4.0 Methodology

4.1 Introduction

This chapter describes methodology used in this study based on input-output analysis in the Malaysian case, analytical framework, data analysis technique, the advantages of input-output table, source of data and the sector aggregation.

Relatively recent studies adopting the input output approach include those by Kubo (1985), Mohommad Alauddin (1986), Abdul Aziz (1987), Nor'ini Harin (1991), Steven G Cochrane (1990) and Sangeeta Dhawan and K K Saxena (1992), which stem from Leontief (1931). Basically the methodology used in this study modifies the approach used by Abdul Aziz (1987) and Nor'ini Harin (1991). This method overcomes some of the weaknesses of alternative models due to its ability to depict the importance of strategic sectors in economy, particularly in applied analysis.

In order to evaluate the contribution and impact of investment in telecommunication and construction in Malaysia, the concept of direct and indirect final demand will be employed to examine the degree and level of structural interdependent among the sectors.

4.2 Input-Output Analysis In Malaysia

The fraction of analytical and empirical work using input-output methodology in Malaysia is relatively small. This situation arises because of several reasons, such as the recent development of input-output studies which use international linkages in Malaysia, the lack of expertise and outdated nature of inputıut table. However, regardless the above constraints Malaysia still managed to ıpile the input-output data in the mid of 1960s. The national Accounts Division of Department of Statistics was assigned to construct a series of inter-industry tables West Malaysia economy.

This signified preliminary efforts by Department of Statistic to ıstruct the input-output framework on national accountings based on the United tion's System of National Account (SNA). Subsequently, in the following years, partment of Statistics started to construct and publish Malaysia's input output les for the year of 1970, 1983 and 1987.

Analytical Framework

There are two types of interdependence in the system of economy e developed. Those are backward linkage and forward linkage. Before calculating e linkages, the input technical coefficients have to be computed. The technical fficients are derived by dividing quadrants I and III of the transactions table (table y the corresponding column totals

The formula as below :

$$a_{11} = x_{11} / X_1 \; ; \; a_{12} = x_{12} / X_2$$

In general :

$$a_{ij} = x_{ij} / X_j$$

i represent the number of the row and j is the number of the column that a fficient is located.

The above equation can be rewrite as :

$$x_{ij} = a_{ij} X_j$$

therefore : $x_{11} = a_{11}X_1, \quad x_{12} = a_{12}X_2 \ , \ x_{13} = a_{13}X_3$ (4.1)

The inter-industry technical coefficients (tables 5) in input output terminology is referred as the A matrix.

Table 5: Inter Industry Technical Coefficients

Sectors	Intermediate		Demand
	Agriculture (1)	Industry (2)	Services (3)
Agriculture (1)	a_{11}	a_{12}	a_{13}
Industry (2)	a_{21}	a_{22}	a_{23}
Services (3)	a_{31}	a_{32}	a_{33}

Table 6: Commodity flows by sector of origin and destination in symbolic terms

Input	Intermediate	Demand		Total Final Demand	Total Output
	Agriculture (1)	Industry (2)	Services (3)		
Agriculture (1)	x_{11}	x_{12}	x_{13}	Y_1	X_1
Industry (2)	x_{21}	x_{22}	x_{23}	Y_2	X_2
Services (3)	x_{31}	x_{32}	x_{33}	Y_3	X_3
All Primary Input	Z_1	Z_2	Z_3		
Total Inputs	X_1	X_2	X_3		

The linear equation of the above transaction (table 6) are as below:

$$X_1 = x_{11} + x_{12} + x_{13} + Y_1$$

$$X_2 = x_{21} + x_{22} + x_{23} + Y_2$$

$$X_3 = x_{31} + x_{32} + x_{33} + Y_3 \qquad (4.2)$$

Substituting equation (4.1) into equation (4.2) will obtain the equation as below :

$$X_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + Y_1$$

$$X_2 = a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + Y_2$$

$$X_1 = a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + Y_3$$

By transferring all the X's to the left had side and re-grouping will obtain the below equations:

$$(1-a_{11}) - a_{12}X_2 - a_{13}X_3 = Y_1$$

$$-a_{21}X_1 + (1-a_{22})X_2 - a_{23}X_3 = Y_2$$

$$-a_{31}X_1 - a_{32}X_2 + (1-a_{33})X_3 = Y_3 \qquad (4.3)$$

Equation (4.3) can be written in matrix form as below :

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & -a_{13} \\ -a_{21} & (1-a_{22}) & -a_{23} \\ -a_{31} & -a_{32} & (1-a_{33}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} \qquad (4.4)$$

ɔox in equation 4.4 containing the a_{ij}'s is referred only 3 x 3 matrix that is having vs and 3 columns. To simplify it may be written as (I-A). The columns of X's ľ's are called vectors that may be written as X and Y. The whole system may be en in abbreviated matrix form. Alternatively can be written as below :

$$(1-A)X = Y \tag{4.5}$$

where :

X = vector of gross output

A = vector of technical coefficients

Y = vector of final demand

equation (4.5) can be solved as below :

$$X = (I-A)^{-1}Y$$

$$= zY \tag{4.6}$$

where :

X = vector of gross output

$(1-A)^{-1}$ = z = vector of inverse matrix (1-A)

Y = vector of final demand

Each elements z_{ij} of z indicate the direct and indirect increase in the ut of industry i need to supply a unit increase of final demand for the product of stry j. Therefore, z measures the impact on supplier industries of an increase in demand. The Leontief inverse matrix table will be shown in appendix E.

4.3.1 Backward and Forward Linkages

The following step is the calculation of output backward and forward linkages. The backward linkage of a sector measures the extent to which that sector absorbs inputs from the system of industries. The forward linkage of a sector measures the extent to which that sector provides inputs for utilisation by other sectors.

The output backward linkages can be derived by dividing the column's averages set of sector no j (j=1,2……n) with the sum of column elements after dividing by $1/n^2$ sectors. The formula is given as below :

Backward linkage :

$$U_j = \frac{\frac{1}{n} Z_{.j}}{\frac{1}{n^2} \sum_{j=1}^{n} Z_{.j}} \qquad (4.7)$$

The forward linkage is almost similarly calculated by dividing the row's averages set of sectors no i (i = 1,2…… n) with the sum of row element after dividing by $1/n^2$ sectors. The formula is given as below :

Forward linkage :

$$U_i = \frac{\frac{1}{n} Z_{i.}}{\frac{1}{n^2} \sum_{j=1}^{n} Z_{i.}}$$

(4.8)

The backward and forward linkages according to Hirschman (1958) can be interpreted as below :

When $U_j > 1$ indicate sector j draws heavily on economy. Alternatively, indicate the impact of a unit increase in the final demand of sector j on the system will be big as compared to the sectors in general.

When $U_i > 1$ indicate sector i has to increase its output more that other sector for each unit increase in final demand. Alternatively, indicate the impact of a unit increases in final demand of sector i on the system of the of sectors will have greater repercussions compared to the sectors in general.

4.3.2 Variation Of Linkages

The variation is the degree of dispersion of linkages. The corresponding measures of relative variability is calculated by following formula below :

Backward variation :

$$V_j = \frac{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(z_{ij} - \frac{1}{n}\sum_{i=1}^{n} z_{ij}\right)^2}}{\frac{1}{n}\sum_{i=1}^{n} z_{ij}} \qquad (4.9)$$

Forward Variation :

$$V_i = \frac{\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(z_{ij} - \frac{1}{n}\sum_{j=1}^{n} z_{ij}\right)^2}}{\frac{1}{n}\sum_{j=1}^{n} z_{ij}} \qquad (4.10)$$

High value of V_j shows that a particular sector draws heavily on one or few sectors. Low V_j shows that the sector draws evenly to the rest of economy.

High value of V_i shows that one or few sectors use the output of sector i. Low V_i shows that sectors i supplier evenly to the other sectors.

4.3.3 Employment Generation

In order to have the employment generation linkages, employment-output coefficients have to be computed first. The employment-output coefficients are computed as below formula:

$$b = E_i / X_i \qquad (4.11)$$

Where :

E_i = employment for sector i

X_i = output for sector i

The direct and indirect employment requirements per unit of final demand will calculate as the following formula :

$$E = b\,(I-A)^{-1}$$
$$= bz \qquad (4.12)$$

Where :

b = sectoral employment-output coefficients

z = elements of the inverse matrix

By denoting the elements of matrix, E, as E_{ij} (i, j = 1,2 ....n).

The sum of column elements as below :

$$\sum_{i=1}^{n} E_{ij} = \sum_{i=1}^{n} b_i z_{ij}$$
$$= E_{.j} \qquad (4.13)$$

indicates the total employed which is required by jth sector per unit increase of jth final demand.

The sum of row elements :

$$\sum_{j=1}^{n} E_{ij} = \sum_{j=1}^{n} b_i z_{ij}$$
$$= E_{i.} \qquad (4.14)$$

indicate the increase in employment in sector i per unit increase in the final demand in all sectors

The backward employment generation is calculated by dividing the employment's column's average set with the sum of the column elements after dividing by $1/n^2$ sectors.

The formula is as below :

Backward Employment Generation :

$$EU_j = \frac{\frac{1}{n} E_{.j}}{\frac{1}{n^2} \sum_{j=1}^{n} E_{.j}} \qquad (4.15)$$

e forward employment linkages generation is similarly calculated by dividing the ployment row's average set with the sum of the row elements after dividing by $\imath^2$ sectors. The formula is given as below :

Forward Employment Generation :

$$EU_i = \frac{\frac{1}{n} E_{i.}}{\frac{1}{n^2} \sum_{j=1}^{n} E_{i.}} \qquad (4.16)$$

U$_j$ indicate the extent of employment generate in other sectors by the jth sector due a change in the jth final demand. EU$_i$ indicate the extent to which employment in e ith sector is affected by the increase in the final demand of all sectors.

The corresponding measures of relative variability will drive as formula ɛlow:

Backward variability :

$$EV_j = \frac{\sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(E_{ij} - \frac{1}{n} \sum_{i=1}^{n} E_{ij} \right)^2}}{\frac{1}{n} \sum_{i=1}^{n} E_{ij}} \qquad (4.17)$$

Forward variability :

$$EV_i = \frac{\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(E_{ij} - \frac{1}{n}\sum_{j=1}^{n} E_{ij}\right)^2}}{\frac{1}{n}\sum_{j=1}^{n} E_{ij}} \qquad (4.18)$$

This study's data are adopted from the Statistical Year Book that is published by Malaysia Statistic Department and the Economic Report 1999/2000 that is published by Ministry of Finance. The aggregate demand for consumption (C), public (G), change in stork (S), investment (I) and export (X) for year 2000 will able to be obtained from the Economic Report 1999/2000. Subsequently, the final direct and indirect output can be derived multiplying the final direct demand for each sector with the Leontief inverse matrix (I-A)–1.

In order to evaluate the impact of investment in telecommunication and construction sectors to the rest of economy, a modified demand vector was used to test the implication of increased investment in :

a. Telecommunication sector

b. SPRINT highway project.

4.4 Data Analysis Technique

The 1990 input-output table was keyed into and processed in Excel 97. All the mathematical calculation like calculating matrix, inverse matrix, structural linkages, variation of linkages and changes in final demand all are constructed by using the mathematical solving program available in the Excel 97 software. Data is processed from the aggregation of column and row values entries and division by column total. Processing of data is to generate fixed input coefficient.

Spearman and Pearson tests are used to evaluate the relationship of the linkages. Both tests are conducted by using the SPSS (Statistical Packages For Social Sciences) after the output and employment forward backward linkages were keyed into the SPSS worksheet. The correlation coefficient measures how much or how little two series of number move together or apart.

Some of the characteristics of Spearman and Pearson correlation coefficients are as below :

a. If there is no linear relationship between two variables the values of the coefficient is zero.
b. If there is a perfectly positive relationship the values is positive one (+1).
c. If there is a perfectly negative linear relationship the values is negative one (-1)

The value of the coefficient can range from positive one to negative one with a value of zero indicating no linear relationship.

4.5 Advantages of The Input-Output Table

The appropriateness and well suited of input-output tables in the analysis structural changes are because of the below three advantages:

a. Consistency of data in the input-output table

Input-output tables include all the formal market place activity that occurs in an economy. The tables also includes those services which usually hard to define. By the way, some countries use more than hundred different data sources in order to ensure the completeness and internal consistency of the data. The purpose is to obtain the most comprehensive and complete source for economic data to most countries. Therefore, input output tables frequently play a fundamental role in the construction of national accounts. This means that the data are not only thoroughly checked for their accuracy but the tables are also intrinsically linked with many traditional indicators of economic performance such as production and GNP.

b. The nature of input-output analysis enables it to analyse the economy as an interconnected system of industries, tracing structural changes back through industrial interdependence

When the production processes become increasingly complex, it will involve interaction of many different businesses at the various stages of a product's processing. The input-output techniques will trace these linkages from the raw material stage to the sale of the products as a final finished good. This allows the decomposition analysis regarding the fact that a decline in domestic demand for a sector will not only affect the sector's output but also its suppliers sector and so on.

c. Decomposition of structural changes and identification of sources of changes from direction and magnitude of change.

The input-output analysis includes the description of changes in producer's recipes. The producer's recipes describe how industries are linked to one another, in input-output language called "technology" of the economy. Thus, the input-output analysis enables changes in output to be linked with underlying changes in factor such as exports, imports, domestic final demand and technology. This will allow a consistent estimation of generating output and employment growth. The input-output techniques also shown how the macroeconomic phenomena corresponding to microeconomic changes

4.6 Sources of data

The primary source of statistical data used in this study obtained mainly from secondary source provided by Department of Statistics of Malaysia the Malaysian 1987, 96 sectors input-output tables, that has been updated to 1990 using the bi-proportional rating or RAS method by Yap (1998).

4.7 Sectoral Aggregation

The aggregation of 1990 (30 x 30) input-output table follows the classification of 1987 (60 x 60) input-output tables. In this study classification is based on the 1990 input-output table prepared by Yap (1998). Sectors in 1990 (30 x 30) input-output table classify are based on the similarity and interdependency of activities and commodities among the sectors (table 7) which was prepared by Yap (1998).

4.8 Conclusion

This chapter explained the techniques used to calculate the intersectoral linkages for output, employment linkages and the final direct and indirect demand in order to analyses the structural interdependence in Malaysia. This chapter also explained the advantages of input-output system as the proper way to analyses the structural interdependence linkages.

Table 5 Sectoral Aggregation for the 1990 Input-Output Table.

New Sector No	Classification According to the 1990 Input Output tables (30 x 30)	Original sector No	Classification According to the 1987 Input Output Tables (60 x 60)
1	Other Agriculture	1 4	Agriculture, Others Livestock Breeding etc
2	Rubber Planting	2	Rubber Planting
3	Oil Palm Estates	2	Oil Palm Estates
4	Forestry and Logging	5	Forestry and Logging
5	Fishing	6	Fishing
6	Mining and Quarrying	7	Mining and Quarrying
7	Manufactured Oils and Fats	10	Manufactured Oils and Fats
8	Food Processing	8 9 11 12 13 14	Meat, dairy production Preserved food Grain mills Bakeries, confect industry Other food production Manufacturing animal feed
9	Beverages and Tobacco	15 16	Beverage industries Manufactured tobacco
10	Textiles And Wearing Apparel	17 18	Manufacturing of textiles Manufacturing wearing apparel
11	Wood-based Industry	19 20 21	Sawmills Manufacturing furniture and fixtures Paper products and printing
12	Chemicals	22 23 24	Manufacturing Industrial Chemicals Manufacturing paints and lacquers Other Chemical industries
13	Petroleum Products	25 26	Petroleum, coal products Manufacturing plastic products
14	Rubber Products	27 28	Rubber processing Rubber industries
15	Non-metallic Products	29 30 31	China, glass, clay industries Cement. lime, plaster industries Other non-metallic mining products
16	Metallic	32 33	Basic metal industries Other metal industries
17	Non-electrical Machinery	34	Manufacturing non-electrical machinery

Source : Yap (1998)

Table 5 Sectoral Aggregation for the 1990 Input-Output Table

New Sector No	Classification According to the 1990 Input Output Tables (30 x 30)	Original Sector No	Classification According to the 1987 Input Output Tables (60 x 60)
18	Electrical Machinery	35	Manufacturing electrical machinery
19	Motor Vehicles and Transport Products	36 37	Manufacturing motor vehicles Manufacturing other transport equipment.
20	Other Manufacturing	38	Other manufacturing
21	Electricity and Gas Products	39	Electricity and gas products
22	Waterworks and Supply	40	Waterworks and supply
23	Building, Construction	41	Building , construction
24	Wholesale and Retail Trade	42	Wholesale and retail trade
25	Transport and Communication	44 45	Transport Communication
26	Hotels and Restaurants	43	Hotels and restaurants
27	Business Services	46 47 48 49	Financial Institutions Insurance Real estate, owner-occupied dwellings Business services
28	Professional Services	50 51 52	Private education Private health Recreation, culture
29	Personal Services	53 54 59 60	Repair vehicles Other repair, cleaning Private, non profit institutions Other private services
30	Government Services	55 56 57 58	Public administrations, defense Government education Government health Other government institutions

Source : Yap (1998)