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The Economic Impact of China's Industrialisation on ASEAN: an Inter-Regional Approach

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Abstract: By using the inter-regional input-output approach, this paper attempts to analyse the intra-industry economic linkages and potential impacts of China's industrialisation on ASEAN economies. Our linkage effects strongly suggest that there is a strong argument to believe that a further developed China with greater market openness for the manufactured goods will make it an increasingly powerful engine of growth in the ASEAN region. Moreover, the empirical results also reveal that China's manufacturing sector generates the highest output and income effects on the ASEAN region compared to other sectors.

Keywords: Inter-regional, linkage, multiplier, ASEAN, China
JEL classification: C67, D57, F14

1. Introduction

Over the past decades, China has not only seen the world's fastest economic growth but has also been an outstanding exporter. Its exports increased at a hefty annual rate of 17 per cent, from USD3.7 billion in 1979 to USD 266 billion in 2001, making the nation the world's sixth largest exporting economy (Abeysinghe and Lu 2003). The composition of trade shifted significantly from primary products to manufactured products, which accounted for about 90 per cent of China's exports and 80 per cent of its imports. China's rate of industrialisation and the Gross Domestic Products (GDP) growth rate became spectacularly high, and thus the country has become a competitor in the world's economy. As shown in Table 1, since 1960, the manufacturing sector has been playing an important role in its contribution to China's GDP. As of 2000, the share of the manufacturing sector to GDP grew to about half of the total. In contrast, the share of the agricultural sector to the GDP declined from 22 per cent in 1960 to 16 per cent in 2000. Table 1 also indicates that in the early decades of reform, the role of the agriculture sector in the GDP was more pronounced. However, in the later decades, the emphasis has shifted progressively to the industrial sector. It should be noted that the decline in the agricultural sector's share of GDP due to the expansion of the industrial sector has increased immensely (Dutta 2005).

China's manufacturing sector will expand significantly due to the fact that it has a relatively abundant labour supply at a lower wage rate and abundant endowment of natural resources, which are waiting to be exploited by foreign investors. Its efforts to attract Foreign Direct Investment (FDI) have been successful so far. Statistics demonstrate that from 1988 to 2000, the actual FDI in China increased at an annual rate of 23 per cent to reach a cumulative total of USD 339 billion (Abeysinghe and Lu 2003). No other country in the world, apart from the United States, receives more FDI than China. With its accession to the World Trade Organisation (WTO) in 2001, China is expected to liberalise its rules on foreign

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Table 1: Sectoral shares of GDP to the Chinese economy

Year	Agriculture (% of GDP)	Manufacturing (% of GDP)	Services (% of GDP)
1960	22.32	44.89	32.80
1965	37.94	35.09	26.97
1970	35.22	40.49	24.29
1975	32.40	45.72	21.88
1980	30.09	48.52	21.39
1985	28.35	43.13	28.52
1990	27.05	41.61	31.34
1995	20.51	48.80	30.69
2000	16.35	50.22	33.42

Source: Dutta (2005).

trade particularly on the import side. This should lead to a new economic wave as well as patterns of international trade. China also provides investors a large domestic scale, more industrial depth, a large pool of skills and the government's commitment and willingness to use its market size to bargain for greater technology transfers and local linkages.

Some economists believe that the rise of China's economic power through international trade liberalisation has brought in competitive pressure to bear on the other Asian economies, such as all the members of ASEAN which have had a long and close trade relation with China. Even though China's trade liberalisation will offer an opportunity to these economies to expand their exports, China can also be a competitor in the world market, especially in the manufacturing products sector. With China's abundant labour force, trade liberalisation will allow it to expand more of its resources to produce exportable products, and the lower cost of labour will make China's products very competitive in the world market. Thus, there is concern that China's economic power may bring harm to many industries in the Asian countries. The main reason for this concern is most probably due to a common perception that China and the rest of the Asian economies have a similar stage of development and factor endowments as measured by Wang (2003).

From another standpoint, in order for trading partners to benefit from the trade, they should make a decision based on comparative advantage rather than on absolute advantage. Even if China can produce goods cheaper than its neighbours, the different categories of goods made by China cannot be equally cheaper than those made by its neighbours. As long as that is true, both China and its neighbours can potentially benefit from the trade among the countries by devoting the resources to the production of goods. Several studies, such as by Cheong (2001), Gan (2004) and Lall and Albaladejo (2004), showed the prospects for China to rise as a growth engine for the region, and ASEAN and the Asian New Industrialising Economies would benefit most from trading with China. This argument motivates us to study how growth in China's economy, especially in the manufacturing sector, can stimulate the ASEAN economies.

Therefore, in this paper, the economic impact of China's industrialisation on the ASEAN region is empirically examined by using the inter-regional input-output approach. By applying this approach, the economic impact of China's industrialisation is measured by conducting linkage and multiplier analyses. The main concern of the linkages analysis is to quantify the

relative strength of China's manufacturing sector in boosting and supporting the regional growth compared to the rest of the sectors within the same region. In addition, a multiplier analysis examines the potential impact of the growth in the manufacturing sector on output and income of the ASEAN economies. Data from the latest Asian International Input-Output Table (AIOT) is used to perform the analyses. The table contains five selected ASEAN countries, namely, Indonesia, Malaysia, Singapore, Thailand, and the Philippines.

This paper consists of five sections. Section 2 presents the framework of inter-regional input-output model and its application in the present study. Section 3 discusses the data that is used in the empirical analysis. It mainly provides a description and structure of the AIOT. Section 4 presents a discussion of the results followed by the conclusion in Section 5.

2. Methodology

An input-output model is a useful tool in analysing the economic impact and linkages among the major economic sectors. Economists regularly use the national or single input-output model to examine the inter-industry linkages and economic impacts due to changes in the exogenous variables. The single input-output model, however, fails to connect and does not allow for modelling among countries within a region e.g. the Asian region. To conduct such an analysis requires comprehensive data coverage which can incorporate all sectors across countries within a single framework. To this end, an inter-regional approach is designed to serve this purpose. The development of input-output tables at regional level would enable economic analysis to be carried out for a large geographical area. Impact on regional economies due to new development trade policies or growth can be easily examined by the individual region or country through an intra-industry relationship. By using this approach, we focus the analysis of the linkages and impact of the growth of China's economy on other Asian countries as a whole and specifically on the ASEAN countries.

2.1 Basic Structure of the Inter-regional Input-Output Model

By assuming there is a two-region economy, for example, region M and region S where each region has three producing sectors, the intra-industry data for these regions can be illustrated in Table 2. The uppercase letters denote the specific regions while the lowercase letters represent the input supplier among industries within a region.[2]

The off-diagonal matrices i.e. x_{ij}^{MS} and x_{ij}^{SM} show the composition of the inter-region trade for the particular industry. This transaction refers to the inter-regional or intra-industry trade which indicates flows of export and import when dealing with foreign trade that crosses national boundaries. For example, the element in x_{11}^{MS} represents export of product of industry 1 from region *M* and simultaneously import to region *S* by the same industry classification. On the other hand, the on-diagonal matrices i.e. x_{ij}^{MM} and x_{ij}^{SS} represent the composition of domestically produced goods and services among the industries within the same region. For instance, x_{12}^{MM} shows the flows of goods and services produced by industry 1 that are used by industry 2 as an input in the production of region *M*.

The final demand column shows the composition of goods and services that have gone to the final demand industries of the particular region. Specifically, f_i^{MM} maps the

[2] Region is represented by a specific geographical location e.g. country, state or district, depending on the topic of study. In our study, region refers to the specific Asian country.

Table 2: Intra-industry flows of goods and services

			Intermediate demand						Final demand			
			Region M			Region S			M	S	Export	Total
			1	2	3	1	2	3				output
Intermediate input	Region M	1	x_{11}^{MM}	x_{12}^{MM}	x_{13}^{MM}	x_{11}^{MS}	x_{12}^{MS}	x_{13}^{MS}	f_1^{MM}	f_1^{MS}	e_1^M	X_1^M
		2	x_{21}^{MM}	x_{21}^{MM}	x_{23}^{MM}	x_{21}^{MS}	x_{22}^{MS}	x_{23}^{MS}	f_2^{MM}	f_2^{MS}	e_2^M	X_2^M
		3	x_{31}^{MM}	x_{32}^{MM}	x_{33}^{MM}	x_{31}^{MS}	x_{32}^{MS}	x_{33}^{MS}	f_3^{MM}	f_3^{MS}	e_3^M	X_3^M
	Region S	1	x_{11}^{SM}	x_{12}^{SM}	x_{13}^{SM}	x_{11}^{SS}	x_{12}^{SS}	x_{13}^{SS}	f_1^{SM}	f_1^{SS}	e_1^M	X_1^S
		2	x_{21}^{SM}	x_{22}^{SM}	x_{23}^{SM}	x_{21}^{SS}	x_{22}^{SS}	x_{23}^{SS}	f_2^{SM}	f_2^{SS}	e_2^M	X_2^S
		3	x_{31}^{SM}	x_{32}^{SM}	x_{33}^{SM}	x_{31}^{SS}	x_{32}^{SS}	x_{33}^{SS}	f_3^{SM}	f_3^{SS}	e_2^M	X_3^S
Import			m_1^M	m_2^M	m_3^M	m_1^S	m_2^S	m_3^S	f_m^M	f_m^S		
Taxes			t_1^M	t_2^M	t_3^M	t_1^S	t_2^S	t_3^S	f_t^M	f_t^S		
Value added			v_1^M	v_2^M	v_3^M	v_1^S	v_2^S	v_3^S				
Total input			X_1^M	X_2^M	X_3^M	X_1^S	X_2^S	X_3^S				

inflow of domestically produced goods and services into region *M* final demand industries while f_i^{SM} indicates those imported from region *S*. The last final demand column demonstrates the export of goods and services from region *M* and region *S* to the rest of the world. On the other hand, the import row reveals the import of raw materials by each industry for the both regions from the rest of the world. The rest of the primary inputs i.e. taxes and value added have similar interpretation to the conventional input-output table.

Basically, the inter-regional input-model is similar to the general input-output model. For the two-region case and with three industries, the output of industry 1 in region *M* would be expressed as

$$X_1^M = x_{11}^{MM} + x_{12}^{MM} + x_{13}^{MM} + x_{11}^{MS} + x_{12}^{MS} + x_{13}^{MS} + f_1^M \tag{1}$$

The first three terms on the right-hand side of Equation (1) represent the sales from industry 1 in region *M* to the three industries (itself and two others) within the same region. The next three terms are the inter-regional trade flows from industry 1 in region *M* to the three industries in region *S*. The last term, f_1^M, represents sales to final demand for output of industry 1 in region *M* including export to the rest of the world. There will be similar equations for X_2^M, X_3^M, X_1^S, X_2^S and X_3^S.

Similarly, the derivation of the regional input coefficient and inter-regional trade coefficient are the same as the general input-output model. For instance, the regional input coefficient for region *M* and inter-regional trade coefficient for region *M* to region *S* are derived by using the following expressions:

$$a_{ij}^{MM} = x_{ij}^{MM} / X_j^M \qquad \text{and} \qquad a_{ij}^{MS} = x_{ij}^{MS} / X_j^S \tag{2}$$

By using these regional and trade coefficients to replace x_{ij}^{MM} by $a_{ij}^{MM}X_j^M$ and x_{ij}^{MS} by $a_{ij}^{MS}X_j^S$, Equation (1) can be re-expressed as

$$X_1^M = a_{11}^{MM}X_1^M + a_{12}^{MM}X_2^M + a_{13}^{MM}X_3^M + a_{11}^{MS}X_1^S + a_{12}^{MS}X_2^S + a_{13}^{MS}X_3^S + f_1^M \quad (3)$$

Again, there will be similar expressions for X_2^M, X_3^M, X_1^S, X_2^S and X_3^S. If we move all terms involving X^M and X^S to the left, equation (3) becomes

$$(1 - a_{11}^{MM})X_1^M - a_{12}^{MM}X_2^M - a_{13}^{MM}X_3^M - a_{11}^{MS}X_1^S - a_{12}^{MS}X_2^S - a_{13}^{MS}X_3^S = f_1^M \quad (4)$$

There are similar equations that apply for $f_2^M, f_3^M, f_1^S, f_2^S$ and f_3^S. The complete coefficient matrix for this two-region inter-regional model can be partitioned by the following sub-matrices:

$$A = \begin{pmatrix} A^{MM} & A^{MS} \\ A^{SM} & A^{SS} \end{pmatrix} \quad (5)$$

Using these four sub-matrices, the six equations of which Equation (4) is the first can be represented compactly as

$$\begin{aligned} (I - A^{MM})X^M - A^{MS}X^S &= f^M \\ -A^{SM}X^M + (I - A^{SS})X^S &= f^S \end{aligned} \quad (6)$$

where A represents the regional input coefficients and inter-regional trade coefficients, f^M is the three-element vector of final demand for region M goods, and f^S is the three-element vector of final demands for region S goods. Therefore, the complete two-region inter-regional input-output system is still represented as

$$\begin{aligned} (I - A)\,X &= f \\ X &= (I - A)^{-1} f \end{aligned} \quad (7)$$

where $(I - A)$-1 is the Leontief inverse matrix for this two-region model.

Analysis using the inter-regional input-output model assumes the regional input coefficients and trade coefficients are consistent over time. These assumptions imply that both the structure of the production in each region and trade patterns between regions are frozen in the model (Miller and Blair 1985). The advantage of this approach is that the model captures the magnitude of effects on each sector in each region; inter-regional linkages are made specific by sector in the supplying region and by sector in the receiving region.

2.2 Intra-Industry Linkage Analysis

The main concern of the linkages effects analysis is to quantify the strength of causation among industries, based on the assumption that the economy in related industries can be boosted through linking input and output. Following the input-output analysis, the production of a particular sector in the economy has two types of linkages, namely, forward and backward linkage effects. The inter-dependencies among industries indicate that if the particular sector, say sector *j*, increases its output, it results in an increase in demand for output from other sectors that supply input to sector *j*. This kind of linkage is termed

backward linkage. On the other hand, the increase in output of sector *j* will imply an increase in supply of output to other sectors that will be used as an input. This kind of linkage is termed forward linkage.

Focusing on the Asian region, the backward linkage implies that the individual production sector of a particular country may induce greater use of output from other sectors in other Asian countries as an input. In addition, the forward linkage means that the production sector of the particular country may be used as an input to other sectors of other Asian countries for their own production. These relationships are implicitly measured by the Leontief inverse matrix which reveals the structure of technological interdependence among the production sectors. The indices of backward and forward linkage effects are represented by equations (8) and (9), respectively.

$$U_b = [(1/n)\,\Sigma_i b_{ij}] / [(1/n^2)\Sigma_i\Sigma_j b_{ij}] \quad (8)$$

and

$$U_f = [(1/n)\Sigma_j b_{ij}] / [(1/n^2)\Sigma_i\Sigma_j b_{ij}] \quad (9)$$

where n is the number of sectors across Asian countries, $\Sigma_i b_{ij}$ and $\Sigma_j b_{ij}$ represent the column sum and row sum of the Leontief inverse matrix, respectively, and $\Sigma_i\Sigma_j b_{ij}$ denotes the total sum of the Leontief inverse matrix. Both the left side of equation (8) and (9) are multiplied by $(1/n)$ in order to get an average response of backward and forward linkages to the increase in demand. In addition, both equations on the right side represent the average of the backward and forward linkage effects relative to the total economy. If both the forward and backward linkage indices for the particular sector are greater than average i.e. greater than one, then that sector is considered as a key sector. A key sector is defined as a sector which is largely dependent on other industries, that is, it utilises the products of other sectors in its production process, and on the other hand, other sectors use its output as an intermediate product in their production processes. Briefly, a key sector plays an important role in supporting and boosting other production sectors in a region. Growth in the key sectors would thus initiate economic development due to the tight inter-relations with other production sectors.

2.3 Multiplier Effects

The input-output model is useful in examining the potential impact of any changes or shocks on demand to the regional economy through the multiplier effects. The most frequently used multiplier is to estimate the effects of exogenous changes on output and income generated for the sectors in the economy as a result of the level new demands. In this study, we examine, specifically, the impact of changes in the components of final demand of China's economy on the sectoral output and income of other Asian economies, particularly the ASEAN economies. The Leontief inverse matrix which is derived from Equation (7) is used as a major framework for calculating these multipliers. It captures both direct and indirect output and income effects on the economy as a whole for each dollar of China's final demand.

The output multiplier for a sector is defined as the total value of production in all sectors of the economy that is necessary in order to satisfy a dollar's worth of final demand

for sector *j*'s output. It is derived by summing up the entries in the relevant column of the Leontief inverse matrix as shown by Equation (10)

$$M_j = \sum_{i=1}^{n} b_{ij} \tag{10}$$

where b_{ij} is an element in the Leontief inverse matrix.

The income multiplier captures the sum of direct and indirect changes in income of all industries to an initial per unit increase of final product in a particular sector. In this study, sectoral income is defined as the combination of compensation of employees[3] and operating surplus.[4] The compensation of employees and operating surplus are the income earned by labour and capital, respectively, when supplying primary inputs to the production sector. This type of multiplier is obtained by using the following expression:

$$Y_j = \sum_{i=1}^{n} v_i b_{ij} \tag{11}$$

where b_{ij} is as previously defined and v_i is a coefficient of compensation of employees and operating surplus for sector *i*.

3. Data Source

The main data used in this study is the latest Asian International Input-Output Table for 2000 base-year which was published by the Institute of Developing Economies (IDE). The table is compiled by collaborative work between the IDE with the particular country statistics authority, for instance, the department of statistics for Malaysia. It is designed to depict the industrial network extended over the ten selected countries, namely, China, Indonesia, Korea, Malaysia, Taiwan, the Philippines, Singapore, Thailand, Japan and the United States of America. Structurally, the table breaks up each country into 24 sectors resulting in the intermediate demand quadrants having 240 x 240 dimensions of matrix. However, for the purpose of this study, the sectors are reduced from 24 sectors into seven broad sectors through an aggregation scheme, provided by the table. As our main concern is to study the economic impact of the manufacturing sector, therefore, based on the available information in the table, this sector is disaggregated into 12 individual industries. By taking all the manufacturing industries and the other six broad sectors, the new dimension of intermediate demand quadrant now contains 180 x 180 cells.

In the final demand quadrant, private and government consumption, gross fixed capital formation and increase in stock that have gone into the final demand sectors of the particular country are identified. Furthermore, export of commodities from each country is categorised into three destinations - export to Hong Kong, Europe countries (EU) and the rest of the

[3] Compensation of an employee includes remuneration, in cash or in kind, payable by the production activities to an employee in return for work done during the accounting period. The components of compensation of employees comprise wages and salaries, allowances and other payments received in kind.

[4] Operating surplus measures the surplus accruing from production before taking account of any interest, rent or similar charges payable on financial or tangible non produced assets borrowed or rented or owned by enterprise (company) and unincorporated enterprises (households).

world (ROW). Therefore, taking together all the final demand components, the final demand vector in this table consists of 180 x 7 dimensions of matrix. The primary inputs are disaggregated mainly into import, indirect taxes on commodity which are domestically produced and imported, as well as value added. Similar to the export, components of imports are further disaggregated into those from Hong Kong, EU and ROW. In addition, value added components are categorised into four sub-components, namely, compensation of employees, operating surplus, depreciation of fixed capital and indirect taxes with less subsidies. Totally, the primary input quadrant has 8 x 180 dimensions of matrix.

4. Result and Discussion

4.1 Intra-Industry Linkage Effect

The importance of an individual sector in the economy of a specific country can be examined by using the intra-industry linkage effects as depicted in the inter-regional table. The analysis is mainly carried out for identifying a key sector for the Asian region. Applying this approach, the relative strength of the individual sector across Asian countries is measured by backward and forward linkages which are reported in Table 3 and Table 4, respectively. The top panel for both tables shows the linkage effects for the aggregate sector of the Asian and US economies while the bottom panel shows linkage effects for the individual manufacturing industries of China's economy.

Looking on the sectoral backward linkage effect across countries, Table 3 shows that China has stronger backward linkage effect in all sectors over the rest of the Asian countries. The values of backward linkage indices for all sectors of the China's economy register more than 1 with the average effect being1.2382. This indicates that an expansion in the demand of any sector in China's economy generates a large impact on regional growth, especially the country which supplies large inputs to China's production sectors. In addition, despite the fact that Singapore has a high average forward linkage effect of 1.1036, this country however, does not have strong linkage effect for the trade and transport, and services sectors.

The forward linkage index which is reported in Table 4 tends to show that Japan registers slightly higher values than China by 1.2781 as measured by the average effect. The high forward linkage effect implies that the production output produced by Japan's economy has been substantially utilised by other sectors in the various countries. Although Japan is known for its strong forward linkage, it does have a weak backward linkage as shown in Table 3. Similar to Japan, the US holds a strong forward linkage but registers a weak backward linkage. In contrast, China has both strong backward and forward linkage effects which reflect its role as an engine of growth for regional development. Our results clearly show that China has average backward and forward linkage effects above 1 with 1.2382 and 1.2658, respectively. As an engine of growth, China plays an important role in boosting and supporting other countries via intra-industry linkages effects.

In relation to the stimulus country, it is important to know which sector of China's economy is a key sector for regional sectoral development. Looking on the top panel of both Tables 3 and 4, the manufacturing, trade and transport, and services are considered as the key sectors for China's economy. Both the backward and forward indices show that the manufacturing sector registers the highest linkage index of 1.4416 and 3.4254, respectively,

Table 3: Backward linkages effect

Countries	Agriculture[a]	Mining & quarrying	Manufacturing	Electricity, gas & water	Construction	Trade & transport	Services	Average
Linkage effect for broad sectors of the Asian and US economies								
Indonesia	0.7471	0.6812	1.0434	1.0570	1.0633	0.8640	0.8599	0.9023
Malaysia	0.9210	0.7359	1.2552	0.8900	1.1990	0.8440	0.8655	0.958
The Philippines	0.7813	0.8557	1.0840	1.1831	0.9157	0.8949	0.8189	0.9334
Singapore	1.1880	1.1210	1.1828	1.1178	1.1675	0.9685	0.9794	1.1036
Thailand	0.8955	0.8389	1.1266	0.9883	1.1658	0.8680	0.9868	0.9814
China	1.0550	1.0593	1.4416	1.2623	1.4928	1.1942	1.1624	1.2382
Taiwan	1.0908	0.8382	1.2372	0.5607	1.1998	0.7586	0.7617	0.9210
Korea	0.9232	0.8886	1.2227	0.8987	1.1342	0.8708	0.8648	0.9719
Japan	0.9762	1.0979	1.1830	0.9339	1.0878	0.8344	0.8409	0.9934
USA	1.1934	0.8808	1.1078	0.9855	1.0759	0.8741	0.8559	0.9962

Linkage effect for individual manufacturing industries of the Chinese economy

Food, beverage & tobacco	Textiles & wearing	Timber & wooden	Paper & printing	Chemical products	Petroleum products	Plastics	Non-metallic mineral	Metal products	Machinery equipment	Transport	Others
1.2358	1.4262	1.4117	1.2779	1.4029	1.1202	1.4157	1.3689	1.4771	1.4506	1.5399	1.4350

Source: Derived from Equation (8).
Note: [a]Includes livestock, forestry and fishery.

Table 4: Forward linkages effects

Countries	Agriculture[a]	Mining & quarrying	Manufacturing	Electricity, gas & water	Construction	Trade & transport	Services	Average
Linkage effect for broad sector of the Asian and US economies								
Indonesia	0.7838	1.1540	1.3334	0.6164	0.5862	0.9280	0.8542	0.8937
Malaysia	0.6615	0.6292	1.5474	0.6269	0.5591	0.8496	1.0186	0.8418
The Philippines	0.7058	0.5597	1.2386	0.7697	0.5801	0.7722	1.0181	0.8063
Singapore	0.5568	0.5696	1.5992	0.6838	0.5828	1.1952	1.5972	0.9692
Thailand	0.7134	0.7248	1.6616	0.7581	0.5391	0.9589	1.0158	0.9102
China	0.9501	0.8345	3.4254	0.8850	0.5816	1.0662	1.1175	1.2658
Taiwan	0.6468	0.5697	1.8291	0.5653	0.6044	0.7944	1.1139	0.8748
Korea	0.6502	0.5494	2.3288	0.7027	0.5839	0.7425	1.3108	0.9812
Japan	0.6653	0.5523	3.4491	0.7182	0.6298	1.2303	1.7019	1.2781
U.S.A.	0.8140	0.7533	2.3340	0.6973	0.5807	1.1698	1.9027	1.1788

Linkage effects for individual manufacturing industries of the Chinese economy

Food, beverage & tobacco	Textiles & wearing	Timber & wooden	Paper & printing	Chemical products	Petroleum products	Plastics	Non-metallic mineral	Metal products	Machinery equipment	Transport	Others
1.0334	1.7331	0.7203	0.9929	2.4758	1.5839	0.7446	0.8584	2.1376	2.1503	1.1776	1.1081

Source: Derived from Equation (9).
Note: [a]Includes livestock, forestry and fishery.

which strongly indicates that it is the key sector in China's economy. By disaggregating the manufacturing sector into several industries, the bottom panel of both Tables 3 and 4 reveal that most of the industries play a significant role in the growth of the manufacturing sector, with an exception for the timber and wooden, and paper and printing industries. While transport equipment industry reveals it has strong backward linkage effect (1.5399) in the Chinese economy, the chemical products show a strong forward linkage effect (2.4758).

The linkage analysis, however, only provides information on the relative importance of an individual sector compared to other sectors within a region without giving the potential impact on the Asian region in general and specifically on the ASEAN region. Therefore, the analysis is extended by conducting an impact study using the multiplier analysis.

4.2 Multiplier Effects

In this section, the potential economic impact of the increase in any component in the final demand of China's economy on output and income of the Asian countries, particularly the ASEAN region, are examined through the multiplier effect. The multiplier measures how much output and income are generated by the ASEAN economies as a result of the growth in China's production sectors. It takes into account both direct and indirect effects of the technological inter-dependencies among sectors in the Asian region.

Table 5 shows the impact of China's sectoral growth on the output of the Asian and US economies. The results indicate that China's construction sector generates the largest impact on the regional output growth by 2.7904. An expansion in demand of the construction sector generates 2.7904 dollar of regional output. On the other hand, the capacity of the manufacturing sector to generate regional output is 2.6946, lower than the construction sector. Meanwhile, among the sectors of China's economy, the agriculture sector recorded the lowest output effect with a value of 1.9721.

An expansion in the sectoral demand will generate an additional sectoral output to China's economy. The additional output generated in the domestic economy requires an additional input from domestic as well as foreign sectors (import), depending on economic integration among sectors within the region. In relation to the ASEAN economies, our results show that China's manufacturing sector generates a large output effect on this region, higher than the construction sector. The level of integration of the manufacturing sector is higher than for construction as it utilises more input from other countries through the import. Structurally, as shown in Table 5, for each unit of demand, manufacturing uses about 93 per cent or 2.5014 dollar of local input and 7 per cent or 0.1932 dollar of imported input whereas the construction sector consumes about 94 per cent or 2.6215 dollar of local input and 6 per cent or 0.1689 dollar of imported input.

Although the output effects of China's manufacturing sector to the ASEAN region register the lowest impact compared to Japan, Korea and Taiwan, the results demonstrate that this sector generates the biggest impact over other sectors. Specifically, part of 2.6946 dollar of output generated for the whole region by China's manufacturing sector has produced 0.0270 dollar of output for the ASEAN economies. As part of this gain, Malaysia's manufacturing sector gets more benefits in supplying input to China's manufacturing sector by a value of 0.0075. This is followed by Indonesia, Singapore, Thailand, and the Philippines. Other sectors such as agriculture, mining and quarrying, electricity, gas and water,

Table 5: Output multipliers for every dollar of final demand of China's production sectors

Countries	Agriculture[a]	Mining & quarrying	Manu-facturing	Electricity, gas & water	Construction	Trade & transport	Services
Multiplier effect of aggregate China's production sectors on Asian and US economies							
ASEAN	0.0087	0.0121	0.0270	0.0149	0.0226	0.0142	0.0158
Indonesia	0.0019	0.0024	0.0063	0.0027	0.0051	0.0028	0.0027
Malaysia	0.0023	0.0033	0.0075	0.0038	0.0063	0.0037	0.0043
The Philippines	0.0007	0.0008	0.0022	0.0011	0.0016	0.0010	0.0011
Singapore	0.0021	0.0032	0.0062	0.0044	0.0054	0.0040	0.0044
Thailand	0.0017	0.0023	0.0049	0.0030	0.0042	0.0028	0.0034
China	1.9087	1.8881	2.5014	2.2514	2.6215	2.1351	2.0723
Taiwan	0.0102	0.0153	0.0348	0.0157	0.0287	0.0150	0.0157
Korea	0.0115	0.0174	0.0389	0.0212	0.0329	0.0193	0.0172
Japan	0.0193	0.0316	0.0611	0.0375	0.0581	0.0319	0.0329
United States	0.0137	0.0156	0.0313	0.0189	0.0266	0.0168	0.0189
Total	1.9721	1.9802	2.6946	2.3596	2.7904	2.2322	2.1728

	Food, beverage & tobacco	Textiles & wearing	Timber & wooden	Paper printing	Chemical products	Petroleum products	Plastics	Non-metallic mineral	Metal products	Machinery equipment	Transport	Others
Multiplier effect of individual China's manufacturing industries on Asian and US economies												
ASEAN	0.0135	0.0162	0.0404	0.0478	0.0225	0.0252	0.0261	0.0182	0.0180	0.0432	0.0192	0.0264
Indonesia	0.0041	0.0052	0.0167	0.0309	0.0066	0.0142	0.0073	0.0055	0.0047	0.0051	0.0037	0.0067
Malaysia	0.0045	0.0035	0.0153	0.0046	0.0059	0.0047	0.0094	0.0042	0.0046	0.0136	0.0053	0.0066
The Philippines	0.0007	0.0007	0.0010	0.0012	0.0009	0.0006	0.0008	0.0009	0.0011	0.0045	0.0013	0.0012
Singapore	0.0021	0.0030	0.0037	0.0038	0.0056	0.0030	0.0048	0.0045	0.0044	0.0128	0.0051	0.0077
Thailand	0.0022	0.0038	0.0038	0.0073	0.0035	0.0026	0.0038	0.0030	0.0032	0.0074	0.0037	0.0042
China	2.3152	2.5569	2.5623	2.2246	2.5307	2.0831	2.5505	2.5130	2.6914	2.5112	2.7719	2.5292
Taiwan	0.0099	0.0472	0.0269	0.0312	0.0292	0.0102	0.0376	0.0227	0.0301	0.0544	0.0307	0.0495
Korea	0.0122	0.0549	0.0324	0.0527	0.0412	0.0128	0.0412	0.0264	0.0331	0.0534	0.0329	0.0543
Japan	0.0198	0.0588	0.0442	0.0558	0.0574	0.0226	0.0566	0.0437	0.0596	0.0941	0.0916	0.0767
United States	0.0177	0.0224	0.0220	0.0575	0.0303	0.0110	0.0238	0.0215	0.0225	0.0471	0.0297	0.0371
Total	2.3883	2.7564	2.7283	2.4696	2.7112	2.1649	2.7359	2.6455	2.8547	2.8035	2.9759	2.7732

Source: Derived from Equation (10).
Note: [a]Includes livestock, forestry and fishery.

construction, trade and transport, and services generate 0.0087, 0.0121, 0.0149, 0.0226, 0.0142 and 0.0158 dollar of output for the ASEAN economies, respectively, for every dollar of China's final demand.

By disaggregating the manufacturing sector into several individual industries, the results show that the paper and printing industry contributes a large output effect on the ASEAN economies by a value of 0.0478. The structure of this sector reveals that it uses a large input from Indonesia, higher compared to other ASEAN countries with a value of 0.0309. Malaysia, on the other hand, has strong economic integration with China in the machinery industry as this sector creates the largest output effect on Malaysia over other ASEAN countries. Furthermore, the lowest output effect over other sectors is seen in the food, beverage and tobacco industries which do do not contribute significantly to the growth of the ASEAN economies.

Besides consuming an additional input from other production sectors, an increase in sectoral demand also requires additional input from factors of production in the form of labour and capital.[5] By supplying input to the production sectors, labour receives income in the form of compensation of employees while capital receives operating surplus.[6] The impact of sectoral growth on these two components of incomes is collectively measured in this study and presented in Table 6. The results of income multipliers indicate that China's agricultural sector generates a high value of income for the regional economy by 0.9552, followed by the mining and quarrying, trade and transport, services, electricity, gas and water, construction and manufacturing. Even though sectors like agriculture, and mining and quarrying contribute a low impact on the regional output (Table 5), they relatively generate a large income effect due to the fact that they utilise less leakage (imports) to the regional economy.

Despite the fact that those sectors create the biggest impact on generating income to the regional economy, their capacities to generate income for the ASEAN economies are relatively low. Again, the manufacturing sector still contributes significantly to generate income to the ASEAN economies. For instance, an expansion in the demand of this sector generates 0.0103 dollar of income for the ASEAN economies. The Indonesian manufacturing sector benefited the most over other ASEAN economies from the growth of China's manufacturing sector, especially from the paper and printing industry. Although Malaysia's manufacturing sector generates a higher output than other countries, relatively it generates a lower income compared to Indonesia. This indicates that Malaysia's manufacturing sector has a weak production structure as it is highly dependent on imports. On the other hand, the results also reveal that a growth in the demand of the Chinese manufacturing sector creates more opportunities for Japan, Korea and Taiwan in generating their domestic incomes. This reflects that China's manufacturing sector requires large outputs from these economies as an input in their production process rather than from the ASEAN economies.

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[5] Factors of production is the biggest component of input used by the production sectors. Totally, our data shows that it accounts for about 40 per cent of total inputs used in the region.

[6] Some countries do not distinguish depreciation of fixed capital from the sectoral gross operating surplus. Therefore, for comparison and consistency purposes, gross operating surplus is taken as a measurement for all countries.

Table 6: Income multipliers for every dollar of final demand of China's production sectors

Countries	Agriculture[a]	Mining & quarrying	Manu-facturing	Electricity, gas & water	Construction	Trade & transport	Services
Multiplier effects of aggregate China's production sectors on Asian and US economies							
ASEAN	0.0033	0.0045	0.0103	0.0054	0.0084	0.0052	0.0057
Indonesia	0.0010	0.0013	0.0034	0.0015	0.0027	0.0015	0.0014
Malaysia	0.0008	0.0011	0.0024	0.0012	0.0020	0.0012	0.0014
The Philippines	0.0003	0.0004	0.0009	0.0004	0.0007	0.0004	0.0005
Singapore	0.0005	0.0008	0.0016	0.0012	0.0014	0.0010	0.0011
Thailand	0.0007	0.0009	0.0019	0.0011	0.0016	0.0011	0.0013
China	0.9300	0.9019	0.7926	0.8854	0.8276	0.8958	0.8942
Taiwan	0.0036	0.0054	0.0122	0.0056	0.0101	0.0053	0.0055
Korea	0.0039	0.0059	0.0132	0.0072	0.0111	0.0065	0.0058
Japan	0.0083	0.0136	0.0264	0.0162	0.0251	0.0138	0.0141
United States	0.0061	0.0070	0.0139	0.0085	0.0118	0.0075	0.0084
Total	0.9552	0.9384	0.8686	0.9282	0.8942	0.9340	0.9338

Multiplier effects of individual China's manufacturing industries on Asian and US economies

	Food, beverage & tobacco	Textiles & wearing	Timber & wooden	Paper printing	Chemical products	Petroleum products	Plastics	Non-metallic mineral	Metal products	Machinery equipment	Transport	Others
ASEAN	0.0081	0.0094	0.0275	0.0299	0.0129	0.0161	0.0157	0.0129	0.0096	0.0212	0.0126	0.0155
Indonesia	0.0047	0.0056	0.0144	0.0167	0.0075	0.0106	0.0091	0.0078	0.0055	0.0137	0.0084	0.0082
Malaysia	0.0010	0.0013	0.0050	0.0095	0.0017	0.0034	0.0020	0.0020	0.0010	0.0009	0.0013	0.0022
The Philippines	0.0017	0.0014	0.0063	0.0018	0.0017	0.0013	0.0030	0.0011	0.0012	0.0033	0.0012	0.0025
Singapore	0.0002	0.0002	0.0002	0.0005	0.0003	0.0000	0.0003	0.0003	0.0003	0.0009	0.0004	0.0004
Thailand	0.0006	0.0010	0.0017	0.0013	0.0017	0.0008	0.0014	0.0018	0.0016	0.0024	0.0014	0.0022
China	0.0007	0.0010	0.0010	0.0021	0.0009	0.0007	0.0009	0.0009	0.0007	0.0018	0.0009	0.0010
Taiwan	0.5200	0.5799	0.9155	0.7311	0.5225	0.7426	0.7966	0.8647	0.6603	0.5187	0.8766	0.6858
Korea	0.0027	0.0141	0.0088	0.0089	0.0067	0.0034	0.0137	0.0080	0.0077	0.0153	0.0076	0.0140
Japan	0.0047	0.0202	0.0121	0.0217	0.0133	0.0052	0.0158	0.0114	0.0114	0.0191	0.0089	0.0196
United States	0.0069	0.0203	0.0156	0.0247	0.0208	0.0022	0.0231	0.0209	0.0223	0.0401	0.0294	0.0342
Total	0.5432	0.6449	0.9805	0.8184	0.5771	0.7702	0.8658	0.9189	0.7120	0.6162	0.9359	0.7701

Source: Derived from Equation (11).
Note : [a]Includes livestock, forestry and fisheries.

5. Concluding Remarks

The present paper examines the role of China's manufacturing sector in relation to its growth in the ASEAN region. By using the inter-regional approach, the role of China's manufacturing sector is measured by conducting the linkage and multiplier analyses. This approach is able to capture both direct and indirect effects as a result of any changes in the components of demand in China's economy throughout the whole region. Our linkages effects strongly suggest that there is a strong argument to believe that a further developed China with greater market openness for manufactured goods will make it an increasingly powerful engine of growth in the ASEAN region. In addition, the empirical results also reveal that China's manufacturing sector contributes significantly to generation of output and income for the ASEAN region over the rest of China's sectors. As China fulfills its trade liberalisation agenda with WTO and emerging industrial growth, the multipliers effect of its growth on the region can be reinforced and multiplied.

As the concern over the competitive pressure that arises with China's economic power after accession to WTO on the ASEAN region is understandably mixed, the most important issue, however, is the competition among the Asian and ASEAN economies. China's trade liberalisation will offer an opportunity for these countries to expand their manufacturing exports and at the same time, it will create competition among ASEAN countries and the other core Asian countries especially Japan and Korea. Our results clearly indicate that Japan and Korea will get more opportunities to generate greater domestic output and income from China's economic reform than the ASEAN countries. Indeed, the economic integration between China and those countries is stronger than with the ASEAN countries. Therefore, ASEAN members need to reform their industrial policy in order to attract more FDI into their domestic economy by providing more competitive business incentives.

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