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A Probe into the Status of the Oil Palm Sector in the Malaysian Value Chain

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Abstract: A ban on palm oil imports by the European Union has become a problematic issue, especially for palm oil producers' countries. Oil palm has been widely used in many sub-sectors, and any changes in the production side may affect many sectors that use oil palm as an input factor in their productions. This study explores the chain of the oil palm sector on the other sub-sectors in Malaysia by using a value-added multiplier method and network modeling. The study focuses on the specific oil palm sub-sector and oils and fats sub-sector in the Malaysian economic structure based on the Malaysian Input-Output 2015 Table. Network visualization and all the analyses involving network methods were developed and performed using UCINET and GEPHI software. The value-added multiplier results explained that the net value between output multiplier and import multiplier is vital to depict the real impact of net resources used as an input factor in the oils and fats and oil palm sub-sectors. The high-density value level shows that the Malaysian oil palm sector has high connectivity in the economic system. From the network visualization analysis, the oils and fats sub-sector has a high level of integration with other sectors within the network. Meanwhile, the oil palm sub-sector categorized in the periphery structure group has a low level of integration in the input-output network. This is due to the high value-added demand for oil palm in the oils and fats sub-sector in the manufacturing sector. Overall, most of the sub-sectors in Malaysia are highly interconnected due to the high clustering ratio. Therefore, ensuring sufficient oil palm production is vital for sustainable production of other sub-sectors.

Keywords: network analysis; input-output model; oil palm sector

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1. Introduction

World palm oil production is growing rapidly, especially in Southeast Asia where Indonesia and Malaysia are the primary producers. In the context of Malaysia, the forecast of a decrease in global demand of palm oil due to the ban on imports of palm oil by the European Union is expected to have a significant impact on all stakeholders. The oil palm sector is one of the significant contributors to the income of exporting countries. Many would think that the ban would affect mainly the smallholders as they totally depend on the production of oil palm. In reality, there are significant other parties which would be greatly affected as the oil palm products are widely used in other economic sectors.

Generally, to produce a product, various other materials are needed to produce it, leading to interdependency among production industries (Utit et al. 2015a), and there is no exception in the production within the oil palm sector itself. The oil palm sector is one of the 124 sectors listed in the Malaysian Input-Output Table in Malaysia. In 2018, the oil palm sector contributed around 2.8% (RM37.71 billion) to the composition of Malaysia's GDP (Department of Statistic Malaysia 2019). Besides that, the oil palm sector opened job opportunities up to 400 thousand in 2019, and this number is estimated to increase every year (Bernama 2019).

Based on supply and demand theory, the interactions for supply, demand, and price are interrelated. When demand is low, and collection is high, it will lead to low prices (Whelan and Msefer 1996). Assuming that palm oil production is the same and unchanged and the total demand for palm oil by other countries remains the same, the import ban by the European Union will result in a large inventory of palm oil in the producing countries. Whelan and Msefer (1996) argue that the only direct action by manufacturers to bring inventory to the desired level is to change prices. While the producers do not want to let the price of oil palm products continue to fall and suffer losses, the producing countries can reduce production to maintain prices. By lowering oil palm production, it will indirectly affect this sector input use. Therefore, an analysis is needed to look more closely at other parties involved in reducing oil palm production to frame initial preparation and planning.

For viewing and analyzing the structure of the Malaysian economy, the input-output table is seen as one of the most widely used mediums. This is because the input-output table provides the flow of goods and services purchased and sold by the sector in the economy. Therefore, this study employs the input-output table to extract information about the relationship between the oil palm sector and other sectors in the Malaysian economy.

Even though the input-output method can provide information about the relationship between sectors, the input-output analysis does not indicate the oil palm sector's position in the economic structure and the role of the sub-sector in helping each other in the Malaysian economy structure. From the point of view of production in the oil palm sector in Malaysia, assessing the roles and implications of the oil palm sector in Malaysia's domestic production network on the demand of other sub-sectors would provide valuable information and a clear picture of the importance of the oil palm sector to the Malaysian economy. Thus, a study on the domestic production network of the oil palm sector in Malaysia is essential. The proposed policies can benefit all parties directly involved with this sector to prevent persecution and drop out of aid.

This study will integrate the use of input-output models with network modeling. Therefore, this study contributes in identifying the agents or sectors affected by changes in the production of the oil palm sector in Malaysia using input-output network modelling. Network modeling can provide a clear link for each sub-sector and provide a clear picture of who is connected to who and how each sector reflects in the economy. Network modeling has long been widely used because of its potential to provide new insights into the understanding of complex phenomena in many fields, including science, economics, social interaction, and others (Albert 2005; Barabási and Oltvai 2004; Kitsak et al. 2010; Markose et al. 2012; Pammolli and Riccaboni 2002; Said 2016; Yu and Ma 2020).

Given today's domestic and global economic uncertainty, it is difficult for Malaysia to face an import ban from the European Union. The European Union is one of the biggest markets in the world, while the oil palm sector contributes hugely to Malaysian GDP. Such an incident will affect the Malaysian economy. Nonetheless, the Malaysian economy needs to continue to implement policy initiatives that will contribute to the well-being and sustainability of the current economy. This study provides policymakers with a different perspective on understanding the oil palm sector's relationship with the economy. By clearly understanding the oil palm sector's role and importance in the economic sectors of Malaysia and the interlinkages between the oil palm sector with other sectors, more policy objectives can be implemented accordingly. Therefore, this study aims to analyze the implications of changes in the production of the oil palm sector in Malaysia on the demand of other sub-sectors in Malaysia using the input-output network.

2. Literature Review

Understanding the impact of international oil palm trade on the continuity of various industrial sectors in a country is of great importance. As of now, very little is known about the interaction between domestic production and trade of oil palm due to a lack of relevant data and analysis. Generally, to produce a product offered in the international market, various other materials are needed to produce it. In the context of Malaysia, the forecast of a decrease in global demand due to the ban on imports of palm oil by the European Union is expected to have a significant impact, especially for the oil palm industry itself. Due to this concern, this study will discover the implications of changes in the production of the oil palm sector in Malaysia on the demand of other sub-sectors in Malaysia. To study the flow between various sectors in the domestic economic system and realize the joint transformation of economic data into sectors closely related to the oil palm sector in Malaysia, the methodology proposed by Leontief will be adopted. The Leontief approach (Leontief 1936, 1951, 1975) through input-output has been widely used to analyze various related cases for the country's economic structure. For this study, the matrix model for input-output is chosen because it gives an overview of the relationship between industries in the economy by showing how the output from one industrial sector can be one of the inputs to another industrial sector and vice versa.

Input-output modeling is a linear modeling approach that involves the economic cycle flow for production by analyzing the relative relationship between production input flow and output flow generated in economics (Grealis et al. 2017). The advantages of using input-output modeling allow researchers to capture the relative importance of the different production factors used by each sector and the trade balance that can be generated (Utit et al. 2015b). In the real world, the behaviors of each agent in the economy are interconnected. It is no exception for the economic sectors available in Malaysia. Based on input-output data, there are many methods to measure the level of connectivity; as in development and economic planning, the economic drivers are identified based on two frequently used measurements: linkages and multiplier (Saari et al. 2018). The linkages are used to measure how the growth of one sector can benefit other sectors. Meanwhile, multipliers measure the overall economic impact of certain economic variables due to output growth for a sector.

For the measurement of linkages, there are two measures used, namely forward linkages and backward linkages. Backward linkages are used to measure the relationship between input providers for the economic sector. For example, if one sector increases its output, there will be increasing demand from other industries (as suppliers), whose goods and production factors are used as input for that sector's production (Saari et al. 2018). Meanwhile, forward linkages measure the relationship between buyers for the output produced by the economic sector. In other words, the additional product output available is to be used as input by different sectors for their production and use (Saari et al. 2018).

Sectors with a high value of linkages indicate a significant spillover effect on other economic sectors (Jaafar et al. 2015). One of the primary uses of the input-output model is to assess the impact of economic change on the exogenous elements in the economy. Techniques to evaluate the effects of these changes were first introduced by Wassily Leontief and later developed into many measurement branches such as multipliers and others (Miller and Blair 2009). For multipliers, based on the Leontief inverse matrix function form, this function allows estimates for individual sector multipliers to capture both macroeconomic effects, either directly or indirectly, to increase or decrease exogenous demand (Leontief 1975). Multiplier analysis of the input-output matrix has been widely used in the study of various sectors of the economy, such as studying the waste contained in the economy in Malaysia (Utit et al. 2015b), aquaculture (Grealis et al. 2017), energy, and manufacturing (Bekhet et al. 2016).

Based on previous studies, multiplier measurement was chosen over linkages in this study to achieve the objective. The multiplier can see the changes in a sector by directly impacting the inputs involved in that sector. The multiplier calculation based on the input-output matrix is carried out to see the implications of changes in oil palm on other economic sub-sectors in Malaysia. A literature review conducted on the use of input-output analysis to identify multipliers of each sector found that the most used measurement to analyze multipliers is the output multipliers (Bekhet et al. 2016; Grealis et al. 2017; Utit et al. 2015b).

However, in identifying growth drivers, it was found that the measure of 'value-added' is more relevant to be evaluated by policymakers than the output multiplier because the output multiplier also includes the value of imports, which is the holding of foreign input (Saari et al. 2018). Baldwin and Lopez-Gonzalez (2014), Koopman et al. (2008), and Said and Fang (2019), in their study, stressed the importance of assessing the extent to which the content of domestic value (value-added) is original compared to the total production. Therefore, the contribution of this study applies value-added multiplier measures so that the study results are more realistic and the policy to be proposed will be more effective than the overall calculation.

As it has been said earlier, even though the input-output method can provide information about the relationship between sector using either linkages or multiplier approach, however, the input-output analysis does not indicate the oil palm sector's position in the economic structure and the role of the oil palm sector and others sub-sector plays in helping each other's in the Malaysian economy structure. Therefore, the contribution of this study integrates the use of input-output models with network modeling. Network analysis is one of the tools used to analyze complex systems for relational data. In recent times, network analysis has been seen to have emerged and is widely used in the economic field, especially for analyzing international trade networks as well as financial networks. Although international trade and financial networks are the most popular fields, these network analysis methods have also been used to create input-output networks. There are several studies, such as the study by Alatriste-Contreras (2015), Blochl et al. (2011), Cerina et al. (2015), Grazzini and Spelta (2015), Giammetti et al. (2020), and Prell (2016), on input-output analysis using network approaches found in the existing literature. A study by Cerina et al. (2015) focused on global input output. Her research analyzes network properties based on the three level group, global, regional, and local network properties. Based on her finding, at the global level, industries seem to connect highly. This study also highlights that to identify the key sectors in economic structure, network-based measures such as PageRank centrality and community coreness measure have given valuable insights. Besides Cerina et al. (2015), several other studies have used global input-output as the focus of their study (Liang et al. 2016; Soyyigit and Boz 2017). For example, the Alatriste-Contreras (2015) study uses input-output data with network methodology and found that the most important sectors in each country are also the most important sectors in the European Union. Besides, the most significant sectors have a high shock spreading and a high aggregate impact on the economy.

With a borderless world and a more open economy, the global economy has been integrated over time. Several other studies (Kali and Reyes 2007; Kim and Shin 2002; Liang et al. 2016; Prell 2016; Su 1995) have used the network methodology to describe the entire network structure to look at how well the economy had integrated and growth. Viewing network patterns can help understand the characteristics of a structure, understand the relationship, and see the role of each unit in the whole network.

The input-output model allows researchers to identify and measure the use of resources directly and indirectly through the entire supply chain, either forward or backward processes. The use of input-outputs enables the calculation of the overall needs of the resource to be done more systematically and can identify the geographical origin of the source. In addition, the existence of a network model allows for more systematic structured studies and network evolution to be made. Such studies can help uncover potential weaknesses in exploiting and allocating resources and provide new insights that can assist in preparing and improving a policy.

3. Methodology

Data from the Malaysian Input-Output Table provided by the Statistics Department of Malaysia are required. This study uses the latest data from Malaysia Input-Output Table 2015 since it has been published every five years. However, for the current study, the available data are up to only year 2015. The table comprises 124 economic sub-sectors.

Therefore, this study focuses on a specific analysis of oil palm sub-sectors and oil and fat sub-sectors in the Malaysian economic structure in 2015 based on the Malaysian Input-Output Table 2015. The reason for choosing oil palm with oil and fat sub-sectors is the high demand, especially from other sectors in the economy. In the Malaysian Input-Output Table, the oils and fats sub-sector is also considered palm oil processing sub-sector as other oils and fats are very limited (less than 1%). (Jaafar et al. 2015). Besides that, network visualization and all analyses involving network methods were developed and performed using UCINET software (Borgatti et al. 2002) and GEPHI software (Bastian and Heymann 2009).

The flow for analysis begins by obtaining the Malaysian Input-Output Table for 2015. Next, multiplier calculations based on the input-output matrix are carried out to see the implications of the oil palm sector on other economic sub-sectors in Malaysia. Multiplier data are used to capture macroeconomic effects, directly and indirectly, to increase or decrease exogenous demand (Leontief 1975). Through the input-output multiplier, changes in one sector will directly impact the inputs involved in that sector. Then, the visual of the input-output network for the value-added multiplier is developed to view the network structure. Next, several tests such as density, average path length, core/periphery, degree, betweenness, and clustering were conducted to obtain more detailed information.

3.1. Input-Output Multiplier

The multiplier calculation based on the input-output matrix is carried out to see the implications of the oil palm sector on other economic sub-sectors in Malaysia. Based on the input-output modeling, the matrix algebra forms the basis of input-output analysis (Grealis et al. 2017; Miller and Blair 2009).

3.2. Network Methodology

Input-output network analysis methods adapted from social network analysis emerge as a set of social structure analysis methods. These methods depend only on the existence of relationships or contact data (Scott 2000). The data are organized in a matrix before network visualization and other network tests (density, distance, core/periphery, degree, betweenness, and clustering). The arrangement of this study in a network matrix form shows the actual relationship of the input/output of one sub-sector to another.

The N $\times$ N matrix (124 Malaysian sub-sectors $\times$ 124 Malaysian sub-sectors) represented the Malaysian input-output network matrix for this study. N was the sub-sectors found in the Malaysian domestic input-output table of 2015. For this matrix below, Xij represents the actual value (RM) of input from sector i to sector j, with rows representing input values and columns representing output values as in the following matrix:

$$\mathrm{X} = \begin{bmatrix} 0 & X_{12} & X_{13} & X_{14} & \ldots & \ldots & \ldots & X_{1j} & X_{1n} \\ X_{ij} & 0 & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & X_{2n} \\ X_{31} & \ldots & 0 & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots \\ X_{n1} & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 \end{bmatrix}$$

For the next step, the matrix X above will be converted to the VA matrix, where the VA matrix is the value-added multiplier input-output matrix. Calculations for value-added multipliers can be referred into the sub-section before. The VA matrix is as follows:

$$\text{VA} = \begin{bmatrix} 0 & VA_{12} & VA_{13} & VA_{14} & \ldots & \ldots & \ldots & VA_{1j} & VA_{1n} \\ VA_{ij} & 0 & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & VA_{2n} \\ VA_{31} & \ldots & 0 & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 & \ldots \\ VA_{n1} & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & 0 \end{bmatrix}$$

In this study, input-output networks based on value-added multiplier data are summarized into models as interconnected networks R = (N, M). R is the whole network structure, N is the number of nodes, and M is the edges. In this study, nodes will represent 124 economic sub-sectors listed in the Malaysian Input-Output Table, and the edges represent relationships between each sub-sector. The edges direction is also known as input-output flows. The goal of visualization as a starting point for this study is to get a complete picture of the entire network, focusing on key studied sectors: the oil palm sub-sector and oils and fats sub-sector.

Density in a network procedure measures how many edges are in a network compared to the maximum number of advantages between nodes. Density is used to know the compactness of connection among all nodes in the network. The greater the density value, the closer the relationships between nodes within the network. The definition of network density can be seen through the following equations (Kitamura and Managi 2017):

$$Density = m/n(n-1) \tag{1}$$

where n is the number of nodes and m is the number of actual edges within the network.

The next test is the core/periphery structure, in-network terminology (Prell 2016); the network composition is divided into two types: core and periphery. The core structure consists of nodes or sub-sectors interconnected and are the center point of the whole network. In comparison, a periphery structure refers to a more or less isolated type of nodes. It is associated with the rest of the network mainly through its relationship to the core structure.

The average path length represents the average number of steps for each node pair. Based on Watts and Strogatz (1998), the average path length can be defined as the following equation:

$$l = 1/n(n-1) \sum_{ij} d_{ij} \tag{2}$$

where $d_{i,j}$ represents the shortest distance between nodes i and j, if nodes i and j cannot link or reach each other or $i = j$, then the shortest distance $d_{i,j}$ equals 0.

The degree of the node is the number of edges per node in a network showing the basic network features. The direct networks consist of two types of degrees, which are in-degree and out-degree. Out-degree represents the value of the output/edges exit, while in-degree represents the value of input/edges enters into nodes. Therefore, analyzing the degrees of a node can help further explore the node that is important in the network structure. The degree of the nodes can be defined as follows (Kitamura and Managi 2017):

$$k_{in}i = \sum_{j=1}^{n} a_{ji} \tag{3}$$

$$k_{out}i = \sum_{j=1}^{n} a_{ij} \tag{4}$$

where a_{ji} is the value of input edges and a_{ij} is the value of output edges, while k_{in} is the degree of entry and k_{out} is the degree of exit.

Betweenness for a node is the number of the shortest path between two nodes that pass through i. n^i_{st} is equal to 1 if node i is located on the shortest path from node s to node t and equal to 0 if there is no shortest path available between node s and node t. Therefore, we can determine the intermediate value for node i as in the following equation:

$$x_i \sum_{st} n^i_{st} \tag{5}$$

The clustering ratio of a network is known as the level of interconnectedness of each node's neighbors. It measures the relation between a network in which two neighbors of a node are also neighbors. This process is also called the measurement of the level of transitivity. For simplicity, it is the fraction of the total number of triangles to the possible number of triangles (Said 2016). The clustering ratio of a network (C) can be between 0 and 1. If C = 1, it is said that the network is perfectly transitive, and, on the other hand, C = 0 implies that the network is intransitive.

4. Result & Discussion

4.1. Input-Output Multiplier

The multiplier value is significant because the multiplier can measure the economic impact on certain economic variables as an effect on the growth results in the production of a sector (Saari et al. 2018).

Table 1 shows the ten sub-sectors of the main inputs for the oils and fats sub-sector based on the value-added multiplier. Based on the multiplier value, the sub-sector, the primary input, will receive the most significant implications in any change, either an increase in production or a decrease in production for the palm oil industry in Malaysia. Based on multiplier results, 93%, out of 124 sub-sectors, is an input for the oil palm sector in Malaysia. Although in Table 1, the output multiplier for oils and fats against itself is 1.33, which is higher, while oil palm against itself is only 1, 1.25 out of 1.33 output multiplier come from import input. This is because the oils and fats sub-sector in Malaysia concentrated more on exporting refined palm oil. At the same time, Indonesia dominated the crude palm oil (CPO) export market (Salleh et al. 2016). Through sole investments and joint ventures with local companies in Indonesia, the investors in Indonesia are primarily from Malaysian and Singaporean groups of companies. These investors control more than two-thirds of total palm oil production in Indonesia (Pacheco et al. 2017). Most of this crude palm oil brought back to Malaysia to be processed into refined palm oil. For the oil palm sub-sector, 0.77 out of 1 output multiplier is originated from value-added because input supply for oil palm replanting is from the domestic plantation. The primary input for this sub-sector is palm oil sapling, and the primary output is palm kernel and crude palm oil.

Table 1. The results of the multiplier analysis for the top 10 sub-sectors as input to the oils and fats sub-sector and the oil palm sub-sector based on the Malaysian Input-Output Table 2015.

No.	Oils and Fats Sub-Sector			
	Sub-Sector	**Output Multiplier**	**Value Added Multiplier**	**Import Multiplier**
1	Oil Palm	0.38[1]	0.29	0.08
2	S-93	0.22	0.13	0.09
3	Oils and Fat	1.33	0.08	1.25
4	S-115	0.06	0.04	0.03
5	S-86	0.06	0.03	0.03
6	S-13	0.03	0.03	0.01
7	S-44	0.07	0.02	0.05
8	S-107	0.02	0.01	0.01
9	S-45	0.03	0.01	0.02
10	S-8	0.01	0.01	0.00
Ni	-	-	-	-
	Total	2.49	0.74	1.75
No.	**Oil Palm Sub-Sector**			
	Sub-Sector	**Output Multiplier**	**Value Added Multiplier**	**Import Multiplier**
1	Oil Palm	1.00	0.77	0.23
2	S-8	0.03	0.02	0.01
3	S-93	0.04	0.02	0.01
4	S-46	0.04	0.01	0.03
5	S-13	0.01	0.01	0.00
6	S-115	0.01	0.01	0.00
7	S-44	0.02	0.01	0.02
8	S-107	0.01	0.01	0.00
9	S-11	0.01	0.00	0.01
10	S-45	0.01	0.00	0.01
Ni	-	-	-	-
	Total	1.25	0.89	0.36

4.2. Network Analyses

Table 2 shows a descriptive analysis of the overall pattern of value-added multiplier data for the Malaysia Input-Output Table 2015. The total number of links, also known as edges for the value-added multiplier network, is 15,252 for the 124 nodes involved. One hundred twenty-four nodes consist of 124 economic sub-sectors found in the Malaysian Input-Output Table 2015. For this study, edges represent the value of multiplier input flow or multiplier output flow from one sub-sector to another sub-sector. The minimum score value of the edges is 0, and the maximum is 0.377. Besides that, based on Table 2, the average value of route length is 1.1 sub-sectors. The low average length of the route reflects the level of strong contact with each other. Thus, it will immediately affect the sub-sectors involved as input or output in the event of a shock to one of the sub-sectors.

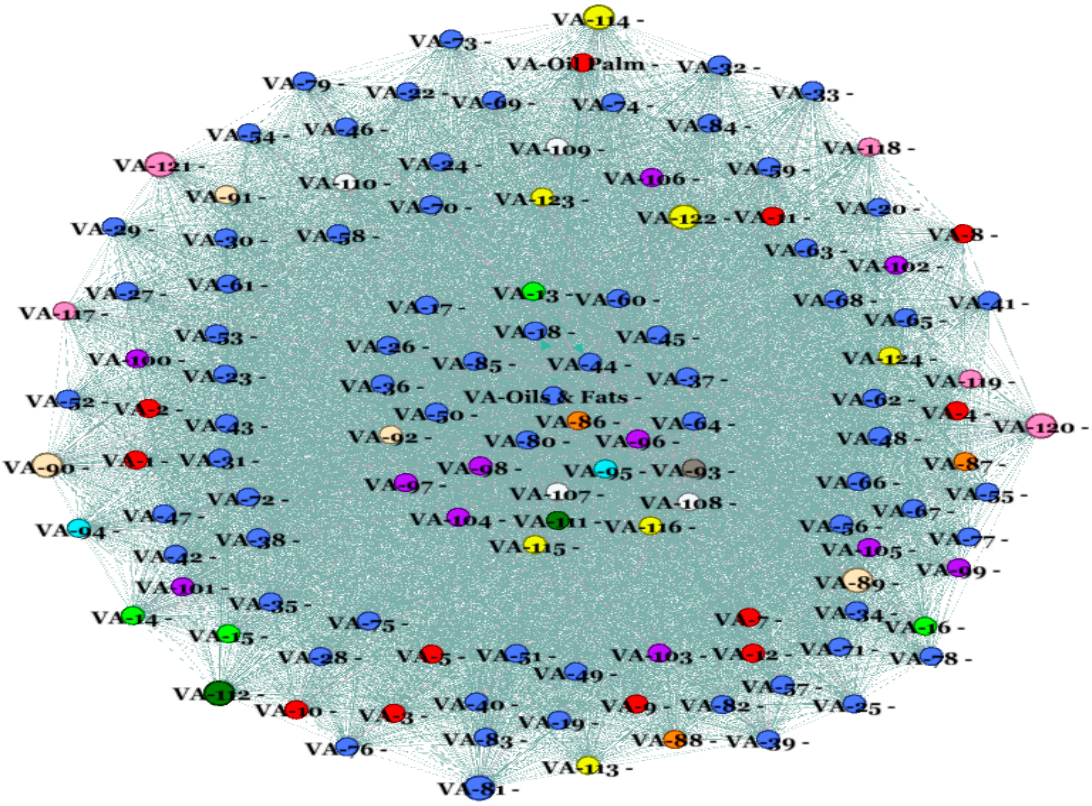
Table 2. The results of the descriptive analysis for the value-added multiplier network based on the Malaysian Input-Output Table 2015.

	Value Added (VA) Multiplier
Edges	15252
Clustering coefficient	0.885
Mean	0.002
Standard deviation	0.010
Sum	37.867
Variance	0
Minimum	0
Maximum	0.377
Density	0.874
Average path length	1.066
Eigenvalue	0.467

Based on the total number of nodes and the number of actual links, the density obtained is 0.874. Density in the network procedure used to measure the closeness or compactness among all sectors in the Malaysian economic network. The density value also shows the degree of network efficiency (Hou et al. 2018), where the closer the relationship between all nodes is represented by the more significant density value. Three basic levels can be used to rank the density values, where 40% and below represents the low values, between 40% to 70% is for median values, and 70% and above is for high values (Alatriste-Contreras 2015). From Alatriste-Contreras (2015), high-density value connectivity in which sectors are highly dependent on almost all other sectors is shown by high-density value, whereas low-density values show otherwise. By referring to this ranking level, it can be said that Malaysia, with the high-density value level, has high connectivity in the economic system based on value-added multiplier where sectors are highly dependent among them in the Malaysian economic structure. Based on the input-output data, France, United Kingdom, and Hungary (Alatriste-Contreras 2015) are among other countries with high-density value levels in the European region. While the value of Eigen is 0.467, which located between the value of zero to one, it shows that this network is stable (May 1972).

4.3. Network Visual

Figure 1 shows the network visualization of the Malaysian economic structure based on the value-added multiplier data from the Malaysian Input-Output Table 2015. The purpose of visualization as a starting point is to obtain an overview of the network (Lovrić et al. 2018), focusing on oil palm sub-sectors and the oils and fats sub-sector found in the Malaysian economic structure. Based on Figure 1, 27 sub-sectors were the primary "core" sub-sector in the Malaysian economic structure in 2015 based on a network of value-added multipliers. The remaining 97 sub-sectors are side or also known as "periphery" sub-sector. Based on the diagram above, the oil palm sub-sector has a periphery structure as a whole network while the oils and fats sub-sector has a core structure. In the diagram above, the oils and fats sub-sector has many edges in the middle of the network and surrounded by dense edges.



Source: The data are derived from the calculation of value-added multipliers from Input-Output Malaysia 2015 and visualized by the author using Gephi.

Diagram indicator

		Sector
1	(red)	Agriculture, forestry, and fisheries
2	(green)	Mining and quarrying
3	(blue)	Manufacturing
4	(orange)	Utility
5	(cream)	Construction
6	(light grey)	Wholesale and retail trade
7	(cyan)	Accommodation, food and beverage
8	(magenta)	Transportation, storage, and communication information
9	(white)	Finance and insurance
10	(dark green)	Real estate and homeownership
11	(yellow)	Business and private services
12	(pink)	Government service

Figure 1. Malaysia's 2015 economic structure based on value-added (VA) multipliers.[2]

The main structure in network analysis for this objective is a sub-sector or node with many edges and can be described as having a high degree of integration to other sub-sectors of nodes in the same network (Lovrić et al. 2018). Whereas sub-sector or nodes categorized in a group of periphery structures are composed of sub-sectors or nodes with few edges and low levels of integration within the network (Lovrić et al. 2018). It can be concluded that the oils and fats sub-sector has a high level of integration with other sectors within this network. Meanwhile, the oil palm sub-sector categorized in the periphery structure group has a low level of integration in this input-output network. It is located outside the central network and has few edges compared to the oil and fat sub-sector. Vandermarliere et al.

(2016) stated if core/periphery structure theory holds, network structure divided into core structure for highly integrated nodes and periphery structure, which is a highly integrated structure with central structured nodes through the visualization in Figure 1.

The oil palm sub-sector is more structured as periphery rather than core due to the characteristics of this sub-sector for the agricultural sector. The agricultural sector only needs a little basic input (fertilizer, soil, capital, etc.) to produce its output than the oils and fats sub-sector located in the manufacturing sector, requiring various inputs to produce each output. Additionally, the agricultural sector's output less likely used as input for other sub-sectors than the manufacturing sector's output. This is also why the oil palm sub-sector does not have a core structure or is a focal node in this network. Based on Appendix B, the total production multiplier for the output of the oil palm sub-sector is RM1.77 for every RM1.00 production of other sub-sectors. Meanwhile, the total production multiplier for oil and fat sub-sector output is RM2.33 for every RM1.00 production of other sub-sectors.

The oil palm sub-sector contributes almost 40% of input requirements based on the value-added multiplier to produce each oil and fat sub-sector production. Here, we can see the strong interconnectedness between these two sub-sectors. Thus, based on the analysis of core/periphery structures, we conclude that these two sub-sectors play an important role in the chain of relations of the Malaysian economic sector. In addition, the oils and fats sub-sector having many interactions with other sub-sectors in the network. In contrast, the oil palm sub-sector is the most extensive input in generating oils and fats sub-sector output.

Due to the key or core structure that highly integrated or connected nodes, if one of the most core sectors of a country hit by a shock, the shock can cause a vast impact on the whole economic structure and vice versa (Alatriste-Contreras 2015). High connectivity or integration of core sub-sector also can cause the economy to be fragile because it allows targeted shocks to spread from one sub-sector to another. If the core sub-sector are intentionally picked out or accidentally touched, the effects will spread rapidly throughout the network. Therefore, it can be inferred that key or core sub-sectors are a good sub-sector for selective promotion and are weak if the economy suffers adverse shocks.

4.4. Degree

Table 3 results from in-degrees and out-degrees for the top 10 sub-sectors and the lowest ten sub-sectors based on input-output value-added multipliers. Degrees for nodes are the link or edges values of each node in a network, showing the network's basic features. As mentioned earlier, this study's edges represent the flow value of the value-added input multiplier or the value-added output multiplier from one sub-sector to another sub-sector. As already described, direct networks have two types of degrees, namely the in-degree and the out-degree. Analyzing the in-degree value can help explore further sub-sectors that use high input in the Malaysian economy based on a value-added multiplier. In any growth contraction for a sub-sector, the sub-sector uses a lot of input to produce one unit of output exposed to affect the input sub-sector significantly.

Based on Table 3, the oils and fats sub-sector is ranked first in the in-degree value for value-added multipliers. This is because the oils and fats sub-sector inputs are primarily derived from Malaysian domestic inputs and do not rely heavily on imported inputs. Meanwhile, the in-degree value for the oil palm sub-sector is ranked 115th for the value-added multiplier with a 0.114 value of inbound links. The high degree of input for value-added multipliers demonstrates the importance of the oils and fats sub-sector in helping to generate the pure Malaysian economy income for each production.

Table 3. Results of in-degrees and out-degrees for the top 10 sub-sectors and the lowest ten sub-sectors based on value-added (VA) multipliers[3].

No.	Sub-Sector	In-Degree	No.	Sub-Sector	Out-Degree
1	VA- Oils and Fats	0.661	1	VA-93	7.487
2	VA-18	0.632	2	VA-13	3.976
3	VA-26	0.611	3	VA-115	3.316
4	VA-17	0.602	4	VA-44	2.229
5	VA-44	0.522	5	VA-86	1.519
6	VA-37	0.483	6	VA-107	1.278
7	VA-98	0.48	7	VA-45	0.976
8	VA-36	0.479	8	VA-11	0.779
9	VA-38	0.466	9	VA-108	0.769
10	VA-122	0.458	10	VA-80	0.667
N_i	-	-	N_i	-	-
115	VA-Oil Palm	0.114	115	VA-42	0
116	VA-3	0.113	116	VA-81	0
117	VA-8	0.113	117	VA-89	0
118	VA-12	0.111	118	VA-90	0
119	VA-11	0.103	119	VA-112	0
120	VA-2	0.09	120	VA-114	0
121	VA-101	0.09	121	VA-119	0
122	VA-112	0.088	122	VA-120	0
123	VA-1	0.073	123	VA-121	0
124	VA-13	0.056	124	VA-122	0

Sub-sectors with high in-degrees and high out-degrees can be the key to creating demand and spreading growth indirectly throughout the economic system. Therefore, identifying sub-sectors that contain high in or out-degree is very useful as each sub-sector will influence other sub-sectors differently based on the links and values of degrees. For example, the implications of demand shocks, whether positive or negative for one sub-sector, vary based on the value of inputs or outputs received or supplied from the demand shock sub-sectors.

So, conducting an analysis of the in-degree and the out-degree will give a clearer picture of the changes to other sectors in the Malaysian economy. In addition, based on Appendix C, the findings also prove that these two sub-sectors supply output to other sub-sectors that contain a high content of imports (goods/services).

4.5. Node Results

The table in Appendix C shows the overall results of the node analysis conducted on the value-added multiplier for the Malaysian Input-Output Table 2015. Column 4 shows the betweenness results for the network. Almost all sub-sectors are intermediaries with the highest value of 59.814 located at node VA-115 (Professional). It indicates that the professional sub-sector in the input-output network, based on the value-added multiplier, has the highest value-added flow connection to other sub-sectors. From the 124 nodes, it found that only 7 per cent of nodes were not intermediaries.

Columns 6 and 7 show in-clustering and out-clustering value. Clustering within the network is also known as the number of neighbors (Said 2016). The highest values for in-clustering are 0.005 at nodes VA-17 (Processing and Preserving of Meat), VA-18 (Processing and Preserving of Seafood), VA-26 (Prepared Animal Feeds), VA-(Oils and Fats). The out-clustering is at node VA-93 (Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles) with a value of 0.06. The last column shows the clustering ratio (C). The clustering ratio for a network is between the values of 0 to 1. If C = 1, it is said that the network is perfectly transitive, whereas if C = 0 indicates that the network is not transitive. For networks, C essentially shows the extent to which the presence of three nodes forms an interconnected triangle in a network (Said 2016).

The results show that the VA-122 sub-sector (Non-Profit Institutions Serving Households) has the highest cluster coefficient of 0.998, close to 1. In contrast, the VA-111 (Real Estate) sub-sector has the lowest clustering coefficient value at only 0.872. Thus, the overall value of the clustering coefficient value concludes that all sub-sectors in the input-output network based on the value-added multiplier have high transitive properties.

5. Conclusions

The value-added multiplier method is used for the input factor's net value in the oils and fats and oil palm sub-sectors analyzed in this paper. The advantage of using a value-added multiplier is to avoid double counting of both domestic and import factors. Thus, it is vital for using the value-added multiplier method to explain the net impact of the flow of input factor of the oil palm industry. Besides, the high-density level shows that the Malaysian oil palm sector has high connectivity in the economic system where sectors are highly dependent on the Malaysian economic structure. In addition, from network visualization analysis, the oils and fats sub-sector has a high level of integration with other sectors within the network. Meanwhile, the oil palm sub-sector categorized in the periphery structure group has a low level of integration in the input-output network. This is due to the high value-added demand for oil palm in the oils and fats sub-sector in the manufacturing sector. Overall, most of the sub-sectors are interconnected due to the high clustering ratio that closed to 1. Therefore, if there is deteriorating or expanding production of oil palm, it will directly affect the value of the other sub-sectors that used oil palm and oils and fats as an input factor. The interdependence of oil palm sector with other sub-sectors in the Malaysian economic structure has proved the importance of the oil palm industry. Therefore, policymakers need to be more sensitive to the chain effect of the change in the production of the oil palm sector. Sufficient oil palm production is vital to ensure the stability of the oil palm sector chain to other sub-sectors.

However, most past studies rarely look at the relationship between the production and demand for oil palm. In the context of Malaysia, the forecast of a decrease in global demand due to the ban on imports of palm oil by the European Union has a significant impact on the Malaysian economy. In conclusion, the importance of the oil palm industry in the Malaysian production chain to other sectors shows the high dependence of different sectors on the oil palm industry. Policymakers need to be more sensitive to these chain relationships. A policy needs to be made to protect this oil palm industry in ensuring the survival of this industry in Malaysia. Based on the pressures faced, producing countries need to seek further development potential. In urgent circumstances, countries that receive pressure or negative demand shock can find early solution measures to reduce the risks faced against future sanctions.

Meanwhile, this study has shown the importance of the oil palm industry in Malaysia to the other sub-sectors. It is exciting to know the position and the role of the oil palm industry in other countries. To achieve this goal, a study based on the input-output table is needed. In addition, by integrating the input-output tables of various countries, an analysis of the global value chain (GVC), which refers to international production sharing, can be implemented to see the interconnectedness between the integrated oil palm sectors. The current study's limitations are more detailed data for palm oil product fractions in the Malaysian Input-Output Table. Here, Malaysia as a producing country can conduct further studies of palm oil products more in line with the needs and wants of a domestic and international market. Meeting the needs and wants of each country more precisely is one way to increase the consumption and demand for palm oil products.

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Conflicts of Interest: The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. 124 Sub-Sector in Malaysia Input-Output Table 2015

Code (S/VA)	Sub-Sector
1	Paddy
2	Food Crops
3	Vegetables
4	Fruits
5	Rubber
Oil Palm	Oil Palm
7	Flower Plants
8	Other Agriculture
9	Poultry Farming
10	Other Livestock
11	Forestry and Logging
12	Fishing and Aquaculture
13	Crude Oil and Natural Gas
14	Mining of Metal Ores
15	Quarrying of Stone, Sand, and Clay
16	Other Mining and Quarrying
17	Processing and Preserving of Meat
18	Processing and Preserving of Seafood
19	Processing and Preserving of Fruits and Vegetables
20	Dairy Products
Oils and Fats	Vegetable and Animal Oils and Fats
22	Grain Mill Products, Starches, and Starch Products
23	Bakery Products
24	Confectionery
25	Other Food Processing
26	Prepared Animal Feeds
27	Spirits, Wines, and Liquors
28	Soft Drinks, Mineral Waters and Other Bottled Waters
29	Tobacco Products
30	Preparation, Spinning, and Weaving of Textiles
31	Finishing of Textiles
32	Other Textiles
33	Wearing Apparel
34	Leather Products
35	Footwear
36	Sawmilling and Planning of Wood
37	Veneer Sheets and Wood-based Panels
38	Builders' Carpentry and Joinery
39	Wooden Containers and Other Wood Products
40	Paper and Paper Products

Code (S/VA)	Sub-Sector
41	Furniture
42	Reproduction of Recorded Media
43	Printing
44	Coke and Refined Petroleum Products
45	Basic Chemicals
46	Fertilizers and Nitrogen Compounds
47	Paints and Varnishes
48	Pharmaceuticals, Medicinal Chemical, and Botanical Products
49	Soaps and Detergents, Cleaning and Polishing, Perfumes, Toilet Preparations
50	Other Chemicals Products
51	Rubber Tyres and Tubes
52	Rubber Processing
53	Rubber Gloves
54	Other Rubber Products
55	Plastic Products
56	Glass and Glass Products
57	Refractory, Clay, Porcelain, and Ceramic Products
58	Cement, Lime, and Plaster
59	Non-Metallic Mineral Products
60	Basic Iron and Steel
61	Basic Precious and Other Non-Ferrous Metals
62	Casting of Metals
63	Structural Metal Products, Tanks, Reservoirs, and Steam Generators
64	Other Fabricated Metal Products
65	Engines and Turbines, Fluid Power Equipment, Other Pumps and others
66	Other General Purpose Machinery
67	Weapons, Ammunition, and Special Purpose Machinery
68	Domestic Appliances
69	Computers, Peripheral, Office Equipment, and Machinery
70	Electric Motors, Generators, and Transformers
71	Electricity Distribution and Control Apparatus, Batteries, and Accumulators
72	Fibre Optic, Electronic, and Other Electric Cables
73	Wiring Devices, Electric Lighting Equipment, and Other Electrical
74	Electronic Components and Boards
75	Communication Equipment and Consumer Electronics
76	Irradiation Equipment, Electro Medical, and Electrotherapeutic"
77	Measuring Equipment, Testing, Navigating, and Control
78	Optical Instruments, Photographic Equipment, Magnetic, and Optical Media
79	Watches and Clocks
80	Motor Vehicles, Trailers, and Semi Trailers
81	Motorcycles
82	Ships, Boats, Bicycles, and Invalid Carriages
83	Other Transport Equipment
84	Other Manufacturing
85	Repair and Installation of Machinery and Equipment
86	Electricity and Gas
87	Water
88	Sewerage, Waste Management and Remediation Activities
89	Residential Buildings
90	Non-Residential Buildings
91	Civil Engineering
92	Specialized Construction Activities
93	Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles
94	Accommodation

Code (S/VA)	Sub-Sector
95	Food and Beverage
96	Land Transport
97	Water Transport
98	Air Transport
99	Warehousing and Support Activities for Transportation
100	Services Incidental to Water and Air Transportation
101	Highway Operation Services, Bridge and Tunnel
102	Postal and Courier Activities
103	Publishing Activities
104	Telecommunications
105	Motion Picture, Programming, and Broadcasting Activities
106	Computer and Information Services
107	Monetary Intermediation
108	Other Financial Service
109	Insurance/ Takaful and Pension Funding
110	Activities Auxiliary to Financial Service and Insurance/Takaful
111	Real Estate
112	Ownership of Dwellings
113	Rental and Leasing
114	Scientific Research and Development
115	Professional
116	Business Services
117	Public Administration
118	Education
119	Health
120	Public Order and Safety
121	Other Public Administration
122	Non-Profit Institutions Serving Households
123	Arts, Entertainment and Recreation
124	Other Private Services

Appendix B. Results of Multiplier Analysis for the Output of Oil Palm Sub-Sector and Oils and Fats Sub-Sector Based on Malaysia Input-Output Table 2015

No.	Sub-Sector	Oil Palm Sub-Sector			Oils and Fats Sub-Sector		
		Output Multiplier	Value Added Multiplier	Import Multiplier	Output Multiplier	Value Added Multiplier	Import Multiplier
1	S-1	0.000351	0.000271	0.000079	0.000730	0.000043	0.000687
2	S-2	0.000427	0.000330	0.000097	0.000868	0.000051	0.000816
3	S-3	0.000560	0.000434	0.000127	0.001164	0.000069	0.001096
4	S-4	0.000741	0.000573	0.000168	0.001624	0.000096	0.001528
5	S-5	0.000533	0.000412	0.000121	0.001037	0.000061	0.000976
6	S-Oil palm	1.000547	0.774124	0.226423	0.001148	0.000068	0.001081
7	S-7	0.000818	0.000633	0.000185	0.001718	0.000101	0.001616
8	S-8	0.001047	0.000810	0.000237	0.002843	0.000168	0.002675
9	S-9	0.003444	0.002665	0.000779	0.010303	0.000609	0.009694
10	S-10	0.004419	0.003419	0.001000	0.013263	0.000784	0.012480

No.	Sub-Sector	Oil Palm Sub-Sector			Oils and Fats Sub-Sector		
		Output Multiplier	Value Added Multiplier	Import Multiplier	Output Multiplier	Value Added Multiplier	Import Multiplier
11	S-11	0.000578	0.000447	0.000131	0.001108	0.000065	0.001043
12	S-12	0.000860	0.000665	0.000195	0.002240	0.000132	0.002108
13	S-13	0.000416	0.000322	0.000094	0.000894	0.000053	0.000841
14	S-14	0.001264	0.000978	0.000286	0.002470	0.000146	0.002324
15	S-15	0.001406	0.001088	0.000318	0.002488	0.000147	0.002341
16	S-16	0.001589	0.001230	0.000360	0.003034	0.000179	0.002855
17	S-17	0.008744	0.006765	0.001979	0.024058	0.001421	0.022636
18	S-18	0.002367	0.001831	0.000536	0.005741	0.000339	0.005402
19	S-19	0.003630	0.002809	0.000822	0.010597	0.000626	0.009971
20	S-20	0.009505	0.007354	0.002151	0.030635	0.001810	0.028825
21	S-Oils and Fats	0.375037	0.290166	0.084870	1.331213	0.078652	1.252561
22	S-22	0.002949	0.002282	0.000667	0.008205	0.000485	0.007721
23	S-23	0.023067	0.017847	0.005220	0.079108	0.004674	0.074434
24	S-24	0.013851	0.010717	0.003135	0.042533	0.002513	0.040020
25	S-25	0.020192	0.015622	0.004569	0.069035	0.004079	0.064956
26	S-26	0.011641	0.009007	0.002634	0.037902	0.002239	0.035662
27	S-27	0.005000	0.003868	0.001131	0.014976	0.000885	0.014091
28	S-28	0.011271	0.008720	0.002551	0.025473	0.001505	0.023968
29	S-29	0.001043	0.000807	0.000236	0.002617	0.000155	0.002462
30	S-30	0.000709	0.000548	0.000160	0.001056	0.000062	0.000993
31	S-31	0.001144	0.000885	0.000259	0.001576	0.000093	0.001483
32	S-32	0.001493	0.001155	0.000338	0.002098	0.000124	0.001974
33	S-33	0.001179	0.000912	0.000267	0.001776	0.000105	0.001671
34	S-34	0.003103	0.002401	0.000702	0.005799	0.000343	0.005456
35	S-35	0.001282	0.000992	0.000290	0.002015	0.000119	0.001896
36	S-36	0.001376	0.001065	0.000311	0.001902	0.000112	0.001789
37	S-37	0.001675	0.001296	0.000379	0.002106	0.000124	0.001982
38	S-38	0.001573	0.001217	0.000356	0.002262	0.000134	0.002128
39	S-39	0.001551	0.001200	0.000351	0.002295	0.000136	0.002159
40	S-40	0.001495	0.001157	0.000338	0.002110	0.000125	0.001986
41	S-41	0.001477	0.001143	0.000334	0.002173	0.000128	0.002045
42	S-42	0.001565	0.001211	0.000354	0.002249	0.000133	0.002116
43	S-43	0.001346	0.001041	0.000305	0.002159	0.000128	0.002031
44	S-44	0.001757	0.001359	0.000398	0.002001	0.000118	0.001883
45	S-45	0.001858	0.001438	0.000421	0.002431	0.000144	0.002287
46	S-46	0.001310	0.001014	0.000297	0.001821	0.000108	0.001713

No.		Oil Palm Sub-Sector			Oils and Fats Sub-Sector		
	Sub-Sector	Output Multiplier	Value Added Multiplier	Import Multiplier	Output Multiplier	Value Added Multiplier	Import Multiplier
47	S-47	0.001712	0.001325	0.000387	0.002460	0.000145	0.002315
48	S-48	0.003327	0.002574	0.000753	0.005394	0.000319	0.005076
49	S-49	0.025042	0.019375	0.005667	0.027717	0.001638	0.026079
50	S-50	0.005838	0.004517	0.001321	0.005826	0.000344	0.005482
51	S-51	0.001869	0.001446	0.000423	0.002252	0.000133	0.002119
52	S-52	0.001508	0.001167	0.000341	0.001761	0.000104	0.001657
53	S-53	0.002379	0.001841	0.000538	0.004490	0.000265	0.004225
54	S-54	0.001778	0.001376	0.000402	0.002822	0.000167	0.002655
55	S-55	0.002556	0.001978	0.000578	0.004452	0.000263	0.004189
56	S-56	0.001415	0.001095	0.000320	0.001874	0.000111	0.001763
57	S-57	0.001672	0.001293	0.000378	0.003002	0.000177	0.002824
58	S-58	0.001498	0.001159	0.000339	0.001987	0.000117	0.001869
59	S-59	0.001690	0.001307	0.000382	0.002516	0.000149	0.002367
60	S-60	0.001599	0.001237	0.000362	0.002834	0.000167	0.002666
61	S-61	0.001431	0.001107	0.000324	0.002073	0.000122	0.001950
62	S-62	0.001411	0.001092	0.000319	0.002501	0.000148	0.002353
63	S-63	0.001260	0.000975	0.000285	0.002045	0.000121	0.001924
64	S-64	0.001194	0.000924	0.000270	0.001955	0.000115	0.001839
65	S-65	0.000933	0.000722	0.000211	0.001358	0.000080	0.001278
66	S-66	0.001287	0.000996	0.000291	0.001971	0.000116	0.001855
67	S-67	0.001207	0.000934	0.000273	0.001958	0.000116	0.001843
68	S-68	0.001153	0.000892	0.000261	0.001536	0.000091	0.001445
69	S-69	0.001029	0.000796	0.000233	0.001268	0.000075	0.001193
70	S-70	0.001031	0.000797	0.000233	0.001441	0.000085	0.001356
71	S-71	0.001194	0.000923	0.000270	0.001641	0.000097	0.001544
72	S-72	0.001339	0.001036	0.000303	0.001917	0.000113	0.001804
73	S-73	0.001227	0.000949	0.000278	0.001922	0.000114	0.001808
74	S-74	0.001098	0.000850	0.000248	0.001447	0.000086	0.001362
75	S-75	0.001042	0.000806	0.000236	0.001366	0.000081	0.001285
76	S-76	0.001130	0.000874	0.000256	0.001628	0.000096	0.001532
77	S-77	0.001061	0.000821	0.000240	0.001475	0.000087	0.001388
78	S-78	0.001163	0.000900	0.000263	0.001564	0.000092	0.001472
79	S-79	0.000986	0.000763	0.000223	0.001469	0.000087	0.001382
80	S-80	0.001034	0.000800	0.000234	0.001559	0.000092	0.001467
81	S-81	0.000935	0.000723	0.000212	0.001559	0.000092	0.001467
82	S-82	0.001035	0.000801	0.000234	0.001648	0.000097	0.001551
83	S-83	0.001106	0.000856	0.000250	0.001664	0.000098	0.001566
84	S-84	0.007430	0.005749	0.001681	0.007368	0.000435	0.006933

No.		Oil Palm Sub-Sector			Oils and Fats Sub-Sector		
	Sub-Sector	Output Multiplier	Value Added Multiplier	Import Multiplier	Output Multiplier	Value Added Multiplier	Import Multiplier
85	S-85	0.001644	0.001272	0.000372	0.002752	0.000163	0.002590
86	S-86	0.000764	0.000591	0.000173	0.001008	0.000060	0.000948
87	S-87	0.000731	0.000566	0.000165	0.001164	0.000069	0.001095
88	S-88	0.001156	0.000894	0.000262	0.001906	0.000113	0.001794
89	S-89	0.001333	0.001031	0.000302	0.001898	0.000112	0.001786
90	S-90	0.001312	0.001015	0.000297	0.001868	0.000110	0.001757
91	S-91	0.001331	0.001030	0.000301	0.001983	0.000117	0.001866
92	S-92	0.001402	0.001084	0.000317	0.002323	0.000137	0.002185
93	S-93	0.006864	0.005310	0.001553	0.006785	0.000401	0.006384
94	S-94	0.001185	0.000917	0.000268	0.002711	0.000160	0.002551
95	S-95	0.074454	0.057605	0.016849	0.262275	0.015496	0.246779
96	S-96	0.001290	0.000998	0.000292	0.001998	0.000118	0.001879
97	S-97	0.002918	0.002258	0.000660	0.008373	0.000495	0.007878
98	S-98	0.006362	0.004922	0.001440	0.020693	0.001223	0.019470
99	S-99	0.002320	0.001795	0.000525	0.005673	0.000335	0.005337
100	S-100	0.002562	0.001982	0.000580	0.007957	0.000470	0.007487
101	S-101	0.000363	0.000280	0.000082	0.000771	0.000046	0.000726
102	S-102	0.001042	0.000807	0.000236	0.001677	0.000099	0.001578
103	S-103	0.001090	0.000844	0.000247	0.002459	0.000145	0.002314
104	S-104	0.001170	0.000906	0.000265	0.003352	0.000198	0.003154
105	S-105	0.001342	0.001039	0.000304	0.003701	0.000219	0.003482
106	S-106	0.001950	0.001508	0.000441	0.005718	0.000338	0.005380
107	S-107	0.000453	0.000350	0.000103	0.000982	0.000058	0.000924
108	S-108	0.000651	0.000503	0.000147	0.001512	0.000089	0.001423
109	S-109	0.001312	0.001015	0.000297	0.003812	0.000225	0.003587
110	S-110	0.001052	0.000814	0.000238	0.002691	0.000159	0.002532
111	S-111	0.002503	0.001937	0.000567	0.003687	0.000218	0.003469
112	S-112	0.000206	0.000159	0.000047	0.000331	0.000020	0.000311
113	S-113	0.003619	0.002800	0.000819	0.007811	0.000462	0.007350
114	S-114	0.001269	0.000982	0.000287	0.003420	0.000202	0.003218
115	S-115	0.002451	0.001896	0.000555	0.005018	0.000297	0.004722
116	S-116	0.002658	0.002056	0.000601	0.007652	0.000452	0.007200
117	S-117	0.002881	0.002229	0.000652	0.008911	0.000527	0.008385
118	S-118	0.001689	0.001307	0.000382	0.004883	0.000289	0.004595
119	S-119	0.002796	0.002163	0.000633	0.007974	0.000471	0.007503
120	S-120	0.003726	0.002883	0.000843	0.011837	0.000699	0.011138

No.	Sub-Sector	Oil Palm Sub-Sector			Oils and Fats Sub-Sector		
		Output Multiplier	Value Added Multiplier	Import Multiplier	Output Multiplier	Value Added Multiplier	Import Multiplier
121	S-121	0.002084	0.001612	0.000472	0.006165	0.000364	0.005800
122	S-122	0.002244	0.001736	0.000508	0.005442	0.000322	0.005120
123	S-123	0.003624	0.002804	0.000820	0.010984	0.000649	0.010335
124	S-124	0.000766	0.000593	0.000173	0.001982	0.000117	0.001865
	Total	**1.771354**	**1.370498**	**0.400855**	**2.326711**	**0.137470**	**2.189242**

Appendix C. Nodes Results

No.	Sub-Sector	In-Degree	Out-Degree	Betweenness	In-Clustering	Out-Clustering	Cluster Ratio
1	VA-1	0.073	0.378	0.072	0.001	0.003	0.874
2	VA-2	0.09	0.005	0	0.001	0.000	0.943
3	VA-3	0.113	0.051	0.124	0.001	0.000	0.873
4	VA-4	0.165	0.152	0.515	0.001	0.001	0.873
5	VA-5	0.135	0.032	0.031	0.001	0.000	0.887
6	VA-Oil Palm	0.114	0.596	0.124	0.001	0.005	0.873
7	VA-7	0.153	0.012	0.624	0.001	0.000	0.873
8	VA-8	0.113	0.279	0.124	0.001	0.002	0.873
9	VA-9	0.261	0.414	1.209	0.002	0.003	0.873
10	VA-10	0.338	0.178	7.287	0.003	0.001	0.873
11	VA-11	0.103	0.779	0.732	0.001	0.006	0.873
12	VA-12	0.111	0.593	0.124	0.001	0.005	0.873
13	VA-13	0.056	3.976	0.501	0.000	0.032	0.873
14	VA-14	0.346	0.04	5.327	0.003	0.000	0.873
15	VA-15	0.348	0.131	5.327	0.003	0.001	0.873
16	VA-16	0.393	0.021	6.201	0.003	0.000	0.873
17	VA-17	0.602	0.046	11.102	0.005	0.000	0.873
18	VA-18	0.632	0.058	6.413	0.005	0.000	0.873
19	VA-19	0.376	0.04	7.287	0.003	0.000	0.873
20	VA-20	0.391	0.003	1.763	0.003	0.000	0.927
21	VA-Oils and Fats	0.661	0.059	11.102	0.005	0.000	0.873
22	VA-22	0.366	0.073	6.97	0.003	0.001	0.873
23	VA-23	0.378	0.007	9.267	0.003	0.000	0.873
24	VA-24	0.288	0.074	6.984	0.002	0.001	0.873
25	VA-25	0.342	0.068	9.123	0.003	0.001	0.873
26	VA-26	0.611	0.129	7.287	0.005	0.001	0.873
27	VA-27	0.332	0.004	8.596	0.003	0.000	0.881
28	VA-28	0.369	0.033	9.267	0.003	0.000	0.873
29	VA-29	0.141	0.003	6.338	0.001	0.000	0.881
30	VA-30	0.202	0.122	1.606	0.002	0.001	0.873
31	VA-31	0.311	0.035	2.257	0.003	0.000	0.881
32	VA-32	0.3	0.002	0.061	0.002	0.000	0.948
33	VA-33	0.292	0.014	29.678	0.002	0.000	0.873
34	VA-34	0.345	0.01	4.308	0.003	0.000	0.89
35	VA-35	0.283	0.02	2.083	0.002	0.000	0.873
36	VA-36	0.479	0.287	4.193	0.004	0.002	0.873
37	VA-37	0.483	0.14	4.193	0.004	0.001	0.873
38	VA-38	0.466	0.016	3.085	0.004	0.000	0.879
39	VA-39	0.451	0.023	4.193	0.004	0.000	0.873
40	VA-40	0.393	0.043	20.461	0.003	0.000	0.873

No.	Sub-Sector	In-Degree	Out-Degree	Betweenness	In-Clustering	Out-Clustering	Cluster Ratio
41	VA-41	0.41	0.026	4.193	0.003	0.000	0.873
42	VA-42	0.325	0	0.519	0.003	0.000	0.969
43	VA-43	0.29	0.132	18.958	0.002	0.001	0.873
44	VA-44	0.522	2.229	1.195	0.004	0.018	0.873
45	VA-45	0.406	0.976	6.413	0.003	0.008	0.873
46	VA-46	0.337	0.127	6.096	0.003	0.001	0.873
47	VA-47	0.333	0.113	4.193	0.003	0.001	0.873
48	VA-48	0.268	0.092	7.287	0.002	0.001	0.873
49	VA-49	0.301	0.014	7.1	0.002	0.000	0.873
50	VA-50	0.364	0.347	4.193	0.003	0.003	0.873
51	VA-51	0.375	0.028	6.172	0.003	0.000	0.873
52	VA-52	0.265	0.156	4.193	0.002	0.001	0.873
53	VA-53	0.293	0.011	1.966	0.002	0.000	0.881
54	VA-54	0.301	0.08	3.889	0.002	0.001	0.873
55	VA-55	0.271	0.181	3.918	0.002	0.001	0.873
56	VA-56	0.329	0.042	2.386	0.003	0.000	0.873
57	VA-57	0.363	0.039	2.386	0.003	0.000	0.873
58	VA-58	0.397	0.137	4.193	0.003	0.001	0.873
59	VA-59	0.411	0.174	8.007	0.003	0.001	0.873
60	VA-60	0.375	0.311	6.028	0.003	0.003	0.873
61	VA-61	0.385	0.073	4.193	0.003	0.001	0.873
62	VA-62	0.316	0.035	6.201	0.003	0.000	0.873
63	VA-63	0.312	0.257	4.222	0.003	0.002	0.873
64	VA-64	0.274	0.659	4.222	0.002	0.005	0.873
65	VA-65	0.256	0.022	4.222	0.002	0.000	0.873
66	VA-66	0.316	0.081	4.222	0.003	0.001	0.873
67	VA-67	0.296	0.035	4.222	0.002	0.000	0.873
68	VA-68	0.284	0.002	0.463	0.002	0.000	0.91
69	VA-69	0.25	0.099	1.209	0.002	0.001	0.873
70	VA-70	0.262	0.018	1.512	0.002	0.000	0.873
71	VA-71	0.28	0.009	3.359	0.002	0.000	0.879
72	VA-72	0.347	0.031	6.028	0.003	0.000	0.873
73	VA-73	0.281	0.005	3.101	0.002	0.000	0.879
74	VA-74	0.235	0.502	1.512	0.002	0.004	0.873
75	VA-75	0.23	0.403	0.891	0.002	0.003	0.873
76	VA-76	0.265	0.009	1.401	0.002	0.000	0.881
77	VA-77	0.261	0.021	1.512	0.002	0.000	0.873
78	VA-78	0.283	0.018	4.222	0.002	0.000	0.873
79	VA-79	0.248	0.001	0.516	0.002	0.000	0.945
80	VA-80	0.241	0.667	4.222	0.002	0.005	0.873
81	VA-81	0.259	0	0	0.002	0.000	0.988
82	VA-82	0.332	0.09	12.751	0.003	0.001	0.873
83	VA-83	0.297	0.01	4.072	0.002	0.000	0.873
84	VA-84	0.316	0.1	33.32	0.003	0.001	0.873
85	VA-85	0.344	0.443	20.793	0.003	0.004	0.873
86	VA-86	0.252	1.519	0.718	0.002	0.012	0.873
87	VA-87	0.262	0.172	4.532	0.002	0.001	0.873
88	VA-88	0.298	0.179	11.56	0.002	0.001	0.873
89	VA-89	0.398	0	0	0.003	0.000	0.977
90	VA-90	0.394	0	0	0.003	0.000	0.977
91	VA-91	0.396	0.023	3.027	0.003	0.000	0.891
92	VA-92	0.385	0.518	6.201	0.003	0.004	0.873
93	VA-93	0.207	7.487	11.102	0.002	0.060	0.873
94	VA-94	0.283	0.072	19.586	0.002	0.001	0.873
95	VA-95	0.377	0.36	11.102	0.003	0.003	0.873

No.	Sub-Sector	In-Degree	Out-Degree	Betweenness	In-Clustering	Out-Clustering	Cluster Ratio
96	VA-96	0.368	0.486	3.492	0.003	0.004	0.873
97	VA-97	0.408	0.235	51.179	0.003	0.002	0.873
98	VA-98	0.48	0.22	16.778	0.004	0.002	0.873
99	VA-99	0.391	0.163	8.421	0.003	0.001	0.873
100	VA-100	0.21	0.19	7.627	0.002	0.002	0.873
101	VA-101	0.09	0.21	0.624	0.001	0.002	0.873
102	VA-102	0.321	0.038	3.015	0.003	0.000	0.873
103	VA-103	0.289	0.086	44.581	0.002	0.001	0.873
104	VA-104	0.219	0.604	2.697	0.002	0.005	0.873
105	VA-105	0.247	0.052	2.388	0.002	0.000	0.887
106	VA-106	0.243	0.246	4.532	0.002	0.002	0.873
107	VA-107	0.151	1.278	9.248	0.001	0.010	0.873
108	VA-108	0.2	0.769	9.565	0.002	0.006	0.873
109	VA-109	0.249	0.481	9.248	0.002	0.004	0.873
110	VA-110	0.331	0.139	32.648	0.003	0.001	0.873
111	VA-111	0.245	0.379	59.814	0.002	0.003	0.872
112	VA-112	0.088	0	0	0.001	0.000	0.998
113	VA-113	0.266	0.206	57.624	0.002	0.002	0.872
114	VA-114	0.268	0	0	0.002	0.000	0.965
115	VA-115	0.198	3.316	59.814	0.002	0.027	0.872
116	VA-116	0.369	0.397	38.372	0.003	0.003	0.873
117	VA-117	0.248	0.13	1.006	0.002	0.001	0.914
118	VA-118	0.221	0.026	0.222	0.002	0.000	0.935
119	VA-119	0.292	0	0.68	0.002	0.000	0.943
120	VA-120	0.385	0	0	0.003	0.000	0.955
121	VA-121	0.206	0	0	0.002	0.000	0.96
122	VA-122	0.458	0	0	0.004	0.000	0.972
123	VA-123	0.353	0.02	2.976	0.003	0.000	0.913
124	VA-124	0.312	0.111	3.015	0.003	0.001	0.873

Notes

1. Based on the value of the output multiplier, value added multiplier, and import multiplier, every RM1.00 increase in output for the Oils and Fats sub-sector will further increase the production of the Oil Palm sub-sector by RM0.38. However, from the increase of RM0.38 from the Oil Palm sub-sector, only RM0.29 is owned by Malaysia while the remaining RM0.08 is through import input.
2. Each color represents different sector.
3. For the full results of in-degrees and out-degrees based on value-added multipliers please refer to Appendix B.

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