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Abstract

This paper studies the economic interdependency in 8 East Asian countries (Indonesia, Malaysia, Philippines, Singapore, Thailand, China, Taiwan and Korea), Japan and USA using Asian International Input-Output Table for years 1985, 1990, 1995 and 2000. In general, the interdependency is studied using macro economic data such as GDP, export, import, trade balance etc. But it is known fact that there are various types of production technique and patterns of trade at industry level. In order to analyze the interdependency at inter-industry level we use the concept of interdependency with respect to total intermediate input goods, which includes not only the direct effect of the import of intermediate input goods but also indirect ones using Input-Output method. We show that the economic interdependency in East Asia has been growing stronger from 1985 to 2000. But we also show that the differences in dependency structure among East Asian countries at country level as well as at industry level. Therefore, although the economic integration or FTA will increase the trade in the region, there will be biasness in the economic benefit for different countries.

Keywords: Economic integration; Interdependency; Input-Output; East Asia; Intermediate inputs

1. Introduction

To achieve the successful goal of economic integration in East Asia, one of the criteria is the strong economic interdependency among the integrating countries. Kawai (2005) concludes that “the East Asian economies have achieved strong economic interdependence, particularly through external liberalization, domestic structural reforms and market driven integrations with the global and regional economies. Expansion of foreign trade, direct investment and financial flows has created a ‘naturally’ integrated economic zone in East Asia”. Kawai (1996), Mukoyama (2005) also states the strong economic interdependency in East Asia in recent years. It is, of course, true that the economic interdependency is becoming stronger in East Asia from the macro level point of view.

The economic interdependency study, in general, uses macro economic data such as GDP, export, import, trade balance etc. But, it is well known fact that there are various

types of production technique and patterns of trade at industry level. The economic interdependency study using macro economic variables only does not provide the complete picture of the interdependency among the countries and industries. To overcome this limitation, we focus our study of economic interdependency on intermediate input goods as it is one of the important factors in production process.

The Input-Output framework allows distinguishing the final goods and intermediate input goods so that the study of economic interdependency with respect to intermediate input goods is possible. Here, we propose a new method to study the economic interdependency, from the intermediate input goods point of view, in East Asian countries using International Input-Output framework¹.

An International Input-Output table, which is the basis for International Input-Output framework, provides the information about the transaction of intermediate goods and final goods across each industrial sector and each endogenous country (in our case, 8 East Asian countries, Japan and USA). Further it provides the information about the import of the intermediate input goods from the exogenous country (ROW; Rest of the world) to each production sector of each endogenous country.

¹ International Input-Output framework, the extension of single country Input-Output framework, consist the number of production sectors for each endogenous country.

In general, the International Input-Output study includes the direct and indirect effects of the production sector from the endogenous countries only. This will completely ignore the effect of the import of the intermediate input goods from the exogenous countries. Hasebe (2002) studied the economic interdependency of East Asian countries for 1985, 1990 and 1995. Shimoda, Watanabe and Fujikawa (2005) studied the structure of international division of labor in Asia Pacific region. The later uses the dependency measure based on value added. The main difference lies in the definition of the dependency measure as we use dependency based on total intermediate input goods.

The original contribution of this paper is to study the economic interdependency with respect to “total intermediate input goods”, defined as the intermediate input goods from endogenous countries as well as exogenous country. Using this concept, we study the economic interdependency at macro level as well as at industry level.

We find that the economic interdependency in East Asia, from total intermediate input goods point of view, has become stronger and dependency on Japan, USA and other countries have decreasing trend. But the structure of dependency, in East Asian countries, is not similar and the dependency on Japan, USA and other countries are relatively high. Further, at industry level, the interdependency structure of Transport

Equipment, Machinery and Chemical Products sectors show very low self dependency level in contrast to the self dependency level at country level.

Differences in interdependency structures at country level as well as at industry level will lead to the biased economic benefits for different countries. Under the continuation of such situation, the economic benefit of economic integration or FTA will, mostly, be enjoyed by the non regional countries. Further, the level of economic benefits for the regional country will also differ, which makes the implementation of common economic policy more difficult.

2. Methods and Data

As we focus our study on “Intermediate Input Goods”, we use International Input-Output framework for our analysis. The main reason lies in the fact that the International Input-Output Table, which is the main data source for the analysis, distinguishes the origin and destination (by country) of the intermediate input goods and the goods for the final use. Further, the study at the industry sector level is possible with this framework.

Figure 1 is a layout of typical International Input-Output table with two (for example) endogenous countries (P and Q), one exogenous country(O), two production sector

(Sect1 and Sect2), export column, total output column, value added row and total input row. ${}^{kl}Zd_{ij}$ represents the transaction of intermediate goods among the endogenous countries, in monetary term, from sector i of country k to sector j of country l . ${}^{cl}Zw_{ij}$ represents the import of intermediate goods by sector j of endogenous country l from sector i of exogenous country O .

Figure 1: A Typical International Input-Output Table

Country		P		Q		P	Q	Export	Total Output
	Sectors	Sect1	Sect2	Sect1	Sect2	Final Demand			
P	Sect1	${}^{PP}Zd_{11}$	${}^{PP}Zd_{12}$	${}^{PQ}Zd_{11}$	${}^{PQ}Zd_{12}$	${}^{PP}Fd_1$	${}^{PQ}Fd_1$	${}^P E_1$	${}^P X_1$
	Sect2	${}^{PP}Zd_{21}$	${}^{PP}Zd_{22}$	${}^{PQ}Zd_{21}$	${}^{PQ}Zd_{22}$	${}^{PP}Fd_2$	${}^{PQ}Fd_2$	${}^P E_2$	${}^P X_2$
Q	Sect1	${}^{QP}Zd_{11}$	${}^{QP}Zd_{12}$	${}^{QQ}Zd_{11}$	${}^{QQ}Zd_{12}$	${}^{QP}Fd_1$	${}^{QQ}Fd_1$	${}^Q E_1$	${}^Q X_1$
	Sect2	${}^{QP}Zd_{21}$	${}^{QP}Zd_{22}$	${}^{QQ}Zd_{21}$	${}^{QQ}Zd_{22}$	${}^{QP}Fd_2$	${}^{QQ}Fd_2$	${}^Q E_2$	${}^Q X_2$
O	Sect1	${}^{OP}Zw_{11}$	${}^{OP}Zw_{12}$	${}^{OQ}Zw_{11}$	${}^{OQ}Zw_{12}$	${}^{OP}Fd_1$	${}^{OQ}Fd_1$		
	Sect2	${}^{OP}Zw_{21}$	${}^{OP}Zw_{22}$	${}^{OQ}Zw_{21}$	${}^{OQ}Zw_{22}$	${}^{OP}Fd_2$	${}^{OQ}Fd_2$		
Value Added		${}^P V_1$	${}^P V_2$	${}^Q V_1$	${}^Q V_2$				
Total Input		${}^P X_1$	${}^P X_2$	${}^Q X_1$	${}^Q X_2$				

${}^{kl}Fd_i$ represents the transaction of final demand goods among the endogenous countries from sector i of country k to country l . ${}^{cl}Zw_{ij}$ represents the import of final demand goods by endogenous country l from exogenous country O 's sector i . In the similar manner, ${}^k E_i$ represents the export of goods produced by sector i of endogenous country k to the countries other than endogenous countries; ${}^l V_j$ represents the value added created by sector j of country l and ${}^k X_i$ (${}^l X_j$) are the column (row) of total

output (input) of corresponding sector and endogenous country

For the particular international IO table given in Figure 1, the input coefficient matrix² (Ad), input coefficient matrix corresponding to exogenous country (Aw), total intermediate input coefficient matrix (A) are given as follows.

$$Ad = \left[\frac{{}^{kl}Zd_{ij}}{{}^lX_j} \right] = [{}^{kl}ad_{ij}]$$

$$Aw = \left[\frac{{}^{ol}Zw_{ij}}{{}^lX_j} \right] = [{}^{ol}aw_{ij}]$$

$$A = \begin{bmatrix} Ad \\ Aw \end{bmatrix}$$

${}^{kl}ad_{ij}$, elements of input coefficient matrix Ad , represents the transaction of intermediate input goods among the endogenous countries to produce a unit amount of output in each sector of the endogenous countries. While ${}^{ol}aw_{ij}$ represents the import of intermediate goods from exogenous country O to produce a unit amount of output in each sector of the endogenous countries. And, the elements of matrix A represent the transaction of the amount of intermediate input goods, from endogenous and exogenous countries, to produce unit output in each sector of the endogenous countries.

The requirement matrix (RI) corresponding to endogenous countries, which also corresponds to the Leontief Inverse matrix in Input-Output methodology, is given as

² Input coefficient matrix corresponding to endogenous countries.

$$R1 = (I - Ad)^{-1}$$

Now the total intermediate input requirement matrix ($R2$) is given as³

$$R2 = A * (I - Ad)^{-1} = \begin{bmatrix} Ad \\ Aw \end{bmatrix} * R1$$

The j^{th} column of matrices A , Ad , $R1$ and $R2$ of endogenous country l represents the intermediate input structure of the production for country l 's j th sector. We, then, differentiate the sources as domestic, import from other endogenous country and import from exogenous country of intermediate input goods, which ever applies, and calculate the interdependency structure with respect to $R1$ and $R2$ as follow.

The dependency structure of a particular country is defined as the ratio of the intermediate inputs from each country to the total intermediate inputs from all the countries.

Thus the dependency structure with respect to intermediate inputs from endogenous countries only, $DR1$, is given as

$$DR1 = \begin{bmatrix} {}^{PP} dr1 & {}^{PQ} dr1 \\ {}^{QP} dr1 & {}^{QQ} dr1 \end{bmatrix}$$

$$\text{where } {}^{PP} dr1 = \frac{\sum_{ij} {}^{PP} r1_{ij}}{\sum_{ij} {}^{PP} r1_{ij} + \sum_{ij} {}^{QP} r1_{ij}}, \quad {}^{PQ} dr1 = \frac{\sum_{ij} {}^{PQ} r1_{ij}}{\sum_{ij} {}^{PQ} r1_{ij} + \sum_{ij} {}^{QQ} r1_{ij}} \text{ and so on.}$$

³ For derivation of total intermediate input requirement matrix please refer to the

The problem with above dependency calculation lies in the fact that, it does not take account of the intermediate inputs imported from the exogenous countries. To overcome this problem, we define a new interdependency structure, DR2, which take an account of the intermediate inputs imported from exogenous countries as

$$DR2 = \begin{bmatrix} {}^{PP}dr2 & {}^{PQ}dr2 \\ {}^{QP}dr2 & {}^{QQ}dr2 \\ {}^{OP}dr2 & {}^{OQ}dr2 \end{bmatrix}$$

$$\text{where, } {}^{QP}r2 = \frac{\sum_{ij} {}^{QP}r2_{ij}}{\sum_{ij} {}^{PP}r2_{ij} + \sum_{ij} {}^{QP}r2_{ij} + \sum_{ij} {}^{OP}r2_{ij}}, \quad {}^{OQ}r2 = \frac{\sum_{ij} {}^{OQ}r2_{ij}}{\sum_{ij} {}^{PQ}r2_{ij} + \sum_{ij} {}^{OQ}r2_{ij} + \sum_{ij} {}^{OQ}r2_{ij}} \text{ and so on.}$$

In dependency structure matrix, ${}^{PP}dr2$ and ${}^{QQ}dr2$ are termed as the self dependency of country P and Q respectively, because ${}^{PP}dr2$ and ${}^{QQ}dr2$ represents the share of domestic intermediate input goods which is necessary for the production of unit output in countries P and Q respectively. In the similar manner, ${}^{QP}dr2$ and ${}^{OP}dr2$ are termed as the dependency of country P on country Q and O respectively; ${}^{PQ}dr2$ and ${}^{OQ}dr2$ are termed as the dependency of country Q on country P and O respectively.

We use, basically, the Asian International Input-Output Tables published by Institute of Development Economies (IDE) for years 1985, 1990 and 1995⁴. These tables consists

⁴ According to IDE homepage, table for year 2000 will be published in March 2006.

(<http://www.ide.go.jp/Japanese/Library/material.html>)

10 endogenous countries, 2 exogenous countries and maximum 78 industrial sectors (1985 table consists 24 industrial sectors only). To include the analysis of recent year, we use the 19 sector table for year 2000 estimated by Takagawa and Okada (2004). We aggregate the IDE 24 sector tables into 19 sector tables⁵, as in 2000 table for the comparability and consistency.

3. Results

The dependency structure matrix with respect to intermediate inputs from the endogenous countries, DR1, does not include the effect of the import of intermediate input goods from exogenous countries, although, it takes an account of direct and indirect effects of the production. Thus, in this paper, we only present the results based on the dependency structure matrix DR2 i.e. the dependency structure with respect to total intermediate inputs.

Table 1 is the dependency structure, for each endogenous country, categorized into self dependency, dependency on other East Asian countries + Japan and ROW + USA⁶.

⁵ Please refer to the Appendix 2 for the list of endogenous countries and aggregation correspondence between 24 sector and 19 sector table.

⁶ For the detailed country wise dependency structure, please refer to Appendix 3.

Table 1: Dependency Structure - 1 (%)

Dependency on		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Self	1985	67.4	51.9	69.3	42.3	66.8	89.5	67.3	65.7	84.3	91.7
	1990	69.4	58.3	55.9	34.8	57.3	90.0	65.3	69.2	86.5	89.9
	1995	72.8	50.3	47.0	47.8	57.6	85.9	59.8	68.8	88.7	88.4
	2000	72.6	53.7	54.0	46.2	60.0	87.3	55.8	69.7	86.9	88.3
Other East Asian + Japan	1985	15.7	26.9	13.5	35.6	17.2	4.9	11.1	13.6	4.4	2.9
	1990	14.7	25.6	22.6	37.2	23.8	4.1	13.5	11.6	4.0	3.3
	1995	13.6	29.2	29.3	30.8	23.8	6.6	18.6	13.2	3.6	3.9
	2000	13.8	26.1	23.2	32.2	21.6	5.3	21.6	11.7	4.8	3.9
ROW+USA	1985	16.9	21.2	17.2	22.1	16.0	5.6	21.6	20.6	11.3	5.4
	1990	15.9	16.1	21.5	27.9	18.9	5.8	21.2	19.2	9.6	6.8
	1995	13.6	20.4	23.8	21.5	18.6	7.5	21.6	18.0	7.7	7.7
	2000	13.6	20.2	22.8	21.6	18.4	7.4	22.6	18.6	8.3	7.8

The self dependency for China, Japan and USA shows more than 80%. This indicates that most of the intermediate input goods are produced domestically in these countries. While the self dependencies of East Asian countries are comparatively low, indicating these countries, still largely depend on imported intermediate input goods. In general, the trend of self dependency is increasing from 1995 to 2000.

The dependency of East Asian countries on other East Asian countries including Japan and ROW including USA shows relatively higher percentage and decreasing trend in general. This means that the East Asian countries are becoming more dependent on domestic intermediate input goods or import from the other East Asian countries including Japan. On the other hand, despite of the decreasing trend East Asian countries somehow largely depends on ROW including USA for intermediate input goods

Table 2 shows the decomposition of dependency structure of other East Asian countries including Japan into other East Asian countries and Japan. This table shows

that the dependency on Japan by East Asian countries is relatively high indicating the importance of Japan as the source of intermediate input goods. In general, dependency on Japan shows decreasing trend, while dependency on other East Asian countries shows the increasing trend from 1985 to 2000.

Table 2: Dependency Structure – 2 (%)

Dependency on		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea
Other East Asian except Japan	1985	5.8	13.1	9.1	24.2	8.0	1.0	3.6	4.7
	1990	6.2	12.4	10.7	20.0	11.5	2.1	4.4	4.3
	1995	6.6	14.0	15.9	17.2	11.3	3.3	8.7	6.7
	2000	7.8	13.8	13.9	20.6	11.9	3.2	11.8	6.9
Japan	1985	9.9	13.9	4.4	11.4	9.3	3.9	7.5	9.0
	1990	8.5	13.2	12.0	17.2	12.3	2.0	9.0	7.4
	1995	7.0	15.2	13.4	13.6	12.5	3.2	9.9	6.5
	2000	6.0	12.3	9.3	11.5	9.7	2.1	9.8	4.8

When the dependency structure on Japan and ROW including USA is considered, although the dependency trend is decreasing the East Asian countries imports most of the intermediate input goods, for the production process, from either Japan or USA or ROW.

The self dependency and dependency on other East Asian countries except Japan in Transport Equipment sector, shows moderate level and very low level dependency respectively, while the dependency on Japan is very high.

Table 3, Table 4 and Table 5 are the dependency structure in East Asian countries at industry level in Transport Equipment, sector Machinery sector and Chemical Products sector respectively.

Table 3: Dependency Structure (%) in Transport Equipment Sector

Dependency on		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Self	1985	52.5	22.5	76.8	71.2	52.9	89.4	65.1	63.4	93.0	87.6
	1990	52.3	34.1	41.5	33.3	31.3	83.9	60.4	73.4	94.1	84.7
	1995	52.9	36.0	33.8	45.2	38.5	80.1	56.5	71.1	94.5	83.6
	2000	47.9	39.1	42.5	43.4	41.9	83.7	52.7	73.6	93.8	83.7
Other East Asian except Japan	1985	5.2	4.6	6.0	5.4	7.0	0.5	1.3	2.0	1.5	1.4
	1990	4.2	4.1	6.9	10.3	8.6	1.5	2.6	1.7	1.4	2.0
	1995	5.4	6.9	9.5	11.9	9.2	3.2	5.2	3.6	1.7	3.1
	2000	7.2	7.5	9.9	14.6	10.6	2.6	7.7	4.0	2.2	3.6
Japan	1985	28.3	60.2	5.3	10.3	26.5	5.3	18.4	19.3	-	4.3
	1990	30.5	50.8	42.8	27.8	45.3	5.7	20.6	13.1	-	5.0
	1995	28.0	42.9	46.9	18.3	34.5	7.1	17.3	11.9	-	4.9
	2000	31.0	38.8	37.6	16.6	29.3	4.4	17.8	8.9	-	4.3
ROW+USA	1985	14.1	12.7	11.9	13.2	13.7	4.8	15.2	15.3	5.5	6.7
	1990	13.0	11.0	8.8	28.6	14.7	8.9	16.3	11.8	4.5	8.3
	1995	13.8	14.1	9.9	24.6	17.8	9.6	21.0	13.4	3.8	8.4
	2000	13.9	14.6	10.0	25.5	18.2	9.3	21.8	13.4	4.0	8.4

Table 4: Dependency Structure (%) in Machinery Sector

Dependency on		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Self	1985	27.6	25.1	35.6	27.2	49.2	84.3	58.1	57.3	91.3	87.4
	1990	34.9	39.7	33.5	25.0	26.6	88.0	54.8	61.6	91.4	85.2
	1995	43.6	29.7	29.8	26.2	24.9	80.0	43.4	59.6	89.4	79.3
	2000	40.9	34.1	37.2	23.7	27.9	83.8	39.1	63.1	87.5	79.3
Other East Asian except Japan	1985	10.3	16.1	17.7	15.8	7.5	0.6	2.3	2.6	2.1	2.6
	1990	6.3	16.3	14.0	17.4	17.5	1.5	4.5	3.1	2.6	3.5
	1995	11.7	18.9	15.8	24.9	21.4	3.6	11.8	6.3	4.2	6.7
	2000	14.9	18.6	15.0	30.8	23.3	3.1	16.5	6.9	5.7	7.6
Japan	1985	27.8	23.7	13.4	26.0	24.8	8.2	22.6	21.5	-	4.7
	1990	15.2	19.6	28.5	31.7	28.2	3.7	21.1	20.2	-	5.0
	1995	17.3	25.6	22.0	28.4	28.3	7.5	23.7	16.5	-	6.7
	2000	16.4	21.3	16.8	24.5	23.4	4.6	22.3	12.6	-	5.8
ROW+USA	1985	34.4	35.2	33.4	31.0	18.6	6.8	17.0	18.6	6.6	5.3
	1990	43.5	24.4	23.9	25.9	27.7	6.7	19.7	15.0	6.0	6.3
	1995	27.3	25.8	32.4	20.5	25.4	8.9	21.0	17.6	6.4	7.3
	2000	27.8	25.9	31.1	21.0	25.5	8.6	22.0	17.5	6.8	7.3

Table 5: Dependency Structure (%) in Chemical Products Sector

Dependency on		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Self	1985	44.5	47.4	66.6	45.8	54.1	88.1	60.1	58.4	82.5	92.6
	1990	53.0	68.1	56.1	31.1	56.1	88.1	57.6	62.6	85.6	89.8
	1995	52.6	52.1	40.4	53.3	54.8	83.2	50.1	60.8	87.5	88.7
	2000	51.4	58.6	48.3	56.1	58.5	84.7	44.2	63.1	85.1	88.5
Other East Asian except Japan	1985	10.0	13.8	10.1	11.8	8.4	1.0	3.0	3.8	5.2	0.8
	1990	11.5	9.2	9.3	11.9	10.0	2.3	3.5	2.9	3.6	1.1
	1995	14.2	15.4	20.3	11.4	12.4	4.6	7.2	6.0	3.4	1.4
	2000	18.2	14.1	18.9	12.5	13.1	4.5	11.2	7.0	5.1	1.7
Japan	1985	14.0	11.0	5.5	13.0	15.6	3.9	10.2	12.0	-	0.9
	1990	10.6	8.0	10.0	14.7	13.5	2.8	11.8	11.6	-	1.2
	1995	12.3	13.3	13.8	11.5	14.4	3.8	14.8	11.0	-	1.6
	2000	10.2	9.3	8.8	8.8	10.7	2.5	14.8	7.5	-	1.4
ROW+USA	1985	31.5	27.8	17.8	29.4	21.9	7.0	26.7	25.7	12.3	5.6
	1990	24.8	14.7	24.6	42.3	20.4	6.8	27.2	22.9	10.9	7.9
	1995	20.8	19.3	25.5	23.8	18.4	8.5	27.9	22.2	9.1	8.3
	2000	20.2	18.0	24.0	22.6	17.8	8.2	29.8	22.3	9.7	8.4

The self dependency and dependency on other East Asian countries except Japan in Transport Equipment sector, shows moderate level and very low level dependency respectively, while the dependency on Japan is very high.

Dependency structure in Machinery sector and Chemical Products sector also shows high level of dependency on either Japan or ROW including USA and comparatively low level of self dependency and dependency on other East Asian countries. Here also the general trend dependency is decreasing towards non East Asian countries.

4. Conclusions

The results stated above indicate that the interdependency, in terms of use of intermediate input goods, is becoming stronger among East Asian countries. The self dependency and dependency on other regional partners in this region has increasing trend. Further the dependency on Japan and ROW including USA has the decreasing trend in general. This indicates that stronger linkage has been developing inside the East Asian countries when the use of intermediate input goods is considered.

On the other hand, while the linkages among the East Asian countries are becoming stronger, it is worthy to note the dependency level of these countries towards Japan and ROW including USA is comparatively high. This means increase in import of

intermediate goods by East Asian countries increases the export earnings of Japan, USA and ROW.

We also focus on the dependency structure at the sector level, for example Transport Equipment, Machinery and Chemical Products sectors which show quite different result as that showed by the country as a whole. In case of these industrial sectors, the self dependency and dependency on other East Asian countries are very low. It means that most of the intermediate input goods are imported from outside the East Asian region.

Further, the portion of the import of intermediate goods, to produce export goods in East Asian countries, from Japan, USA and ROW are very high as compared to import from other East Asian countries. This phenomenon of importing intermediate input goods to produce export goods, also leads to the large portion of leakage of the export earnings from East Asia to Japan, USA or ROW.

In such situation, increase in economic activity (production and export) in East Asian countries will result in more economic benefits to the non East Asian countries compared to East Asian countries.

Finally we conclude that, the structure of self dependency and the dependency on other East Asian countries are different, at country level as well as at industry level, among the East Asian countries. Economic integration among the countries with such

diverse dependency structure leads to the fact that the level of economic benefits will be different according to interdependency structure, which leads to the difficulty in making and implementing the common economic policy.

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Appendix 1

The total intermediate input requirement matrix (R_2) is derived as follows.

According to the definition of total intermediate input coefficient matrix A , intermediate input goods required to produce unit output in each sector of exogenous countries is simply given by the matrix A , i.e.

$$\begin{bmatrix} Ad \\ Aw \end{bmatrix} = A$$

The first round effect will be

$$\begin{bmatrix} Ad \\ Aw \end{bmatrix} [Ad] = A * Ad$$

The second round effect will be

$$[A * Ad][Ad] = A * Ad^2$$

The third round effect will be

$$[A * Ad^2][Ad] = A * Ad^3$$

And so on,

Finally, total intermediate inputs that is necessary, from endogenous as well as exogenous countries, to fulfill the unit demand in each sector of the endogenous countries is

$$\begin{aligned} & A + [A * Ad] + [A * Ad^2] + [A * Ad^3] + \dots \\ &= A * [I + Ad + Ad^2 + Ad^3 + \dots] \\ &= A * (I - Ad)^{-1} \\ &= \begin{bmatrix} Ad \\ Aw \end{bmatrix} * R1 \\ &= R2 \\ &= \left[\begin{array}{cc} \begin{pmatrix} {}^{PP}r_{211} & {}^{PP}r_{212} \\ {}^{PP}r_{221} & {}^{PP}r_{222} \end{pmatrix} & \begin{pmatrix} {}^{PQ}r_{211} & {}^{PQ}R_{212} \\ {}^{PQ}r_{221} & {}^{PQ}r_{222} \end{pmatrix} \\ \begin{pmatrix} {}^{QP}r_{211} & {}^{QP}r_{212} \\ {}^{QP}r_{221} & {}^{QP}r_{222} \end{pmatrix} & \begin{pmatrix} {}^{QQ}r_{211} & {}^{QQ}r_{212} \\ {}^{QQ}r_{221} & {}^{QQ}r_{222} \end{pmatrix} \\ \begin{pmatrix} {}^{OP}r_{211} & {}^{OP}r_{212} \\ {}^{OP}r_{221} & {}^{OP}r_{222} \end{pmatrix} & \begin{pmatrix} {}^{OQ}r_{211} & {}^{OQ}r_{212} \\ {}^{OQ}r_{221} & {}^{OQ}r_{222} \end{pmatrix} \end{array} \right] \end{aligned}$$

Appendix 2

Aggregation correspondence between 24 and 19 sector table

S.No	24 Sectors List	S.No	19 Sectors List
1	Paddy	1	Agriculture and Forestry
2	Other Agricultural Products		
3	Livestock		
4	Forestry		
5	Fishery	2	Fishery
6	Crude petroleum and natural gas	3	Mining, Crude petroleum and natural gas
7	Other Mining		
8	Food, Beverage and tobacco	4	Food, Beverage and tobacco
9	Textile, Leather and their products there of	5	Textile, Leather and their products there of
10	Timber and Wooden Products	6	Timber and Wooden Products
11	Pulp, Paper and printing	7	Pulp, Paper and printing
12	Chemical Products	8	Chemical Products
13	Petroleum and Petro-products	9	Petroleum and Petro Products
14	Rubber Products	10	Rubber Products
15	Non Metallic Mineral Products	11	Non Metallic Mineral Products
16	Metal Products	12	Metal Products
17	Machinery	13	Machinery
18	Transport Equipment	14	Transport Equipment
19	Other Manufacturing Products	15	Other Manufacturing Products
20	Electricity, gas and water supply	16	Electricity, gas and water supply
21	Construction	17	Construction
22	Trade and Transport	18	Trade and Transport
23	Services	19	Services
24	Public administration		

List of Endogenous countries

- | | |
|----------------|----------------------|
| 1. Indonesia | 5. Thailand |
| 2. Malaysia | 6. China |
| 3. Philippines | 7. Taiwan |
| 4. Singapore | 8. Republic of Korea |

9. Japan

10. United States of America Indonesia

Appendix 3

Detailed country wise Dependency Structure

		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Indonesia	1985	67.4	1.1	1.0	4.3	0.4	0.3	1.1	1.2	1.4	0.3
	1990	69.4	0.7	0.6	2.3	0.4	0.4	1.3	1.3	1.0	0.3
	1995	72.8	1.3	1.5	2.2	0.7	0.5	2.1	1.5	0.7	0.1
	2000	72.6	1.2	1.1	2.3	0.5	0.6	2.2	1.5	1.0	0.1
Malaysia	1985	0.3	51.9	2.0	7.9	2.6	0.1	1.3	2.2	0.7	0.1
	1990	0.6	58.3	1.4	7.3	2.7	0.4	1.2	1.6	0.6	0.1
	1995	0.6	50.3	1.4	5.0	2.4	0.4	1.6	1.1	0.4	0.2
	2000	1.0	53.7	1.7	6.7	2.9	0.4	2.2	1.3	0.7	0.3
Philippines	1985	0.1	0.4	69.3	0.3	0.2	0.0	0.2	0.1	0.1	0.1
	1990	0.1	0.1	55.9	0.2	0.2	0.0	0.1	0.1	0.1	0.0
	1995	0.0	0.2	47.0	0.3	0.3	0.0	0.1	0.1	0.1	0.1
	2000	0.1	0.2	54.0	0.4	0.4	0.0	0.2	0.1	0.1	0.2
Singapore	1985	2.0	6.0	0.5	42.3	1.6	0.1	0.4	0.3	0.2	0.1
	1990	1.1	5.2	1.7	34.8	2.5	0.2	0.6	0.3	0.2	0.1
	1995	1.3	4.6	2.2	47.8	2.3	0.3	0.8	0.3	0.1	0.2
	2000	1.4	4.2	1.8	46.2	2.1	0.4	1.0	0.3	0.2	0.2
Thailand	1985	0.2	1.0	0.3	1.6	66.8	0.1	0.2	0.2	0.3	0.1
	1990	0.2	0.6	0.2	2.0	57.3	0.2	0.3	0.2	0.3	0.1
	1995	0.3	1.1	0.6	2.0	57.6	0.2	0.4	0.4	0.4	0.1
	2000	0.4	1.2	0.7	2.5	60.0	0.2	0.6	0.3	0.5	0.1
China	1985	0.8	2.0	2.7	5.2	1.1	89.5	0.1	0.1	1.1	0.2
	1990	1.2	1.9	0.9	3.9	2.3	90.0	0.1	0.1	1.0	0.3
	1995	1.5	2.2	2.7	2.9	2.1	85.9	2.2	2.7	1.0	0.5
	2000	2.0	2.8	2.6	4.1	2.7	87.3	3.5	3.0	1.3	0.6
Taiwan	1985	1.4	1.4	1.1	3.1	1.3	0.3	67.3	0.5	0.3	0.4
	1990	1.8	2.6	3.3	2.8	1.9	0.6	65.3	0.7	0.3	0.4
	1995	1.2	2.4	3.9	2.3	1.8	0.6	59.8	0.6	0.3	0.4
	2000	0.9	1.8	2.5	1.9	1.3	0.4	55.8	0.4	0.3	0.3
Korea	1985	1.1	1.2	1.4	1.8	0.8	0.0	0.3	65.7	0.4	0.3
	1990	1.2	1.3	2.5	1.5	1.5	0.2	0.8	69.2	0.5	0.3
	1995	1.7	2.2	3.5	2.4	1.8	1.3	1.4	68.8	0.5	0.4
	2000	2.1	2.4	3.4	2.9	2.1	1.3	2.0	69.7	0.7	0.5
Japan	1985	9.9	13.9	4.4	11.4	9.3	3.9	7.5	9.0	84.3	1.5
	1990	8.5	13.2	12.0	17.2	12.3	2.0	9.0	7.4	86.5	1.6
	1995	7.0	15.2	13.4	13.6	12.5	3.2	9.9	6.5	88.7	1.9
	2000	6.0	12.3	9.3	11.5	9.7	2.1	9.8	4.8	86.9	1.6
USA	1985	6.5	5.8	7.7	6.6	3.1	1.3	7.2	8.3	3.0	91.7
	1990	3.2	4.5	6.9	9.5	4.5	1.5	7.6	7.7	2.8	89.9
	1995	3.6	6.4	8.4	8.6	5.3	1.7	7.7	6.1	2.3	88.4
	2000	3.4	5.9	6.4	8.4	4.8	1.3	8.8	5.1	2.5	88.3
ROW	1985	10.4	15.4	9.5	15.5	12.9	4.2	14.4	12.4	8.3	5.4
	1990	12.7	11.6	14.6	18.4	14.4	4.3	13.6	11.4	6.8	6.8
	1995	10.0	14.0	15.3	12.9	13.3	5.8	13.9	11.9	5.4	7.7
	2000	10.1	14.3	16.4	13.1	13.6	6.1	13.7	13.4	5.8	7.8

Detailed Dependency Structure for Transport Equipment Sector

		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Indonesia	1985	52.5	0.3	0.6	0.9	0.4	0.1	0.3	0.4	0.4	0.1
	1990	52.3	0.4	0.2	1.1	0.4	0.1	0.3	0.3	0.2	0.1
	1995	52.9	0.7	0.3	1.4	0.4	0.2	0.5	0.4	0.2	0.1
	2000	47.9	0.4	0.3	0.9	0.3	0.2	0.4	0.4	0.2	0.1
Malaysia	1985	0.2	22.5	1.1	1.5	1.2	0.1	0.3	0.6	0.2	0.1
	1990	0.3	34.1	0.5	2.6	1.0	0.2	0.4	0.4	0.1	0.2
	1995	0.4	36.0	1.1	2.8	1.0	0.3	0.6	0.4	0.1	0.4
	2000	0.6	39.1	1.4	4.2	1.5	0.3	1.0	0.5	0.2	0.6
Philippines	1985	0.1	0.1	76.8	0.1	0.1	0.0	0.1	0.1	0.1	0.0
	1990	0.1	0.0	41.5	0.2	0.2	0.0	0.1	0.1	0.1	0.0
	1995	0.1	0.1	33.8	0.3	0.5	0.0	0.1	0.1	0.1	0.1
	2000	0.1	0.2	42.5	0.3	0.6	0.0	0.1	0.1	0.1	0.2
Singapore	1985	1.4	2.1	0.3	71.2	1.2	0.1	0.2	0.2	0.1	0.1
	1990	0.9	1.0	0.6	33.3	1.5	0.1	0.5	0.2	0.1	0.2
	1995	0.7	1.5	0.5	45.2	1.5	0.3	0.6	0.3	0.1	0.3
	2000	0.8	1.5	0.4	43.4	1.4	0.2	0.7	0.2	0.1	0.2
Thailand	1985	0.1	0.3	0.2	0.2	52.9	0.1	0.1	0.1	0.1	0.0
	1990	0.2	0.3	0.3	0.7	31.3	0.2	0.1	0.1	0.1	0.1
	1995	0.3	0.7	0.9	1.2	38.5	0.1	0.2	0.2	0.2	0.2
	2000	0.4	0.7	0.8	1.4	41.9	0.1	0.3	0.2	0.2	0.2
China	1985	0.7	0.4	1.7	1.3	0.6	89.4	0.1	0.1	0.3	0.1
	1990	0.7	0.5	0.2	2.0	2.4	83.9	0.1	0.1	0.3	0.3
	1995	1.3	0.9	1.8	2.1	2.0	80.1	2.0	1.7	0.5	0.6
	2000	2.1	1.4	2.3	3.4	3.0	83.7	3.4	2.2	0.7	0.9
Taiwan	1985	1.6	1.1	0.8	0.9	2.2	0.1	65.1	0.5	0.1	0.6
	1990	1.0	1.2	1.4	2.0	1.7	0.5	60.4	0.6	0.3	0.7
	1995	1.2	1.4	1.4	1.5	1.7	1.0	56.5	0.5	0.3	0.6
	2000	1.0	1.0	0.9	1.2	1.3	0.5	52.7	0.3	0.2	0.5
Korea	1985	1.1	0.4	1.2	0.6	1.2	0.0	0.2	63.4	0.2	0.3
	1990	1.1	0.7	3.5	1.8	1.4	0.3	1.0	73.4	0.3	0.5
	1995	1.5	1.7	3.5	2.6	2.0	1.3	1.2	71.1	0.3	0.7
	2000	2.0	2.2	3.8	3.2	2.4	1.2	1.8	73.6	0.4	0.9
Japan	1985	28.3	60.2	5.3	10.3	26.5	5.3	18.4	19.3	93.0	4.3
	1990	30.5	50.8	42.8	27.8	45.3	5.7	20.6	13.1	94.1	5.0
	1995	28.0	42.9	46.9	18.3	34.5	7.1	17.3	11.9	94.5	4.9
	2000	31.0	38.8	37.6	16.6	29.3	4.4	17.8	8.9	93.8	4.3
USA	1985	7.2	3.0	5.0	5.7	3.7	0.8	5.2	6.7	2.2	87.6
	1990	2.9	3.3	2.7	17.4	4.5	2.4	6.8	5.4	1.9	84.7
	1995	2.9	5.0	3.9	14.3	5.1	2.2	6.2	6.3	1.7	83.6
	2000	3.3	5.1	3.4	14.9	4.9	1.6	7.2	5.5	1.8	83.7
ROW	1985	6.8	9.7	6.9	7.5	9.9	4.0	10.0	8.6	3.2	6.7
	1990	10.2	7.7	6.1	11.2	10.2	6.6	9.5	6.4	2.6	8.3
	1995	10.9	9.1	6.0	10.4	12.8	7.4	14.8	7.1	2.1	8.4
	2000	10.6	9.5	6.6	10.5	13.2	7.7	14.6	7.9	2.1	8.4

Detailed Dependency Structure for Machinery Sector

		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Indonesia	1985	27.6	0.6	1.4	1.9	0.3	0.1	0.3	0.4	0.5	0.1
	1990	34.9	0.5	0.2	0.6	0.4	0.1	0.3	0.3	0.3	0.1
	1995	43.6	0.7	0.4	1.2	0.4	0.2	0.4	0.4	0.2	0.1
	2000	40.9	0.5	0.3	0.8	0.3	0.2	0.4	0.5	0.3	0.1
Malaysia	1985	0.5	25.1	3.0	6.3	1.2	0.1	0.5	0.6	0.2	0.3
	1990	0.4	39.7	1.0	5.6	1.7	0.2	0.9	0.6	0.2	0.3
	1995	1.0	29.7	1.5	6.4	4.2	0.3	2.1	0.9	0.4	1.0
	2000	1.7	34.1	2.1	9.6	6.0	0.4	3.4	1.3	0.6	1.5
Philippines	1985	0.1	3.3	35.6	1.1	0.4	0.1	0.3	0.2	0.1	0.2
	1990	0.1	0.4	33.5	0.7	0.3	0.0	0.3	0.1	0.1	0.1
	1995	0.1	0.5	29.8	1.0	1.5	0.0	0.6	0.2	0.1	0.3
	2000	0.2	0.6	37.2	1.4	2.0	0.0	0.9	0.3	0.2	0.4
Singapore	1985	3.6	7.4	1.3	27.2	1.9	0.1	0.7	0.4	0.1	0.3
	1990	1.7	8.1	5.0	25.0	7.3	0.1	1.1	0.6	0.2	0.7
	1995	2.1	7.0	4.3	26.2	5.8	0.4	2.0	1.1	0.4	1.1
	2000	2.0	5.9	3.5	23.7	4.7	0.3	1.9	0.8	0.3	0.9
Thailand	1985	0.1	0.8	0.4	1.5	49.2	0.1	0.1	0.1	0.1	0.1
	1990	0.3	0.7	0.4	1.8	26.6	0.1	0.3	0.2	0.2	0.1
	1995	0.5	1.6	0.5	4.5	24.9	0.1	0.7	0.3	0.3	0.4
	2000	0.6	1.7	0.5	4.8	27.9	0.1	0.9	0.3	0.4	0.4
China	1985	0.6	0.8	6.2	0.9	0.8	84.3	0.1	0.1	0.3	0.1
	1990	0.7	1.2	0.3	1.2	1.5	88.0	0.1	0.1	0.4	0.3
	1995	2.3	1.8	1.5	2.4	2.3	80.0	2.5	2.0	1.0	0.8
	2000	4.1	2.8	1.9	3.9	3.5	83.8	4.2	2.8	1.8	1.3
Taiwan	1985	3.0	1.7	2.3	2.8	1.7	0.2	58.1	0.8	0.3	0.8
	1990	1.9	3.4	4.0	4.1	3.9	0.6	54.8	1.2	0.6	1.1
	1995	2.8	3.5	3.4	3.0	4.3	0.8	43.4	1.4	0.6	1.4
	2000	2.4	2.6	2.3	2.3	3.1	0.5	39.1	0.9	0.5	1.1
Korea	1985	2.2	1.5	3.0	1.3	1.3	0.0	0.3	57.3	0.4	0.7
	1990	1.3	2.1	3.2	3.3	2.5	0.4	1.5	61.6	0.6	0.8
	1995	3.0	3.8	4.2	6.4	3.0	1.6	3.6	59.6	1.1	1.6
	2000	4.0	4.5	4.3	7.9	3.6	1.5	4.8	63.1	1.6	2.0
Japan	1985	27.8	23.7	13.4	26.0	24.8	8.2	22.6	21.5	91.3	4.7
	1990	15.2	19.6	28.5	31.7	28.2	3.7	21.1	20.2	91.4	5.0
	1995	17.3	25.6	22.0	28.4	28.3	7.5	23.7	16.5	89.4	6.7
	2000	16.4	21.3	16.8	24.5	23.4	4.6	22.3	12.6	87.5	5.8
USA	1985	19.6	22.4	16.6	20.2	6.5	1.2	5.2	10.5	2.6	87.4
	1990	3.5	9.5	15.2	15.7	16.2	1.3	9.1	8.1	2.4	85.2
	1995	8.5	12.5	22.5	12.8	15.5	2.1	10.1	10.1	3.3	79.3
	2000	9.5	12.2	20.6	13.0	15.2	1.5	11.1	9.1	3.7	79.3
ROW	1985	14.8	12.8	16.7	10.9	12.0	5.6	11.8	8.1	4.1	5.3
	1990	40.0	14.9	8.7	10.3	11.5	5.5	10.6	6.9	3.6	6.3
	1995	18.8	13.4	10.0	7.7	9.9	6.8	10.9	7.5	3.1	7.3
	2000	18.2	13.8	10.5	8.0	10.3	7.0	10.9	8.4	3.2	7.3

Detailed Dependency Structure for Chemical Products Sector

		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Indonesia	1985	44.5	1.5	1.2	1.5	0.4	0.2	0.6	1.1	1.4	0.2
	1990	53.0	1.0	0.7	1.4	0.4	0.1	0.7	0.7	0.7	0.1
	1995	52.6	2.4	3.5	1.4	1.1	0.3	0.9	0.9	0.4	0.1
	2000	51.4	1.6	2.9	1.1	0.7	0.4	0.9	1.0	0.7	0.1
Malaysia	1985	0.8	47.4	2.1	3.4	1.1	0.1	0.4	1.1	0.4	0.1
	1990	0.7	68.1	1.0	4.2	0.9	0.6	0.3	0.7	0.3	0.1
	1995	0.8	52.1	2.5	3.0	1.2	0.5	0.4	0.9	0.4	0.1
	2000	1.5	58.6	3.0	4.1	1.8	0.5	0.9	1.5	0.7	0.2
Philippines	1985	0.9	0.2	66.6	0.1	0.2	0.0	0.1	0.1	0.1	0.1
	1990	1.1	0.1	56.1	0.2	0.2	0.0	0.1	0.1	0.1	0.0
	1995	0.1	0.1	40.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	2000	0.1	0.2	48.3	0.2	0.2	0.2	0.1	0.1	0.2	0.2
Singapore	1985	3.8	7.1	0.7	45.8	2.4	0.1	0.9	0.8	0.6	0.0
	1990	2.6	3.3	2.5	31.1	1.9	0.2	0.9	0.5	0.5	0.1
	1995	4.0	3.7	2.8	53.3	2.4	0.3	1.5	0.9	0.4	0.2
	2000	5.1	3.6	2.6	56.1	2.5	0.4	2.3	0.8	0.5	0.2
Thailand	1985	0.2	0.7	0.4	0.6	54.1	0.1	0.2	0.1	0.1	0.0
	1990	0.2	0.7	0.3	0.6	56.1	0.1	0.1	0.1	0.1	0.0
	1995	0.5	1.4	0.8	1.8	54.8	0.2	0.2	0.2	0.1	0.1
	2000	0.8	1.5	1.0	2.5	58.5	0.2	0.4	0.2	0.2	0.1
China	1985	1.6	1.9	2.8	2.9	2.3	88.1	0.2	0.3	1.8	0.2
	1990	3.6	1.9	1.2	2.8	3.1	88.1	0.1	0.1	1.1	0.3
	1995	3.4	3.0	3.3	1.3	2.7	83.2	1.6	2.6	1.0	0.5
	2000	4.9	3.6	3.7	1.6	3.5	84.7	2.7	3.1	1.5	0.7
Taiwan	1985	1.7	1.4	1.0	2.3	1.5	0.4	60.1	0.4	0.2	0.2
	1990	1.8	1.5	2.1	1.7	2.0	0.9	57.6	0.5	0.2	0.2
	1995	2.2	3.0	3.3	2.6	2.6	1.0	50.1	0.5	0.2	0.2
	2000	1.5	1.8	1.8	1.7	1.7	0.6	44.2	0.3	0.2	0.1
Korea	1985	0.9	1.0	2.0	1.0	0.6	0.0	0.7	58.4	0.4	0.1
	1990	1.6	0.7	1.5	1.0	1.6	0.3	1.2	62.6	0.5	0.2
	1995	3.3	1.8	4.0	1.2	2.3	2.1	2.5	60.8	0.7	0.2
	2000	4.3	1.9	4.0	1.3	2.7	2.3	4.0	63.1	1.1	0.2
Japan	1985	14.0	11.0	5.5	13.0	15.6	3.9	10.2	12.0	82.5	0.9
	1990	10.6	8.0	10.0	14.7	13.5	2.8	11.8	11.6	85.6	1.2
	1995	12.3	13.3	13.8	11.5	14.4	3.8	14.8	11.0	87.5	1.6
	2000	10.2	9.3	8.8	8.8	10.7	2.5	14.8	7.5	85.1	1.4
USA	1985	9.9	10.4	8.7	12.0	6.8	2.3	10.9	11.0	3.2	92.6
	1990	7.4	4.3	8.5	18.5	6.2	2.6	13.0	9.7	2.7	89.8
	1995	7.6	7.1	8.8	11.8	6.5	2.4	14.6	9.0	2.6	88.7
	2000	7.2	5.6	6.3	10.4	5.6	1.8	16.6	7.1	2.8	88.5
ROW	1985	21.6	17.4	9.1	17.4	15.1	4.7	15.8	14.7	9.1	5.6
	1990	17.5	10.4	16.1	23.8	14.1	4.2	14.2	13.1	8.1	7.9
	1995	13.2	12.2	16.7	12.1	11.8	6.1	13.4	13.2	6.6	8.3
	2000	13.0	12.4	17.7	12.2	12.2	6.4	13.2	15.2	7.0	8.4