MEASURING GLOBAL FRAGMENTATION USING HARMONIZED INTERNATIONAL INPUT-OUTPUT DATABASE

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Abstract

The world production networks are increasingly fragmented, resulting in higher dependence on supplies of goods and services from neighbouring countries. This paper summarises approaches for measuring international production networks and presents selected results based on OECD's suite of internationally harmonised sectoral databases, including its Input-Output tables and bilateral trade database in goods and services. The target economies in these data collections have been expanded recently to cover major economies in emerging economies from the mid-1990s to the mid-2000s. Therefore, this study is better able to highlight the comprehensive spillovers and feedback mechanisms at the global level than earlier analyses using OECD data resources.

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1. Introduction

In recent decades, global economy particularly in emerging Asian countries [3] have experienced great changes in their trade structures with respect to their trading partners and the types and categories of goods traded. The industrial activities in each Asian country have also been greatly transformed in response to the shifts in demand for goods from neighbouring countries in Asia and the rest of the world.

Another notable phenomenon concerning industrial activity is the evolution of global supply chains, in other words, increasingly fragmented production processes distributed over country borders. Both macroeconomic indicators (De Backer and Yamano, 2007; Miroudout, *et al*., 2009) and firm level analyses (Kimura and Ando, 2005; Ando and Kimura, 2009; OECD, 2009) have, in recent years, confirmed the fragmentation of production networks in both Europe and Asia-American regions. Imports, particularly of intermediate goods and services, have become increasingly sensitive to export demand and domestic consumption and investment (Bussière *et al*., 2011).

This international division of production stages (Figure 1) can be considered as the consequence of various changes in social and economic environments such as the removal of trade barriers, the relative increase/decrease in labour costs, more favourable investment conditions and improved logistics and infrastructure services.

Figure 1. Domestic and global production networks

Since the shift in production activity is highly correlated to the changes in the relative positions in global production networks, competitiveness ranking and productivity of each country, the analysis of globalisation activity has risen high on the agenda for many countries in order to address policy questions such as:

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[3] The composition of geographical regions and country names in this paper follows the United Nations definitions of standard country or area codes for statistical use (http://unstats.un.org/unsd/methods/m49/m49.htm)

1) What has driven the changes in patterns of international trade in intermediate and final goods and services?

2) Who has benefitted the most from the evolution of global production networks (countries, regions or industries)?

3) How big are the indirect economic effects from neighbouring countries' shifts in demand?

There has been much research devoted to measuring *globalisation* using international harmonised database such as the import content share of exports (Hummels *et al.,* 2001), alternative demand-driven vertical specialization indicators (Uchida and Inomata, 2009; Yamano *et al.,* 2011), supply-driven vertical specialisation indicators (Meng *et al.,*2010), the effects of processing trade (Koopman *et al,*2008; Yang *et al.*, 2009) and factor decomposition analysis of vertical specialization (Meng *et al*., 2011).

Given the increased demand for such indicators, OECD and other international bodies have been expanding the country coverage of harmonised industry-based statistics and looking more closely at the classification standards used for statistics such as the International Standard Industry Classification (ISIC) for industry activity, Harmonized System (HS) for trade statistics and Central Product Classification (CPC) for product categories. Based on long experience in harmonising international data at the OECD, this paper summarises the methodology and measurement results of production network indicators for the target countries. Due to the availability of data sources, six economies from ASEAN and four economies from East Asia are respectively selected in our analysis. The rest of the world is divided into the countries and regions shown in Table 1.

Table 1. Target economies

The paper continues as follows: the next section introduces the methodology for measuring trade- related indicators using the latest data produced at the OECD. The third section describes the production structures of the target economies, while the fourth section introduces global fragmentation indicators. A summary is provided in the last section.

2. Changing patterns of global trade structures

Many observed evidences of trade figures clearly indicate the significant structure change among Asian trade network. In particular China and surrounding economies has increased the production capabilities of various final and intermediate goods and played a role as the world factory region. All of our target Asian countries increased the export dependencies since the mid 1990s (Figure 2). In 2005, Malaysia and Singapore notably have high dependency indices.

Figure 2. Export dependency (Export of goods and services / GDP)

At the same time, it is often argued that the imports of intermediate goods have also increased in these countries to produce the exporting goods (Figure 3) and there is a limitation of export oriented growth of output and GDP. In particular, the ratio of total intermediate imports to output has increased in Vietnam (12.3%), Chinese Taipei (5.5%), India (8.1%) and Malaysia (5.0%).

Figure 3. Intermediate imports ratio (Intermediate imports to output)

The net trade effects, in fact, are very different among Asian countries as observed in the indicator of net trade ratio to total expenditure in **Figure 4**. Having said that, in general, the trade surpluses have increase between 1995 and 2005 and contributed economic growth in most countries. It also applies to some emerging European countries such as Czech Republic, Estonia, Hungary and Norway (Annex Table B1).

Figure 4. Net trade contribution to total final expenditure (GDP)

As we have seen, an impact from trade activity on domestic economy is widely different. At the same time the global structure (industry share) of goods exported are basically constant between 1995 and 2005 (Error! Reference source not found.). This Error! Reference source not found. also shows that the global shares of end-use structure i.e. intermediate and final goods categories have not significantly changed although the evolutions of production networks in major countries are evident.

Figure 5. Total merchandize exports global share (1995 and 2008)

The global trade structure seems stable from early 1990s to the late 2000s, but this does not assure the inter or intra region (country group) trade also keeps stable. Here, if a country's intermediate exports to

a particular partner country exceed a given threshold percentage of total exports (thresholds of 15% and 20% are used in our exercise), we consider such trade node as a dominant link. Charts with dominant link flows such as **Figure 6** and **Figure 7** enable us to understand the changes in relative important trade links in Asia Pacific region. In particular, the emergence of China as a dominant demand center, has significantly impacted the location-shift of its partner country's exports.

Figure 6. Dominant trade links between countries (exports of intermediates, 1995)

Figure 7. Dominant trade links between countries (exports of intermediates, 2005)

Another global share of trade structure can be explored by the total merchandize export share by regions (Figure 8). The regional export shares over 1995 and 2008 are stable for most end-use categories except for capital goods. Further increasing share of East Asia mainly due to the Chinese exports of capital goods and the emergence of East European region as a supplier of capital goods are the notable changes.

Figure 8. Total merchandize exports by regions (1995 and 2008)

On the other hand, the trade structures of leading exports (Table 2) are widely different across countries and the further international division of labour in these leading export goods are implied from Figure 9. The characteristics of exports destinations from Southeast Asia and East Asia are broadly separated. While most of the leading products e.g. mining, food and textile products of Southeast Asian countries are mainly supplied to East Asian countries, various machinery products, East Asian leading industries are purchased by other large economies i.e. Western Europe and North America.

Table 2. Selected leading exports (partner shares, 2005)

Figure 9. Selected leading export by partner regions (1995 and 2005, 100=total exports)

Recently developed bilateral trade database by industry and end-use category allows us to analyse not only the type of goods supplied and purchased from trade partners, but also gives the insights of each country's participation patterns in global production chains (Figure 10 for China and Chinese-Taipei). See Annex C for other Asian country's evolution patterns of exported goods by industry and end-use category). The notable structural changes for Asian countries are summarised as follows:

Figure 10. Export share by industry and category (China and Chinese Taipei)

- Australia: The intermediate and final goods shares of major export goods are stable. The share of mining products (ISIC10-14) has significantly expanded partially due to the increases in price of mining products.
- Japan: The industry and end-use category structures of exported goods are basically stable.
- Korea: Household consumption goods of textile industry are replaced by capital goods of precision equipment (ISIC33) and general machinery equipments (ISIC29). Computing machinery (ISIC30) has also lost the share.
- United States: The industry and end-use category is stable during 1995 to 2009.
- Philippines: Most parts of export share of textile products have replaced by the share of radio, television and communication equipments (ISIC32). Unlike China's exports of radio, television and communication equipments, the exports are mainly end up as intermediate parts and equipments in partner countries.
- Singapore: Singaporean exports are previously specialized in final goods of office machinery (ISIC30) and intermediates of communication equipments (ISIC32). While the exports of communication equipments remain, exports of office machinery have replaced the position by petro-chemical products (ISIC23-24).
- Thailand: The export shares of food products (ISIC15-16) and textile products (ISIC17-19) have decreased and chemical products (ISIC24) and motor vehicles (ISIC34) are emerging. The variety of exporting goods has increased in Thailand.
- Viet Nam: The agricultural export has lost the majority share and capital and intermediate of machinery sectors (ISIC 29, 30, 31 and 32) have increased.
- France:
- Germany:

- Italy:
- United Kingdom:
- Turkey:

3. Economic and production structures of target economies

The trade statistics related indicators of previous section imply that the global supplies of goods and intermediates for large OECD economies and world total remained stable while the exporting structures of emerging countries have significantly changed. The reasons for this can be further analysed using the internationally harmonised input-output database.

The traditional indicator to analyse the overall impacts of marginal changes in final demands on domestic economy is well known as backward and forward linkage indicators. The former indicator measure the impact of unit increase in final demand on output (*BL*) is written as

$BL = u\ (I\text{-}A)^{-1}$

where, *u* is a unifying row vector of 1 and A is input coefficient matrix which is Z X*

where Z is intermediate transaction matrix and X* is a diagonal matrix of inverse of output. The term of $(I\text{-}A)^{-1}$ is referred to as Leontief Inverse.

Measurement results using OECD Inter-country Inter-industry model (2011) for both Southeast and East Asia indicate that (Figure 11 and Figure 12) machinery sectors (ISIC Rev.3: 32-35) have relatively higher backward effects on their economy and primary sectors (ISIC Rev.3: 01-14) have relatively less indirect ripple effects on other sectors.

Figure 11. Backward linkage (Southeast Asia)

Figure 12. Backward linkage (East Asia)

Alternatively, forward linkage measured by supply-driven model (Ghoshian inverse) is given as

$FL = (I\text{-}G)^{-1}\ u$

where u is a unifying column vector of 1 and G is allocation coefficient matrix = X* Z.

The forward linkage indicators measured for Southeast and East Asian regions show that Mining and quarrying (ISIC10-14) and Basic metals (ISIC 27) sectors are located in the upper stream of the industrial chain (Figure 13 and Figure 14). The exceptionally high numbers are

observed for Electrical machinery's forward linkage value of 2000 and 2005 in Southeast Asia.

Figure 13. Forward linkage (Southeast Asia)

Figure 14. Forward linkage (East Asia)

If we define a key influential sector as a sector that has the higher magnitude of backward and forward linkage indices, the key sectors are selected by the multiple of backward and forward indicators. The material manufacturing sectors such as refined petroleum products, chemical products and basic metals are chosen as key sectors in each region. It should be noted again that there are some exceptions. Electric machinery has one of highest linkage impacts on economy in Southeast Asia, Western Europe and Northern America. Office and computing machinery is also selected as a key sector in ASEAN economy.

Figure 15. Key sectors by region

The Leontief inverse derives not only the economic impacts in terms of production, but it is also used as the multipliers of employment and income. For example, the value-added induced by final demand vector (F) can be defined as

$V(\text{I-}A)^{-1}\text{ F}$

where V is a vector of sectoral GDP-Output ratio. The average value-added induced by each component of final demand expenditure e.g. household consumption and gross fixed capital formation in a country is then written as

$$\left(V(I-A)^{-1}F\right)/(uF)$$

where u is unifying row vector.

Applying above formula to the input-output tables of our target economies, the decreasing in domestic value-added impacts over 1995 and 2005 are confirmed both for household consumption and gross fixed capital formation (Figure 16 and Figure 17). These indicators, in general, imply that the external leakages of economic impacts are significant in smaller ASEAN countries particularly for Thailand and Viet Nam.

Figure 16. Domestic impact ratio of household consumption expenditure (1995 and 2005)

Figure 17. Domestic impact ratio of gross fixed capital formation expenditure (1995 and 2005)

4. International fragmentation indicators

The framework of single country input-output model

As we have seen in the previous sections, the marginal economic effects of domestic final expenditures i.e. household consumption and capital investment are widely different across countries (Figure 18). It is also true for the domestic value-added (or import contents) of exports. **Import contents share of exports** (vertical specialization), a well known indicator on globalisation indicates the backward effects of global supply chains of exports. The indirectly imported intermediate values that are included by country's exports (ICE) is defined as

$$ICE = uAm(I - Ad)^{-1}E \Big/ uE$$

where u is a unifying row vector of 1, Am is import coefficient (import matrix / output), Ad is input coefficient of domestically provided goods and services (domestic transaction matrix / output), E is export vector of goods and services. Import contents share can also be estimated for individual sector's export.

Figure 18. Import content of exports (Total industry)

Figure 19. Import content of exports (Assembly manufacturing)

Figure 20. Import content of exports (Other manufacturing)

Figure 21. Import content of exports (Services)

Firstly, the natural resource oriented countries depend less on imported intermediates because these industries are primary suppliers to other industries. Also, large industrialized economies

depend less imported goods due to the existence of wider variety of domestic suppliers. Divergent parts, equipment and services are available in larger countries.

Note that the rest of the economic demand induced by exports is equal to domestic contents i.e. value-added (IVE) , so ICE is rewritten as

$ICE = 1 - IVE$,

where *IVE* is $uV(I - Ad)^{-1}E \big/ uE$.

The marginal impacts on domestic value-added had decreased over 1995-2005 for most Asian countries (Figure 22). However, this marginal impact has increased in natural resource oriented economies such as Australia mainly due to the changes in the price effects of mining products.

Figure 22. Induced value-added by unit exports

Other final expenditures of domestically provided goods and services e.g. government expenditure and gross fixed capital formation, indeed, induce intermediate imports as well. The induced intermediate imports is, therefore, sum of each final expenditure components and written as

Intermediate imports = $u\left(Am(I - Ad)^{-1}(E + Fdc + Fdk + Fdi)\right)$

where Fdc is final consumption of domestic goods and services, final demand of domestic capital formation and Fdi is changes in inventories of domestic goods.

The total imports are then described as a sum of induced intermediate imports and direct imports of final goods and services as

Total imports = $u\left(Am(I - Ad)^{-1}(E + Fdc + Fdk + Fdi) + Fmc + Fmk + Fmi\right)$

Figure 23. Direct imports of final demand and induced intermediate imports (1995 and 2005)

The evidences of increased inter-country leakages of economic impact of unit increased in final expenditures i.e. exports, consumption and capital formation are confirmed by the backward linkages indicators separated by geographical regions or any other groups such as OECD member group and BRIICS.

The value-added by industry of each country includes the labour income components. The impacts on job market induced by exports of each country are broadly implied by the indicator of value-added induced by unit exports. More specifically, the jobs induced by unit exports is given as

$$IJE = uJVe(I - Ad)^{-1}E \big/ uE$$

where *Ve* is a vector of labour compensation – output ratio and *J* is the vector ratio of number employment to labour compensation.

However this linear relationship between labour compensation and number of jobs are not exactly stable (e.g. working hour adjustment and some limitations in instant adjustability of labour market due to the demographic and human capital availability of each region in country).

Figure 24. Number of jobs induced by unit exports (1995 and 2005)

Inter-country Input-output model framework

The evolution of fragmented production processes in different geographical regions and increased linkages of economic activity across borders have changed the structures of international spillover and feedback effects, the ripple effects on other countries. One effective database used in regional economics to record the transactions between regions is interregional input-output database.

The inter-country input-output database is useful data to measure the economic dependencies across countries in order to interpret the various economic policies e.g. formation of custom union, free-trade agreement and regional market integration. This database is not only useful to measure the globalisation indicator, but also it can be used as a fundamental data of various

economic empirical models such as international computable general equilibrium model, environmental pollution embodied in international trade and international diffusions of innovation activities (R-D expenditures).

At OECD, using the harmonised input-output tables and bilateral trade coefficients in goods and services, the inter-country input-output tables for the reference years of 1995, 2000 and 2005 are estimated applying the multi-regional input-output model techniques previously established for regional analyses (Chenery-Moses; Isard).

The model specification and estimation procedures are briefly summarised as follows:

a) Preparation of Input-Output tables for reference years using the latest published data sources e.g. supply and use tables, national account and trade statistics.

b) Preparation of Bilateral import data in end-use for reference year

c) Conversion of c.i.f. price based imports to fob price-based imports to minimize the inconsistency issues of mirror trade (import=export) in international I-O system.

d) Separation of import matrix of national I-O tables by bilateral trade statistics

e) Total adjustment (missing sectors, trade with rest of the world, etc)

Once the inter-country table estimated, the countries can be easily aggregated to any regional blocs such as NAFTA, EU, and ASEAN. The regional aggregated database table allows us to examine directly the regional average figures of production and trade structures.

The non-domestic part of induced output i.e. **inter-country spillover effects,** have increased particularly in European region. This spillover effects is measured by the ratio of inter-country part of Leontief inverse (B). For simplicity, three countries example can be expressed as follows.

$$B = \left[(I - A)^{-1}\right] = \left[\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}\right]^{-1} = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix}$$

The spillover effect (S_1), the output induced in foreign countries due to the increase in final expenditure of country 1 is then defined as

$S_1 = (B_{21}+B_{31})/(B_{11}+B_{21}+B_{31})$.

The spillover magnitudes are widely different across Asian countries (Figure 25 for Asian/Pacific countries and Annex for all target countries). While the induced output remains within domestic economy in large countries (China, India and Japan), the spillover magnitudes are greater in smaller Asian countries. In particular, the domestic impacts of final expenditures are less in the higher income countries in Southeast Asia (Malaysia, Singapore and Thailand). Nonetheless, most of the ripple effects of these countries are still confined in the other Asian countries; more than 70% of total economic effects are induced within Asia/Pacific region.

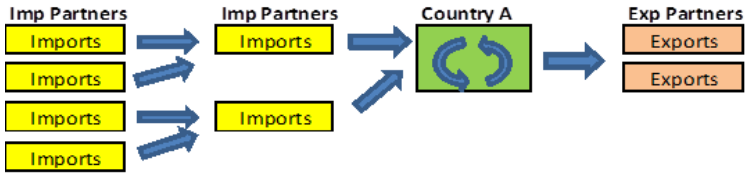
Figure 25. Inter-country spillover effects

More advanced inter-country I-O based indicator such as **Fragmentation chain index** measures the complete effects involved in induced intermediate trade regarding increases in country's exports of final expenditure. While the import contents share index of single country framework does not measure the further inducement effects of trade by partner countries, our fragmentation chain index explicitly measure the indirect trade flows.

Figure 26. International Fragmentation Production Process

Figure 26 illustrates an example of international fragmentation in multi-country framework. Both target country A and B import total of 40-unit intermediate goods from the rest of the world (ROW) to produce 100 units exporting goods for the ROW. In this case, the

conventional VSs for both counties are measured at the same level of 40%. However, the component (structure) of imported intermediate goods for both countries is different. For country A, its imports include 10-unit high fragmentation intensity goods (machinery), and 30-unit low fragmentation intensity goods (textile). On the other hand, Country B's imports comprise 30-unit high fragmentation intensity goods, and 10-unit low fragmentation intensity goods. As a result, the further induced intermediate imports due to country A's exports may be 8 units, and for country B, the figure should be larger than the case of country A since for producing high fragmentation intensity goods, much more intermediate imports will be induced in ROW by global production networks. When considering the spillover impact by the way of the ROW, it is easy to see that the participation degrees measured by the proposed Fragmentation Chain Index for the target countries are different.



Let the global intermediate transactions (N countries x S sectors) induced by final demand is written as

$$Z = A\hat{diag}([I - A]^{-1}F),$$

where F is a column vector of final demand (N countries x S sectors).

Direct intermediate imports of country A (FCd) is then defined as $FCd = u(\Theta \otimes Z)u \Big/ \sum E$

where u is again unifying vector, Θ is the element of 1 for the cells corresponds to import matrix of country A, and $\otimes$ represents a cell-by-cell multiplier calculation.

The rest of international fragmentation transactions (FCr) is $FCr = u(\Psi \otimes Z)u \Big/ \sum E$

where Ψ is a matrix with element of 1 for the off-diagonal parts. For simplicity, the three regions examples can be expressed as follows

$$Z = A \cdot diag\left[(I - A)^{-1} \begin{bmatrix} F_1 \\ 0 \\ 0 \end{bmatrix} \right] = \begin{bmatrix} z_{11} & z_{12} & z_{13} \\ z_{21} & z_{22} & z_{23} \\ z_{31} & z_{32} & z_{33} \end{bmatrix}$$

$$FCI_1 = FCd + FCr = u \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \otimes \begin{bmatrix} z_{11} & z_{12} & z_{13} \\ z_{21} & z_{22} & z_{23} \\ z_{31} & z_{32} & z_{33} \end{bmatrix} u / F_1 + u \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} z_{11} & z_{12} & z_{13} \\ z_{21} & z_{22} & z_{23} \\ z_{31} & z_{32} & z_{33} \end{bmatrix} u / F_1$$

$$= (z_{21} + z_{31}) / F_1 + (z_{12} + z_{32} + z_{13} + z_{23}) / F_1$$

The indirect induced trade flows are not explicitly measured in conventional vertical specialization index of single-country based framework. For most countries, total fragmentation chain has increased between 1995 and 2005, and contributions of indirect imports are evident. The conventional vertical specialisation measures underestimate the fragmentation magnitudes around 10 to 20%. The measurement result of Indonesia, for example, clearly illustrates the differences between conventional measurement results and overall effects. Although the direct effect decreased in 1995 to 2005, the total fragmentation magnitude increased due to the significant increase in indirect part. It is also true for most countries that the indirect fragmentation chain index has increased more, so the global value chains become longer and inter-country spillover effect plays more import role in the whole production processes.

Figure 27. Fragmentation chain index (1995 and 2005)

Figure 28. Fragmentation chain index for Asia (1995 and 2005)

Average propagation length (APL) indicator in multi-country framework, another advanced analysis using inter-country input-output model, indicates the complexity of inter-industry transaction both domestic and inter-country production network. APL is an indicator which indicates the complexity of inter-industrial transactions in the input-output table (Dietzenbacher and Romero, 2007; Romero *et al*., 2009; Inomata, 2009). While backward linkage indicator only shows the overall effects of marginal changes in final demand for each sector in target economy, APL allows us to evaluate the fragmentation process into spatial fragmentation and functional fragmentation.

The APL indicator APL_{ij} can be defined as follows:

$APL_{ij}=H_{ij}/B_{ij}$ for $i \neq j$, $L_{ij}=H_{ij}/(B_{ij}-1)$ for $i=j$

where, $B = (I-A)^{-1} = (I+A+A^2+A^3\ldots)$ is Leontief inverse, $H=(I+1A+2A^2+3A^3\ldots)=B(B-I)$ is the APL related matrix.

Using single national I-O table (with *n* sectors), the average figures of propagation by industry and country are given as

- Average propagation length of industry i $= \sum_j APL_{ij} / n$.
- Average propagation length of total economy $= \sum_i \sum_j APL_{ij} /(nn)$.

In the framework of inter-country I-O model, the APL indicator can be easily decomposed into domestic and internationally fragmented parts separately as shown below:

$$APL = APLd + APLm$$

- $$\begin{bmatrix} APL_{11} & APL_{12} \\ APL_{21} & APL_{22} \end{bmatrix} = \begin{bmatrix} APL_{11} & 0 \\ 0 & APL_{22} \end{bmatrix} + \begin{bmatrix} 0 & APL_{12} \\ APL_{21} & 0 \end{bmatrix}$$

The measurement results for Asian and clearly indicate that the propagation production processes has increased particularly in foreign propagation. The magnitude of changes in this index basically follows the result of fragmentation chain index.

Figure 29. Average propagation link indicator in multi-country framework

Finally, **Production stage decomposition analysis** is a technique developed to extract the transaction at each production process. Using the input coefficient of inter-country input-output table, following decomposition technique explicitly gives the orders of economic impacts on domestic and foreign economies for each production stage

Leontief inverse (B) = $(I-A)^{-1}$ where I is diagonal matrix and A is input coefficient.

$B= (I+A+A^2+\ldots)$

For example, 95% of original output is reproduced by the 4^{th} stage of production network in the OECD inter-country input-output table i.e.

0.95 sum $((I-A)^{-1}$ FD) = sum $((I+A+ A^2+A^3+ A^4)$FD). However, the number of indirect production stages to reach 95% of original output is very different across sectors and countries. In general, country has complex machinery manufacturing sectors such as automobile assembly sectors have high backward effects and depends on longer supply chains, while most of services sectors demand is accomplished by few stages of indirect inter-industry linkages.

Note that more detailed analysis of production stage decomposition is to decompose the transaction by each sectoral linkage and gives the order of magnitude of linkages in the perspectives of both country and industry. This analysis explicitly gives the insights of trade and industry policy implications at detailed sectors of specific bilateral relationship, but the computing requirement demand is enormous. It is recommended that the sectors and countries to be grouped at certain levels to achieve the results in time.

Figure 30. Spillover of GDP by production stages (ASEAN, East Asia and Other Asia/Pacific)

Figure 31. Spillover of GDP by production stages (EU15+Switzerland+Norway, Other Europe, North America and Latin America

5. Concluding remarks

Firstly, the measured indicators of bilateral trade in end-use and input-output fragmentation indices, in general, show that the participation intensities on global production network of large and developed countries are relatively stable compared to the emerging countries. These differences imply two evolutionary patterns of division of labour across countries.

1) The industrial specialisation is less visible in larger countries, because their domestic production networks are much more self-contained that those in smaller countries.

2) The relative positions in global production networks of smaller economies, on the other hand, are sensitive to the changes in external factors such as removal of trade barriers and changes in final expenditure patterns in larger countries.

Secondly, it is clear from the impact of globalisation that all countries have increased the dependencies on external markets both for inputs (intermediate and final goods imports) and outputs (exports). It is thus evident that the marginal gain in terms of value-added from exports and other final demand components has decreased in most countries. However, the total value added from trade increased in Asian countries, as the total volume of exports rose.

The measurement limitation of the framework of single-country, input-output model is obvious, and the inter-country, input-output model is a useful tool to understand the inter-country spillover.

However, the inter-country, input-output model is very data-intensive approach. It requires highly harmonised data from neighbour countries to measure the inter-country economic spillover. We should therefore suggest that the statistical cooperation across Asian countries become much more important to pursue this research avenue.

As we have seen that the evolution of production networks is affected by complex factors, the unidirectional impact of regional integration is not clearly identifiable.

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FIGURE 1. DOMESTIC AND GLOBAL PRODUCTION NETWORK

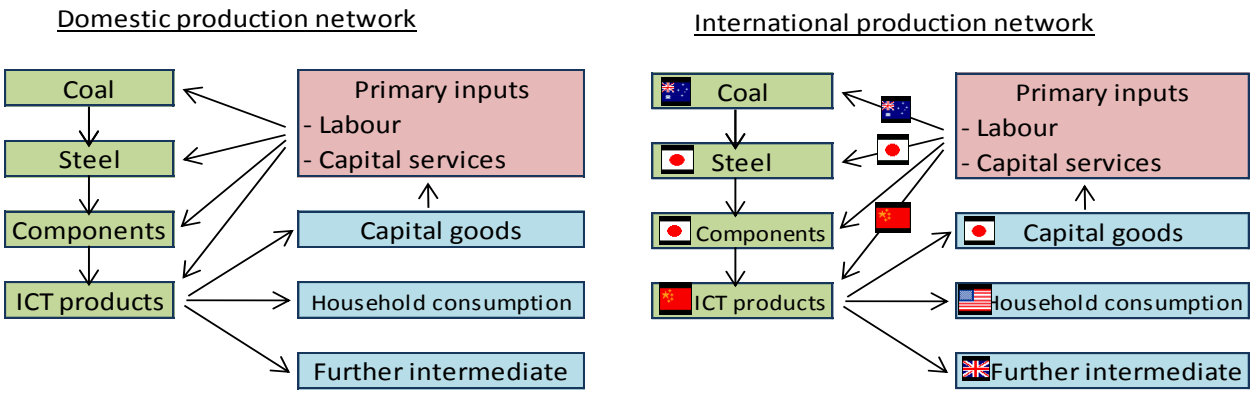
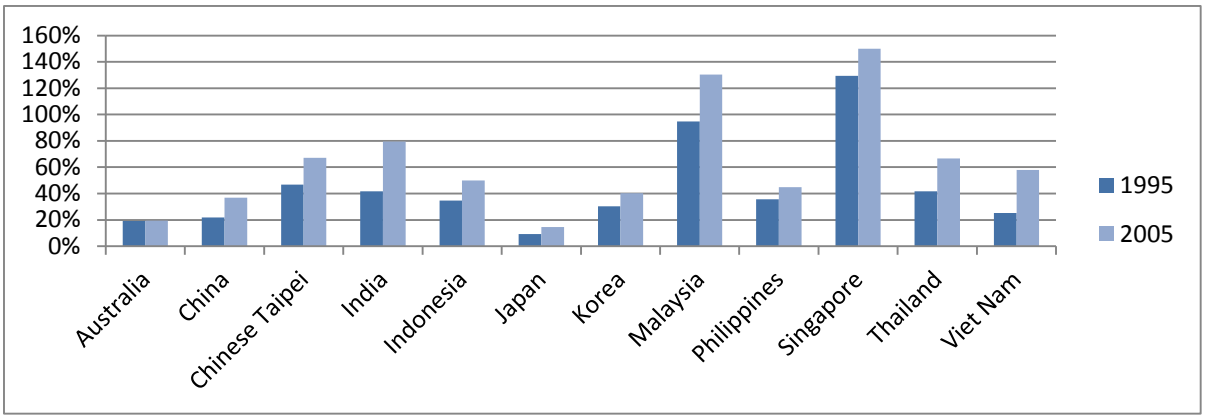


Table 1. Target economies

Region	Country	Population (Thousand)		
		1995	*2000*	*2005*
Southeast	Indonesia	191,501	205,280	219,210
Asia	Malaysia	20,594	23,274	25,633
	Philippines	69,965	77,689	85,496
	Singapore	3,480	4,018	4,267
	Thailand	60,140	62,347	65,946
	Viet Nam	72,957	78,663	84,074
East	China	1,210,969	1,266,954	1,312,253
Asia	Chinese Taipei	21,357	22,277	22,770
	Japan	125,571	126,927	127,767
	Korea	45,093	47,008	48,138
Other	Australia	18,072	19,153	20,395
Asia	India	953,148	1,042,590	1,130,618
	New Zealand	3,673	3,858	4,134
North	Canada	29,302	30,689	32,312
America	Mexico	91,725	98,439	103,947
	United States	266,278	282,194	295,896
Latin	Argentina	34,772	36,939	38,732
America	Brazil	161,692	174,175	186,075
	Chile	14,410	15,419	16,297
Eastern	Czech Republic	10,331	10,273	10,234
Europe	Estonia	1,439	1,370	1,347
	Hungary	10,329	10,211	10,087
	Poland	38,275	38,258	38,161
	Romania	22,681	22,138	21,635
	Slovak Republic	5,364	5,401	5,387
	Slovenia	1,966	1,985	2,001

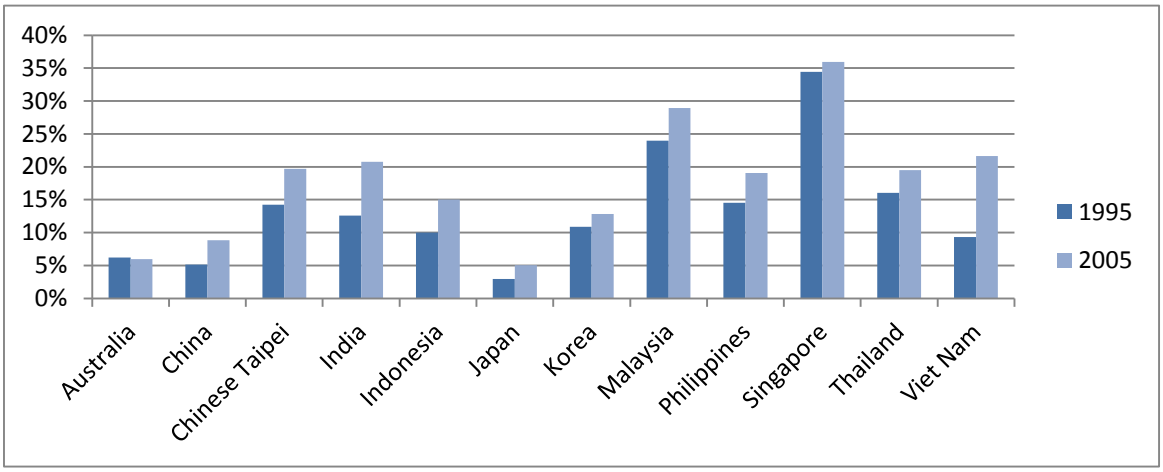
Region	Country	Population (Thousand)		
		1995	*2000*	*2005*
EU15 and	Austria	7,948	8,012	8,225
Other	Belgium	10,137	10,251	10,479
West	Denmark	5,228	5,337	5,416
Europe	Finland	5,108	5,176	5,246
	France	57,844	59,062	61,182
	Germany	81,678	82,212	82,469
	Greece	10,634	10,917	11,104
	Iceland	267	281	296
	Ireland	3,601	3,790	4,134
	Italy	56,844	56,942	58,607
	Luxembourg	409	436	465
	Netherlands	15,459	15,926	16,320
	Norway	4,359	4,491	4,623
	Portugal	10,030	10,226	10,549
	Spain	39,388	40,264	43,398
	Sweden	8,827	8,872	9,030
	Switzerland	7,041	7,184	7,437
	United Kingdom	58,025	58,886	59,402
Rest	Israel	5,374	6,084	6,692
of the	Russia	148,497	146,670	143,170
World	Saudi Arabia	18,255	20,808	23,613
	South Africa	41,375	44,872	48,073
	Turkey	61,771	67,393	72,065
	RoW	1,536,413	1,698,930	1,871,663

FIGURE 2. EXPORT DEPENDENCY (EXPORT OF GOODS AND SERVICES / GDP)



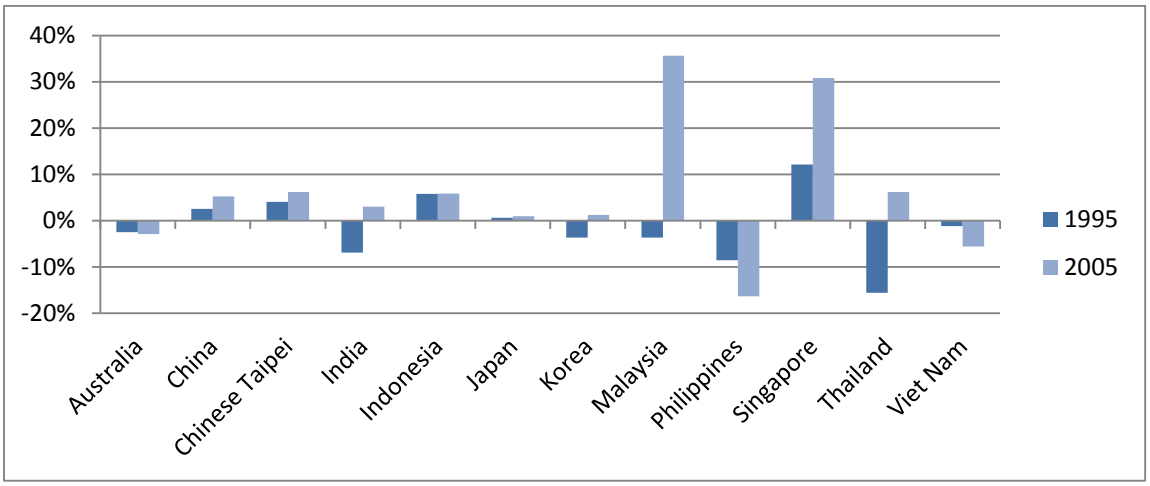
***Source*: OECD Input-Output Database (2011). *Note*: The figures for other countries are available in Annex**

FIGURE 3. INTERMEDIATE IMPORTS RATIO (INTERMEDIATE IMPORTS TO OUTPUT)



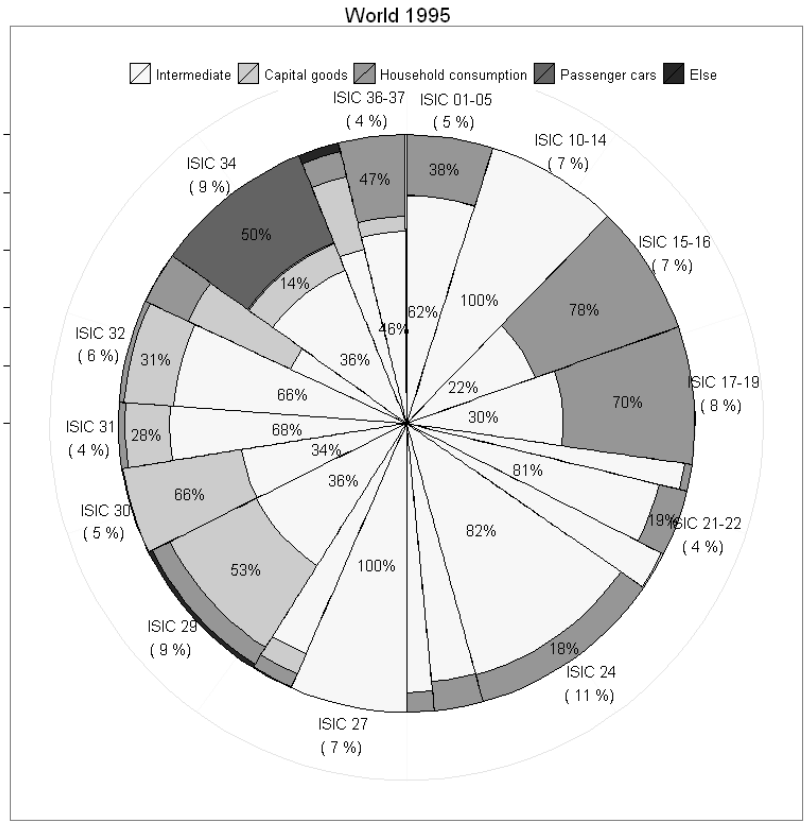
***Source*: OECD Input-Output Database (2011). *Note*: The figures for other countries are available in Annex**

FIGURE 4. NET TRADE CONTRIBUTION TO GDP



***Source*: OECD Input-Output Database (2011). *Note*: The figures for other countries are available in Annex**

FIGURE 5. TOTAL MERCHANDIZE EXPORTS GLOBAL SHARE (1995 AND 2008)



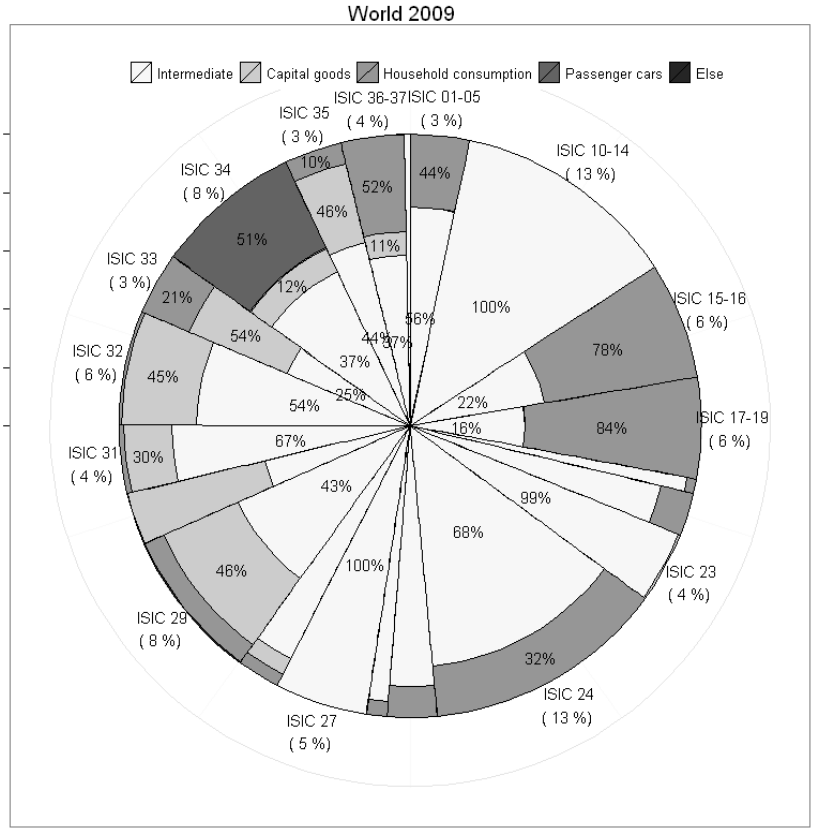


FIGURE 6. DOMINANT TRADE LINKS BETWEEN COUNTRIES (EXPORTS OF INTERMEDIATES, 1995)

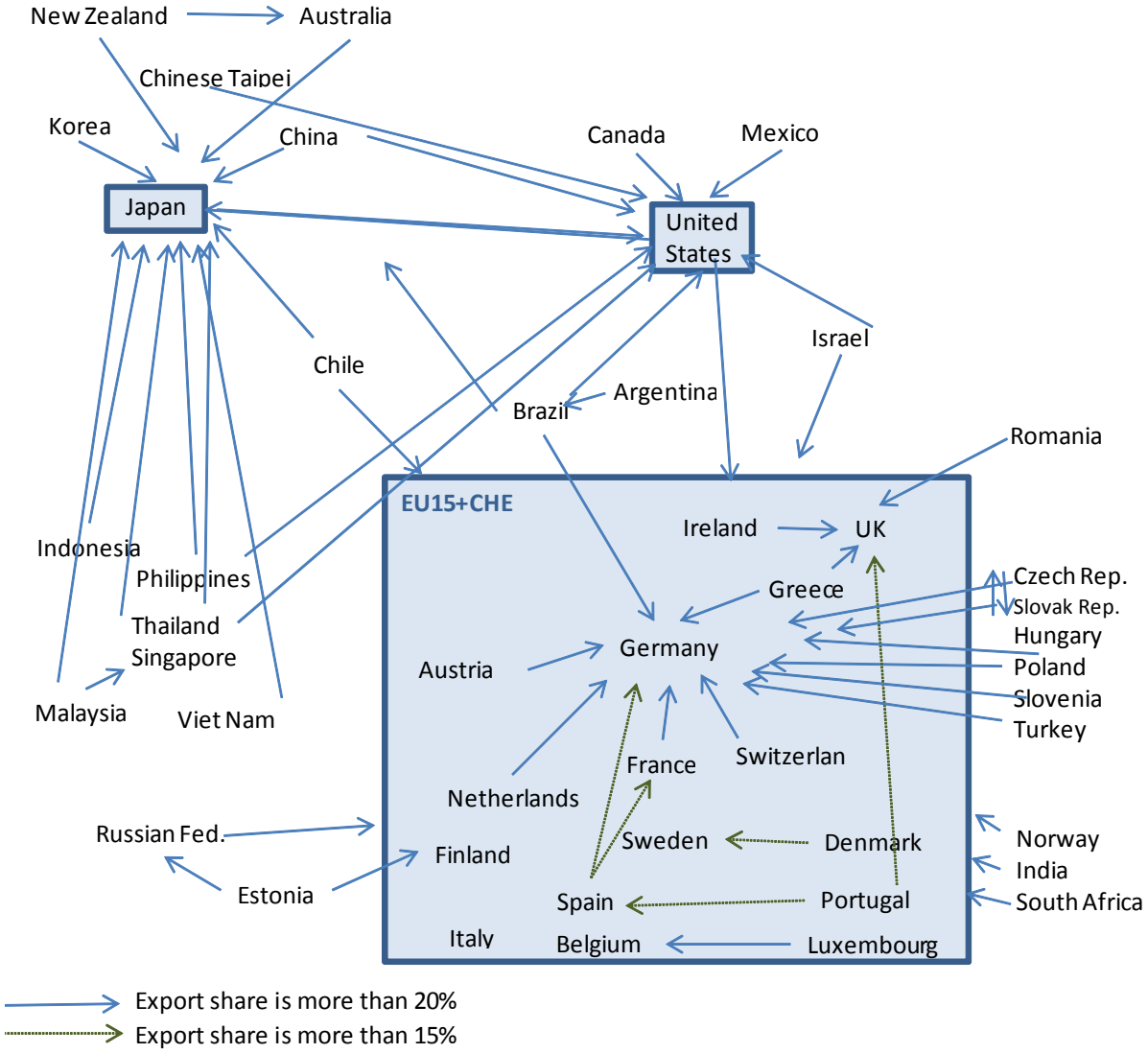


FIGURE 7. DOMINANT TRADE LINKS BETWEEN COUNTRIES (EXPORTS OF INTERMEDIATES, 2005)

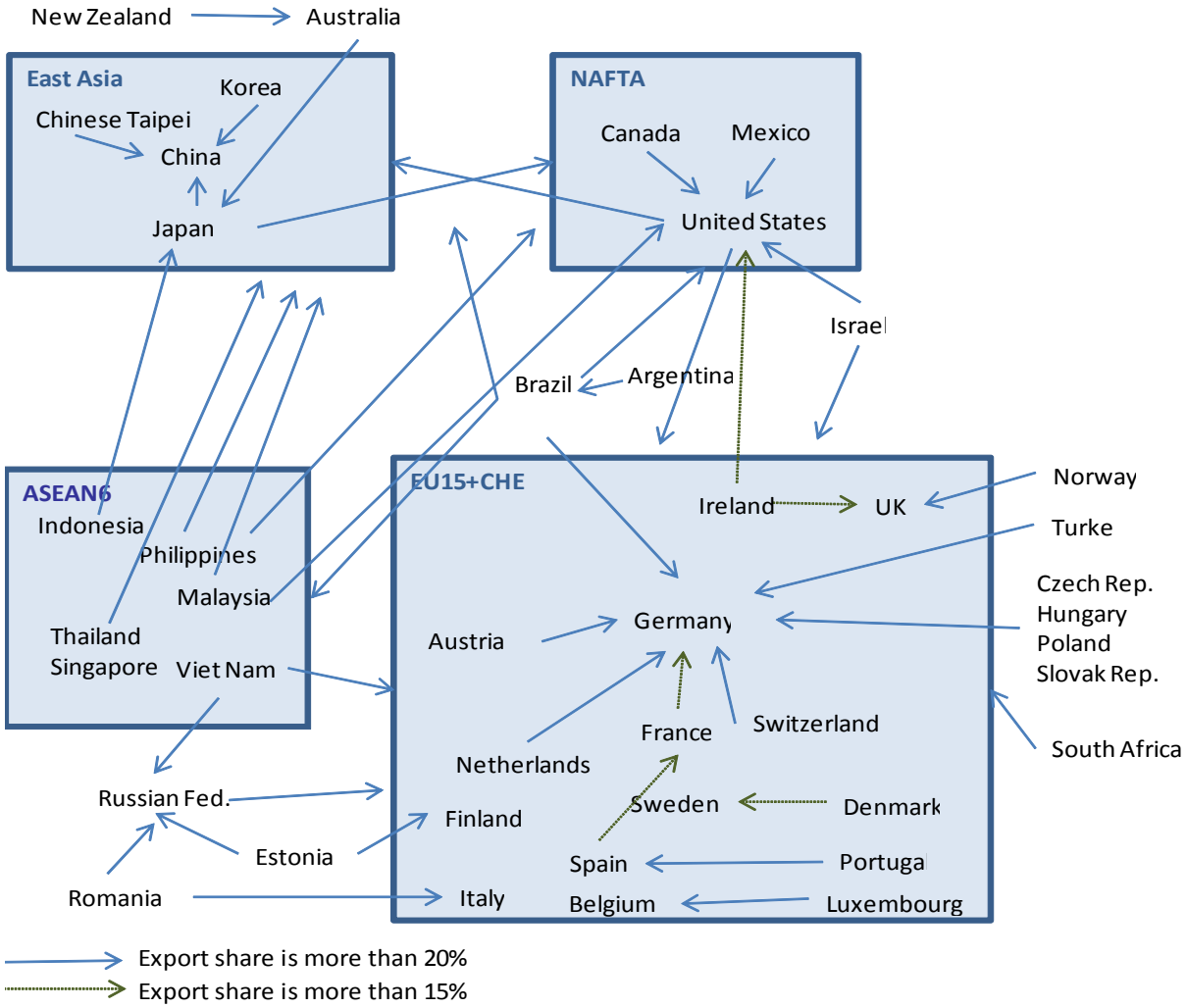


FIGURE 8. TOTAL MERCHANDIZE EXPORTS BY REGION (1995 AND 2008)

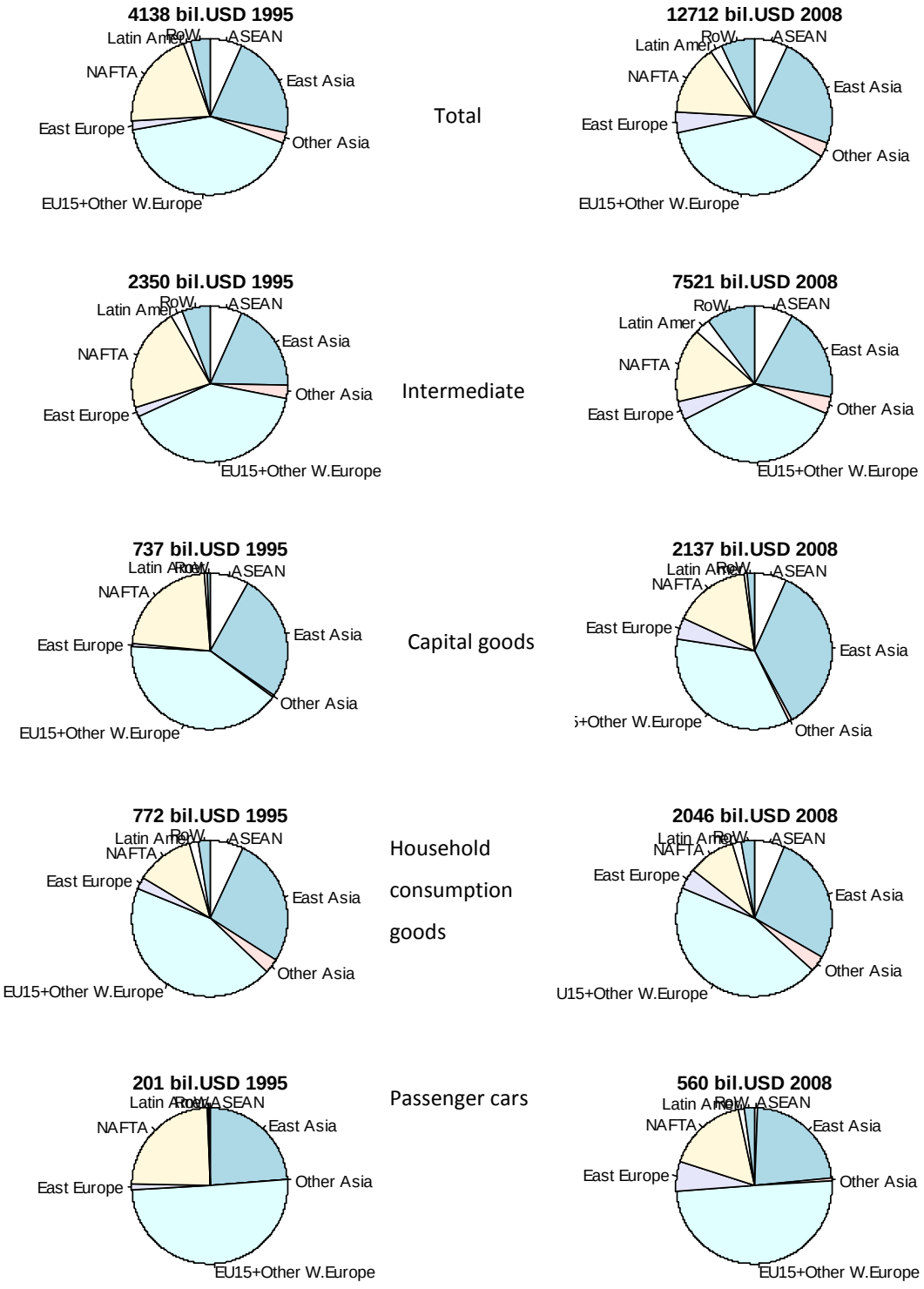
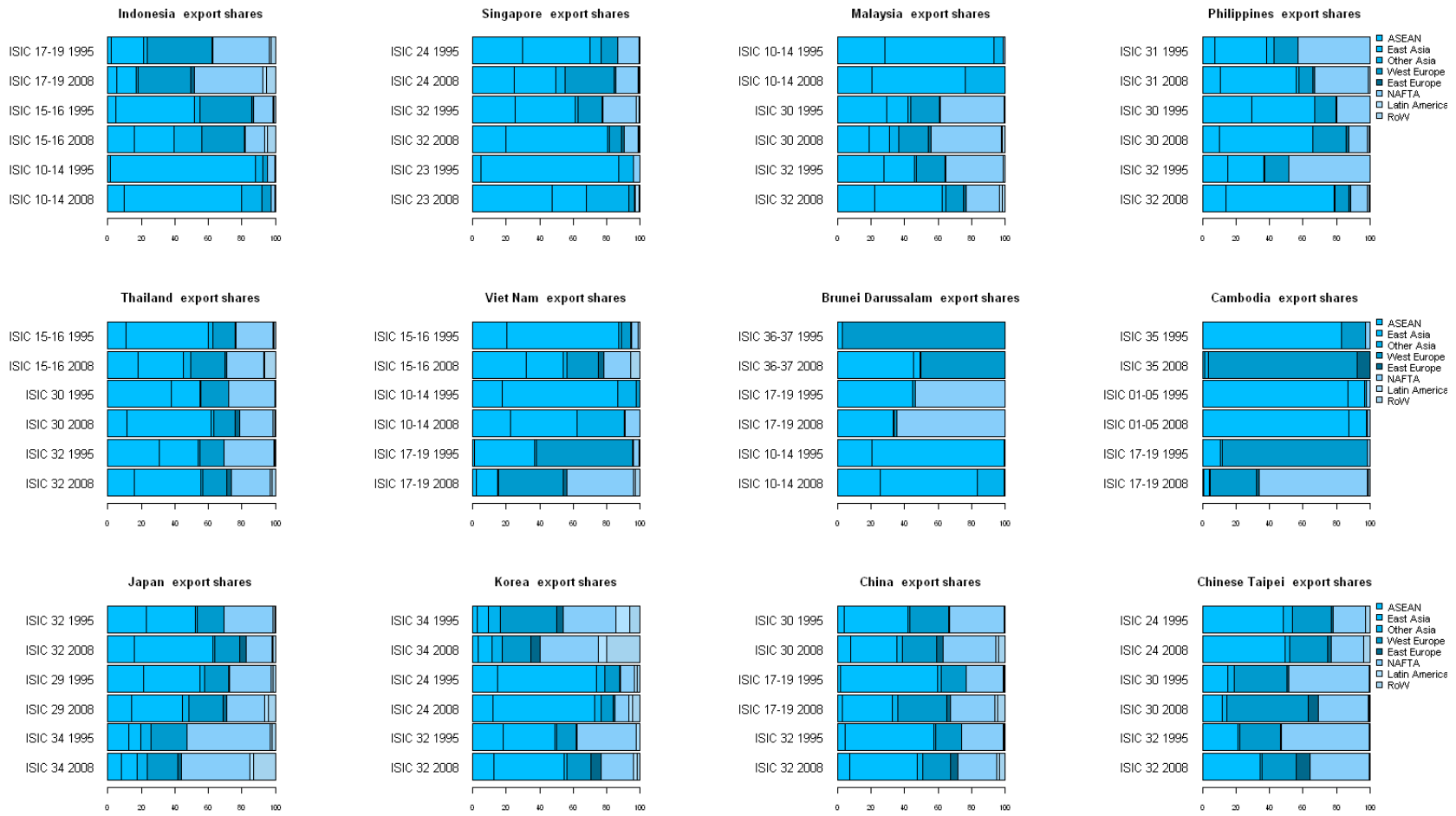


Table 1. Selected leading exports (partner shares, 2005)

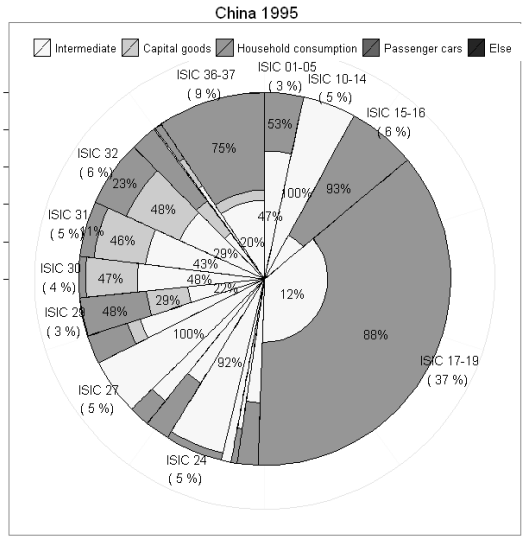
South-Eastern Asia		(Mil.USD)	ASEAN	East Asia	Other Asia/Pc	EU15	Eastern Europe	North America	Latin America	RoW
Brunei										
	Mining and quarrying	1,520	14%	56%	11%	0%	0%	20%	0%	0%
Cambodia										
	Textiles, textile products, leather and footwear	26	5%	95%	0%	0%	0%	0%	0%	0%
Indonesia										
	Mining and quarrying	24,707	7%	76%	9%	6%	0%	1%	0%	0%
	Textiles, textile products, leather and footwear	8,939	7%	12%	2%	26%	1%	41%	2%	10%
	Chemicals	5,227	25%	36%	8%	8%	1%	6%	2%	14%
Malaysia										
	Mining and quarrying	13,806	23%	49%	24%	0%	0%	2%	0%	2%
	Office, accounting & computing machinery	23,491	19%	12%	6%	14%	1%	46%	0%	1%
	Radio, television & communication equipment	39,113	27%	34%	2%	14%	1%	21%	0%	1%
Philippines										
	Office, accounting & computing machinery	7,806	13%	45%	1%	13%	2%	24%	0%	2%
	Electrical machinery & apparatus, nec	3,676	3%	72%	1%	4%	0%	20%	0%	1%
	Radio, television & communication equipment	16,485	23%	45%	1%	23%	0%	8%	0%	0%
Singapore										
	Coke, refined petroleum products and nuclear fuel	29,265	39%	26%	17%	2%	0%	1%	0%	16%
	Chemicals	28,880	27%	28%	6%	24%	0%	9%	0%	5%
	Office, accounting & computing machinery	32,308	21%	27%	8%	17%	1%	24%	0%	3%
	Radio, television & communication equipment	71,550	27%	42%	2%	12%	1%	13%	1%	2%
Thailand										
	Food products, beverages and tobacco	11,862	13%	31%	4%	13%	1%	22%	0%	17%
	Office, accounting & computing machinery	11,511	20%	41%	1%	17%	1%	19%	0%	1%
	Radio, television & communication equipment	13,751	16%	42%	2%	14%	1%	23%	1%	2%
Viet Nam										
	Mining and quarrying	8,169	35%	30%	28%	0%	0%	6%	0%	0%
	Food products, beverages and tobacco	4,342	18%	34%	2%	10%	1%	16%	0%	18%
	Textiles, textile products, leather and footwear	8,747	2%	16%	1%	33%	1%	42%	1%	4%
Eastern Asia		**(Mil.USD)**	**ASEAN**	**East Asia**	**Other Asia/Pc**	**EU15**	**Eastern Europe**	**North America**	**Latin America**	**RoW**
China										
	Textiles, textile products, leather and footwear	155,805	5%	22%	4%	22%	2%	25%	1%	19%
	Office, accounting & computing machinery	108,095	6%	31%	2%	27%	1%	30%	1%	2%
	Radio, television & communication equipment	119,823	11%	29%	3%	22%	2%	26%	2%	5%
Chinese Taipei										
	Chemicals	25,629	13%	60%	3%	6%	0%	8%	1%	9%
	Office, accounting & computing machinery	14,672	6%	30%	2%	30%	2%	26%	1%	4%
	Radio, television & communication equipment	46,256	18%	55%	1%	10%	1%	13%	1%	1%
Hong Kong										
	Textiles, textile products, leather and footwear	54,987	4%	35%	2%	21%	0%	30%	0%	7%
	Office, accounting & computing machinery	36,995	9%	64%	2%	12%	1%	10%	0%	2%
	Radio, television & communication equipment	77,735	6%	68%	1%	11%	1%	10%	1%	2%
Japan										
	Machinery & equipment, nec	86,693	14%	37%	3%	14%	1%	24%	1%	5%
	Radio, television & communication equipment	80,155	18%	43%	1%	15%	2%	19%	0%	2%
	Motor vehicles, trailers & semi-trailers	119,258	7%	8%	7%	17%	1%	47%	1%	12%
Korea										
	Chemicals	29,296	10%	59%	3%	6%	0%	9%	2%	11%
	Radio, television & communication equipment	66,063	12%	41%	4%	17%	3%	18%	2%	3%
	Motor vehicles, trailers & semi-trailers	35,918	4%	11%	4%	25%	2%	34%	1%	18%
Australia										
	Mining and quarrying	33,832	6%	69%	7%	10%	0%	3%	1%	3%
	Food products, beverages and tobacco	12,144	11%	43%	6%	12%	0%	21%	0%	7%
	Basic metals	11,875	26%	36%	22%	9%	0%	3%	0%	4%
New Zealand										
	Food products, beverages and tobacco	9,536	12%	23%	9%	21%	0%	22%	0%	12%
	Basic metals	1,200	1%	45%	31%	6%	0%	12%	0%	6%
India										
	Textiles, textile products, leather and footwear	18,239	2%	7%	1%	44%	1%	31%	1%	13%
	Chemicals	11,219	14%	14%	1%	21%	2%	16%	4%	29%
	Manufacturing nec; recycling (include Furniture)	13,325	13%	24%	1%	18%	0%	37%	0%	7%

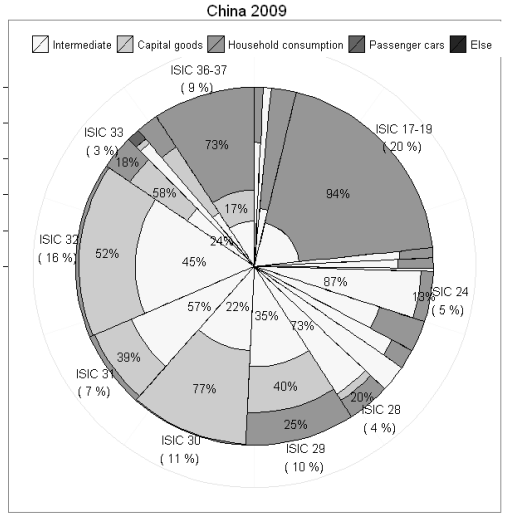
FIGURE 9. SELECTED LEADING EXPORT BY PARTNER REGIONS (1995 AND 2005, 100=TOTAL EXPORTS)

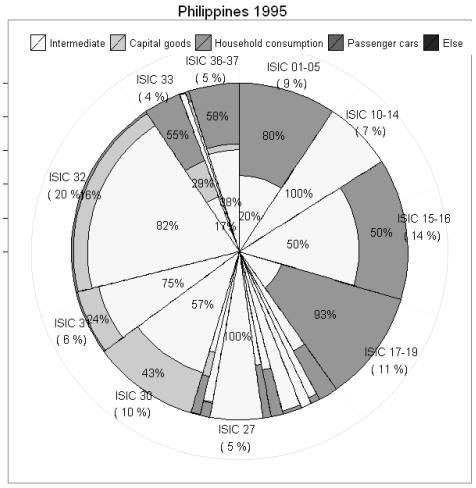


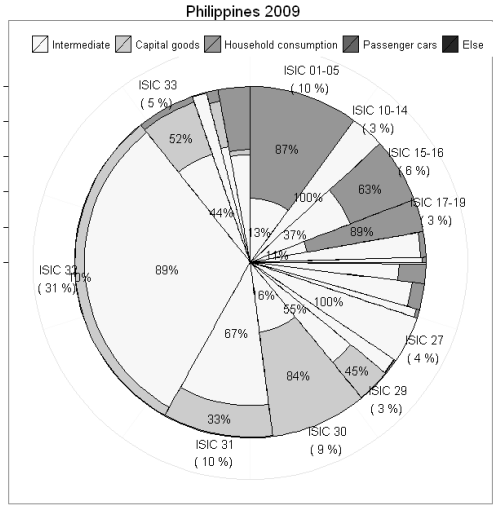
Notes: ISIC01-05 Agriculture, hunting, forestry and fishing, ISIC 10-14 Mining and quarrying, ISIC15-16 Food products, beverages and tobacco, ISIC 17-19 Textiles, textile products, leather and footwear, ISIC24 Chemicals, ISIC29 Machinery & equipment, nec , ISIC30 Office, accounting & computing machinery, ISIC 31 Electrical machinery & apparatus, nec, ISIC 32 Radio, television & communication equipment, ISIC36-37 Manufacturing nec; recycling (include Furniture).

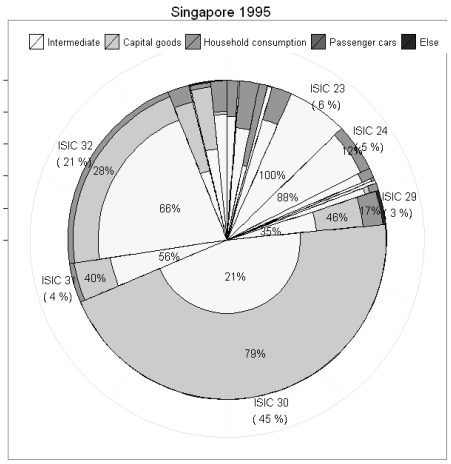
FIGURE 10. EXPORT SHARE BY INDUSTRY AND CATEGORY (CHINA AND **CHINESE TAIPEI)**











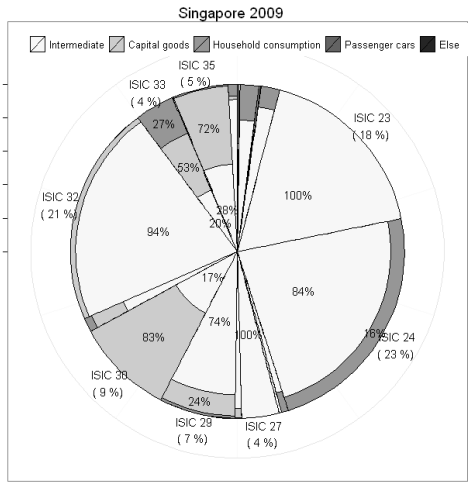
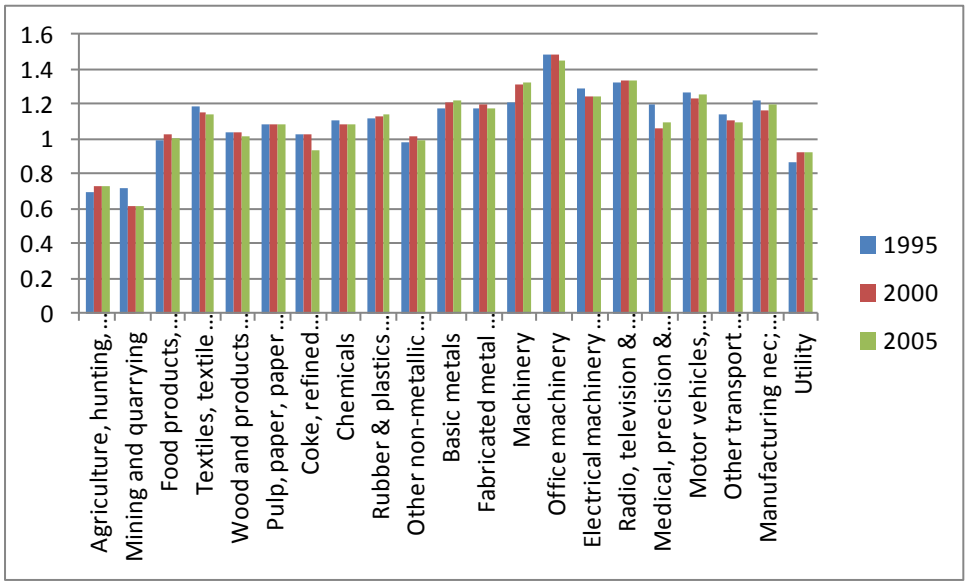
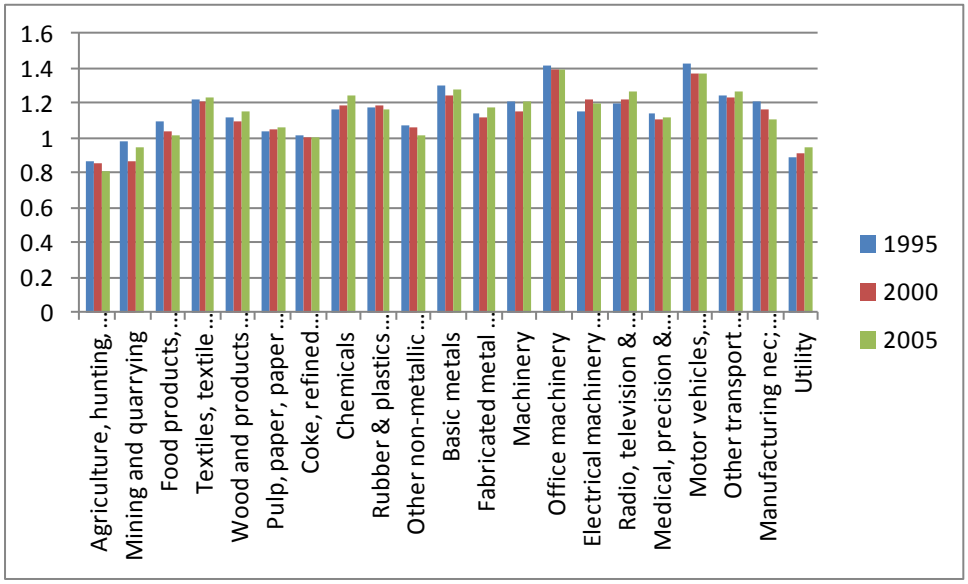


FIGURE 11. BACKWARD LINKAGE (SOUTHEAST ASIA)



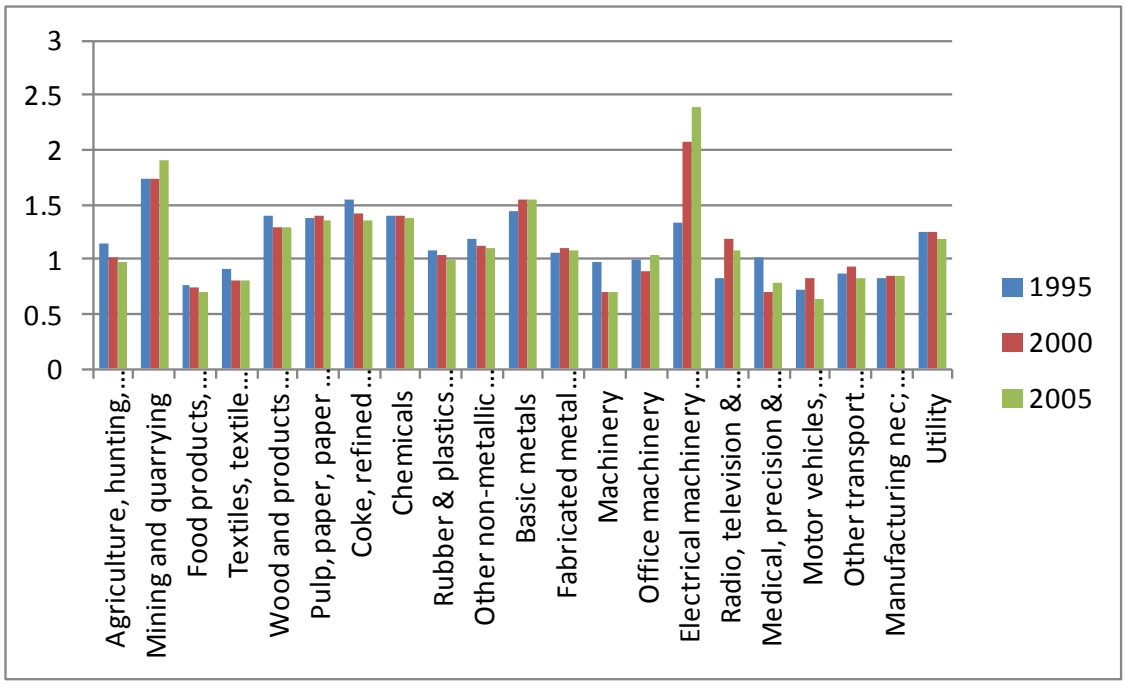
Note: Southeast Asia is Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam. Industry average = 1.0. *Source:* Region aggregate tables are estimated from the OECD Inter-country Inter-industry model (2011).

FIGURE 12. BACKWARD LINKAGE (EAST ASIA)



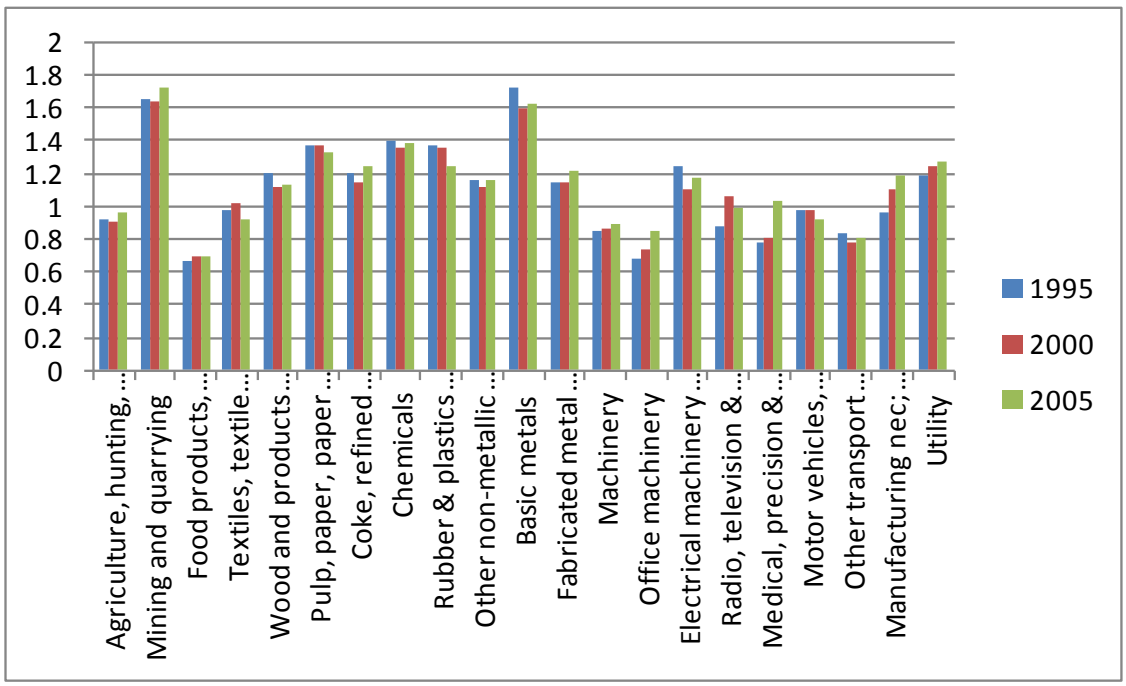
Note: East Asia is China, Chinese Taipei, Japan and Korea. Industry average = 1.0. *Source:* Region aggregate tables are estimated from the OECD Inter-country Inter-industry model (2011).

FIGURE 13. FORWARD LINKAGE (SOUTHEAST ASIA)



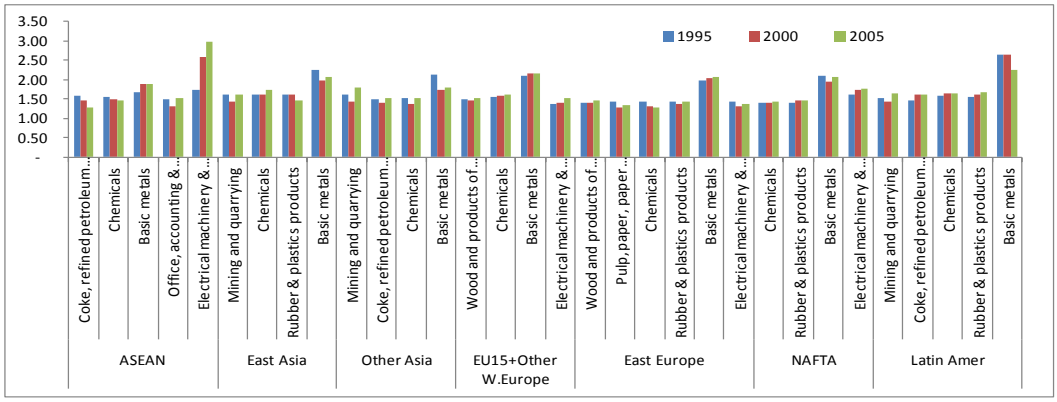
Note: Southeast Asia is Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam. Industry average = 1.0. *Source:* Region aggregate tables are estimated from the OECD Inter-country Inter-industry model (2011).

FIGURE 14. FORWARD LINKAGE (EAST ASIA)



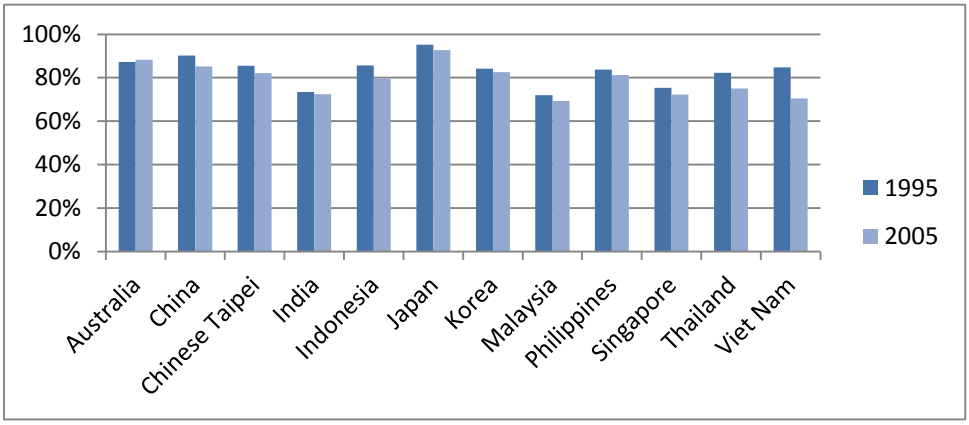
Note: East Asia is China, Chinese Taipei, Japan and Korea. Industry average = 1.0. *Source:* Region aggregate tables are estimated from the OECD Inter-country Inter-industry model (2011).

FIGURE 15. KEY LINKAGE SECTORS BY REGION



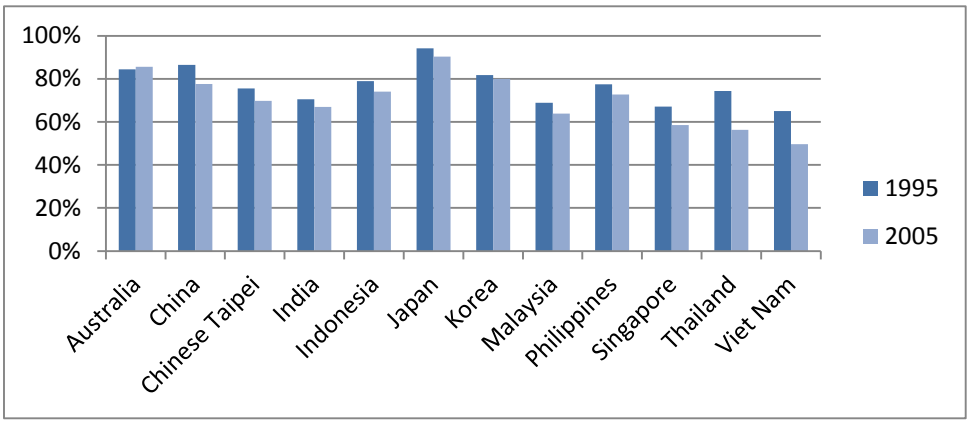
Note: Regional aggregates are derived from OECD Inter-country inter-industry model (2011). Forward linkage indicators are estimated based on Leontief inverse matrix and standardized by the average figure.

FIGURE 16. DOMESTIC IMPACT RATIO OF HOUSEHOLD CONSUMPTION EXPENDITURE (1995 AND 2005)



***Source*: OECD Input-Output Database (2011). *Note*: The figures for other countries are available in Annex**

FIGURE 17. DOMESTIC IMPACT RATIO OF GROSS FIXED CAPITAL FORMATION EXPENDITURE (1995 AND 2005)



***Source*: OECD Input-Output Database (2011). *Note*: The figures for other countries are available in Annex**

FIGURE 18. IMPORT CONTENTS OF EXPORTS (TOTAL INDUSTRY)

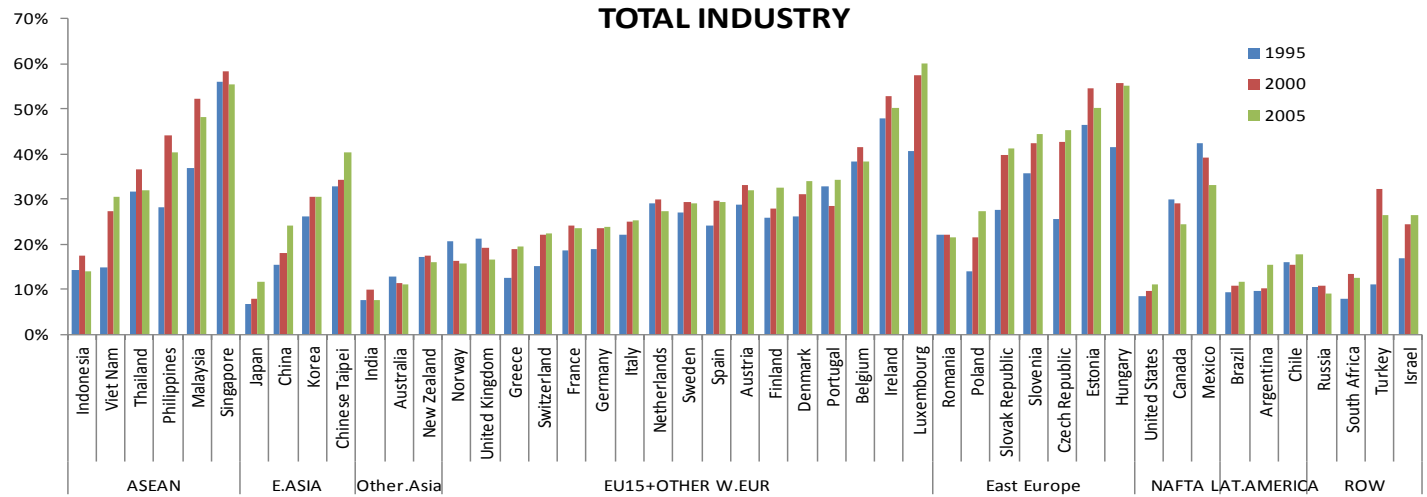


FIGURE 19. IMPORT CONTENTS OF EXPORTS (ASSEMBLY MANUFACTURING)

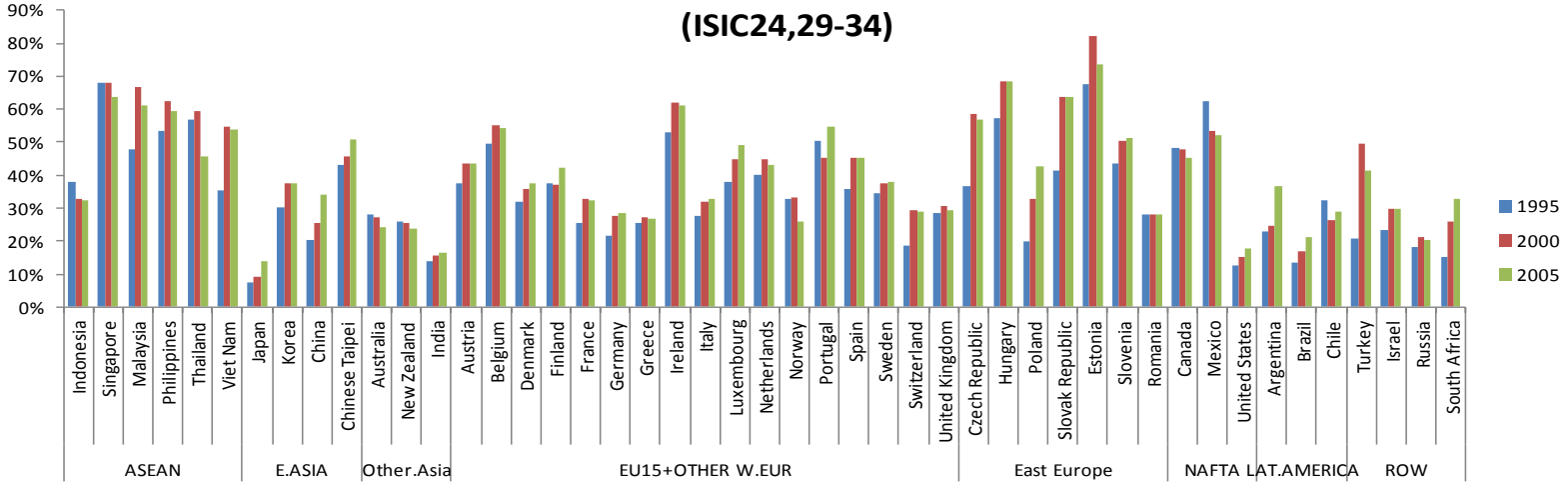
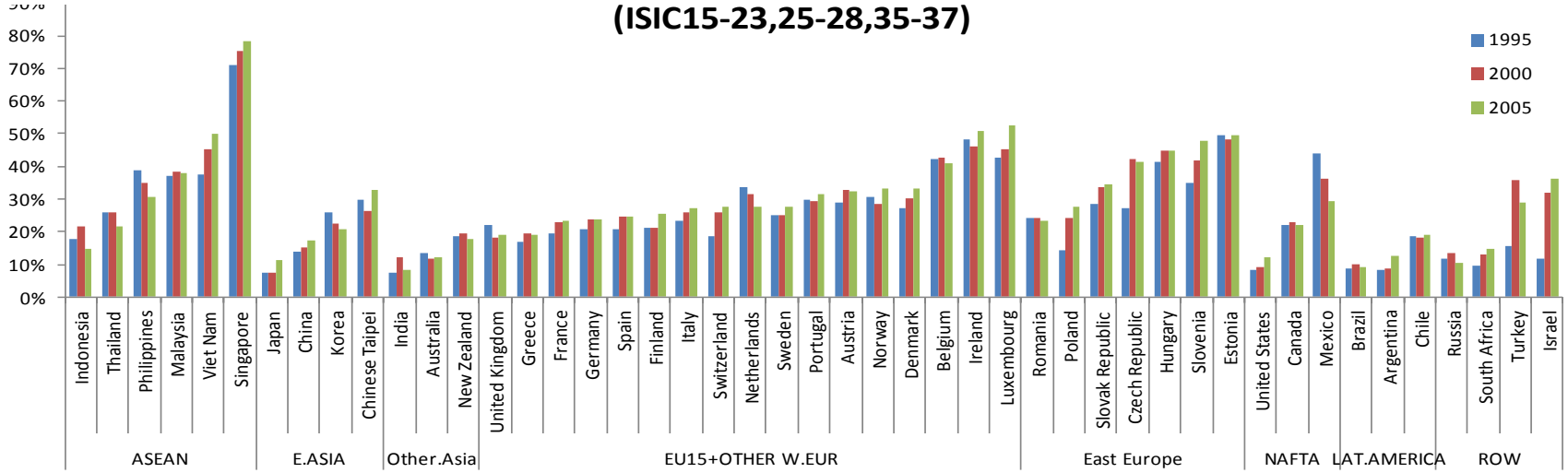
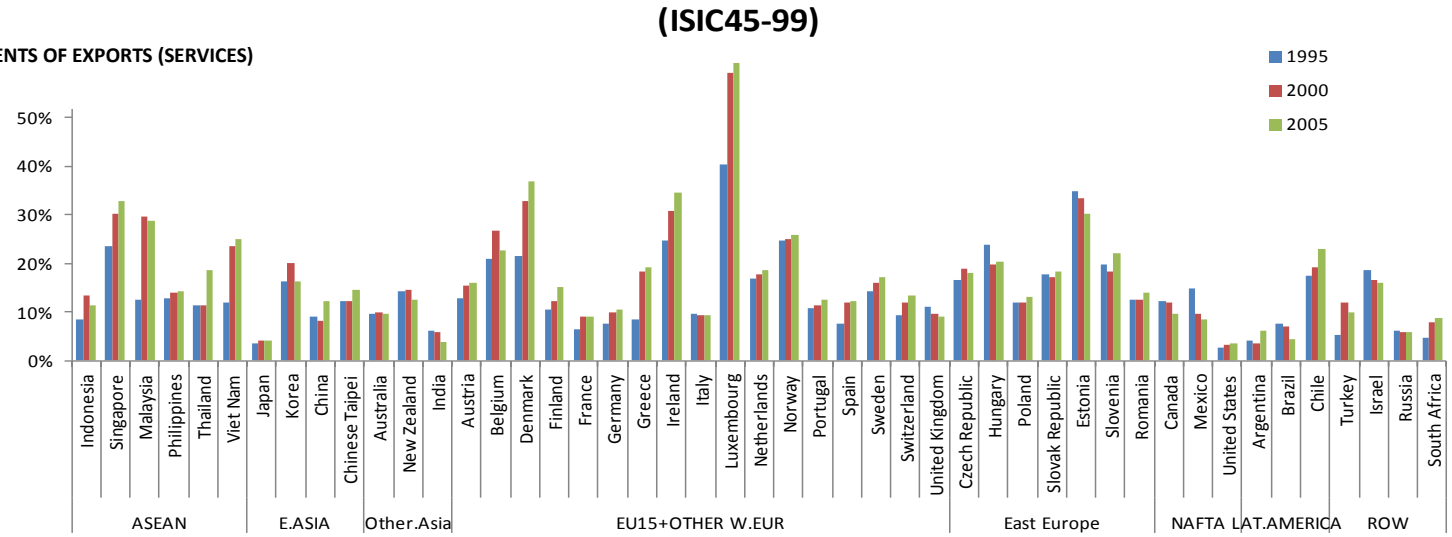


FIGURE 20 IMPORT CONTENTS OF EXPORTS (OTHER MANUFACTURING)



Note: Intermediate imports of mining sectors are excluded

FIGURE 21. IMPORT CONTENTS OF EXPORTS (SERVICES)



Note: Intermediate imports of mining sectors are excluded

FIGURE 22. INDUCED VALUE-ADDED BY UNIT EXPORTS

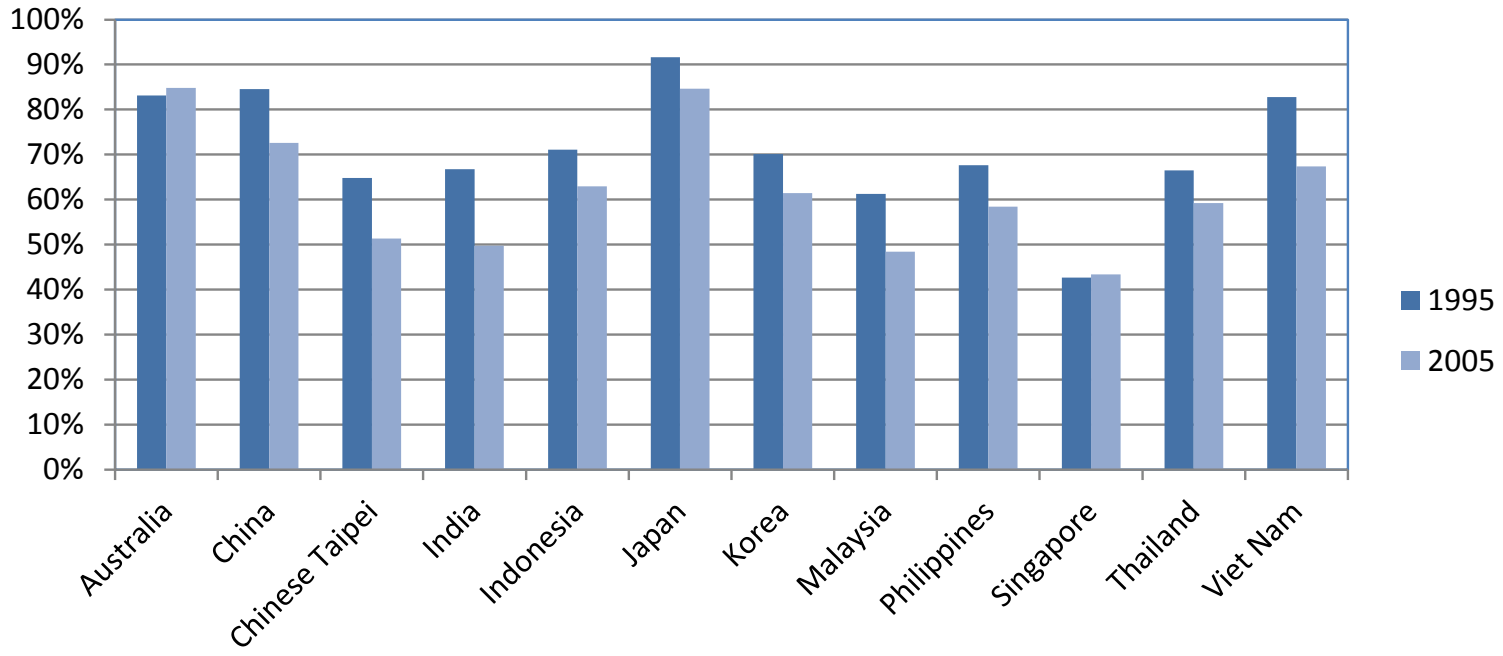


FIGURE 23. DIRECT IMPORTS OF FINAL GOODS AND INDUCED INTERMEDIATE IMPORTS

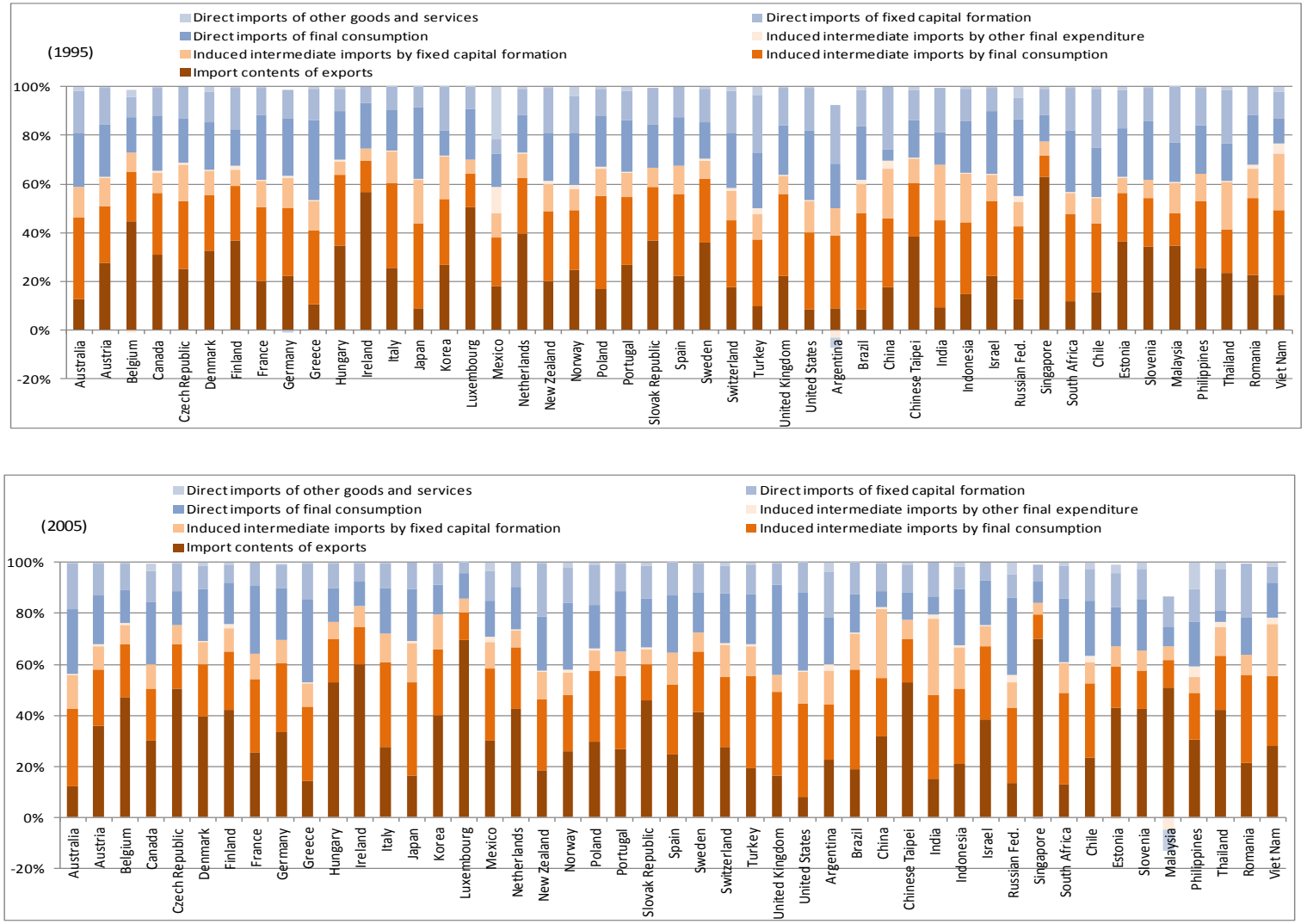
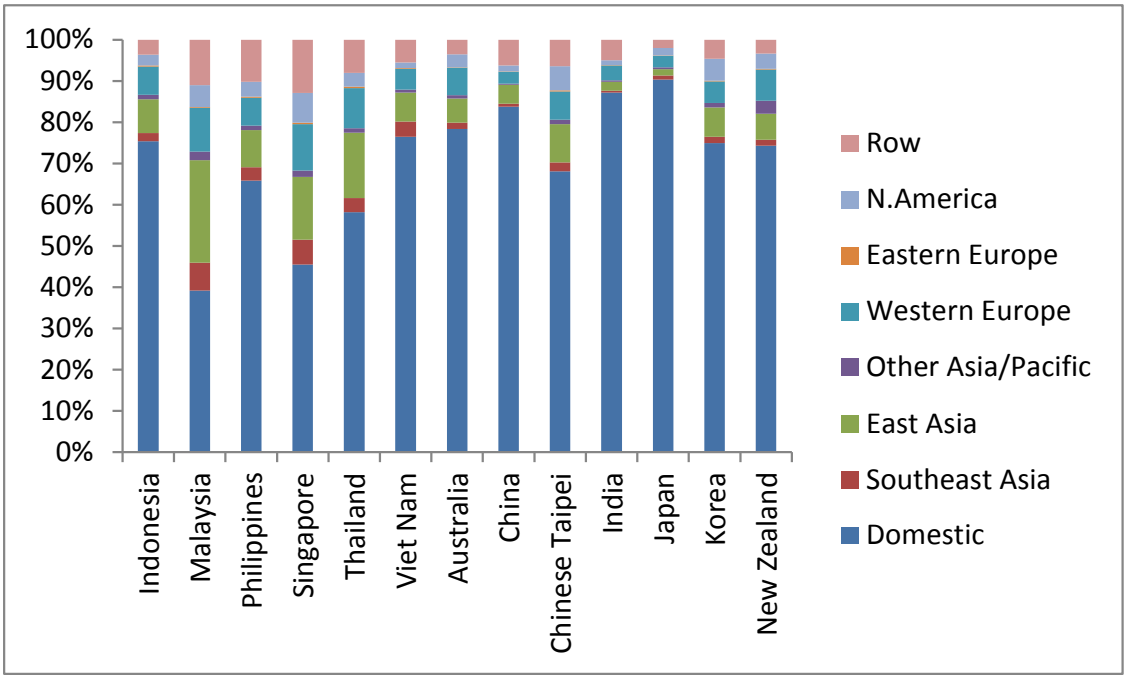


FIGURE 24. INTER-COUNTRY SPILLOVER EFFECTS(2005)



Source: OECD Inter-country inter-industry model (March 2011)

FIGURE 25. INTERNATIONAL FRAGMENTATION PRODUCTION PROCESS

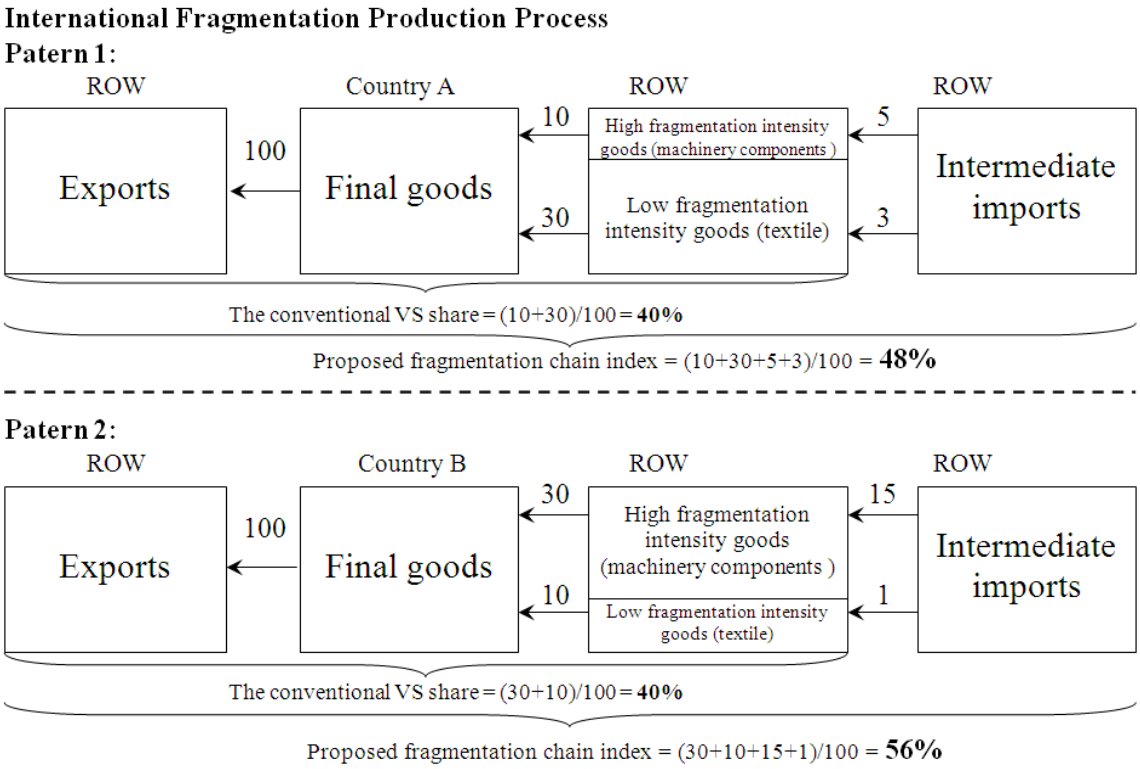
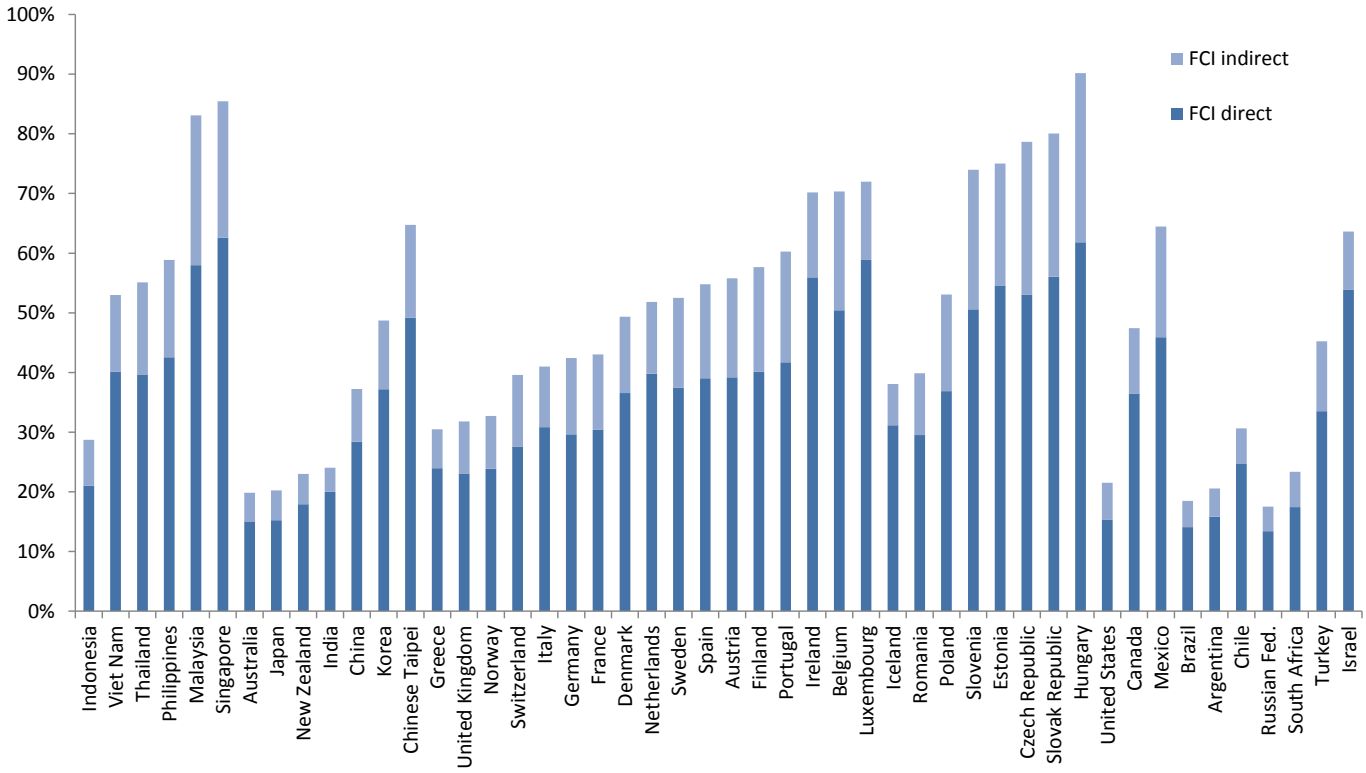
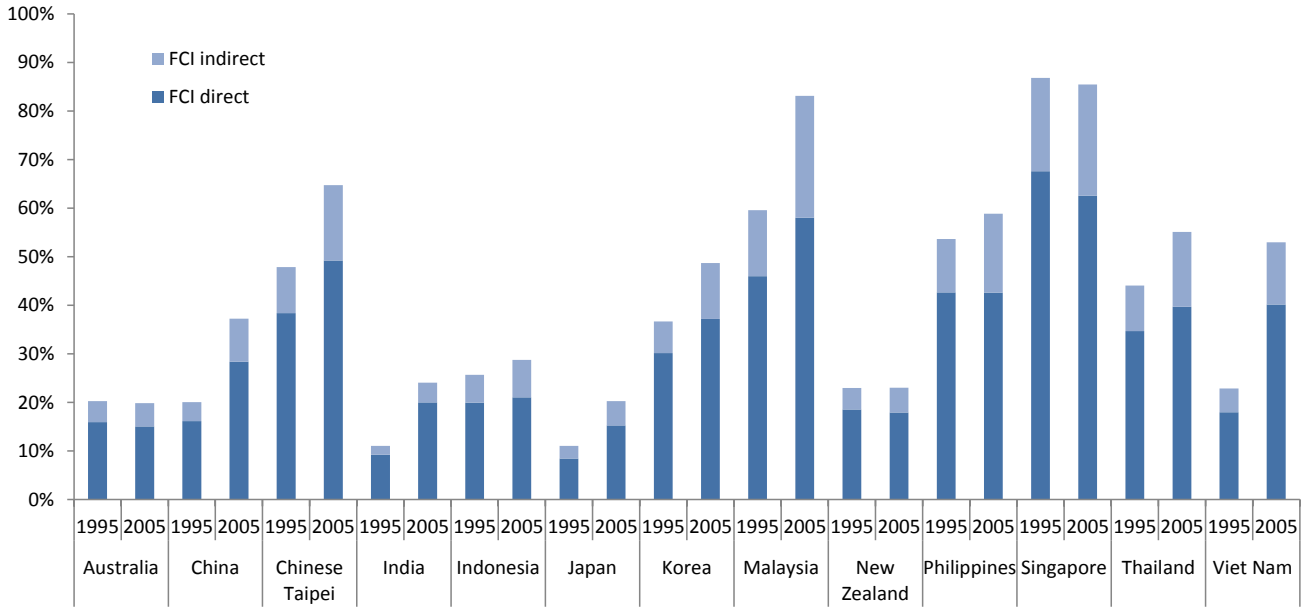


FIGURE 26. FRAGMENTATION CHAIN INDEX (2005)



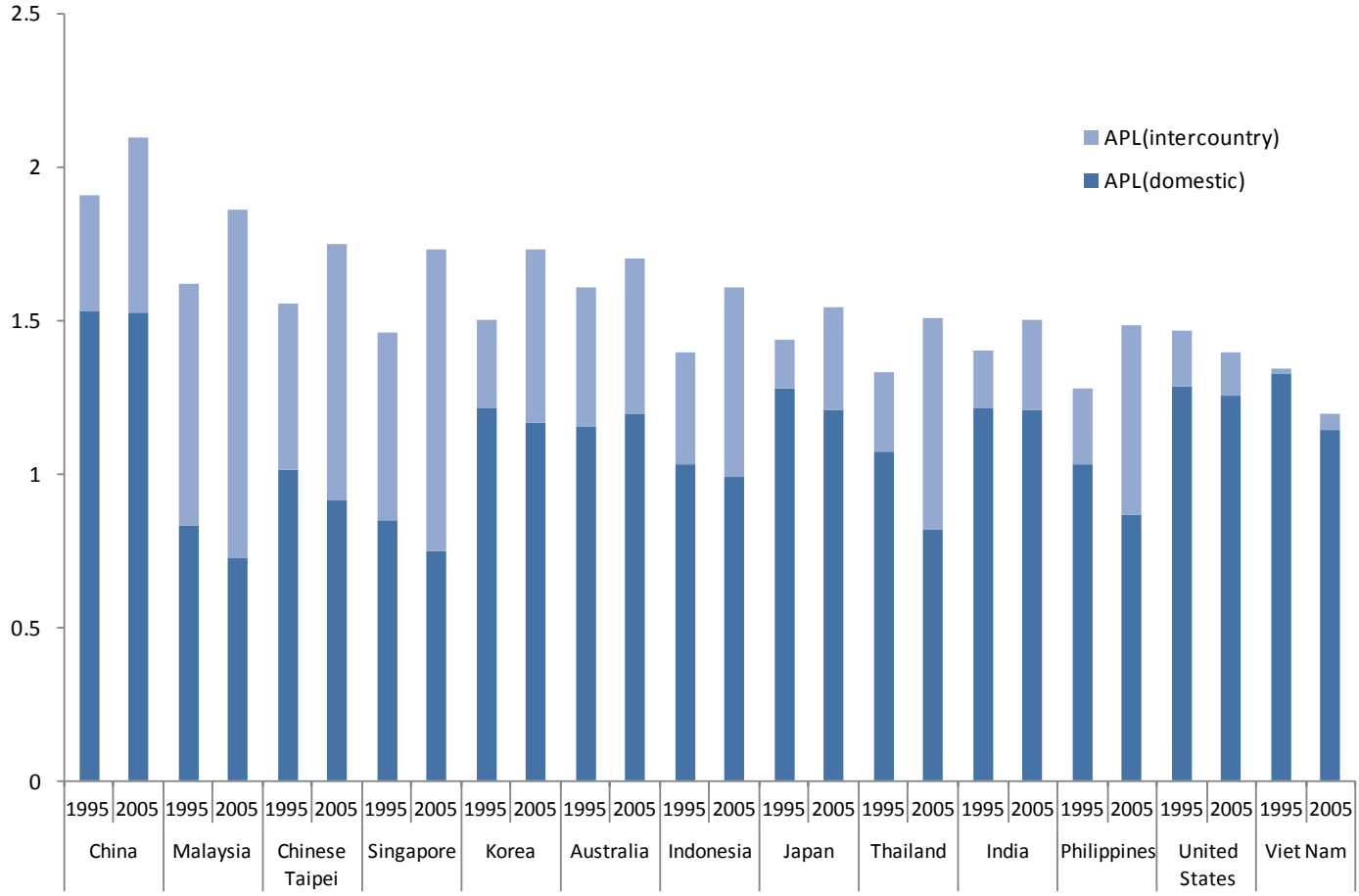
Source: OECD Inter-country inter-industry model (March 2011)

FIGURE 27. FRAGMENTATION CHAIN INDEX FOR ASIA (1995 AND 2005)



Source: OECD Inter-country inter-industry model (March 2011)

FIGURE 28. AVERAGE PROPAGATION LINK INDICATOR IN MULTI-COUNTRY FRAMEWORK



Source: OECD Inter-country inter-industry model (March 2011)

FIGURE 29. SPILLOVERS OF GDP BY PRODUCTION STAGES (SOUTHEAST ASIA, EAST ASIA AND OTHER ASIA/PACIFIC)

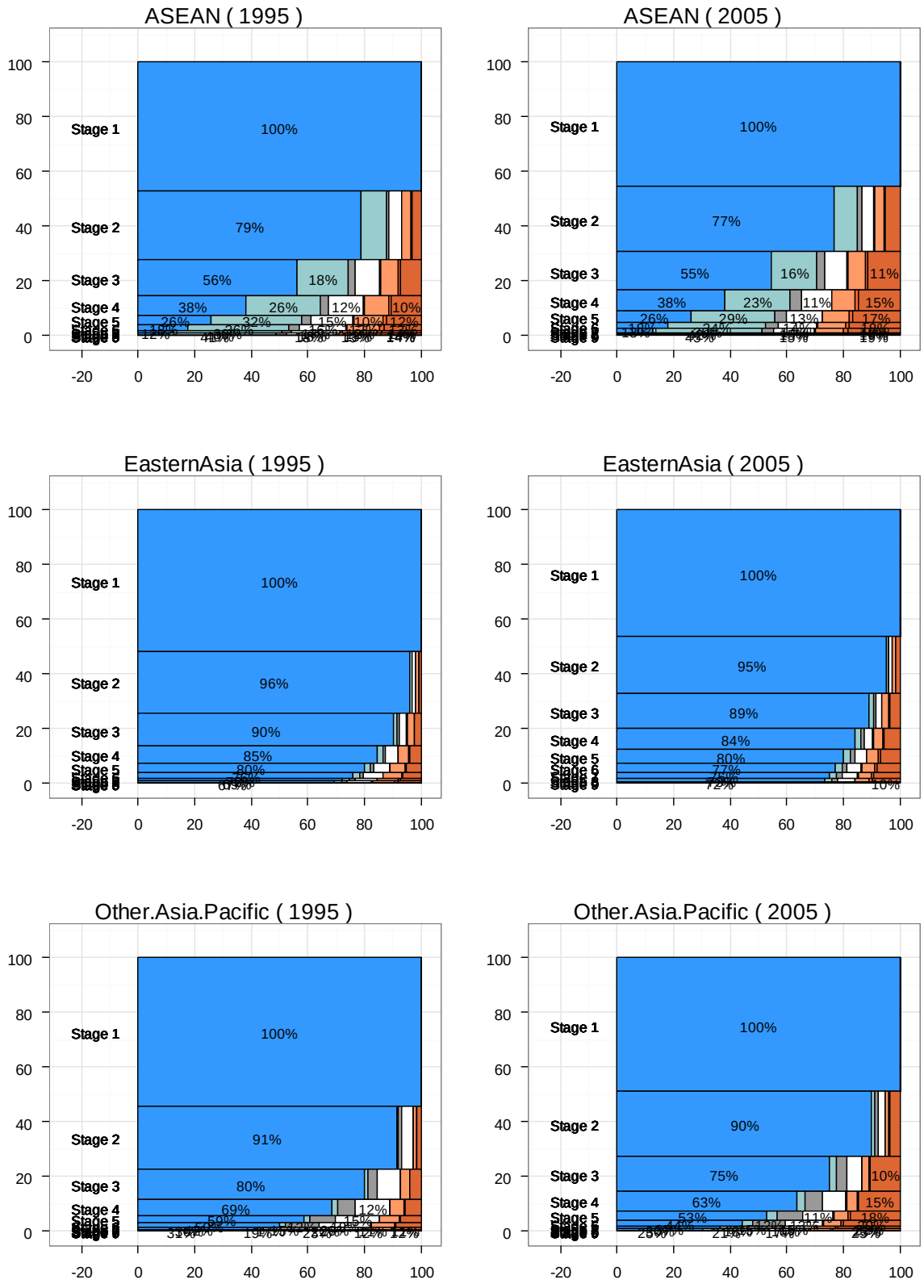


FIGURE 30. SPILLOVERS OF GDP BY PRODUCTION STAGES (EU15+SWITZERLAND+NORWAY, OTHER EUROPE, NORTH AMERICA AND LATIN AMERICA)