TRADE IN VALUE ADDED (TiVA) ANALYSIS: MALAYSIA'S INTERDEPENDENCIES IN THE PRODUCTION STRUCTURE USING SPATIAL LINKAGES ANALYSIS

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ABSTRAK

Kertas kerja ini memberikan penjelasan tentang kebergantungan komponen intraregional dan interregional dalam struktur pengeluaran Malaysia. Untuk pengukuran kesalingbergantungan ini, satu varian baru kaedah pengekstrakan hipotetikal diperkenalkan. Berbeza dengan penyesuaian awal kaedah ini, pendekatan kami membolehkan perbezaan semula jadi antara kebergantungan kepada hubungan ke belakang dan ke hadapan spatial. Keputusan empirikal adalah berdasarkan Jadual Input-Output Berbilang Serantau (MRIO) yang dikeluarkan oleh Asian Development Bank (ADB) untuk tahun rujukan 2015 hingga 2021. Data tersebut terdiri daripada 63 ekonomi termasuk Seluruh Dunia. Untuk analisis, data itu diagregatkan kepada 10 ekonomi yang merangkumi Malaysia dan lapan rakan dagangan utama utama iaitu Hong Kong (HKG), India (IND), Jepun (JPN), Korea (KOR), China (PRC), Singapura (SIN), Thailand (THA), Amerika Syarikat (AS) dan negara lain diagregatkan ke dalam Seluruh Dunia (ROW). MRIO diklasifikasikan kepada 35 sektor ekonomi dan diagregatkan lagi kepada lima sektor utama iaitu Pertanian, Perlombongan & Pengkuarian, Pembuatan, Pembinaan dan Perkhidmatan untuk memberi tumpuan kepada dimensi sektoral serta ruang bagi saling bergantung. Penemuan kajian ini menunjukkan bahawa kira-kira 71.2 peratus daripada penggunaan pengeluaran input adalah dihasilkan secara domestik. Manakala, baki 28.8 peratus diimport dari negara lain dengan 16.2 peratus adalah daripada rakan dagang utama Malaysia. China adalah salah satu rakan dagangan utama Malaysia di mana 7.6 peratus penggunaan input untuk pengeluaran output diimport dari China. Dari segi pengagihan keluaran, Malaysia mengagihkan lebih daripada dua kali ganda keluaran domestik berbanding keluaran yang dieksport.

Kata kunci: TiVA, hubungan spatial, komponen intraregional dan antara wilayah, hubungan ke belakang dan ke hadapan.

ABSTRACT

This paper provides an explanation of the interdependence of intraregional and interregional components in Malaysia's production structure. For the measurement of these interdependencies, a new variant of the hypothetical extraction method is introduced. In contrast to earlier adaptations of this method, our approach allows for a natural distinction of the interdependencies into spatial backward and forward linkages. The empirical results are based on the Multi-Regional Input-Output (MRIO)

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Table released by the Asian Development Bank (ADB) for the reference year 2015 until 2021. The data consists of 63 economies, including the Rest of the World. For the analysis, the data is aggregated into 10 economies, which include Malaysia and the top eight major trading partners, namely Hong Kong (HKG), India (IND), Japan (JPN), Korea (KOR), China (PRC), Singapore (SIN), Thailand (THA), the United States of America (USA), and other countries are aggregated into the Rest of the World (ROW). MRIO is classified into 35 economic sectors and further aggregated into five main sectors, namely Agriculture, Mining & Quarrying, Manufacturing, Construction, and Services for this purpose to focus on the sectoral as well as the spatial dimension of the interdependencies. This study's findings, showed that approximately 71.2 per cent of the input production consumption was domestically produced. Meanwhile the remaining 28.8 per cent was imported from other countries, of which 16.2 per cent was from Malaysia's major trading partners. China was one of Malaysia's main trading partners, where 7.6 per cent input consumption for the production of output was imported from China. In terms of output distribution, Malaysia distributed more than twice the domestic output compared to exported output.

Keywords: TiVA, Spatial linkages, intraregional and interregional component, backward and forward linkages.

1. INTRODUCTION

Trade in Value Added (TiVA) refers to the exports, imports, and net trade in value added between one economy and another. TiVA provides the ability to redefine the relationship between countries of origin and destination in international trade. In contrast to the conventional concept based on foreign trade statistics. It focuses on the value-added contents of a traded product and considers each country's contribution to the value-added generation in a production process. Nonetheless, note that the value added defined in the national account is the difference between output and intermediate consumption, while TiVA analysis captures the value that is added in each step of the production process in the global value chain.

There are various analyses to explore TiVA, namely Basic Trade Indicators, Multiplier Decomposition, Value Added Decomposition of Gross Exports, Revealed Comparative Advantage, Global Value Chains (GVC) and Spatial Linkages. Therefore, this paper aims to focus on Malaysia's interdependencies in the production structure using spatial linkage analysis with its eight major trading partners.

The purpose of this study is to assess the types and intensities of spatial interdependence or connectedness. This analysis is also able to compute the strength of economic connections among regions in an economy and their evolution over time, for example, increasing regional self-sufficiency or increasing interregional dependence.

The aggregation is in line with Malaysia's external trade statistics for 2022 which showed that China was Malaysia's top trading partner with a contribution of 18.9 per cent, followed by Singapore (12.0%), the USA (9.7%), the European Union (8.1%), Japan (6.7%), and Thailand (4.4%).

TIVA has been studied and widely used to define the relationship between countries of origin and trading destinations. Since measuring countries' value added in gross trade (Koopman, Wang, & Wei, 2014), there has been a rapidly expanding demand for measures of GVC participation that offer a macro-view of the phenomenon (Borin, Mancini, & Taglioni, 2021) and the topic has proliferated in economic research both in international trade and macroeconomics (Bems & Kikkawa, 2021).

One of the methods that have been used to study MRIO is spatial linkage analysis. Using MRIO models for the commodity-by-industry input-output accounts, (Shao & Miller, 1990) examined spatial linkages in the USA multiregional economy for 1977 and compared them with similar linkages for 1963. They found out that spatial linkages were relatively stable over this 14-year period, both at an aggregated regional level and at the state level. In addition to that, (Freytag & Fricke, 2017) evaluated sectoral linkages of financial services of the Nigerian and Kenyan economies by means in an input–output analysis for 2007, 2009 and 2011. They investigated mobile money linkages for the communication sector and found high forward and backward linkages for the Nigerian financial services sector.

There were other studies that used linkage analysis, such as the study about the effect of financial development through input-output (IO) linkages in determining the growth of industries across countries by (Turco, Maggioni, & Zazzaro, 2019) and East Asian equity market linkages in and out of the Asian and global financial crises by Tam (2014).

2. METHODOLOGY

TiVA analysis is adopted in this study using Multi-Regional Input-Output (MRIO) released by the Asian Development Bank (ADB) for the reference year 2015 until 2021. The data consists of 63 economies, including the Rest of the World. For the analysis, the data is aggregated into 10 economies, which include Malaysia and the top eight major trading partners, namely Hong Kong (HKG), India (IND), Japan (JPN), Korea (KOR), China (PRC), Singapore (SIN), Thailand (THA), the United States of America (USA), and other countries are aggregated into the Rest of the World (ROW). MRIO is classified into 35 economic sectors and further aggregated into five main sectors, namely Agriculture, Mining & Quarrying, Manufacturing, Construction, and Services for this purpose.

Spatial linkage analysis can be used to assess the types and intensities of spatial interdependence or connectedness. There are two kinds of linkages: forward and backward. It consists of two components, namely the intraregional and interregional components.

Intraregional Component refers to components within the region itself. It computes the intraregional dependence between all sectors in region *r.*

Interregional Component refers to components within the region itself. It computes the interregional dependence between all sectors between regions *r* and *s.*

The spatial backward and forward linkages by sector were generated based on the equation below:

2.1 Total Backward Linkage

The Total backward linkage (BL) of sector *j* in region *r* captures both direct and indirect linkages and is given by the column sums of the total requirements matrix L. It will likewise have an intraregional and an interregional component.

$$BL(d)_j^r = BL(d)_j^{rr} + BL(d)_j^{sr} = \sum_{i=1}^{n} a_{ij}^{rr} + \sum_{i=1}^{n} a_{ij}^{sr}$$

$$b(t)^r = b(t)^{rr} + b(t)^{sr}$$

where $b(t)^{rr} = i'(L)^{rr}$ and $b(t)^{sr} = i'(L)^{sr}$

Suppose we want to know the total BL of sector 1 in region s. Given the L matrix:

		Region r			Region s	
Selling sector		1	2	3	1	2
Region r	1	l_{11}^{rr}	l_{12}^{rr}	l_{13}^{rr}	l_{11}^{rs}	l_{12}^{rs}
	2	l_{21}^{rr}	l_{22}^{rr}	l_{23}^{rr}	l_{21}^{rs}	l_{22}^{rs}
	3	l_{31}^{rr}	l_{32}^{rr}	l_{33}^{rr}	l_{31}^{rs}	l_{32}^{rs}
Region s	1	l_{11}^{sr}	l_{12}^{sr}	l_{13}^{sr}	l_{11}^{ss}	l_{12}^{ss}
	2	l_{21}^{sr}	l_{22}^{sr}	l_{23}^{sr}	l_{21}^{ss}	l_{22}^{ss}

Intraregional Interregional

To measure the relative strength of the intra- vs. interregional (internal vs. external) direct (or total) backward linkage of sector j in region r, we can calculate them using the formula below:

Use percentages

Relative strength of intraregional $BL = \frac{BL(d)_j^{rr}}{BL(d)_j^r} \times 100$

Relative strength of interregional $BL = \frac{BL(d)_j^{sr}}{BL(d)_j^r} \times 100$

Use alternative normalization

Relative strength of intraregional $BL = \frac{BL(d)_j^{rr}}{BL(x)_j^{r}}$

Relative strength of interregional $BL = \frac{BL(d)_j^{sr}}{BL(x)_j^{r}}$

2.2 Total Forward Linkage

The Total forward linkage (FL) of sector *i* in region *r* captures both direct and indirect linkages and is given by the column sums of the total requirements matrix **L**. It will likewise have an intraregional and an interregional component.

$$FL(t)_i^r = FL(t)_i^{rr} + FL(t)_i^{sr} = \sum_{j=1}^{n} l_{ji}^{rr} + \sum_{j=1}^{n} l_{ji}^{sr}$$

$$f(t)^r = f(t)^{rr} + f(t)^{sr}$$

where $f(t)^{rr} = j'(L)^{rr}$ and $f(t)^{sr} = j'(L)^{sr}$

Suppose we want to know the total FL of sector 1 in region s. Given the L matrix:

		Region r			Region s	
Selling sector		1	2	3	1	2
Region r	1	l_{11}^{rr}	l_{12}^{rr}	l_{13}^{rr}	l_{11}^{rs}	l_{12}^{rs}
	2	l_{21}^{rr}	l_{22}^{rr}	l_{23}^{rr}	l_{21}^{rs}	l_{22}^{rs}
	3	l_{31}^{rr}	l_{32}^{rr}	l_{33}^{rr}	l_{31}^{rs}	l_{32}^{rs}
Region s	1	l_{11}^{sr}	l_{12}^{sr}	l_{13}^{sr}	l_{11}^{ss}	l_{12}^{ss}
	2	l_{21}^{sr}	l_{22}^{sr}	l_{23}^{sr}	l_{21}^{ss}	l_{22}^{ss}
		Intraregional			Interregional	

To measure the relative strength of the intra- vs. interregional (internal vs. external) direct (or total) forward linkage of sector j in region r, we can calculate them using the formula below:

Use percentages

Relative strength of intraregional $FL = \frac{FL(d)_i^{rr}}{FL(d)_i^{r}} \times 100$

Relative strength of interregional $FL = \frac{FL(d)_i^{sr}}{FL(d)_i^{r}} \times 100$

Use alternative normalization

Relative strength of intraregional $FL = \frac{FL(d)_i^{rr}}{FL(x)_i^{r}}$

Relative strength of interregional $FL = \frac{FL(d)_i^{sr}}{FL(x)_i^{r}}$

3. RESULT AND DISCUSSION

For the production of output, Malaysia uses most of the input that was produced domestically. About 71.2 per cent of the input consumption was domestic. Meanwhile the remaining 28.8 per cent was imported from other countries, of which 16.2 per cent was from Malaysia's major trading partners. China was one of Malaysia's main trading partners, where 7.6 per cent input consumption for the production of output was imported from China. This was followed by the USA (1.9%) and Singapore (1.8%).

In terms of output distribution, Malaysia distributed more than twice the domestic output compared to exported output. Domestic sectors used 68.9 per cent of the total output, while 31.1 per cent was exported to other countries in 2021. Malaysia's major trading partners received 18.1 per cent of the exported output, with China as the main trading partner for exports (8.4%). This was followed by the USA (3.5%) and Japan (1.6%).

3.1 Backward Linkages

Intraregional consumption refers to the use of inputs that have been produced domestically. **Chart 1** shows the intraregional consumption of input in the production of output by specific sectors in Malaysia.

From 2015 until 2021, the Mining & quarrying sector had the highest intraregional consumption of input, with an intraregional consumption of more than 80.0 per cent every year. From the chart above, intraregional consumption has been steadily increasing, from 84.6 per cent in 2015 to 87.0 per cent in 2021. The highest was 87.9 per cent in 2020, with the remaining of 12.1 per cent being input that has been imported from other countries.

The Manufacturing sector was the sector with the lowest share of intraregional consumption of input in the production of output. However, more than half of the inputs used by the Manufacturing sector were still produced domestically. The share of domestic input used by the Manufacturing sector decreased from 63.3 per cent in 2015 to 62.0 per cent in 2021. The highest share of intraregional consumption for the Manufacturing sector was 64.7 per cent in 2020.

Chart 1: Intraregional Consumption of Malaysia by Sectors

Meanwhile, interregional consumption of input refers to input that was imported in order to produce the output. This study focuses on the Manufacturing sector, as it has the highest share of imported input compared to other sectors. In 2021, the interregional consumption of Malaysia's Manufacturing sector was 38.0 per cent of which 21.2 per cent was from the major trading partners. The top three (3) trading partners were China, the USA and Japan with a total contribution of 15.6 per cent.

China has been the major trading partner for Malaysia's Manufacturing sector in supplying input for output production. Since 2015, China has had the highest share of imported input, with 5.3 per cent of the total input needed, as shown in **Chart 2**.

Chart 2: Interregional Consumption of the Manufacturing Sector in Malaysia by Top Three (3) Major Trading Partners

The input contribution from China gradually increased as the years went by. The highest share of interregional consumption for the Manufacturing sector imported from China was 10.2 per cent, recorded in 2021. This was followed by the USA, which had a 2.8 per cent share of imported inputs in 2021. The USA consistently ranked as the second major importer of Malaysia, contributing between 2.4 per cent and 3.3 per cent of inputs from 2015 until 2021.

Japan is the third-highest importer for Malaysia's Manufacturing sector, with only a slightly lower margin compared to the USA. Interregional consumption from Japan was 2.6 per cent in 2021.

3.2 Forward Linkages

Intraregional distribution of output refers to output that has been produced in Malaysia and is distributed to other sectors in Malaysia for their input consumption. In other words, intraregional distribution was output that was used for domestic production.

Chart 3 shows that the Construction sector has the highest share of output used for domestic production. From 2015 until 2021, more than 80.0 per cent of the Construction sector's output was taken by other domestic sectors every year. In 2021, the Construction sector distributed 86.8 per cent of its output to other domestic sectors and 13.2 per cent as exported output to other countries.

Chart 3: Intraregional Distribution of Malaysia by Sectors

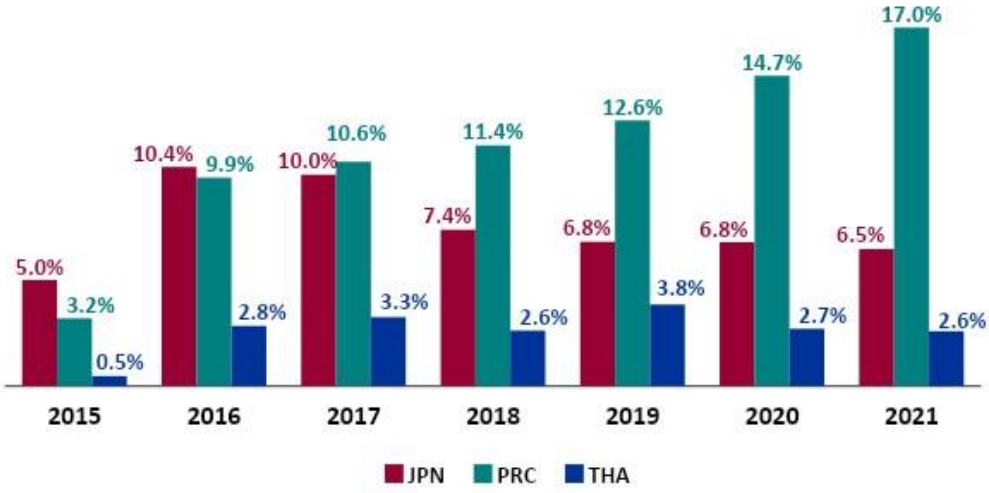
The lowest was in 2015 with a share of 83.5 per cent while the highest share throughout the period was 89.4 per cent in 2016. Based on the findings, the Construction sector was a key sector throughout the entire period, as its output was vastly used by other sectors. The sector with the lowest share of output distributed domestically was the Mining & quarrying sector, with output used by other sectors slightly higher than exported output. The intraregional distribution for the Mining & quarrying sector for 2021 was 52.0 per cent. The highest contribution was 56.4 per cent in 2015 and 2019, while the lowest was 51.2 per cent in 2017.

Interregional distribution is the exported output of a certain region to another region. The interregional distribution of Malaysia is the output produced in Malaysia that is exported to other countries as their input consumption. The Mining & quarrying sector was chosen for this study as it has the highest share of exported output to other countries. Hence, it has the highest interregional distribution of output.

For the Mining & quarrying sector, 48.0 per cent of the output produced was exported to other countries in 2021. More than half of the output was exported to Malaysia's major trading partners, with a share of 33.7 per cent of the total interregional consumption. The top three (3) trading partners were China, Japan and Thailand, with a total share of interregional distribution of 26.1 per cent.

Similar to imported input, China was the major trading partner of Malaysia's exports in 2021, as shown in **Chart 4**. However, the trend was different in 2015 and 2016, with Japan being the highest receiver for the Mining & quarrying sector's exports with a share of 5.0 per cent and 10.4 per cent respectively. This was followed by China and Thailand. The trend started to change into the current trend as China managed to take over Japan with a slight margin of 0.6 per cent in 2017.

Chart 4: Interregional Distribution of the Mining & quarrying Sector in Malaysia by Top Three (3) Major Trading Partners



The gap between China and Japan later grew larger year by year as China began to dominate the exported output of the Mining & quarrying sector throughout the year. In 2021, China consumed 17.0 per cent of the total exported output of the Mining & quarrying sector, followed by Japan with 6.5 per cent. Thus, creating the first double-digit gap between the two countries with a difference of 10.5 per cent.

Thailand also showed an increase in Malaysia's interregional distribution of the Mining & quarrying sector to 2.6 per cent in 2021 as compared to 2015 (0.5%). This shows that Thailand has begun to consume an increasing amount of the exported output of Malaysia's Mining & quarrying sector as input in its output production.

4. CONCLUSION

Overall, TiVA reflects the current nature of businesses in view of global production. Its method, Spatial Linkages, allows tracking the source of inputs and flows of outputs by intraregional and interregional level in the production of goods and services consumed worldwide.

Malaysia's intraregional input consumption remained above 60.0 per cent, with domestic input consumption of 71.2 per cent and 28.8 per cent imported input in 2021. Meanwhile, Malaysia distributed 68.9 per cent of its output domestically and exported 31.1 per cent to interregional levels. These findings prove that Malaysia is a self-sufficient country, with both intraregional distribution and consumption above 50.0 per cent.

From the perspective of the interregional level, China and the USA are both our major trading partners, with imported inputs of 7.6 per cent and 1.9 per cent, respectively. Meanwhile, exported output for both countries was 8.4 per cent and 3.5 per cent, respectively. This indicates that we are highly dependent on both countries for our global productivity.

To further improve the research, several analyses on spillover effects and dependency between sectors and trading partners are recommended to be explored using Value Added Decomposition of Gross Exports, Revealed Comparative Advantage and the Global Value Chain. The spatial linkages can be further analysed at a deeper level, whether by product level or regions in Malaysia.

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