

Identifying Key Sectors of Malaysian Economy: A Comparison of Unweighted and Weighted Approaches

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Abstract

This paper presents the results of the study on the identification of the key sectors of the Malaysian economy using the Rasmussen unweighted and weighted approaches. The backward linkage, which is based on Leontief demand-driven model and forward linkage, based on Ghosh supply-driven model, were applied to the Malaysian input-output tables for the years 1983, 1987, 1991 and 2000 using 58 aggregated sectors. The sectors with both the backward and forward indices greater than one were classified as key sectors. The unweighted approach looks from the perspective of technical linkages, while the weighted approach looks from the perspective of structural changes. From the results obtained, it is found that both approaches tend to analyse the economy differently.

Keywords: Input-Output tables; backward and forward linkages; key sectors

INTRODUCTION

The most common procedure in understanding the economic structure of a country is to analyze the input-output (I-O) tables. The I-O tables portray the macroeconomic activities as a system of interrelated goods and services as well as the structural changes in the economy. It also provides the necessary tools to evaluate the industries and the relationships to the rest of the economy and the effects of international trade (Jiemin Guo and Planting, 2000). The input-output analysis and the derivation of linkage indices were initially proposed by Leontief (1936). He considered the various economic sectors as a series of inputs of source materials (or services) and outputs of finished or semi-finished goods (or services). Rasmussen (1956) then developed the procedures for measuring inter-industry linkages using the inverse of Leontief I-O tables that takes into account both the direct and indirect effects of an increase in the output of an industry. Rasmussen's backward and forward linkages are known as *power of dispersion index* and *sensitivity of dispersion index*, respectively. Chenery and Watanabe (1958) proposed using the column (or row) sums of the input coefficient matrix to calculate backward and forward linkages. However, this measure only captures direct effects and leaving out indirect impacts.

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The inter-industry linkages procedure describes the interdependencies between economic sectors with the purpose of identifying “key sectors” of a country’s economy in the formulation of economic development strategies. Oyamada (1999) defined a key sector as a sector whose growth will promote or generate growth in other sectors via its technological linkage. He further stated that growth impulses generated by a key sector encourages the expansion of other sectors in two ways: (1) as a user of inputs from other sectors (backward linkage); (2) as a supplier of inputs to other sectors (forward linkage). Key sectors are those that have values of both backward and forward linkages above the corresponding average. For comparability purposes, the linkage indicators are normalized, such that their average equals one. If backward indices and forward indices of sectors are greater than one, then these sectors can be classified as key sectors. Hirschman (1958) proposed that since the key sector is supposed to drive the economy towards increased sectoral interdependence and income levels, therefore, investment in the key sectors should promote a country’s general economic development.

Over the years, the methodological framework of Rasmussen improved and expanded in its applications. Alternative analytical methods were proposed for the measurement of inter-industry linkages, such as those by Hazari (1970), Jones (1976), Laumas (1976), Cella (1984), Sonis *et al.* (1995) and Dietzenbacher and Van Der Linden (1997). Incidentally, each has its own advantages and disadvantages. Hazari (1970) recommended that the relative importance of each sector in terms of final demand and primary input (value added) can be considered by incorporating a weighting scheme into backward and forward measures. Jones (1976) criticised Rasmussen’s measures of forward linkage which used the row sum of the Leontief inverse as a measure of forward linkages, symmetrical to that provided by the column sum for backward linkages. Instead, he suggested using the row sum of the output inverse matrix derived from the output coefficient matrix to measure the forward linkages. In measuring the backward and forward linkages, Laumas (1976) commented on the work of Yotopoulos and Nugent (1973) who used unweighted index which assumed that all industries are of equal importance. Alternatively, he suggested that the indices should be weighted based on a given sector share in the final demand or value added. Cella (1984), on the other hand, proposed a total linkage effect based on the hypothetical extraction method (HEM) in which he decomposed the total linkage effect into backward and forward linkages. The HEM measures the effect of a sector by extracting their coefficients from the input (or output) coefficient matrix. It measures the importance of the sector in the total economy from which it is completely extracted (Miller & Lahr, 2001). As a modification of Cella’s measure of inter-industry linkages, Sonis *et al.* (1995) introduced the concept of pure linkages, a modification of Cella’s measure of inter-industry linkages. This was later revised by Dietzenbacher and Van Der Linden (1997) by measuring the backward and forward linkages separately using a non-complete extraction method. According to Midmore *et al.*, (2006), although there have been improvements and expansion in I-O analysis, the standard

procedures in assessing inter-industry linkages are in fact, based on methods developed by Rasmussen (1956) and Chenery and Watanabe (1958).

In this study, the Rasmussen weighted and unweighted approaches were used to identify the key sectors of the Malaysian economy using the non-competitive I-O tables of 1983, 1987, 1991 and 2000. This paper discusses the methodology and the data used followed by the findings and conclusion.

METHODOLOGY

The inter-industry linkages are focused on demand and supply relationship with other industries that have the maximum effects on the total economy. In this context, the work of Rasmussen is widely used in identifying key sectors in the economy (Sonis *et al.*, 1995; Andreosso-O'Callaghan and Yue, 2004; Temurshoev, 2004; Aydin, 2007). Linkage measures are generally derived from the input-output table as shown in Table 2.1.

Table 2.1: Framework of an Input-Output Table, Industry by Industry

		Intermediate Demand	Final Demand	Total Output
		Sector j ($j=1, \dots, n$)		
Intermediate Input	Sector i ($i=1, \dots, n$)	x_{ij}	F_i	X_i
Primary Input		V_i		
Total Input		X_i		

Table 2.1 displays the industry by industry I-O framework. For each sector i , the value of total production or output (X_i) is the sum of the intermediate demand (x_{ij}) and final demand (F_i) and this relationship can be represented as;

$$X_i = \sum_{j=1}^n x_{ij} + F_i \quad (2.1)$$

where, X_i is the total output i

x_{ij} is the intermediate input of sector i to j

F_i is the final demand

In the input-output analysis, the input coefficient provides valuable information on the input structure for a specific industry, i.e., the inputs that a specific industry purchased to be used in the production process. The term input coefficient refers to the quantity of inputs required from each industry to produce one dollar's worth of a given industry's output. The proportions in which different inputs enter the production process of a particular industry are assumed to be constant over time. The input coefficient can be presented as follows;

$$a_{ij} = \frac{x_{ij}}{X_j} \quad (2.2)$$

where, a_{ij} is the input coefficient of sector i to sector j
 x_{ij} is the intermediate input of sector i to sector j
 X_j is the total input for sector j

Since x_{ij} is the input of sector i required by sector j , thus, $a_{ij}X_j$ is the total unit of input i required to produce X_j units of good j .

By replacing the x_{ij} in equation (2.1) by $a_{ij}X_j$ as in equation (2.2), we obtain the following equation;

$$X_i = \sum_j a_{ij} X_j + F_i \quad (2.3)$$

which can be expressed in the matrix form as follows,

$$X = AX + F$$

and re-written as

$$F = (I - A)X \quad (2.4)$$

or

$$X = (I - A)^{-1}F \quad (2.5)$$

where, X is a column vector of total output i.e., $X = [X_1 \ X_2 \ \dots \ X_n]$
 F is a column vector of final demand i.e., $F = [F_1 \ F_2 \ \dots \ F_n]$
 A is an $(n \times n)$ matrix of input coefficient, a_{ij}
 I is the $(n \times n)$ identity matrix, and
 $(I - A)^{-1}$ is called the "Leontief inverse"

The Leontief model is a demand-oriented economic input-output model which was introduced by Wassily Leontief in 1936. It was originally created to study the degree of inter-industry linkages among various industries and is assumed that the economy consists of n inter-industry economic sectors. The $(I - A)^{-1}$ gives the direct and indirect material requirements per unit of final output of a sector. Ghosh (1958) formulated the supply driven model that relates sectoral output to primary inputs. The primary inputs consist of value-added component. It is an alternative to the Leontief demand oriented I-O model and is commonly used to find forward linkages of sectors of an economy (Temurshoev, 2004). The Ghosh model is based on the assumption of fixed output coefficients (allocation coefficients) which is the direct supply matrix.

The output coefficient can be defined as;

$$b_{ij} = \frac{x_{ij}}{X_i} \quad (2.6)$$

where, b_{ij} is the output coefficient of sector j to sector i

x_{ij} is the intermediate input of sector j to sector i

X_i is the total output of sector i

The total input for industry j is the sum of intermediate demand (x_{ij}) and value added (or primary input) (V_j) as follows,

$$X_j = \sum_{i=1}^n x_{ij} + V_j \quad (2.7)$$

$\sum_i x_{ij}$ is the amount sector i supplies to all sectors in the economy as inputs in their production process.

By replacing the x_{ij} in equation (2.7) by $b_{ij}X_i$ as in (see equation 2.6), we obtain the following equation;

$$X_j = \sum_j b_{ij}X_i + V_j \quad (2.8)$$

which can be expressed in the matrix form below

$$X' = X'B + V \quad (2.9)$$

or written as

$$X' = (I - B)^{-1}V \quad (2.10)$$

where, X' is a column vector of total input ($X'_1, \dots, X'_n$)

V is a column vector of primary input ($V_1, \dots, V_n$)

B is a $(n \times n)$ matrix of output coefficient, b_{ij}

I is the $(n \times n)$ identity matrix

$(I - B)^{-1}$ is called the "Ghosh inverse"

Based on both the Leontief and Ghosh inverse matrices, a measure of the strength of the backward and forward linkages is then calculated. The backward linkages are based on the demand-driven model and forward linkages are on the supply-driven model. Backward linkage is defined as the amount by which sector j production depends on inputs from other sectors. This is given by the sum of the elements in the j^{th} column of the Leontief inverse matrix and known as the *output multiplier*. Similarly, a measure of the forward linkage (supplier of inputs to other sectors) of sector i is given by the sum of the elements in the i^{th} row of

the Ghosh inverse matrix. This is termed as the *input multiplier* (Miller *et al.*, 1985). Detailed discussions of the weighted and unweighted approaches for calculating Backward Linkage (BL) and Forward Linkage (FL) are given in the following sections.

The Rasmussen Unweighted Approach

Rasmussen (1956) proposed the use of the column sums of the Leontief inverse, $(I - A)^{-1}$, to measure the *backward linkages*. The backward linkages represent the total input requirements for a unit increase in the final demand for the j^{th} sector and is defined as:

$$\begin{aligned} BL_j &= \sum_{i=1}^n k_{ij} \\ &= B_{\bullet j} \end{aligned} \quad (2.11)$$

where, BL_j is the backward linkage of sector j of Rasmussen unweighted method

k_{ij} is the ij^{th} element of Leontief inverse matrix

$B_{\bullet j}$ is the sum of column elements in sector j and n is the number of sectors

Haji (1997) stated that the average $\frac{1}{n} B_{\bullet j}$ was interpreted by Rasmussen as “an estimate of all the direct and indirect increases in output to be supplied by an industry chosen at random if the final demand for the products of industry j is increased by one unit”. For inter-industry comparison purposes, the linkage indices are normalized in such a way that their average equals one. Rasmussen termed the backward indices as the *Power of Dispersion Index*. It describes the relative extent to which an increase in final demand for the products of a given industry is dispersed throughout the total system of industries. The Power of Dispersion Index is defined as:

$$U_j = \frac{\frac{1}{n} B_{\bullet j}}{\frac{1}{n^2} \sum_{j=1}^n B_{\bullet j}} \quad (2.12)$$

In the Ghosh supply driven model, the *forward linkages* represent the row sums of the elements of the Ghosh inverse matrix and is given as:

$$\begin{aligned} FL_i &= \sum_{j=1}^n g_{ij} \\ &= B_{i\bullet} \end{aligned} \quad (2.13)$$

where, FL_i is the forward linkage of sector i of Rasmussen unweighted method
 g_{ij} is the ij^{th} element of Ghosh inverse matrix
 $B_{i\bullet}$ is the sum of row elements in sector i

$B_{i\bullet}$ represents the total output of sector i in response to one unit increase in value added for sector j . This is known as *Sensitivity of Dispersion Index* and is defined as,

$$U_i = \frac{\frac{1}{n} B_{i\bullet}}{\frac{1}{n^2} \sum_{i=1}^n B_{i\bullet}} \quad (2.14)$$

The Rasmussen Weighted Approach

Hazari (1970), Jones (1976) and Laumas (1976) proposed using *weighting scheme* in the backward and forward linkages in order to remedy the deficiency of the method developed by Rasmussen in identifying key sectors. The weights for backward linkages are the share of sectors in final demand while the weights for forward linkages are the primary inputs (value added). The basic idea of a weighted average is to take into account the relative importance of each sector in terms of final demand or primary inputs.

Let the weight be based on final demand, and the weighted Leontief inverse elements be k_{ij}^w , then

$$k_{ij}^w = k_{ij} \frac{F_i}{\sum_{i=1}^n F_i} \quad (2.15)$$

where, k_{ij}^w is the weighted ij^{th} element of Leontief inverse matrix
 k_{ij} is the ij^{th} element of Leontief inverse matrix
 F_i is the final demand

Similarly, if the weight is based on value added, then

$$g_{ij}^w = g_{ij} \frac{V_j}{\sum_{j=1}^n V_j} \quad (2.16)$$

where, g_{ij}^w is the weighted ij^{th} element of Ghosh inverse matrix
 g_{ij} is the ij^{th} element of Ghosh inverse matrix
 V_j is the value added

Hence, the respective weighted backward and forward measures are given as:

$$BL_j^w = \sum_{i=1}^n k_{ij}^w \quad \text{and} \quad (2.17)$$

$$= B_{\bullet j}^w$$

$$FL_i^w = \sum_{j=1}^n g_{ij}^w \quad (2.18)$$

$$= B_{i\bullet}^w$$

Using the normalizing approach, the weighted backward and forward indices are respectively defined as:

$$U_j^w = \frac{\frac{1}{n} B_{\bullet j}^w}{\frac{1}{n^2} \sum_{j=1}^n B_{\bullet j}^w} \quad \text{and} \quad (2.19)$$

$$U_i^w = \frac{\frac{1}{n} B_{i\bullet}^w}{\frac{1}{n^2} \sum_{i=1}^n B_{i\bullet}^w} \quad (2.20)$$

DATA

The data used in this study represent the non-competitive Malaysia Input-Output Tables for the years 1983, 1987, 1991 and 2000. The non-competitive I-O Table segregates imports from domestic production in the compilation of the tables. Consistent with the rapid country's economic development experienced over the years, the numbers of sectors also increased from 60 in 1983 and 1987 to 92 in 1991 and 94 in 2000. Hence, for the purpose of consistency and comparability of data, in this study the sectors were reclassified and aggregated into 58 similar sectors in each of the years analysed (as shown in Table 3.1).

Table 3.1 : Reclassified sectors used in the study

No.	Sector	Abbreviation	No.	Sector	Abbreviation
1.	Rubber planting	RUB	30.	Cement, lime & plaster industries	CLP
2.	Oil Palm estates	OIL	31.	Other non-metallic mineral products	ONM
3.	Agriculture, other	AGR	32.	Basic metal industries	BMI
4.	Livestock breed. etc.	LIV	33.	Other metal industries	OMI
5.	Forestry and logging	FOR	34.	Manufacture of non-electric machinery	MNE
6.	Fishing	FIS	35.	Manufacture of electric machinery	MEM
7.	Mining and quarrying	MIN	36.	Manufacture of motor vehicles	MMV
8.	Meat and dairy production	MDP	37.	Manufacture other transport equipment	MOT
9.	Preservation of foods	PFO	38.	Other manufacturing	OMF
10.	Manufacture of oils and fats	O&F	39.	Electricity & gas production	EGP
11.	Grain mills	GRM	40.	Water works & supply	WWS
12.	Bakeries and confectionery	BCI	41.	Building and construction	BLC
13.	Other foods production	OFP	42.	Wholesale & retail trade	WRT
14.	Manufacture of animal feeds	MAF	43.	Hotels & restaurants	HRT
15.	Beverages production	BEI	44.	Transport	TRS
16.	Manufacture of tobacco	MFT	45.	Communication	COM
17.	Manufacture of textiles	MOT	46.	Financial institutions	FIN
18.	Manufacture wearing apparels	MWA	47.	Insurance	INS
19.	Sawmills	SAW	48.	Real estate, ownership of dwelling	ROD
20.	Manufacture of furniture & fixtures	MFF	49.	Business services	BUS
21.	Paper production & printing	PPP	50.	Education	EDU
22.	Manufacture of industries chemical	MIC	51.	Health	HEA
23.	Manufacture of paints & lacquers	MPL	52.	Private non-profit institution	PNI
24.	Other chemical industries	OCI	53.	Recreation, culture	REC
25.	Petrol & coal industries	PCI	54.	Repair vehicles	REV
26.	Rubber processing	RUP	55.	Other repair, cleaning	ORC
27.	Rubber industries	RUI	56.	Other private services	OPS
28.	Manufacture of plastic products	MPP	57.	Public administration defence	PAD
29.	China, glass & clay industries	CGC	58.	Other government institution	OGI

FINDINGS

The unweighted and weighted sectoral indices of backward and forward linkages are obtained by applying equations (2.12) and (2.14) and equations (2.19) and (2.20) respectively. The results of these analyses are shown in Table 4.1 for unweighted and Table 4.2 for weighted approach and Figure 4.1 to 4.4 provides further illustration of the results. Column 1 of both tables are the sectors for each of the years analysed and the values under each of the years are the resulting indices of backward linkages (U_j) and forward linkages (U_i). The values of the indices for all sectors in which both U_j and U_i are greater than one, are then identified as key sectors as shown under column Kr. The value of U_j greater than one, indicates that the sectors has a greater impact on the suppliers of the inputs. Likewise, for value of U_i greater than one, indicates that the sectors as suppliers has greater impact on the producers. Therefore, in order to compare the level of importance of each of the key sectors identified, they were ranked based on the values of U_j and U_i . The results are shown under column Kr for each of the years. The sector with the highest value is ranked 1.

Based on the values of the ranks of the indices obtained, it is found that in using the unweighted approach, the number of key sectors identified in 1983 were 15, in 1987 were 8, in 1991 were 11 and in 2000 were 15. However, in the weighted approach, the number of key sectors found in years under review were different. In 1983 and 1987 there were 17 key sectors while in 1991, the number was 15 and in 2000 it was 11. The Manufacture of oils and fats sector was ranked 1 for each years using the unweighted approach. However, in using the weighted approach, the rank dropped for all the years. Similarly, Manufacture of animal feeds sector which ranked 2 in the unweighted approach in 1983, 1987 and 1991, was not even qualified to be a key sector in the years studied using the weighted approach. On contrary, the Wholesale & retail trade sector which ranked among the highest in all the years by using the weighted approach was not even identified as a key sector using the unweighted method. Similar pattern was also observed for Building of construction sector.

The Building and construction, Wholesale & retail trade and Mining and quarrying sector were ranked as the highest in the year 1983, 1987 and 1991. The Manufacture of electric machinery sector was the prominent sector in 1991 and 2000 indicating structural change has taken place in the economy as reflected in the weighted approach.

The Manufacture of oils and fats sector showed consistency in rank for all the years under study in the unweighted approach. This shows that Manufacture of oils and fats sector is demand and supply driven which provide high impact to the economy.

Table 4.1: Backward Indices, Forward Indices and Key Sectors using Rasmussen Unweighted Approach

SECTOR	No.	1983			1987			1991			2000		
		U_j	U_i	Kr	U_j	U_i	Kr	U_j	U_i	Kr	U_j	U_i	Kr
Rubber planting	1	0.73	1.00		0.71	1.19		0.73	1.22		0.70	1.24	
Oil Palm estates	2	0.79	1.46		0.82	1.43		0.72	1.46		0.83	1.65	
Agriculture, other	3	0.76	1.07		0.80	1.04		0.82	0.99		0.82	1.10	
Livestock breed. etc.	4	1.27	1.07	9	1.28	1.06	6	1.38	1.04	6	1.39	1.07	4
Forestry and logging	5	0.82	0.98		0.74	1.00		0.73	1.01		0.77	1.17	
Fishing	6	0.73	0.95		0.77	0.93		0.85	0.96		1.03	1.07	15
Mining and quarrying	7	0.78	1.06		0.73	1.06		0.75	1.04		0.71	1.01	
Meat and dairy production	8	1.57	0.81		1.58	0.83		1.53	0.81		1.38	1.03	6
Preservation of foods	9	1.27	0.72		1.25	0.76		1.30	0.74		1.28	0.92	
Manufacture of oils and fats	10	1.84	1.22	1	1.76	1.25	1	1.74	1.23	1	1.88	1.43	1
Grain mills	11	1.13	0.94		1.18	0.94		1.14	1.05	9	1.18	1.17	7
Bakeries and confectionery	12	1.29	0.70		1.30	0.72		1.25	0.69		1.09	0.79	
Other foods production	13	0.98	0.89		1.01	0.90		0.99	0.91		1.18	1.02	12
Manufacture of animal feeds	14	1.09	1.61	2	1.11	1.77	2	1.02	1.74	2	0.93	1.70	
Beverages production	15	1.05	0.76		1.03	0.78		1.04	0.77		1.09	0.88	
Manufacture of tobacco	16	0.88	0.67		1.00	0.71		1.01	0.75		0.88	0.67	
Manufacture of textiles	17	1.18	0.98		1.03	0.94		0.93	0.84		1.00	0.89	
Manufacture wearing apparels	18	0.96	0.77		0.91	0.73		0.87	0.69		1.01	0.75	
Sawmills	19	1.15	1.02	14	1.18	0.95		1.27	0.84		1.18	0.84	
Manufacture of furniture & fixtures	20	1.23	0.73		1.20	0.74		1.18	0.76		1.11	0.77	
Paper production & printing	21	0.92	1.37		0.95	1.34		0.91	1.38		1.01	1.21	11
Manufacture of industries chemical	22	0.95	1.25		1.07	1.07	8	0.95	0.96		1.20	1.10	8
Manufacture of paints & lacquers	23	1.04	1.41	4	0.99	1.09		0.94	1.20		1.20	1.04	10
Other chemical industries	24	1.06	1.02	15	1.03	0.95		0.98	0.91		0.96	1.02	
Petrol & coal industries	25	1.06	1.26	10	1.15	0.99		1.30	1.23	4	1.03	1.14	13
Rubber processing	26	1.29	0.69		1.28	0.71		1.33	0.74		1.33	0.76	
Rubber industries	27	1.04	0.93		1.09	0.93		1.06	0.82		0.97	0.94	
Manufacture of plastic products	28	0.96	1.08		0.90	1.13		1.01	1.05	11	0.91	0.82	
China, glass & clay industries	29	1.03	1.15	12	0.98	1.15		0.96	1.15		1.01	1.11	14
Cement, lime & plaster industries	30	1.04	1.40	5	0.99	1.50		1.07	1.52	3	1.09	1.56	2
Other non-metallic mineral products	31	1.07	1.31	7	1.06	1.36	4	1.14	1.34	5	1.16	1.31	3
Basic metal industries	32	1.12	1.06	13	1.14	1.23	5	1.06	1.20	7	0.93	1.13	
Other metal industries	33	1.04	1.21	11	1.04	1.26	7	1.06	1.05	10	1.00	1.25	9
Manufacture non-electric machinery	34	0.96	1.04		0.98	1.02		0.94	1.21		0.80	0.91	
Manufacture electric machinery	35	0.86	0.73		0.80	0.69		0.89	0.77		0.81	0.70	
Manufacture motor vehicles	36	0.84	0.80		0.92	0.84		0.94	0.88		1.00	0.95	
Manufacture other transport equipment	37	0.82	0.83		0.95	1.10		0.89	0.89		0.87	0.73	
Other manufacturing	38	0.94	0.83		0.88	0.77		0.90	0.95		1.00	0.94	
Electricity & gas production	39	1.08	1.31	6	0.85	1.32		0.98	1.37		0.88	1.39	
Water works & supply	40	1.04	1.41	3	0.93	1.17		0.97	1.27		1.02	1.42	5
Building of construction	41	1.13	0.71		1.17	0.75		1.06	0.72		1.05	0.71	
Wholesale & retail trade	42	0.89	1.00		0.90	1.05		0.88	1.08		0.78	1.25	
Hotels & restaurants	43	1.21	0.97		1.19	1.00		1.14	0.92		1.11	0.96	
Transport	44	0.90	1.11		0.92	1.04		0.99	1.05		1.02	0.97	
Communication	45	0.75	1.17		0.75	1.16		0.83	1.21		0.81	0.97	
Financial institutions	46	0.82	0.74		0.84	0.74		0.83	0.75		0.77	0.72	
Insurance	47	0.88	1.34		1.12	1.36	3	1.03	1.21	8	0.86	0.78	
Real estate, ownership of dwelling	48	0.74	0.88		0.75	0.91		0.73	0.93		0.76	0.90	
Business services	49	0.83	1.40		0.82	1.39		0.92	1.42		0.85	1.08	
Education	50	0.73	0.64		0.76	0.66		0.78	0.66		0.77	0.64	
Health	51	0.89	0.65		0.88	0.67		0.87	0.66		0.81	0.65	
Private non-profit institution	52	0.99	0.63		0.87	0.64		0.94	0.63		1.18	0.70	
Recreation, culture	53	1.00	0.77		0.92	0.82		0.82	0.79		0.94	0.73	
Repair vehicles	54	1.01	1.35	8	0.99	1.37		0.95	1.41		0.90	1.17	
Other repair, cleaning	55	0.80	1.14		0.89	1.08		0.96	1.07		0.97	0.87	
Other private services	56	0.87	0.66		0.91	0.66		0.74	0.65		0.98	0.92	
Public administration defence	57	0.87	0.66		0.87	0.68		0.98	0.66		0.91	0.67	
Other government institution	58	1.03	0.67		1.05	0.66		1.05	0.71		0.91	0.68	

Note: U_j - Backward Indices (Power of Dispersion Index) Kr -Key sector and rank

U_i - Forward Indices (Sensitivity of Dispersion Index)

Table 4.2: Backward Indices, Forward Indices and Key Sectors using Rasmussen Weighted Approach

SECTOR	No.	1983			1987			1991			2000		
		U_j	U_i	Kr	U_j	U_i	Kr	U_j	U_i	Kr	U_j	U_i	Kr
Rubber planting	1	1.24	1.01	16	1.31	0.64		0.64	0.25		0.23	0.07	
Oil Palm estates	2	1.33	1.14	14	1.24	1.19	17	0.99	0.80		0.95	0.54	
Agriculture, other	3	1.17	1.21	15	1.28	1.39	15	0.96	1.00		0.62	0.49	
Livestock breed. etc.	4	0.90	0.87		0.89	0.95		0.88	0.75		0.69	0.43	
Forestry and logging	5	1.29	1.43	11	1.57	1.92	9	1.31	1.30	11	1.12	0.72	
Fishing	6	0.93	0.93		0.66	0.74		0.72	0.43		0.95	0.36	
Mining and quarrying	7	3.51	4.54	3	3.23	3.96	2	2.70	3.38	4	3.19	3.47	2
Meat and dairy production	8	0.93	0.80		0.92	0.78		0.87	0.49		0.68	0.24	
Preservation of foods	9	0.88	0.22		0.76	0.24		0.86	0.20		0.84	0.16	
Manufacture of oils and fats	10	1.59	3.15	4	1.39	2.95	6	1.27	2.44	7	1.29	1.89	8
Grain mills	11	0.80	0.50		0.88	0.48		0.68	0.25		0.50	0.14	
Bakeries and confectionery	12	0.79	0.29		0.86	0.36		0.81	0.27		0.54	0.21	
Other foods production	13	0.53	0.49		0.61	0.52		0.56	0.36		0.75	0.34	
Manufacture of animal feeds	14	0.59	0.08		0.58	-0.05		0.53	-0.05		0.36	0.02	
Beverages production	15	0.55	0.29		0.50	0.28		0.58	0.23		0.51	0.17	
Manufacture of tobacco	16	0.52	0.45		0.66	0.51		0.55	0.24		0.37	0.12	
Manufacture of textiles	17	0.76	0.61		0.65	0.70		0.61	0.72		0.70	0.57	
Manufacture wearing apparels	18	0.48	0.40		0.50	0.68		0.55	0.71		0.63	0.66	
Sawmills	19	1.11	1.14	17	1.32	1.57	13	1.29	1.27	12	1.04	0.74	
Manufacture of furniture & fixtures	20	0.73	0.12		0.74	0.15		0.80	0.24		0.82	0.64	
Paper production & printing	21	0.69	0.37		0.67	0.49		0.75	0.45		0.81	0.64	
Manufacture of industries chemical	22	0.81	0.81		1.66	1.59	11	1.00	1.39	14	1.16	1.22	11
Manufacture of paints & lacquers	23	0.61	0.03		0.61	0.09		0.52	0.08		0.71	0.11	
Other chemical industries	24	0.65	0.32		0.66	0.36		0.64	0.35		0.76	0.46	
Petrol & coal industries	25	1.77	1.73	8	2.10	1.46	8	2.20	0.90		2.05	2.29	5
Rubber processing	26	1.22	0.95		1.33	1.51	14	0.78	0.63		0.48	0.23	
Rubber industries	27	0.70	0.45		0.75	0.52		0.77	0.70		0.68	0.52	
Manufacture of plastic products	28	0.54	0.27		0.52	0.33		0.71	0.51		0.76	0.87	
China, glass & clay industries	29	0.76	0.15		0.68	0.14		0.73	0.19		0.88	0.29	
Cement, lime & plaster industries	30	0.87	0.06		0.69	0.05		0.74	0.04		0.85	0.04	
Other non-metallic mineral products	31	0.79	0.06		0.73	0.06		0.88	0.08		0.99	0.07	
Basic metal industries	32	1.76	1.30	9	1.41	0.95		1.15	1.16	15	0.75	1.09	
Other metal industries	33	0.80	0.34		0.72	0.24		0.83	0.59		0.64	0.27	
Manufacture non-electric machinery	34	0.69	0.44		0.67	0.54		0.60	0.06		0.69	0.57	
Manufacture electric machinery	35	1.09	2.76	7	1.21	4.21	4	2.08	8.95	1	3.68	17.08	1
Manufacture motor vehicles	36	0.49	1.40		0.64	0.70		1.21	2.23	8	0.84	1.25	
Manufacture other transport equipment	37	0.32	0.38		0.46	0.26		0.70	0.40		0.62	0.39	
Other manufacturing	38	0.56	0.21		0.55	0.39		0.65	0.33		0.80	0.28	
Electricity & gas production	39	1.31	0.76		1.10	0.80		1.14	0.54		1.32	0.60	
Water works & supply	40	0.61	0.04		0.50	0.14		0.44	0.14		0.69	0.06	
Building of construction	41	2.48	6.28	1	1.77	4.52	3	2.21	5.31	3	1.81	3.28	4
Wholesale & retail trade	42	3.48	4.95	2	3.20	4.57	1	3.89	4.74	2	3.25	2.01	3
Hotels & restaurants	43	1.13	1.36	13	1.07	1.39	16	1.16	1.50	10	1.11	1.56	9
Transport	44	1.66	2.55	6	1.84	3.08	5	1.78	2.73	5	1.62	2.50	6
Communication	45	0.53	0.41		0.71	0.62		0.75	0.57		1.31	1.22	10
Financial institutions	46	0.99	1.07		1.24	0.12		1.34	0.21		2.04	0.44	
Insurance	47	0.44	0.35		0.63	0.38		0.61	0.42		0.70	0.44	
Real estate, ownership of dwelling	48	1.50	1.54	10	1.56	1.78	10	1.86	2.06	6	1.68	1.63	7
Business services	49	0.86	0.28		0.80	0.35		0.91	0.36		0.99	1.04	
Education	50	1.30	1.41	12	1.42	1.68	12	1.18	1.29	13	1.02	0.97	
Health	51	0.75	0.67		0.77	0.76		0.72	0.58		0.60	0.53	
Private non-profit institution	52	0.50	0.01		0.29	0.01		0.47	0.01		0.77	0.02	
Recreation, culture	53	0.81	0.64		0.53	0.41		0.55	0.51		0.72	0.36	
Repair vehicles	54	0.56	0.09		0.59	0.09		0.71	0.07		0.60	0.09	
Other repair, cleaning	55	0.22	0.02		0.29	0.02		0.53	0.02		0.77	0.02	
Other private services	56	0.39	0.13		0.47	0.17		0.22	0.09		0.47	0.12	
Public administration defence	57	1.66	2.85	5	1.59	2.27	7	1.44	1.82	9	0.98	1.03	
Other government institution	58	1.07	0.86		1.02	0.98		0.98	0.68		0.64	0.44	

Note: U_j - Backward Indices (Power of Dispersion Index)

Kr - Key sector and rank

U_i - Forward Indices (Sensitivity of Dispersion Index)

Figure 4.1 : Sectors' of Backward and Forward Indices, 1983

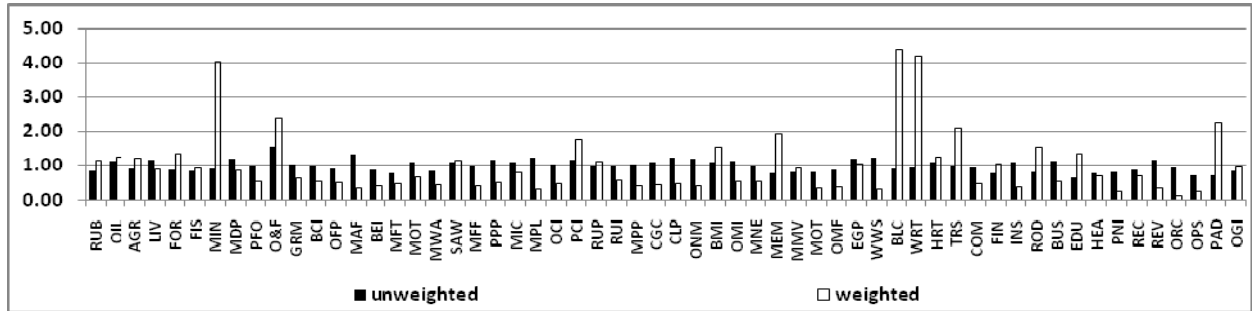


Figure 4.2 : Sectors' of Backward and Forward Indices, 1987

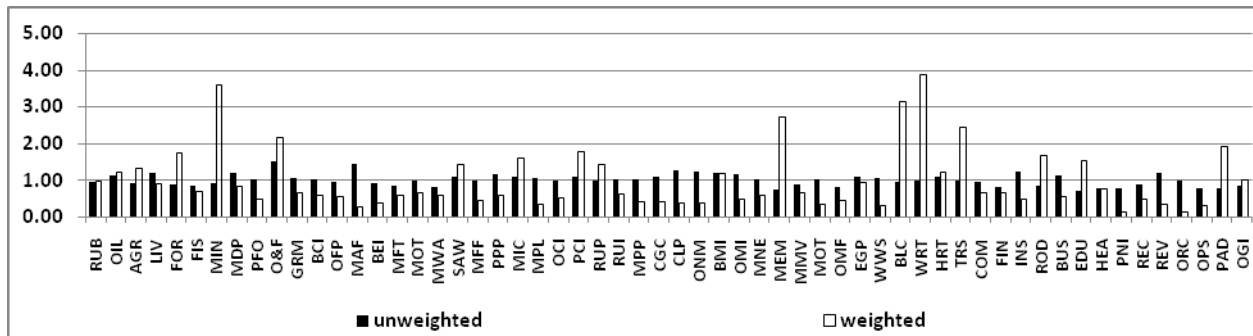


Figure 4.3 : Sectors' of Backward and Forward Indices, 1991

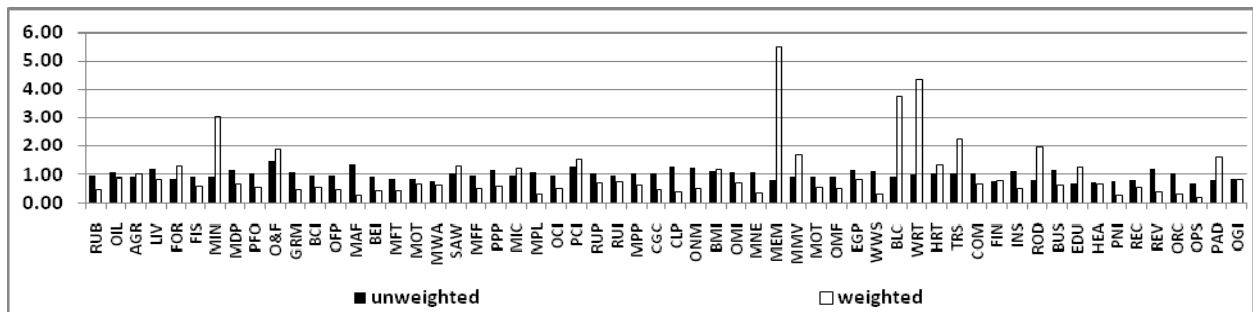
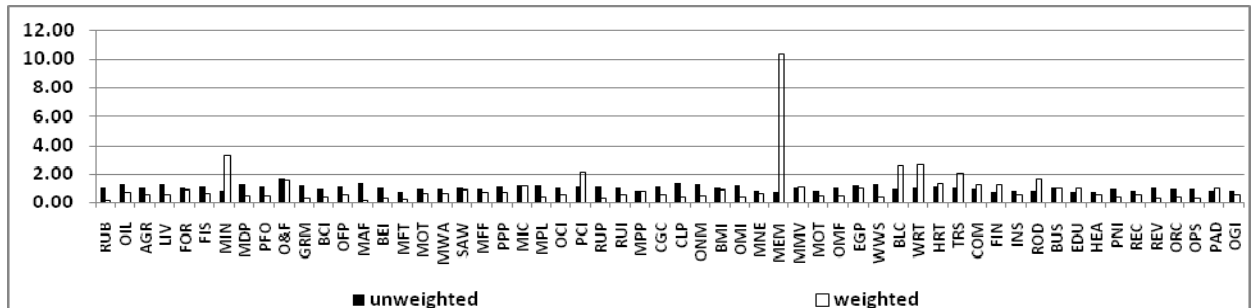


Figure 4.4 : Sectors' of Backward and Forward Indices, 2000



CONCLUSION

The study over the four selected years indicated that the technical linkages were observed in Manufacture of oils and fats sector due to its high dependence on oil palm, petrol and coal and agriculture sectors as provider of intermediate inputs. Thus, the application of unweighted approach suggested by Rasmussen is the appropriate approach to identify the technical linkages in the economy.

The Mining and quarrying sector ranked among the highest in the years studied. The significance of the sector as the supplier to the manufacturing sector and also to the external sector. This is in line with the emergence of Oil and gas sector in the 1980s. The Manufacture of electric machinery sector strengthen its position in the 1991 and 2000 due to the increase in external demand for E&E products. These two sectors implied that the Malaysian economy has undergone structural change from the traditional to industrial sector. The weighted approach recommended as plausible method in discerning the structural change in Malaysian economy.

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