Nuclear Fuel	11%	19%
24	Chemicals and Chemical Products	6%	17%
30	Office, Accounting and Computing Machinery	32%	15%
32	Radio, Television and Communication Equipment	26%	26%
Thailand			
15-16	Food products, Beverages and Tobacco	17%	9%
17-19	Textiles, Textile Products, Leather and Footwear	12%	6%
30	Office, Accounting and Computing Machinery	16%	14%
32	Radio, Television and Communication Equipment	14%	17%
Vietnam			
01-05	Agriculture, Hunting, Forestry and Fishing	19%	7%
10-14	Mining and Quarrying	21%	23%
15-16	Food products, Beverages and Tobacco	17%	10%
17-19	Textiles, Textile Products, Leather and Footwear	32%	31%
World			
01-05	Agriculture, Hunting, Forestry and Fishing	4%	2%
10-14	Mining and Quarrying	6%	11%
15-16	Food products, Beverages and Tobacco	6%	5%
17-19	Textiles, Textile Products, Leather and Footwear	8%	6%
23-26	Chemical, Rubber, Plastics, Fuel, and Other non-mineral	16%	18%
27-28	Basic Metals and Fabricated Metal Products	6%	6%
29	Machinery and Equipment, n.e.c	9%	8%
30	Office, Accounting and Computing Machinery	5%	5%
31	Electrical Machinery	4%	4%
32	Radio, Television and Communication Equipment	8%	10%
33	Medical, Precision and Optical Instruments	3%	3%
34-35	Transport equipment	12%	11%
20-22,36-37	Other Manufacturing	7%	6%

Notes: Export shares were calculated from import-based bilateral trade statistics.
Source: OECD Bilateral Trade Database, 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

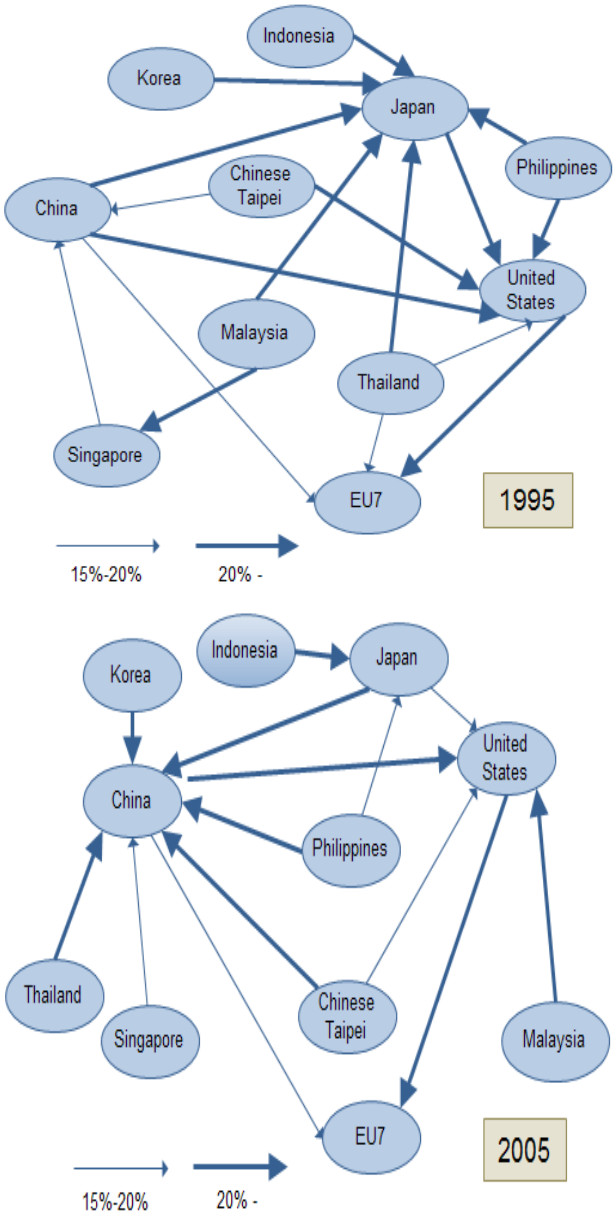
Note: The maximum number of partner countries is 13 for the Asia-Pacific and 48 for total.
Source: OECD Bilateral Trade Database, March 2010.

The major transformation of the Asian trade network can be further highlighted by counting the "dominant links" of trade flows in intermediate goods and services. As a dominant link we consider a country's intermediate exports in both goods and services to a particular partner country exceeding a given threshold percentage of that country's total intermediate imports. In the current exercise we use 15% and 20% as thresholds when exploring trade nodes (Figure 2).

Examining the bilateral intermediate trade data for 48 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 destination centres of intermediate goods and services. 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 2 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 global production networks over the past decade. In addition to 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 inter-country 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 Asia's supply chains 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 15.1% of world intermediate trade, 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%.

Figure 2. Major trade partners for Asia's intermediate exports in goods and services



Notes: EU7 is Belgium, Germany, France, Italy, Netherlands, Spain and United Kingdom. Arrows are depicted when a partner's share of a country's total exports is greater than 15%. The pointer of the arrow denotes the direction of the flow. Thin arrows denote flows between 15% and 20%. Thick arrows denote flows greater than 20%.

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)

		Destination						
		Asia-Pacific				NAFTA	Europe	RoW
Origin		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	1995	0.4%	1.0%	0.2%	1.6%	0.2%	0.4%	0.1%
Pacific	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.

2.2. Integration of ASEAN priority sectors

Here we take a closer look at the extent of trade integration in nine ASEAN priority goods sectors.[7] They are (1) agro-based products; (2) automotives; (3) ICT equipment (e-ASEAN); (4) electronics; (5) fisheries; (6) health care products; (7) rubber-based products; (8) textiles and apparel; and (9) wood-based products. These priority sectors have been identified as an important vehicle for advancing the Blueprint for the ASEAN Economic Community. The total annual export and import value of these nine sectors in six ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam) averaged USD 464 billion and USD 318 billion, respectively, during the period of 2006-2008 (Table 4). These sectors, taken together, accounted for 55 and 42%of total merchandise exports and imports, respectively. As a matter of comparison, Table 4 also shows the relative export and import shares of these nine priority sectors for China and India. They are found to be at least as important to China as to ASEAN and much less important to India.

Comparing the export structures of ASEAN and other East Asian economies helps reveal the extent to which ASEAN economies may be competing with China and India in the global market. Results show that most of the direct export competition involves a cluster of economies with similar per capita incomes.[8] In East Asia, five ASEAN economies, namely Indonesia, Malaysia, the Philippines, Thailand and Viet Nam, display a high degree of export similarity with China.[9] Empirical evidence also suggests that, contrary to the case of China, the export specialisation similarities between ASEAN countries and India are at best modest.[10]

Furthermore, Table 4 highlights that trade in the nine priority sectors considered is indeed dominated by two sectors, electronics and ICT equipment, in both ASEAN and China. Taken together, these two sectors accounted for nearly a third of total merchandise exports in both cases.[11] Looking more closely at the data, we see that ASEAN countries tend to specialise in exports of parts and components to global supply chains for electronic products. Conversely, China's export specialisation lies in downstream

segments as assemblers of final products, including ICT equipment.[12] On the other hand, India's export specialisation among the nine priority sectors is quite different from that of the ASEAN countries and China. In India, automotive products are predominant in the country's net exports. The export shares of ICT equipment and electronics are much smaller in India than in ASEAN and China.

Table 4. Trade in nine priority goods sectors: ASEAN, China and India (USD million and percentage; 2006-2008 annual average(a)) ASEAN (b)

		Exports		Imports		Trade
	Nine Priority Goods Sectors	Value	Share	Value	Share	Balance
1	Agro-based products	57,575	6.8	35,745	4.7	21,829
2	Automotives	22,451	2.7	19,597	2.5	2,854
3	ICT equipment (E-ASEAN)	86,781	10.3	41,855	5.4	44,926
4	Electronics	184,648	21.8	165,145	21.5	19,503
5	Fisheries	13,051	1.5	3,644	0.5	9,407
6	Healthcare products	15,527	1.8	15,885	2.1	-358
7	Rubber-based products	22,364	2.6	6,086	0.8	16,278
8	Textiles and apparel	35,741	4.2	18,450	2.4	17,291
9	Wood-based product	26,254	3.1	12,196	1.6	14,058
	Total of 9 PGS	464,392	54.9	318,605	41.5	145,788
	Total	845,506	100.0	768,535	100.0	76,971
	China					
		Exports		Imports		Trade
	Nine Priority Goods Sectors	Value	Share	Value	Share	Balance
1	Agro-based products	25,091	2.1	33,987	3.5	-8,896
2	Automotives	37,899	3.1	21,951	2.3	15,947
3	ICT equipment (E-ASEAN)	208,341	17.3	66,713	6.9	141,628
4	Electronics	174,840	14.5	191,876	20.0	-17,036
5	Fisheries	9,423	0.8	3,438	0.4	5,984
6	Healthcare products	15,776	1.3	12,483	1.3	3,293
7	Rubber-based products	9,380	0.8	9,937	1.0	-557
8	Textiles and apparel	168,967	14.0	26,023	2.7	142,945
9	Wood-based product	42,359	3.5	22,144	2.3	20,215
	Total of 9 PGS	692,075	57.4	388,552	40.5	303,524
	Total	1,206,563	100.0	960,046	100.0	246,517
	India					
		Exports		Imports		Trade
	Nine Priority Goods Sectors	Value	Share	Value	Share	Balance
1	Agro-based products	8,183	2.3	22,174	5.7	-13,991
2	Automotives	59,094	16.9	6,365	1.6	52,730
3	ICT equipment (E-ASEAN)	17,306	5.0	17,031	4.4	275
4	Electronics	27,379	7.8	23,255	6.0	4,124
5	Fisheries	1,683	0.5	4,694	1.2	-3,011
6	Healthcare products	8,973	2.6	9,249	2.4	-276
7	Rubber-based products	4,697	1.3	2,517	0.7	2,179
8	Textiles and apparel	16,780	4.8	13,126	3.4	3,654
9	Wood-based product	2,416	0.7	9,209	2.4	-6,793
	Total of 9 PGS	146,512	41.9	107,620	27.8	38,892
	Total	349,504	100.0	386,464	100.0	-36,960

Notes: (a) Except for Viet Nam in which trade data refer to 2006-2007;
(b) ASEAN figures refer to Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam.
Source: OECD calculation based on the UN Comtrade database

In order to shed more light on the extent of trade integration, we calculate the Grubel-Lloyd (GL) index of intra-industry trade (Grubel and Lloyd, 1975). The GL index measures the degree to which the trade of an individual country in a given product comprises both exports and imports. The level of such two-way trade is regarded as an indicator of a country's economic integration with the global economy.[13] The GL index is 100 if all trade in the category is intra-industry; a value of zero indicates all trade is in one direction (only exports or only imports) so that there is no intra-industry trade.[14]

The phenomenon of intra-industry trade (IIT) is conventionally seen as the two-way trade in manufactured products between similar countries in terms of income levels and relative factor endowment. Evidence, however, suggests the prevalence of IIT in the North-South context.[15] A study by the OECD (2010a) also argues that there are expanding opportunities for South-South trade. One source of such trade expansion stems from an increasing number of regional trade arrangements within the South that often leads to greater trade creation than diversion. For example, South-South trade liberalisation can make intermediate inputs cheaper and thereby stimulate South-South trade and eventually South-to-North exports. As discussed in the previous section, trade fragmentation is also beneficial to South-South trade, some of which takes the form of IIT (Box 1).

The GL indices of IIT are presented in Figure 3. Panel A compares the overall level of IIT in the nine priority sectors of six ASEAN and other selected Asian economies. As a matter of comparison, the United States and European Union (25) are also added to this panel. Furthermore, Panels B and C present the sectoral level of IIT with respect to the top four priority sectors in terms of export value: electronics and ICT equipment (E-ASEAN) for Panel B and agro-based products and textiles and apparel for Panel C.

On average, the six ASEAN countries are integrated with the global economy as closely as other Asia-Pacific countries, though IIT in some countries is much higher than in others. Singapore's IIT was highest at 70 in the panel; the city state is the hub of Southeast Asia as an entrepôt economy, so that its merchandise exports include a substantial amount of re-exports.[16] Overall the average IIT index of the six ASEAN economies (46) was eight points below that of the EU 25 (54) in 2006-2008.

Overall IIT masks large differences across sectors, however. For instance, Malaysia, the Philippines, Singapore and Thailand are highly integrated with global supply chains in electronics, but the situation seems quite diverse among them in the case of ICT equipment (E-ASEAN), as seen in Panel B.[17] This difference between electronics and ICT equipment reflects the industrial characteristic of these economies as suppliers of parts and components to global supply chains in electronic products. Turning to Panel C, much of trade in agro-food is of the inter-industry type for the ASEAN countries (except for Singapore). A similar trend can also be observed for textiles and apparel, which is rather surprising, given the involvement of transnational manufacturing and distribution activities and the fragmentation of production processes from fibres to yarn and fabrics to apparel and other textile products. A low level of intra-industry trade in textiles and apparel may reflect the greater trade barriers facing their producers.

Box 1. Fragmentation and Intra-Industry Trade

A basic characteristic of the fragmentation process lies in the distinction between production blocks and service links. A typical case of international fragmentation occurs when production is separated into two or more production blocks that are located in different countries (to take advantage of different factor prices between countries). The blocks must be economically linked by certain types of services that involve communication, transportation and other co-ordination costs. In other words, total production costs can be decomposed into the production cost *per se* that is subject to constant returns to scale and the service link cost that is treated as a fixed cost over a range of output, thereby introducing increasing returns. As production volumes expand, an initial vertically integrated supply chain may be replaced by an increasingly fragmented one, depending upon whether the total costs with fragmentation become lower than those without fragmentation.[1]

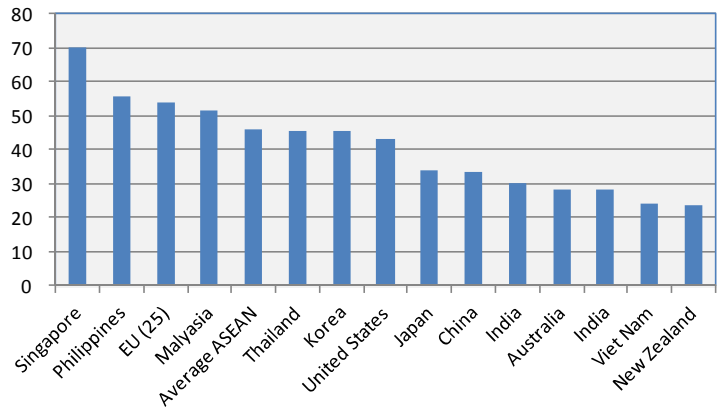
International fragmentation of vertically integrated supply chains is likely to increase intra-industry trade relative to total trade if various segments in the supply chains are classified in the same industrial category. Two major forces have greatly stimulated the process of international fragmentation, resulting in a higher degree of intra-industry trade. The first is liberalisation and deregulation of trade and investment regimes both nationally and regionally. The second is a significant reduction in communication and transportation costs. The spatial dispersion of production across countries usually entails costs of communication, logistics and co-ordination as well as other trade costs, due to restrictive trade and investment policies and practices. However, advances in telecommunication and transportation technologies and reductions in trade and investment barriers substantially reduce the cost of service links and thus facilitate fragmentation of production processes across national borders.[2]

[1] See Kimura and Ando (2005) for a detailed exposition of fragmentation and its application to East Asia.

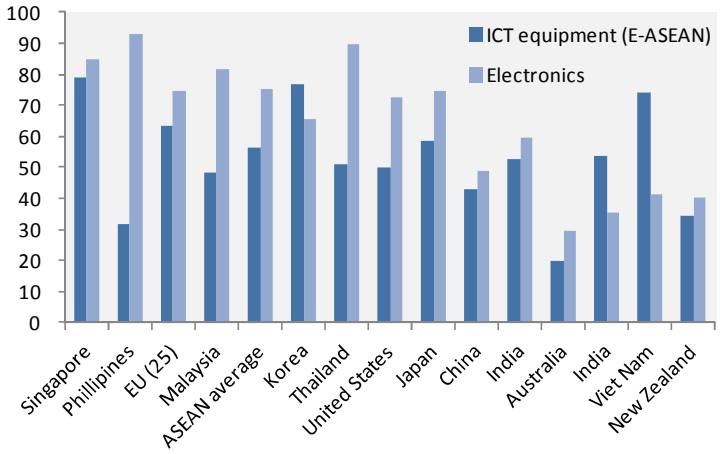
[2] See Jones *et al*. (2002) for further discussion.

Figure 3. Intra-industry trade (GL) index, 2006-2008 average (a)

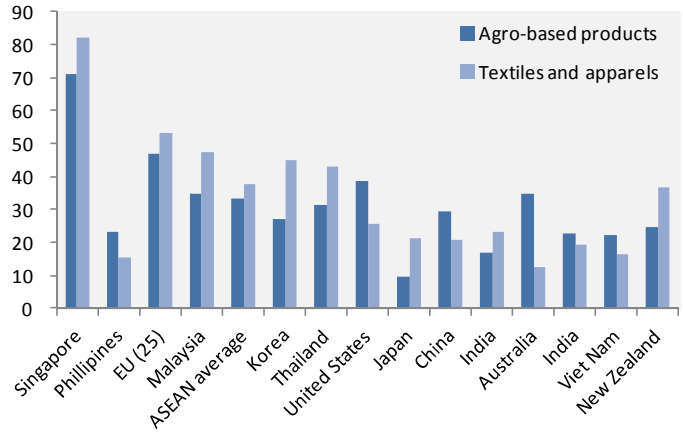
Panel A



Panel B



Panel C



(a) Except for Viet Nam for which the IIT index refers to the 2006-2007 average.
Source: OECD calculation based on the UN Comtrade database

3. Fragmentation and regional integration in Asia

In the previous section our descriptive statistics highlighted Asia's increased dependence on imported intermediate goods and services since the mid-1990s. Our analysis also suggested that the extent of trade integration, as measured by the GL index of intra-industry trade, differs significantly across sectors. For instance, both ASEAN and other East Asian economies are highly integrated with global supply chains in electronics, while agro-based products and textiles and apparel show low levels of intra-industry trade compared with those prevailing in the European Union.

The linkage between fragmentation and regional integration are further examined in this section by applying the input-output techniques. The country coverage and sector classification of the OECD's harmonised input-output (Yamano and Ahmad, 2006) and bilateral trade databases are described in Annex Tables A and B, respectively.

We first calculate the Hummels-Ishii-Yi's indicator of vertical specialisation. This indicator measures the import contents of exports, in other words, the induced imported inputs used for export production (Hummels *et al*. 2001). It therefore captures an important aspect of a country's engagement in global supply chains.[18]

In the single-country input-output framework, the import contents of country k's export of product *i* is defined as follows:[19]

$$vs_i^k = u\ \mathbf{A_m^k}\ (\mathrm{I}-\mathbf{A_d^k})^{-1}\ \mathbf{EX_i^k}$$

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 and imported goods and services, respectively, which are calculated from national input-output tables. $\mathbf{EX_i^k}$ is a vector of export value which only has a value of sector *i* such as

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

The induced intermediate imports (vs_i^k) are then 'sliced' by the origin country *p*'s import shares of bilateral trade as

$$vs_i^{pk} = u\ \mathbf{A_m^{pk}}\ (\mathrm{I}-\mathbf{A_d^k})^{-1}\ \mathbf{EX_i^k}$$

where $\mathbf{A_m^{pk}} = \mathrm{diag}(ts_1^p \ldots ts_n^p)\ \mathbf{A_m^k}$

diag ($ts_1^p \ldots ts_n^p$) is a diagonal matrix in which the elements are partner *p*'s share to total imports of product 1 to product *n*. Therefore, ts_1^p =imports of product 1 from country p divided by total imports of product 1.

Using the above notation of vertical specialisation, the import contents share of exports of country A (ICE^A) is written as

$$ICE^A = \frac{\sum_p \sum_i vs_i^{pA}}{\sum_i EX_i^A}$$

where vs_i^{pA} is the intermediate imports from country *p* induced by country A's exports of product *i* and EX_i^A is country A's exports of product *i*.

In addition, the phenomenon of international fragmentation is also captured from the perspective of an individual supplier of intermediate goods and services. Here we propose two alternative indicators. One is to measure the amount of country B's intermediate exports that are induced by country B's partners' exports (EPE^B), expressed as percentage of world exports, namely,

$$EPE^B = \frac{\sum_p \sum_i vs_i^{Bp}}{\sum_p \sum_i EX_i^p}$$

Another indicator is to measure the share of re-exported intermediate inputs relative to total intermediate exports originally supplied by a particular country C (REI^C), namely

$$REI^C = \frac{\sum_p \sum_i vs_i^{Cp}}{\sum_p \sum_i IMEX_i^{Cp}}$$

where $IMEX_i^{Cp}$ is the total amount of intermediate exports of product i supplied from country C to its partner country p.

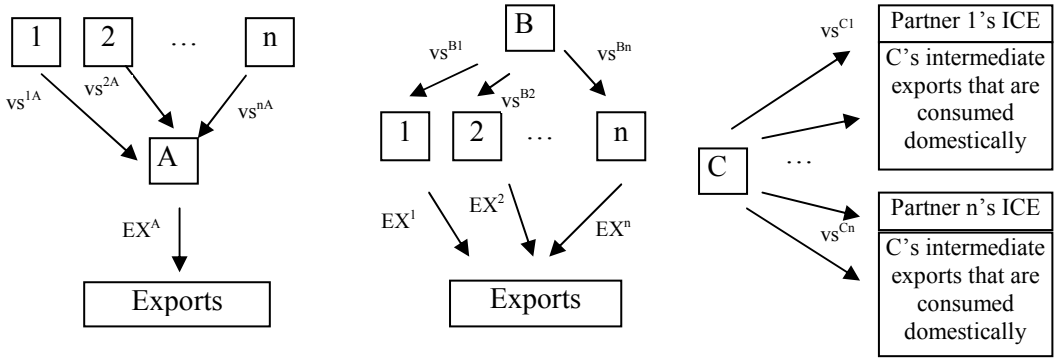
Figure 4 shows an illustration of these three indicators. The measurement results for selected Asia-Pacific economies are presented in Table 5 as well as Figures 5 and 6 below.

First, Table 5 reports the measurement results of the import contents share of exports (ICE) for *(i)* total products; *(ii)* higher and lower technology-intensive manufactured products and *(iii)* services with respect to 12 Asia-Pacific economies. It shows that the import contents (vertical specialisation) 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 to be smaller than those of manufacturing 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 economies.

Second, Figure 5 summarises the measurement results of the second indicator (EPE) which is the share of a country's intermediate exports induced by its partner's exports relative to world exports. 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 4. Three indicators of trade fragmentation



Imports contents share of exports of country A (ICE^A)	Country B's exports induced by B's partner's exports (EPE^B)	Country C's re-exported intermediate exports (REI^C)

Table 5. Import contents share of exports by industry group (ICE, 1995 and 2005)

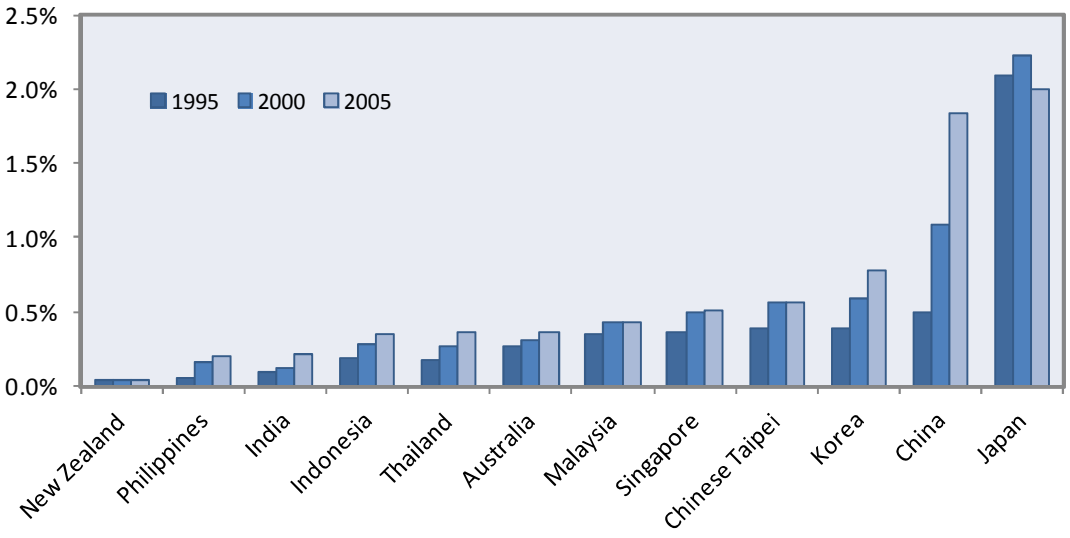
	Total		Manufacturing				Services	
			Higher technology manuf.		Lower technology manuf.			
	1995	2005	1995	2005	1995	2005	1995	2005
Australia	14%	14%	28%	25%	16%	20%	10%	11%
China	16%	25%	22%	34%	15%	20%	10%	14%
Chinese Taipei	35%	48%	45%	55%	34%	53%	14%	19%
India	10%	13%	16%	21%	12%	18%	8%	6%
Indonesia	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. Excludes energy imports (ISIC10-14 and ISIC40).

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. Includes interpolated and updated tables.

Figure 5. Induced intermediate exports by partner's exports (EPE)

Percentage of world exports in goods and services

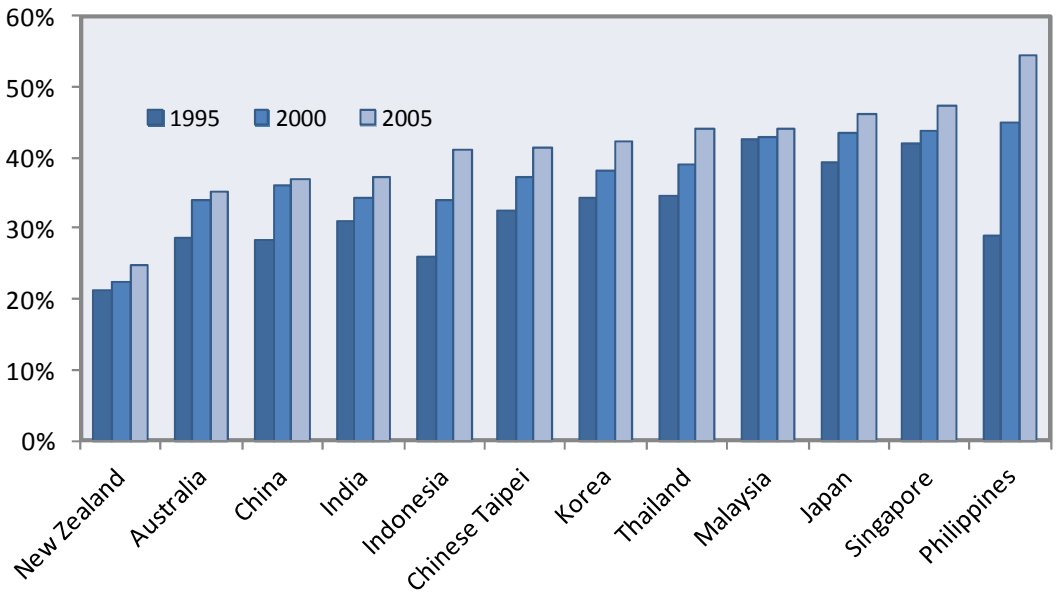


Sources: OECD Input-Output Database, March 2010; IDE-JETRO Asian International Input-Output Database, 2005; OECD Bilateral Trade Database, March 2010; OECD Trade in Services, January 2010.

In contrast to the measurement of ICE and EPE, country size seems to be neutral to the measurement of the third indicator (REI) which measures a country's re-exported intermediate inputs relative to its total intermediate exports (Figure 6). This indicator suggests the relative position of individual countries along global supply chains. The value of REI becomes high, if a country provides the parts and components used in the assembly factories of the trade partners where most of the final products are sold abroad. Conversely, the value of this indicator becomes smaller, if the country's main exports are used as intermediate inputs of domestically consumed goods. An example for the former is the Philippine electronic parts and components sold to Chinese and other Asian assemblers, whereas the latter includes Australian agricultural products consumed in Japanese and Korean food manufactures.

Seen from this angle, it is interesting to note some additional observations. One is the lower value of REI for China. This may be interpreted as indicating that China's exported intermediate products tend to be consumed at the later stage of global supply chains. This observation contrasts with the relatively higher value of REI for several ASEAN countries, such as the Philippines, Singapore, Malaysia and Thailand. Such difference suggests that ASEAN countries tend to supply their intermediate products that are used at the earlier stage of global supply chains.

Figure 6. Re-exported Intermediate Exports (REI)
Percentage of 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.

4. Conclusions

In this paper we propose several alternative indicators of trade integration and fragmentation and presented the measurement results of these indicators based on the OECD's harmonised input-output and bilateral trade databases. Our analysis highlights major transformations in Asia's inter-country production networks between 1995 and 2005 which is a result of the progressive advancement of Asian economic integration. Such structural changes can only be captured by applying input-output techniques. The results presented here point to the distinct role of several ASEAN countries as suppliers of intermediate goods and services to global supply chains. Other major findings are summarised below.

First, while the basic structure of European supply chains remained relatively stable, East Asia underwent some major changes in its inter-country production networks. The partner shares of East Asian trade in intermediate goods and services have significantly increased, as China has emerged as a dominant supplier within the region.

Second, 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 major transformations in the Asian trade network. This reflects the fact that the machinery production requires a wider variety of both domestic and imported intermediate goods and services.

Third, the increased engagement of ASEAN and East Asian economies as suppliers of intermediate inputs to global supply chains was evident in the period concerned. Four East Asia economies (China, Japan, Korea and Chinese Taipei) supplied about 17% of world intermediate trade in goods and services in 2005, while five ASEAN 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.

Fourth, several ASEAN economies appeared to be more closely integrated with global supply chains than other Asian economies largely because of the dominant role played by their electronics sector. The level of integration, as measured by the intra-industry trade index, differs widely across sectors.

Finally, the relatively higher value of REI was observed for several ASEAN countries (Figure 6). 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 engage in the earlier stage of global supply chains.

Greater fragmentation of production processes and higher dependence on supplies of goods and services from neighbouring countries have gone hand-in-hand and led to deepening economic integration in ASEAN and East Asia. The descriptive statistics and measurement results of our indicators presented here have important implications for the strategies of regional economic integration. In particular, ASEAN policy makers need to explore deeper integration within the whole East Asian region, and not just among ASEAN countries themselves.

ENDNOTES

1. See Asian Development Bank (2010) and OECD Development Centre (2010b, Chapters 1-2) for further details.
2. See, for example, Plummer and Chia eds. (2009), Fung et al. (2010) and OECD Development Centre (2010b, Chapter 3) for detailed discussions on regional economic integration in ASEAN and East Asia.
3. See Asian Development Bank (2008) and Capanneli et al. (2009) for efforts to measure the progress of Asian economic integration in a broader economic context.
4. "ASEAN+3" means the ASEAN 10 countries (Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam) plus China, Japan and Republic of Korea, while "ASEAN+6" refers to ASEAN+3 plus Australia, India and New Zealand.
5. 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). For availability of OECD's harmonised input-output tables and bilateral trade databases, see Annex Table A, while the ISIC sector classification is given in Annex Table B.
6. 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.
7. In addition, ASEAN priority sectors include five priority services sectors, such as ICT services (e-ASEAN), healthcare services, air travel, tourism and logistics. For the significance of ASEAN priority sectors, see De Dios (2007), Oktaviani et al. (2007), Wattanapruttipaisan (2008) and OECD Development Centre (2010b, Chapter 3).
8. See Petri (2009, Table 6-1) for further details.
9. The correlation of export shares with those of China exceeds 30% for all five ASEAN countries (see Petri ibid).
10. Among ASEAN economies, only Cambodia shows a higher degree of export similarity with India (see Petri ibid.).
11. This number reached 45% when ASEAN economies enjoyed a high-tech boom a decade ago.
12. This observation is also consistent with the input-output analysis of Asian trade networks presented in the following section.
13. See Austria (2004) and Oktaviani et.al. (2007) for the use of IIT in a regional context. See also Ecochard et al. (2006) for the relationship between intra-industry trade and economic integration.
14. The Grubel-Lloyd index for a product i of a given country (GLi) is derived from the formula: $GLi/100 = 1 - Abs\{Xi - Mi\}/(Xi + Mi)$ where Xi and Mi are exports and imports of product i, respectively, and $Abs\{Xi - Mi\}$ is the absolute value of their difference. The index is 100 when exports and imports of the product are equal and zero when either exports or imports are zero (so that trade is entirely one-way).
15. See OECD Development Centre (2010b, Chapter 3) for further details.
16. Re-exports accounted for 48% of Singapore's total merchandise exports in 2008 (WTO, 2009).
17. See, for example, Athukorala and Menon (2010) and Gangnes and Van Asshe (2010) for further discussions on intra-Asian trade in parts and components, especially those in electronics.
18. See WTO and IDE-JETRO (2011) for a detailed discussion of vertical specialisation.
19. We follow the similar methodology as those used in Hummels et al. (2001) and De Backer and Yamano (2007).

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ANNEX

Table A. Target countries of global production network model

	Name			Name			Name			Name	
AR	Argentina	la	DE	Germany	euw	NL	Netherlands	euw	CH	Switzerland	euw
AU	Australia	oa	GR	Greece	euw	NZ	New Zealand	oa	TH	Thailand	as
AT	Austria	euw	HU	Hungary	oe	NO	Norway	euw	TR	Turkey	rw
BE	Belgium	euw	IS	Iceland	oe	PH	Philippines	as	GB	United Kingdom	euw
BR	Brazil	la	IN	India	oa	PL	Poland	oe	US	United States	na
CA	Canada	na	ID	Indonesia	as	PT	Portugal	euw	VN	Viet Nam	as
CL	Chile	la	IE	Ireland	euw	RO	Romania	oe			
CN	China	ea	IL	Israel	rw	RU	Russian Federation	rw			
TW	Chinese Taipei	ea	IT	Italy	euw	SG	Singapore	as			
CZ	Czech Republic	oe	JP	Japan	ea	SK	Slovak Republic	oe			
DK	Denmark	euw	KR	Korea	ea	SI	Slovenia	oe			
EE	Estonia	oe	LU	Luxembourg	euw	ZA	South Africa	rw			
FI	Finland	euw	MY	Malaysia	as	ES	Spain	euw			
FR	France	euw	MX	Mexico	na	SE	Sweden	euw			

Notes: as is ASEAN, ea is East Asia, oa is other Asia-Pacific country, na is North America, la is Latin America, euw is EU15 and Norway and Switzerland, oe is other Europe, rw is rest of the world. The figures for Iceland and Viet Nam are not available for single country-based I-O indicators.

Table B. Sectors

	Sectors	ISIC3		Sectors	ISIC3
1	Agriculture, hunting, forestry and fishing	01-02-05	21	Utility	40-41
2	Mining and quarrying	10-11-12-13-14	22	Construction	45
3	Food products, beverages and tobacco	15-16	23	Wholesale and retail trade; repairs	50-52
4	Textiles, textile products, leather and footwear	17-18-19	24	Hotels and restaurants	55
5	Wood and products of wood and cork	20	25	Transport and storage	60-63
6	Pulp, paper, paper products, printing and publishing	21-22	26	Post and telecommunications	64
7	Coke, refined petroleum products and nuclear fuel	23	27	Finance and insurance	65-67
8	Chemicals	24	28	Real estate activities	70
9	Rubber and plastics products	25	29	Renting of machinery and equipment	71
10	Other non-metallic mineral products	26	30	Computer and related activities	72
11	Basic metals	27	31	Research and development	73
12	Fabricated metal products	28	32	Other Business Activities	74
13	Machinery and equipment, nec	29	33	Public admin. and defence	75
14	Office, accounting and computing machinery	30	34	Education	80
15	Electrical machinery and apparatus, nec	31	35	Health and social work	85
16	Radio, television and communication equipment	32	36	Other community, social and personal services	90-93
17	Medical, precision and optical instruments	33	37	Private households with employed persons	95-99
18	Motor vehicles, trailers and semi-trailers	34			
19	Other transport equipment	35			
20	Manufacturing nec; recycling (include Furniture)	36-37			