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The Importance of the Agricultural Sector to the Malaysian Economy: Analyses of Inter-Industry Linkages

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ABSTRACT

This paper assesses the importance of the agricultural sector to the economic growth in Malaysia. A hypothetical extraction method was used to quantify the relative strength of backward and forward linkages of the agricultural sector. For empirical analyses, we ran an extended input-output table that takes into account detailed agricultural sub-sectors. Findings suggested that the agricultural sector contributes mainly through forward linkages, implying that the output of this sector is demanded larger by other sectors, in particular the manufacturing sector as their input. Large-scale oil palm (estate and smallholdings) should be highlighted for growth policies due to strong pull effects on the rest of the economic sector.

JEL classification: C67, O13, Q18

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INTRODUCTION

How does the agricultural sector contribute to economic growth? There are reasons to be pessimistic about the role of the agricultural sector as an engine of growth in developing economies. Recent trends indicate that the agricultural sector represents a small share of gross domestic product (GDP) – on the average between 5% and 15% (see, for example, Valdés & Foster, 2010). Although the share of the agricultural sector in overall GDP is decreasing, it still plays an important role: growth in the agricultural sector contributes proportionally more to poverty reduction than growth in any other sector (see, for example, Diao *et al*., 2010; World Bank, 2002). In Malaysia, for instance, most poor people are trapped in the

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agricultural sector (34% of the total number of poor) and it might seem obvious that this is the 'key' sector for poverty reduction in the economy. However, agriculture's principal role in poverty reduction can only be taken up when its inter-industrial linkages with other production sectors are sufficiently strong and well developed.

Improving the agricultural sector itself, with the assumption that spillover effects to other production sectors of the economy will be generated automatically, is the common policy in developing economies. This has often not happened, leading to pessimism about the role of agricultural sector in economic development. Recently Valdés and Foster (2010) have shown that the main contribution of the agricultural sector to growth is through forward linkages rather than backward linkages, indicating that output from agricultural sector is demanded much higher than what it demands from other sectors. This implies that stimulating growth in the output of the agricultural sector would mostly benefit the sector itself, with minimal spillover effects to other sectors.

This paper is principally concerned with the question: to what extent is the magnitude of the multipliers associated with inter-industrial linkages between the agricultural and non-agricultural sectors relevant to the development of the Malaysian economy. To answer this empirical question, we measured the linkages between the agricultural sector and the rest of the economy by calculating the two commonly used methods of backward and forward linkages. Understanding the extent to which the agricultural sector is integrated with other sectors allowed us to estimate the potential for agriculture to have positive spillover effects on the growth of other sectors.

The linkages of agriculture sector were analysed within the framework of input-output analysis. The potential of input-output analysis for studying linkages among the sectors of an economy is widely recognised. This method allowed us to study the importance of the agricultural sector as a whole in the economic system, as well as to analyse the role played by each sub-sector and their relationships with other production sectors. For more meaningful analysis, we further extended the existing input-output table, accounting for detailed agricultural activities in the economy.

The rest of this paper is organised as follows. The next section explains the input-output model and its application to the analysis of agricultural linkages. Section of Data briefly discusses the data sources that have been used to run our analyses. The structure of the existing input-output table and how it has been extended to account for detailed agricultural sub-sectors is elaborated in some length. Results and Discussion presents the results of linkage analyses. Finally, Conclusions section summarises the main conclusions drawn from this paper.

INPUT-OUTPUT MODEL

The hypothetical extraction method

The study of sectoral relations and dependence has a long tradition within the field of input-output analysis. In the input-output framework, two kinds of interdependence measures are developed. First, if a particular sector, say sector *j*, increases its output, this means there will be increased demands from sector *j* (as a purchaser) on the sectors whose goods are used as inputs to the production of *j*. This kind of interconnection is termed as backward linkage. On the other hand, increased output in sector *j* also means that additional amounts of product *j* are available to be used as inputs to other sectors for their own production, that is, there will be increased supplies from sector *j* (as a seller) for the sectors that used goods from *j* in their production. The term forward linkage is used to indicate this kind of interconnection.

Several studies have analysed the inter-industrial linkages of the agricultural sector in Malaysia (see, for example, Bekhet & Abdullah, 2010; Puasa & Rahman, 2008; Saari et al., 2008). All these studies have applied Rasmussen's (1956) traditional linkage measure; however, there have also been numerous suggestions for refinements of linkages (see Miller & Blair, 2009 for a detailed discussion). For our purpose, we applied the hypothetical extraction method instead of other traditional measures (see, for example, Chenery & Watanabe, 1958; Hirschman, 1958; Rasmussen, 1956). The hypothetical extraction method was proposed by Strassert (1968) and further formalised by Dietzenbacher et al. (1993) and Dietzenbacher and van der Linden (1997). The unique thing about this approach is that we were able to quantify explicitly the degree of the interdependency between the agricultural sector and other production sectors.

According to this approach, sectoral inputs should be hypothetically eliminated in order to measure the backward linkage. Leaving the technical production process invariant, it is thus assumed that the inputs required for production are no longer delivered by the sectors within the system, but have their origin outside the system. In our case, whenever the agricultural sector was considered, it was assumed that the required inputs were from non-agricultural sectors. The backward linkage was then obtained by comparing the actual production with the production in the hypothetical situation where the sector under consideration did not depend on any sector within the system. Similarly, the forward linkage of a sector was obtained by considering the hypothetical situation where this sector provided no intermediate deliveries. Therefore, this method allowed us to calculate explicitly output reduction for the rest of the production sectors as a result of extraction for a particular sector.

Let us start with an ordinary input-output table. with *n* sectors and z_{ij} denoting the intermediate deliveries from sector *i* to sector *j*, the independencies among production activities can be shown based on the following material balance equation[1]:

[1]For clarity, matrices are indicated by bold, upright capital letters; vectors by bold, upright lower case letters, and scalar by italicized lower case letters. Vectors are columns by definition, so that row vectors are obtained by transposition, indicated by a prime (e.g. $\mathbf{x'}$). A diagonal matrix with the elements of vector x on its main

$$\mathbf{x} = \mathbf{Ax} + \mathbf{f} \quad (1)$$

where $\mathbf{x}$ is the vector for gross output $\mathbf{A}(\mathbf{A} = \mathbf{Z}\hat{\mathbf{x}}^{-1})$ is known as the technical coefficient and $\mathbf{f}$ is the vector for final demand. In the standard input-output model, (1) can be transformed and solved in matrix notation as follows:

$$\mathbf{x} = (\mathbf{I}-\mathbf{A})^{-1}\mathbf{f} = \mathbf{Lf} \quad (2)$$

where $\mathbf{I}$ is the identity matrix, and $(\mathbf{I}-\mathbf{A})^{-1}$ is known as the Leontief inverse matrix.

For the backward linkage, it was assumed that sector j buys no intermediate inputs from any productions sector. Operationally, this was done by replacing column j in $\mathbf{A}$ with zero entries. Let us denote this new matrix as $\bar{\mathbf{A}}_{(cj)}$ (subscript c indicates that column j only is gone). Then, the new output level as a result of extraction was given by

$$\bar{\mathbf{x}}_{(cj)} = (\mathbf{I} - \bar{\mathbf{A}}_{(cj)})^{-1}\mathbf{f} \quad (3)$$

in which the backward linkage for sector j was directly obtained as

$$Bj = \mathbf{i}'\mathbf{x} - \mathbf{i}'\bar{\mathbf{x}}_{(cj)} \quad (4)$$

The backward linkage was based on the input coefficients matrix $\mathbf{A} = \mathbf{Z}\hat{\mathbf{x}}^{-1}$. Its element a_{ij} measured the delivery z_{ij} of sector i to sector j per unit of the buyer's output x_j.

The forward linkage was based on the output coefficients matrix $(\mathbf{B} = \hat{\mathbf{x}}^{-1}\mathbf{Z})$. Its element b_{ij} measured the delivery z_{ij} of sector i to sector j per unit of the seller's output x_i. For the forward linkage, we used the following accounting equations and identities.

$$\mathbf{x}' = \mathbf{x}'\mathbf{B} + \mathbf{v}' = \mathbf{v}'(\mathbf{I} - \mathbf{B})^{-1} \quad (5)$$

where $\mathbf{v}'$ is the (row) vector of primary inputs (i.e. value added and imports).

It is important to note here that Saari *et al*. (2008) and Puasa and Rahman (2008) relied on the coefficient in matrix $\mathbf{A}$ to calculate both the backward and forward linkages. This is inappropriate and both have been viewed with scepticism, because they are generated by a peculiar stimulus.

In contrast to the backward linkage, the forward linkage of sector j is hypothetical, extracted through elimination of the sector's intermediate sale in the matrix $\mathbf{B}$ (i.e. sector j does not sell intermediate deliveries to sector i). That is, we replaced row j of the matrix $\mathbf{B}$ with a row of zeros and we defined this new matrix as $\bar{\mathbf{B}}_{(rj)}$. It follows directly that the new output level as a result of extraction was given by

$$\bar{\mathbf{x}}'_{(rj)} = \mathbf{v}'(\mathbf{I} - \bar{\mathbf{B}}_{(rj)})^{-1} \quad (6)$$

in which the forward linkage for sector j was directly obtained as

$$F_j = \mathbf{x}'\mathbf{i} - \bar{\mathbf{x}}'_{(rj)}\mathbf{i} \quad (7)$$

Normalisations for (4) and (7) are possible and often used. Division of (4) and (7) by $\sum_{j=1}^{n} x_j$ would give the percentage decrease in total output. That is,

$$\bar{B}_j = 100[(\mathbf{i}'\mathbf{x} - \mathbf{i}'\bar{\mathbf{x}}_{(cj)}) / \mathbf{i}'\mathbf{x}] \quad (8a)$$

$$\bar{F}_j = 100[(\mathbf{i}'\mathbf{x} - \mathbf{i}'\bar{\mathbf{x}}_{(rj)}) / \mathbf{x}'\mathbf{i}] \quad (8b)$$

diagonal and all other entries equal to zero are indicated by a circumflex (e.g. $\hat{\mathbf{x}}$). A summation vector is represented by $\mathbf{i}$.

Similarly, the index relative to the average were obtained as follows:

$$\tilde{B}j = n\overline{B}j \,/\, \mathbf{i}'\overline{B}j \tag{9a}$$

$$\tilde{F}j = n\overline{F}j \,/\, \mathbf{i}'\overline{F}j \tag{9b}$$

The Agricultural sub-system

Results of linkages that we obtained in this study (see Agricultural linkages) indicate that agricultural sub-sectors have been associated with lower backward and forward linkages. Of all 26 agricultural sub-sectors, 25 activities have linkage indices below the average of all sectors in the economy. In turn, it seems that the agricultural sub-sectors only have strong interdependence within their own economic system and less spillover effects on the rest of the economic sectors. This leads to the question: should we consider the agricultural sector in Malaysia as a single sub-system delinked from the rest of the systems? To quantify this, we extended our analysis by treating the agricultural sector as a sub-system generating a single output. Our approach here was based on previous methodology developed by Heimler (1991) and, later, by Alcántara and Padilla (2009) for the decomposition of an input-output matrix into sub-systems. We started our methodological approach by partitioning (1) in the following way:

$$\begin{pmatrix} \mathbf{x}_A \\ \mathbf{x}_R \end{pmatrix} = \begin{pmatrix} \mathbf{A}_{AA} & \mathbf{A}_{AR} \\ \mathbf{A}_{RA} & \mathbf{A}_{RR} \end{pmatrix} \begin{pmatrix} \mathbf{x}_A \\ \mathbf{x}_R \end{pmatrix} + \begin{pmatrix} \mathbf{f}_A \\ \mathbf{f}_R \end{pmatrix} \tag{10}$$

where subscripts A and R denote production sectors that belong to the agricultural sector and production sectors that do not belong to the agricultural sector, respectively. It follows directly that (2) can be partitioned in a similar way

$$\begin{pmatrix} \mathbf{x}_A \\ \mathbf{x}_R \end{pmatrix} = \begin{pmatrix} \mathbf{L}_{AA} & \mathbf{L}_{AR} \\ \mathbf{L}_{RA} & \mathbf{L}_{RR} \end{pmatrix} \begin{pmatrix} \mathbf{f}_A \\ \mathbf{f}_R \end{pmatrix} \tag{11}$$

or

$$\mathbf{x}_A = \mathbf{L}_{AA}\mathbf{f}_A + \mathbf{L}_{AR}\mathbf{f}_R \tag{12a}$$

$$\mathbf{x}_R = \mathbf{L}_{RA}\mathbf{f}_A + \mathbf{L}_{RR}\mathbf{f}_R \tag{12b}$$

The way the input-output is partitioned basically decomposes the input-output model into sector groups. This kind of analysis allowed us to examine the specific productive structure of each of the n sectors of the economic system.

Assuming the final demand of the agricultural sector $\mathbf{f}_A$ only is a variable, the total output effects were divided into two components. The first expression on the right-hand side of (12a) represents the requirements for own inputs that each activity in the agricultural sub-system needs to satisfy its new final demand. We termed this the own-component effect. The second expression on the right-hand side of (12b) shows the production inputs required by each agricultural sub-sector from other sub-systems. This was considered as the spillover effect. The spillover effect was of greater interest because lower spillover effect implies weak integration with other sub-systems. Therefore, the agricultural sector is totally independent.

DATA

Analyses were run by using the latest input-output table for 2005 published by the Department of Statistics Malaysia (DOSM, 2010). The input-output table consisted of 120 sectors and was classified according to the Malaysia Standard Industrial Classification (MSIC, see DOSM, 2000). There are 12 agriculture sub-sectors distinguished in the table (for details, see Appendix 1). This sectoral disaggregation, however, may have limitations in offering a complete analysis of the role of the agricultural sector in the Malaysian economy. A more meaningful analysis should be carried out with a finer sectoral disaggregation. For this purpose, we extended the standard input-output table by further detailing the sectors of food crops, fruits, rubber, oil palm, other livestock, forestry and logging, and fishing into their specific individual activity (the full lists of the disaggregation are available in Appendix 1). Unfortunately, a more detailed sectoral breakdown was not possible for the paddy, vegetables, flower plants and poultry farming sectors due to data limitations. As a result of this extension, the sectoral breakdown of the agricultural sub-sectors increased from 12 to 26 sectors. Therefore, taken together, the total sectoral breakdown in our extended input-output table is 134 sectors.

The extended input-output for the agricultural sub-sectors was constructed in two steps. The first step was to assemble a supplementary matrix (supplied by the DOSM) that contains intermediate deliveries (intermediate inputs and demands) and primary inputs of the 26 agricultural sub-sectors into the standard input-output table. However, the flows of intermediate inputs and demands for the rest of the production sectors (i.e. sector 27 to sector 134) were provided in an aggregated form (i.e., only one row for the intermediate inputs and one column for the intermediate demands). Thus, the main task remaining was to disaggregate these flows. For this purpose, a proportionality assumption based on production structures in the standard input-output table was used to distribute the intermediate inputs and demands. For example, the fruits sector (sector 4 in the standard input-output table) was disaggregated into growing pineapples and growing other fruits (sector 8 and sector 9 in the extended input-output table). Then, a similar structure of intermediate inputs and demands of the fruits sector was applied to growing pineapples and growing other fruits. Results from our analyses were not sensitive to this procedure as long as the primary concern were agricultural sub-sectors and their connection with other sectors in the economy was analysed at aggregated sector.

In addition, the supplementary matrix that was provided by the DOSM did not distinguish final demand's detailed components. In our extended input-output table, we broke down final demand into two categories: domestic demand and export. Export data for each of the 26 agricultural sectors was obtained from external trade statistics (DOSM, various years) which was classified according to the standard international trade classification (SITC). The fact that the economic activities in the input-output table were classified according to the MSIC means the export data must be re-classified. For this purpose, DOSM provided a concordance to re-classify SITC into MSIC. We estimated domestic demand using a residual approach, i.e. taking the difference between the total final demand and export.

Assembling the supplementary matrix and application of proportionality assumption would lead to an unbalanced matrix, i.e. equality of the total output and total input for each sector would not be satisfied. Thus, the next step was to balance the whole input-output table. We used the RAS method for balancing a matrix, given that the row and column sums were known (for an overview of RAS, see Miller & Blair, 2009). In our case, we took the row and column sums from the standard input-output table and the supplementary matrix.

RESULTS AND DISCUSSION

Results are presented in two analyses. The first analysis discusses the degree of connectedness of the agriculture sub-sectors through backward and forward linkages. The second analysis simulates how growth in the agriculture sub-sectors could have significant implication on the whole economy.

Agricultural linkages

The hypothetical extraction method, as sketched above, was applied to the 134 sectors of the Malaysian extended input-output table. Results for the total backward and forward linkages are given in Table 1 and Table 2, respectively. The first three rows of Table 1 show the results in aggregated sectors. For backward linkages, for example, if the agricultural sector is hypothetically removed or disappears from the system, the total output in the economy would fall by 1.8% or 30 billion MR (Malaysian *Ringgit*) from its actual level. Of this, 32% is explained by the loss of its own sector, 32.4% by the manufacturing sector and another 35.6% by the services sector. The forward linkages can be interpreted in a similar fashion. The total output falls by 5.6% or 90 billion MR due to the fact that the output of the agricultural sector is no longer used for further production processes. Of this, there will be a 50% decrease in the output of other sectors (37.1% for the manufacturing sector and 13% for the services sector) due to the fact that no output is supplied from the agricultural sector.

In the aggregated sector, the production structures of the agricultural sector exhibited a large difference compared to other sectors. This sector had the weakest linkages in the economic system. Extraction of this sector reduced total output by 1.8%, which was the smallest reduction seen. This was in contrast to the manufacturing sector, extraction of which led to a 30.6% reduction in total output. Results for the forward linkages were more or less the same as was the case for the backward linkages. However, the agricultural connectedness for the forward linkages was even larger than for the backward linkages (for forward linkages,

TABLE 1
Hypothetical extraction results for backward linkages (% reduction of output)

	Total economy	Own sector	Agri. sector	Manuf. sector[1]	Serv. sector[2]
	(1)	(2)	(3)	(4)	(5)
Manufacturing*	30.67		6.78	52.66	40.55
Services**	20.88		3.01	28.93	68.06
Agriculture	1.83		32.00	32.37	35.63
Paddy	0.02	8.81	1.04	36.56	53.59
Growing of sugar cane & tapioca	0.00	38.33	1.08	29.55	31.03
Growing of cocoa	0.01	38.49	3.16	28.45	29.90
Growing of tea & coffee	0.00	35.77	39.31	11.46	13.45
Growing of pepper	0.01	38.33	1.08	29.55	31.03
Growing of coconuts	0.03	38.34	1.07	29.55	31.03
Vegetables	0.01	43.68	4.63	25.17	26.52
Growing of pineapples	0.01	43.22	17.87	18.30	20.61
Other fruits (banana, durian & other fruits)	0.03	40.72	6.96	24.84	27.48
Rubber estate	0.01	0.49	6.27	31.32	61.92
Rubber smallholdings	0.13	0.29	2.51	32.65	64.55
Oil palm estate	0.62	16.20	14.72	28.13	40.95
Oil Palm Smallholdings	0.26	46.15	17.47	14.99	21.39
Flower plants	0.08	40.78	1.15	25.73	32.35
Other agriculture	0.03	72.95	20.60	4.27	2.19
Poultry farming	0.09	69.35	1.52	20.29	8.84
Cattle farming	0.08	4.03	4.89	61.14	29.94
Pig farming	0.37	24.09	3.73	48.45	23.73
Other livestock farming	0.11	1.98	83.18	10.30	4.54
Logging (except rubber wood logging)	0.10	0.16	1.36	59.06	39.42
Collection of rattan and other jungle produce	0.03	0.05	1.47	59.07	39.42
Bird's nest collection	-	-	-	-	-
Rubber wood logging & forest services	0.06	0.02	1.49	59.07	39.42
Ocean and coastal fishing	0.13	38.26	9.26	32.72	19.75
Inland fishing & fishing	0.04	15.61	3.42	50.49	30.48
Aquaculture	0.09	14.94	19.95	40.60	24.50

Notes: (*) including mining and quarrying and (**) including construction sector

TABLE 2
Hypothetical extraction results for forward linkages (% reduction of output)

	Total economy	Own sector	Agri. sector	Manuf. sector[1]	Serv. sector[2]
	(1)	(2)	(3)	(4)	(5)
Manufacturing*	40.39		0.69	86.54	12.77
Services**	43.04		0.79	22.63	76.58
Agriculture	5.59		49.78	37.15	13.07
Paddy	0.10	2.10	0.88	83.87	13.15
Growing of sugar cane & tapioca	0.01	12.61	0.67	71.03	15.69
Growing of cocoa	0.02	12.40	0.67	71.20	15.73
Growing of tea & coffee	0.00	9.92	0.69	73.22	16.17
Growing of pepper	0.01	12.61	0.67	71.03	15.69
Growing of coconuts	0.04	12.61	0.67	71.03	15.69
Vegetables	0.01	53.63	3.54	19.55	23.27
Growing of pineapples	0.01	50.76	0.33	33.85	15.07
Other fruits (banana, durian & other fruits)	0.02	53.89	0.30	31.70	14.11
Rubber estate	0.01	0.65	0.48	76.53	22.35
Rubber smallholdings	0.10	0.39	0.74	76.53	22.35
Oil palm estate	2.12	4.76	0.61	76.43	18.20
Oil Palm Smallholdings	0.32	0.15	0.81	79.99	19.05
Flower plants	0.14	15.14	25.16	48.15	11.55
Other agriculture	0.12	21.07	32.08	37.81	9.04
Poultry farming	0.21	31.15	30.43	27.02	11.39
Cattle farming	0.03	11.82	0.62	61.12	26.45
Pig farming	0.26	5.35	0.93	65.43	28.30
Other livestock farming	0.25	0.84	0.80	68.67	29.69
Logging (except rubber wood logging)	0.47	0.03	0.30	77.09	22.58
Collection of rattan and other jungle produce	0.14	0.01	0.32	77.09	22.58
Bird's nest collection	-	-	-	-	-
Rubber wood logging & forest services	0.07	0.00	0.33	77.09	22.58
Ocean and coastal fishing	0.09	52.11	0.62	34.79	12.48
Inland fishing & fishing	0.05	11.51	38.34	36.92	13.24
Aquaculture	0.04	36.34	0.70	46.34	16.62

Notes: (*) including mining and quarrying and (**) including construction sector extraction of this sector reduced total output by 5.6%). These results are consistent with a recent study by Valdés and Foster (2010) indicating that the main contribution of the agricultural sector comes through forward, not backward, linkages. This implies that output from agricultural sector is demanded much higher than what it demands from other sectors.

Besides calculating the linkages of the entire agricultural sector (and other sectors) as a whole, we further detailed the results for each of the 26 agricultural activities. Linkages for the edible bird nest collection activity requires further explanation. Extraction of this activity did not have any impact on backward and forward linkages. This was not surprising, because this sector did not purchase any intermediate input from other sectors and all output was destined for final demand. Thus, this agricultural activity was totally independent from the entire economic system.

Results for the backward linkages show that most of the agricultural activities are weakly linked to the rest of the sectors in the economy. Only three agricultural activities show considerable linkages with other sectors: oil palm estate, pig farming and oil palm smallholdings. These three economic activities demand a considerably higher share of intermediate inputs from the rest of the sectors. Extraction of these economic activities leads to lower reduction of output in their own sectors compared to the extraction of other agricultural activities. Results show that the manufacturing sector is the major input supplier to the pig farming (accounting for 48.5%), while the services sector is the main input supplier for the oil palm estate and oil palm smallholdings (account for 41% and 21.4%, respectively).

Results of individual activity are similar to those of the aggregated sector, i.e., the agricultural connectedness for the forward linkages is larger than for the backward linkages. For example, the forward linkages for the oil palm estate are more than triple those of the backward linkages. Among the agricultural sub-sectors, oil palm estate, logging and oil palm smallholdings are the sectors that show considerable integration with other sectors. It can be seen that the manufacturing sector is the major consumer of the products of these sub-sectors. For example, extraction of oil palm estate reduced the total output of the manufacturing sector by 76.4%. The fact that the manufacturing sector shows higher backward and forward linkages therefore discriminates against oil palm in general and oil palm estate in particular, and is likely to hinder economic growth.

Next, we constructed linkage indices to access the relative linkage strength of agricultural sub-sectors and those of other sectors. For this purpose, we normalised the backward and forward linkages by the average of the linkages for all 134 sectors in the economy [see equations (9a) and (9b)]. Individual agricultural activity with backward and forward linkage indices greater than 1 is considered to have strong linkages. For example, backward linkages that are greater than 1 mean that a unitary increase in final demand for a particular sector generates an above-average increase in activity in the economy.

Fig.1 shows the distribution of the 134 sectors according to the normalised backward and forward indices. The distribution shows that 96% of the agricultural activities (25 out of 26 activities) have below-average linkages for both backward and forward indices. Results suggest that almost all agricultural sub-sectors are weak-linkage sectors. Only oil palm estate has strong backward and forward linkages. This provides an indication that oil palm estate uses a significant amount of input from other sectors, and considerable amounts of its output are sold to other sectors for their inputs.

Comparison of the strengths of backward and forward linkages for the sectors in a single economy provides one mechanism for identifying 'key' or 'leading' sectors in that economy (those sectors that are most connected and therefore, in some sense, most 'important'). Determination of a key sector is important for a developing country, given the scarcity of resources, and so the necessity for investment to be selective. In linkage analyses, a key sector is defined as the sector associated with above average backward and forward indices (i.e. greater than 1). Fig.1 clearly shows that oil palm estate is the key (and most important) sector in the Malaysian economy. Investment in this key sector would then initiate economic development due to interaction with other sectors. Thus, development of oil palm estate could potentially have large impacts on the rest of the economy.

The linkage analyses in this sub-section

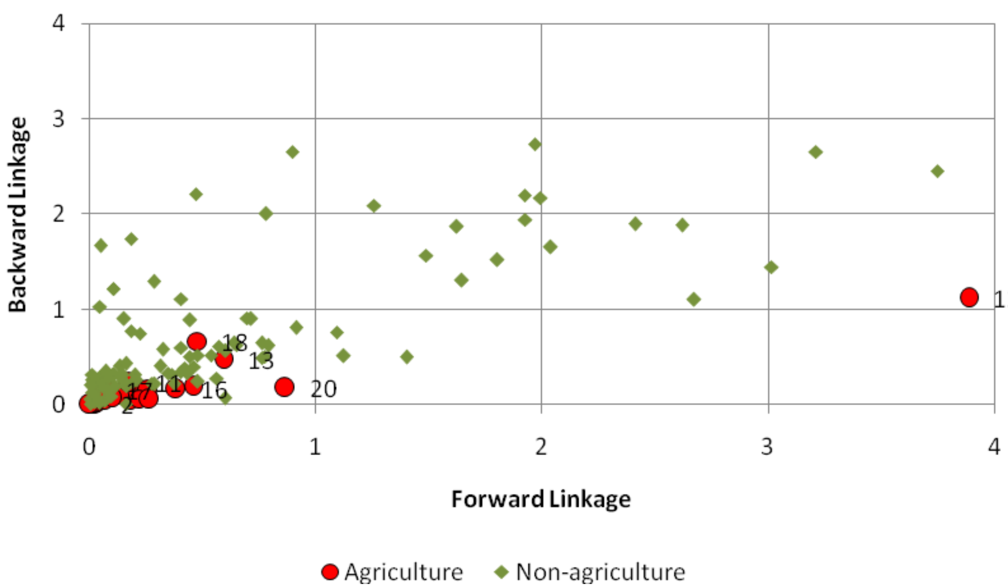

Fig.1: Classification of backward and forward indices for 134 sectors

suggested that the agricultural sector as a whole has a lower degree of economic integration with the rest of the economy. It appears that the output of the agricultural sector is demanded by other sectors more than what it demands from other sectors. The implication is policies designed for higher economic growth may be targeted to the other sectors (e.g. manufacturing and services sectors) than the agricultural sector. Stimulating growth of the agricultural sector would not benefit the whole economy (lower backward linkages) given the fact that it depends more on the growth of other sectors (higher forward linkages).

However, relying heavily on linkages to quantify the importance of the agricultural sector may not provide a complete overview. It is then important to note here that linkage analyses reflect the size effect of the production sector, that is, linkages tend to be lower in the smaller sectors such as paddy and growing sugar cane and tapioca (because smaller sectors use less intermediate input and so are less integrated). Thus, in the next sub-section, we measured explicitly the extent to which growth in the agricultural sector affects the growth of the rest of the economy. In our analyses, we 'removed' the size effect by simulating a fixed increase in final demand for each agricultural sub-sector.

Simulating growth impacts

In this sub-section, the total impacts were simulated by assuming a fixed increase in the final demand of agricultural activities. For instance, results were computed for the case of a one-billion MR (BMR) increase in final demand for the products of a single agricultural sector j (=1….. 26), while the final demand levels in other sectors remain unchanged. Results are given in Table 3. For example, one BMR extra final demand of paddy led to an increase of 1.4 BMR of total output in the economy (see column (1) of Table 3). The last three columns decompose the increase in the total output into two components: own-component effect (column 2) and spillover effect (columns (3) and (4)). Recall that own-component represents the output effect of its own sector and the spillover effect demonstrates the pull effects of the different sectors. For the paddy sector, of the total increase in output, 74% is explained by own-component and another 26% is contributed by the output of other sectors (0.3% for other agriculture sub-sectors and 26% for other sectors).

Fixing the amount by which the final demand level is changed (i.e. one BMR in our case) allowed for a comparison of the output responses across sectors. As an alternative, one might have chosen to increase the final demand level of a sector by a fixed percentage. Both calculations have their pros and cons. The advantage of using a fixed size for the change is that a comparison across sectors is not 'blurred' by the size of the sectors. A disadvantage of using a fixed size (of one BMR) for the change is that the effects are also calculated in cases where any final demand increase is unrealistic. For example, a one-BMR increase in final demand equals a 22% increase for rubber smallholdings, whereas

TABLE 3
Change in output arising from a 1 billion MR increase in final demand

	Total economy (MR mil)	Decomposition of total effects (%)		
		Own component	Other agri.	Other sectors
	(1)	(2)	(3)	(4)
Paddy	1,399	74.00	0.30	25.70
Growing of sugar cane & tapioca	1,171	90.98	0.16	8.86
Growing of cocoa	1,689	74.92	1.29	23.79
Growing of tea & coffee	1,327	84.16	9.70	6.15
Growing of pepper	1,757	73.43	0.46	26.10
Growing of coconuts	1,939	70.14	0.52	29.34
Vegetables	1,370	84.78	1.25	13.97
Growing of pineapples	1,976	71.96	8.83	19.21
Other fruits (banana, durian & other fruits)	1,594	77.90	2.59	19.51
Rubber estate	1,412	70.98	1.83	27.19
Rubber smallholdings	1,417	70.65	0.74	28.62
Oil palm estate	1,544	70.48	5.19	24.34
Oil Palm Smallholdings	1,876	74.85	8.16	16.99
Flower plants	1,947	71.19	0.56	28.25
Other agriculture	1,647	89.38	8.09	2.53
Poultry farming	1,900	85.48	0.72	13.80
Cattle farming	1,884	54.97	2.29	42.74
Pig farming	2,514	54.28	2.25	43.47
Other livestock farming	1,609	62.91	31.48	5.62
Logging (except rubber wood logging)	1,233	81.13	0.26	18.62
Collection of rattan and other jungle produce	1,323	75.61	0.36	24.03
Bird's nest collection	1,000	100.00	-	-
Rubber wood logging & forest services	1,801	55.53	0.66	43.81
Ocean and coastal fishing	1,705	74.47	3.83	21.70
Inland fishing & fishing	1,953	58.82	1.67	39.51
Aquaculture	1,613	67.68	7.58	24.74

growing sugar cane and tapioca has very little final demand and an increase of one BMR equates to almost 379% of its current final demand. This implies that the results should be interpreted with care, particularly in connection to issues of policy making.

Results for the spillover effect are of the greatest interest, because they quantify the importance of the agricultural sector in pulling other sectors. This effect is no more than the result of the backward linkages. Results show that not all of the agricultural sub-sectors are of the same importance. Cattle farming, pig farming and rubber wood logging and forest services sectors have made a significant impact on the rest of the economy, being responsible for more than 40% of the spillover effect to other sectors. More importantly, the spillover effect of these sectors was larger for other sectors than within other agricultural sub-sectors itself, implying that the integration of these sectors with the manufacturing and services sectors is considerable.

The weakest spillover effect sectors (and so less important sectors) were growing sugar cane and tapioca, growing tea and coffee, other agriculture and edible bird nest collection. For these sub-sectors, growth in final demand mainly benefitted their own sector, with benefits ranging from 84% for growing tea and coffee to 100% for edible bird nest collection. Since these four sub-sectors demonstrated weak integration with other sectors, they can be formed as a sub-system that is totally (or to a large extent) independent from the rest of the sub-systems. Other agricultural sub-sectors have likewise made considerable impact on other sectors. All in all, results in this sub-section suggest that the agricultural sector cannot be treated as a single sub-system (i.e. delinking it from the rest of the system) given its positive and fairly strong integration with other sectors.

CONCLUSION

In this paper, we analysed the inter-industrial linkages of the agricultural sector and the Malaysian economy within the framework of input-output analysis. For this purpose, we constructed an extended version of an input-output table, accounting for detailed agricultural sub-sectors in the economy. Using this extended input-output table, backward and forward linkages were calculated by applying the hypothetical extraction method. These analyses allowed us to quantify the importance of the agricultural sector to economic growth and its relationship with other production sectors.

The linkage analyses show that the agricultural sector in general has a lower degree of economic integration with the rest of the economy. Backward and forward indices for the agricultural sector are lower than the average of the economy; however, this does not imply lower importance of the agricultural sector to Malaysian economic growth. The lower linkages are mainly determined by its size – that is, the agricultural sector has a far smaller share of national output. Due to its lower production of output, the agricultural sector demands a lower share of intermediate inputs from the rest of the economy, and as a consequence it has a lower degree of integration compared to other large sectors. Thus, our results tend to suggest that the agricultural sector's contribution to Malaysian economic growth is fairly important. The main contribution of the agricultural sector is through forward linkages, in which output of this sector is in high demand from other sectors, in particular manufacturing.

It is fair to mention here our main limitations. This study only examines the inter-industrial linkages of output growth for the agricultural sector. We do not measure the relative contribution of the agricultural sector from other perspectives, such as on GDP or poverty. Growth in domestic-driven sectors like the agricultural sector may contribute relatively more to national GDP than growth in the manufacturing sector (a sector that is commonly associated with higher leakages because it relies heavily on imported input). Similarly, it is well documented that the agricultural sector has a greater relative impact on poverty eradication than its observed share in the economy. Modelling for GDP and poverty, however, would require massive amounts of additional data, and we consider such analyses beyond the scope of this study .

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APPENDIX 1

Agricultural sectoral breakdown

MSIC	Input-output table (120 sectors)	Input-output table (134 sectors)
01111	Paddy	Paddy
01113, 01114	Food crops	Growing of sugar cane & tapioca
01131		Growing of cocoa
01132, 01133		Growing of tea & coffee
01136		Growing of pepper
01137		Growing of coconuts
01121	Vegetables	Vegetables
01134	Fruits	Growing of pineapples
01135, 01138, 01139		Other Fruits (Banana, Durian & other fruits)
01115	Rubber	Rubber Estate
01116		Rubber Smallholdings
01117	Oil palm	Oil Palm Estate
01118		Oil Palm Smallholdings
01129	Flower plants	Flower plants
01112, 01119, 01400, 01300	Other agriculture	Other agriculture
01212	Poultry farming	Poultry farming
01211	Livestock	Cattle farming
01213		Pig farming
01219		Other livestock farming
02001	Forestry and logging	Logging (except rubber wood logging) .
02002, 02003, 02004		Collection of rattan and other jungle produce
02005		Bird's nest collection
02006, 02009		Rubber wood logging & Forest services n.e.c.
05001	Fishing	Ocean and coastal fishing.
05002, 05009		Inland fishing & Fishing n.e.c.
05003		Aquaculture.