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The Transportation Sector's Role in the Growth of the Upstream Oil Palm Sector

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ABSTRACT

The transportation sector plays a crucial role in supporting the growth of the oil palm sector, whereby an efficient transportation system provides more economic and social opportunities. The relationship between these two sectors can be examined through their inter-sectoral linkages. However, the lack of exposition on the role of sectoral linkages of the transportation sector would disregard the importance of this sector in the growth of the oil palm sector. This study attempts to analyse the role of the transportation sector, comprising land, water, and air transport in the oil palm sector's growth by studying the inter-industry linkages and production-inducing effects. The results indicate that the transportation sector makes a low contribution to the growth of the upstream oil palm sector.

Keywords: input-output analysis, hypothetical extraction method, oil palm sector, transportation sector, inter-linkages.

INTRODUCTION

The Malaysian oil palm sector consists of the upstream cultivation sector and the downstream processing sector. The upstream sector stimulates rural development by providing rural employment and earnings. Meanwhile, the downstream processing activities supply intermediate input to food and non-food industries, which also indirectly create more output for various food processing and manufacturing sectors.

The oil palm sector is targeted to raise its contribution to the country's gross national income through programmes that improve its upstream productivity and sustainability as well as downstream expansion and sustainability (Jaafar, Salleh and Manaf, 2015).

The oil palm fresh fruit bunches (FFB) are harvested and collected in plantations and transported to mills for the production of crude palm oil [National Biomass Vision 2020, 2011]. It also indicates the importance of transportation in ensuring the timely delivery of oil palm products to the next sector in the oil palm industry's supply chain. According to the Department of Statistics Malaysia, DOSM (2019), the oil palm sector's contribution to value addition added in 2017 was RM45.75 billion, while the transportation sector contributed RM47.71 billion to the entire economic sectors. Although both sectors are crucial to Malaysia's economic performance, little is known about the sectoral inter-linkages between them.

Most often, sector efficiency improvements are centred on being transport intensive. In a market-dependent economy, these efficiency

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improvements will influence the whole economic system through the interactions between markets and sectors. It justifies why many analysts use the hypothetical extraction method to provide a comprehensive evaluation for policy makers.

Transport is needed to transfer a consignment to the desired destination. The question here is, does the transportation sector support the growth of the oil palm sector? Thus, it is important to use linkages to identify the importance of the transportation sector in the growth of the oil palm sector.

The linkages structure consists of backward and forward linkages. A sector with substantial linkages tends to have a large spill over effect on other sectors of the economy. By understanding the linkages between the transportation sector and other sectors in the economy, policy makers will have a better idea about the ability of the transportation sector to stimulate other sectors. Therefore, given the sectoral linkages effect, the present study aims to analyse the impact of the transportation sector on the oil palm sector.

This paper aims to contribute to the literature on the evidence-based assessment of the impact of the transportation sector on the growth of the upstream oil palm sector. Specifically, by applying the direct and indirect effects and the hypothetical extraction method analysis, this paper will assess the contribution of the transportation sector to the oil palm sector.

The first section of this paper presents the literature review to inform the research gaps in the transportation and oil palm sectors. Second, the paper provides details of the methodological approach used in this study. The third section discusses the results obtained from the analysis, while the final section provides the conclusion to the study.

LITERATURE REVIEW

The current research on the contribution of transportation to the oil palm sector is limited to analysing the impact on the downstream activities (Jaafar, Salleh and Manaf, 2015; Europe Economics, 2015; Amzul, 2011). Jaafar *et al.* (2015) compared the similarities and differences in linkages between Malaysian and Indonesian oil palm sector by adopting the hypothetical extraction method using 2005 input-output table. Their findings show that the oil palm sector has higher linkages with the manufacturing sector than agriculture and services sectors. Subsequently, Europe Economics (2016) estimated the supply chain of oil palm in Malaysia by analysing the downstream oil palm activities. Their study found that around USD44 billion of traded oil palm was associated with its indirect contribution to the value addition added of downstream activities.

Hirshman (1958), the founder of inter-sectoral linkages, emphasised the importance of intersectoral linkages in policy effectiveness and highlighted how tighter interdependencies translate into stronger economy-wide impacts. The importance of inter-linkages was also stressed by Leontief (1941) using the input-output framework. Other methodologies have also been used to analyse the inter-linkages, such as Classical Multiplier Method (Ramussen, 1957) and Hypothetical Extraction Method (Strassert, 1968; Cella, 1984; Clements, 1990). The uniqueness of the hypothetical extraction method is that it can be used to measure the role of a sector within a network of sectors, especially in multisectoral models. The hypothetical extraction method is capable of weighing a sector by stimulating the elimination of all its external linkages from the economy, by excluding its sale and purchase transactions with other sectors. However, the classical multiplier method only measures the simple averages of technical coefficients (direct and indirect).

While the empirical literature uses both of these approaches liberally to detect and measure how a 'key' sector emerges, the hypothetical extraction method explore the root cause of the problem more deeply (Miller and Lahr, 2001). We propose to use the hypothetical extraction method in a novel way consisting of a double extraction of the external linkages of the transportation sector. It is useful to obtain information about the existing interactions between the transportation sector and the oil palm sector.

Amzul (2011) studied the linkages of oil palm using the 2003 Indonesia social accounting matrix. The study only focused on the oil palm cultivation sector and vegetable oil processing sector. The findings showed that the oil palm cultivation sector had the highest backward linkages among all the agriculture sectors, while the oil palm processing sector had a higher backward and forward linkages.

From these limited literature works, we find that the emphasis on the impact of the transportation sector on the upstream oil palm sector is somewhat inadequate. While most studies have focused on the downstream activities, such as manufacturing sector, that established evidence of higher linkages with other sectors, close attention also needs to be given to upstream activities, which are the primary resources of the oil palm sector whereby better transportation linkages would translate into a more efficient supply chain from the farm's gate to the end consumer.

METHODOLOGY

The Input-Output Model is a sound research methodology that can be

used to investigate the influence of the transportation sector on other sectors (Kwak *et. al*, 2005). This section briefly introduces the Input-Output framework for analysing the inter-industrial linkages between the transportation and oil palm sectors.

Database Structure

This section discusses the structure of the database used in our analysis. This paper used the National Input-Output Table 2015 from the Department of Statistics Malaysia (DOSM, 2017). The table consists of the aggregates of the oil palm sector and transportation sector, which comprises land, water, and air transport.

As shown in *Table 1*, the matrix $\mathbf{z}$ denotes the intermediate deliveries, and each element of Z_{ij} indicates the amount of commodity from sector i used by sector j. The other vectors are private consumption, c; investment, i; government consumption, g; and export, e. These other vectors represent the final demand components.

Direct and Indirect Effects

This study employed the method based on Leontief's input-output, where the structure of an economy was analysed in terms of the interconnectedness between production sectors (Leontief, 1951). The input-output model is written as a market-clearing condition, as follows:

$$\mathrm{x} = (\mathrm{I} - \mathrm{A})^{-1}\mathrm{f} \qquad (1)$$

where x is the column vector of output, f is the column vector of final demand, I is the identity matrix, A is the input-output coefficient, and $(\mathrm{I} - \mathrm{A})^{-1}$ is known as the Leontief inverse matrix. The inverse matrix shows the output multiplier, which indicates the total production of every sector must generate to satisfy the final demand.

The Leontief inverse matrix consists of direct and indirect effects required to meet the final demand. The composition of the direct and indirect effects are shown in equations 2 and 3, respectively.

TABLE 1. A SIMPLIFIED FRAMEWORK OF THE NATIONAL INPUT-OUTPUT TABLE 2015

	Intermediate demand							Final demand				Total output
	S1	S2	S3	.	.	.	S*n*	C	I	G	E	
Sector 1 (S1) Sector 2 (S2) Sector 3 (S3) . . . Sector *n* (S*n*)	*z* (intermediate demand required among production sectors)							*f* (final demand)				*x* (total output)
Import	*m* (imported intermediate input)											
Indirect Tax	*t* (taxes paid)											
Value added	*v* (value added)											
Total input	*x'* (total input)											

Source: Based on the author's illustration

$$\mathrm{x}^{\mathrm{dir}} = \mathrm{Af} \qquad (2)$$

$$\mathrm{x}^{\mathrm{ind}} = (\mathrm{I} - \mathrm{A})^{-1}\mathrm{f} - \mathrm{Af} \qquad (3)$$

The direct effect occurs when a sector produces more output in response to the final demand. Meanwhile, the indirect effect is caused by all sectors adjusting outputs to allow for an increase in demand for the intermediate inputs that accompany any increase in output by any sector.

Hypothetical Extraction Method

The methodology for the hypothetical extraction method linkages was derived from the Leontief input-output framework (Miller and Blair, 2009). The advantage of this approach over other linkage approaches is that the derived linkage values can be translated in terms of the monetary value lost by a specific sector if the sector being examined is extracted from the economy, thus giving a better picture of the significance of a particular sector to the overall economy.

This method is capable of quantifying the degree of interdependencies among sectors by measuring the output changes explicitly. In general, there are two types of linkages in production activities, which are backward and forward linkages. Backward linkages measure the interconnection of the sector to upstream sectors for input, while forward linkages are the interconnection with downstream sectors as markets for output (Saari *et al.* 2013).

For backward linkages, the hypothetical extraction method nullifies the i-th column of the input coefficient matrix, denoted by $\mathrm{A}^{-\mathrm{i}}$, and nullifies the i-th element of the final demand vector, denoted by f^{i}. Following the nullification process, the total output after extracting for sector i is as follows:

$x_l^{-i} = L^{-i}f^{-i}$ with $L^{-i} = (I - A^{-i})^{-1}$ (4)

For forward linkages, by replacing the *i*-th row with zero entries, denoted by B^{-i}, and nullifying the primary input vector for the *i*-th element, denoted by d^{-1} the total input after extracting sector *i* is given by:

$x_l^{-i} = (d^{-i})'G^{-i}$ with $G^{-i} = (I - B^{-i})^{-1}$ (5)

Note that B is known as the Ghosh coefficient matrix $(B = \hat{x}^{-1}Z)$. The Ghosh model is known as the supply-driven model, where the input-output model is operated by rotating or transposing the vertical (column) to a horizontal view.

Based on equations (4) and (5), the normalised backward and forward linkages caused by the complete extraction are as follows:

$$B_i = \frac{i'x - i'x_l^{-i}}{x_i} \quad \text{and} \quad F_j = \frac{x'i - (x_b^{-i})'i}{x_i} \quad (6)$$

where $i'x - i'x_1^{-i}$ and $i'x - (i'x_b^{-i})'i$ represent the total output and total input, respectively, after the extraction of sector *i*.

RESULTS AND DISCUSSION

The discussion of the findings obtained from the analysis of this study is divided into three subsections. The first subsection discusses the multipliers for oil palm and transportation sectors. In the second subsection, we decompose the multipliers into direct and indirect effects. Finally, the third subsection discusses the results of the hypothetical extraction method analysis in assessing the contribution of the transportation sector to the growth of the oil palm sector.

Multipliers for Oil Palm and Transportation Sectors

Table 2 shows the output multipliers for all sectors in 2015, in which the oil palm sector's output multiplier was 1.26. It shows the production inducing effect for the oil palm sector, whereby one Ringgit increase in the final demand would generate RM1.26 of output in the whole economy. Meanwhile, for the transportation sector, land, water, and air transport generate output multipliers of RM1.88, RM2.08, and RM2.09, respectively. It is found that the performance of the transportation subsectors in Malaysia is ranked in the top 5, indicating that these subsectors are vital for Malaysia's output growth.

By breaking down the output multiplier of the oil palm sector, we can see which sectors directly and indirectly contribute to the production of the oil palm sector, which in turn specifies the spill over effect due to the growth of the sector. *Table 3* presents the percentage of direct and indirect contributions of other sectors to the production of the oil palm sector. It is observed that the contribution of land transport is 0.25%, followed by water transport (0.15%) and air transport (0.13%). Among the transport subsectors, the oil palm sector is observed to rely more on land transport compared to water and air transport, despite the relatively low percentage contributions of all the transport subsectors.

Linkages between Oil Palm and Transport Sectors

The backward and forward linkages calculated in this study indicate the normalised index to the overall average of all the economic sectors. A sector has strong economic integration in pulling and supporting other sectors if the index for backward and forward linkages is above 1. It shows that the sector is producing above the average of all sectors in the economy.

The hypothetical extraction method was applied to 18 sectors of the Malaysian Input-Output Table.

The results of the total backward and forward linkages are given in *Table 4*. The result of the backward linkages for the oil palm

TABLE 2. OUTPUT MULTIPLIERS OF ALL SECTORS IN 2015

Sector	Value	Rank
Agriculture, fishery and forestry	1.41	14
Oil palm	1.26	16
Mining and quarrying	1.29	15
Manufacturing	1.95	4
Electricity, gas and water	1.69	9
Construction	2.03	3
Wholesale and retail trade	1.59	11
Hotel and restaurant	1.86	6
Land transport	1.88	5
Water transport	2.08	2
Air transport	2.09	1
Other transport and communication	1.76	7
Finance and insurance	1.52	12
Real estate and ownership of dwellings	1.44	13
Business and private services	1.66	10
Government services	1.70	8

TABLE 3. OIL PALM MULTIPLIERS: DIRECT AND INDIRECT EFFECTS (%)

Sector	Total output multiplier	Direct effect	Indirect effect
Agriculture, fishery and forestry	3.12	2.86	0.26
Oil palm	79.82	0.00	79.82
Mining and quarrying	0.54	0.04	0.50
Manufacturing	9.23	5.20	4.03
Electricity, gas and water	0.45	0.14	0.31
Construction	0.18	0.00	0.18
Wholesale and retail trade	2.98	1.83	1.15
Hotel and restaurant	0.28	0.20	0.08
Land transport	0.25	0.14	0.11
Water transport	0.15	0.09	0.06
Air transport	0.13	0.07	0.06
Other transport and communication	0.33	0.08	0.25
Finance and insurance	1.19	0.67	0.52
Real estate and ownership of dwellings	0.17	0.11	0.06
Business and private services	1.17	0.51	0.66
Government services	0.00	0.00	0.00

sector is 0.19, showing that the oil palm sector has a weak link to the rest of the sectors in the economy. This outcome is supported by Saari *et al.* (2013), which also shows the low backward linkages of the oil palm sector. For the transportation sector, the backward linkages for land, water, and air transport are 0.84, 0.98, and 0.78 respectively. These findings are consistent with Kwak *et al.* (2005) and Morrisey and O'Donoghue (2013), which indicates that the transportation sector has a lesser impact in terms of investment expenditures on the national economy as compared to other sectors.

For the forward linkages as shown in *Table 4*, the result for the oil palm sector is 2.30. As stated by Saari *et al.* (2013) and Valdes and Foster (2010), the main contributions of the oil palm sector come through forward linkages rather than backward linkages. It shows that the demand for the oil palm sector's output is much higher than that of other sectors. Meanwhile, for the transportation sector, land transport has the highest forward linkage at 1.02 compared to water and air transport at 0.79 and 0.80, respectively. These results show that land transport plays a crucial role in economic development by supporting other sectors.

Next, to analyse the role of the transportation sector in the growth of the oil palm sector, we decompose the backward and forward linkages of all the transportation subsectors and examine the extent of the linkages between the oil palm sector and the transportation subsectors. For ease of interpretation, we compute the share of each subsector to the total linkages score to represent the contribution of the transportation sector to the growth of other sectors in the economy.

As shown in *Table 5*, the contributions of the transportation subsectors' backward and forward linkages to the oil palm sector are less than 1%. These results imply two crucial points: i) the transportation sector's growth does not strongly affect the growth of the oil palm sector in the economy, and ii) the use of transportation is rather minimal in the production of the upstream oil palm sector.

In detail, the backward linkages of land transport to oil palm contribute around 0.87% compared to water transport (0.82%) and air transport (0.56%). It indicates that land transport is relatively important in supporting the oil palm sector. This is because land transport is commonly used to freight downstream oil palm products to other processing or manufacturing sectors. In contrast, for forward linkages, water transport contributes the highest to the oil palm sectors' growth (0.28%) compared to land transport (0.24%) and air transport (0.16%). This result is not surprising, because water transport is commonly used to ship out oil palm to other countries for export using ships and vessels.

The hypothetical extraction method can be interpreted as follows. For example, for backward linkages, if land transport is taken out from the system in the oil palm sector, the total output in the economy would fall by 0.87% or RM202 million. For water and air transport, the reduction in the total output would be 0.82% (RM119 million) and 0.56% (RM97 million), respectively. For forward linkages, if land transport is taken out from the system in the oil palm sector, the total output of the economy would fall by 0.24% or RM67 million. For water and air transport, the reduction in the total output would be 0.28% (RM32 million) and 0.16% (RM27 million), respectively. As stated by

TABLE 4. HYPOTHETICAL EXTRACTION METHOD LINKAGES

Sector	Backward	Forward
Agriculture, fishery and forestry	0.89	1.29
Oil palm	0.09	2.30
Mining and quarrying	0.57	1.66
Manufacturing	1.02	0.84
Electricity, gas and water	0.46	1.42
Construction	1.64	0.59
Wholesale and retail trade	0.74	1.30
Hotel and restaurant	1.46	0.69
Land transport	0.84	1.02
Water transport	0.98	0.79
Air transport	0.78	0.80
Other transport and communication	1.06	0.98
Finance and Insurance	0.62	1.44
Real estate and ownership of dwellings	1.25	0.93
Business and private services	0.69	1.28
Government services	1.54	0.67

Saari *et al.* (2013), these reductions are due to no output is being supplied by the transportation sector to the oil palm sector.

In conclusion, the results in this section suggest that the transportation sector has a low influence in stimulating the growth of the oil palm sector. Nevertheless, the transportation sector cannot be ignored as it provides an important link to other sectors.

CONCLUSION

In this study, the role of the transportation sector in the Malaysian oil palm sector was measured using 2015 Input-Output data. The direct and indirect effects of different transportation subsectors (land, water, and air)

TABLE 5. DECOMPOSITION OF BACKWARD AND FORWARD LINKAGES OF TRANSPORTATION SUBSECTORS (%)

Sector	Land transport		Water transport		Air transport	
	Backward	Forward	Backward	Forward	Backward	Forward
Agriculture, fishery and forestry	0.50	0.67	0.56	0.76	0.58	0.43
Oil palm	0.87	0.24	0.82	0.28	0.56	0.16
Mining and quarrying	1.40	0.71	1.33	0.81	0.92	1.89
Manufacturing	26.00	27.78	24.66	29.34	16.62	15.25
Electricity, gas and water	0.96	0.90	0.98	0.93	0.80	0.54
Construction	0.50	6.70	0.56	4.51	0.83	5.69
Wholesale and retail trade	6.20	3.11	5.05	3.38	4.00	2.04
Hotel and restaurant	0.28	1.45	1.50	1.63	3.89	1.18
Land transport	53.71	51.62	0.43	0.57	0.34	0.26
Water transport	0.31	0.24	48.34	51.87	0.20	0.18
Air transport	0.23	0.29	0.27	0.33	49.15	50.63
Other transport and communication	2.59	1.22	7.19	1.27	13.42	4.22
Finance and insurance	1.73	0.31	1.81	0.27	2.62	2.88
Real estate and ownership of dwellings	0.24	0.52	0.34	0.52	1.02	0.44
Business and private services	4.47	1.53	6.16	1.51	5.04	5.27
Government services	0.00	2.71	0.00	2.03	0.00	8.91

on the oil palm sector were studied using the hypothetical extraction method to calculate the inter-linkages, which are backward and forward linkages. These analyses allowed us to quantify the importance of the transportation sector to the upstream oil palm sector. The results suggest that the transportation sector makes a relatively low contribution to the growth of the upstream oil palm sector. The backward and forward linkages scores are relatively low, suggesting that growth in the transportation sector does not strongly affect the growth of the oil palm sector in the economy.

This study has limitations, as it only examined the inter-industrial linkages of output growth for oil palm and transportation sectors. The study did not measure the relative contribution of the transportation and oil sectors in other aspects, such as to GDP, as the modelling for GDP would require a massive amount of additional data. Future studies are recommended to study the downstream sector to understand the contribution of the transportation sector to the oil and fats sectors. Productivity measurements are also important to examine the role of the transportation sector in the efficiency of the oil palm sector.

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