Chapter 4

Methodology of Study

4.1 Introduction

The study will be concentrated on analysis namely the Total Factor Productivity (TFP) and factors that would determine TFP growth. The study will be presented in a comprehensive form with the aid of simple analysis tool such as tabular presentation and charts.

4.2 Theoretical Framework

The theoretical framework developed by Jorgenson et. al (1987) is employed to derive the indices of output, inputs and technical change. It is assumed that capital and labour inputs, as well as time are separable from intermediate input, such that productivity growth will only occur through value added. While there are several methods that can be used for computing TFP, estimates of the TFP at the different sub-sector level in RBIs are computed using growth accounting approach based on the available of data.

The production function for the ith RBIs is given by:

$$Y_i = F_i(K_i, L_i, T),\ i = 1,2,.....n,\ (1)$$

Where Y_i = value added, K_i = capital input, L_i = labour input, and T = time (denotes the technology changes).

The shares of capital input and labour input, $\{v^i_K\}$, and $\{v^i_L\}$ in the value of output by

$$v^i_K = \frac{p^i_K K_i}{q_i Y_i}, \text{ and } v^i_L = \frac{p^i_L L_i}{q_i Y_i} \qquad (1a)$$

Where $\{q_i\}$, $\{p^i_K\}$ and $\{p^i_L\}$ denotes the prices of outputs (value added) and capital, and labour inputs respectively. Since the variables of prices of inputs and output are not observable, therefore for convenient, the necessary conditions for producer equilibrium are given by equalities between the shares of each inputs in the value of output and the elasticities of output with respect to that input.

Totally differentiating (1) with respect to time and assuming conditions of producer equilibrium and constant returns to scale (CRS)[1], one obtains:

$$\frac{d\, lnY_i}{d\,T} = v^i_K * \frac{d\, ln\, K_i}{d\,T} + v^i_L * \frac{d\, ln\, L_i}{d\,T} + v^i_T, i = 1,2,\ldots,n. \quad (2)$$

Where;

$$v^i_K = \frac{d\, lnY_i}{d\, lnK_i} = \frac{p^i_K K_i}{q_i Y_i} \text{ or elasticity of output with respect to capital (K),} \quad (2a)$$

$$v^i_L = \frac{d\, lnY_i}{d\, ln\, L_i} = \frac{p^i_L L_i}{q_i Y_i} \text{ or elasticity of output with respect to labour (L),} \quad (2b)$$

$$v^i_T = \frac{d\, ln\, Y_i}{d\,T} \text{ defined as the rate of factor productivity growth,} \quad (2c)$$

[1] Producer equilibrium is given by equality between the share of each input in the value of output and the elasticity of output with respect to that input. Furthermore, under constant returns to scale, the elasticity and the value share for both inputs sum to unity.

Under constant returns to scale the elasticities and the value shares for all three inputs sum to unity and under condition for producer equilibrium, the value of output is equal to the sum of the values of capital and labour inputs:

$$q_i Y_i = p^i{}_K K_i + p^i{}_L L_i, \qquad (i = 1,2,....n) \quad (2d)$$

Since the production function is separable in capital K_i and labour L_i, therefore the output Y_i can be represented as a function of aggregate input, say W_i:

$$Y_i = F^i\,[W_i\,(K_i, L_i), T], \qquad (3)$$

Where aggregate inputs is independent of the level of technology T. Now the production function F^i is *homothetically separable* in these inputs if aggregate input W_i is homogeneous of degree one. Under constant return to scale, the production function is homogeneous of degree one in input W_i, so that productivity growth is *Hicks neutral* and the function can be rewrite in the form

$$Y_i = A_i(T).\ W_i(K_i, L_i) \qquad (3a)$$

Since the productivity growth is *Hicks neutral,* the rate of productivity is independent of capital and labour inputs and depends only on time:

$$v^i{}_T = \frac{d\ln A_i(T)}{dT} \qquad (3b)$$

The equation (2) can be transformed into translog equation and become:

$\ln Y_i = v_K^i \ln K_i + v_L^i \ln L_i + v_T^i$ (4)

The equation (4) above need to estimates first before calculating of TFP can be conducted. From equation (4), the TFP can be calculated as the residual of growth after deducting the contribution of K and L. Then the equation becomes:

$v_T^i = \ln Y_i - v_K^i \ln K_i - v_L^i \ln L_i$ *(5)*

For any two discrete points of time, T and (T-1), the growth rate of output can be disintegrated into a weighted (i.e. value shares) of the growth rates capital and labour inputs, and the rate of productivity growth, v_T^i becomes;

$$v_T^i = [\ln Y_i(T) - \ln Y_i(T-1)] - v_K [\ln K_i(T) - \ln K_i(T-1)] - v_L [\ln L_i(T) - \ln L_i(T-1)] \quad (6)$$

or

$$v_T^i = \ln[Y_i(T) / Y_i(T-1)] - v_K \ln[K_i(T) / K_i(T-1)] - v_L \ln[L_i(T) / L_i(T-1)] \quad (7)$$

Thus the estimate of the TFP is essentially the residual that is obtained after subtraction from the rates of growth of output and the rates of average growth of inputs such as capital and labour input. The equation (7) is easily to define since all data needed for TFP estimation is observable.

4.3 Limitation of Study

As in any other studies conducted, limitations are inevitable. For this study, some of limitations are identified as follow.

4.3.1 Limitation of Model

The estimation of TFP using Cobb-Douglass function with constant elasticity of scale (CES) and notably the assumption of Hicks-neutral parameter will induce some implication of final value of TFP. According to Sudit (1984), the usage of such common Cobb-Douglas function in estimating TFP with standing properly to the assumption of CES, without any explicit treatment of or reference to the underlying problems of the aggregation of the components outputs will thus resulting an asymmetric TFP measures and subject to possible aggregation bias.

Therefore the Cobb-Douglass production function $Y_i = F_i(K_i, L_i, T), i = 1,2,.....n$ will then estimates the same outcome as stated earlier. The aggregation problems as mentioned by Star (1974), Sudit (1984) and Oulthon and O'Mahony (1994) as part of the major concerned in describe data validity will be discussed in the following section.

4.3.2 Limitation of Measurement

4.3.2.1 Measurement of Output

The use of value added in this research would give biased TFP growth results if intermediate inputs are not at least weakly separable from non-material inputs (Lin and Virabhak, 1998). To the extent that intermediate inputs are relatively a major concern in the manufacturing industries, therefore the measurement of TFP would bias the results. In estimating TFP for sectoral and industrial groups, there is disagreement between using the gross output or the value added figures. Gross output measures all measurable inputs (capital, labour, materials and energy) as sources of income. In contrast, the value added specification allocates the origin of output to the services of two conventional factors of production, capital and labour. Accordingly, value added is defined as gross value of output minus the value of purchased materials and service inputs (Maisom, 1998). However, two problems affect the use of 'value added in constant prices'. This is because the components of value added (rents, profits, net interest and depreciation) all change at different rates over time. Secondly, the actual output produced by sector and its value added component may move in different directions over time.

4.3.2.2 Measurement of Capital

The usage of value of fixed assets instead of net value of fixed assets as a main source of capital input in this research have rise issue of inaccuracy of final value for TFP measurements. The use of net value of fixed assets by many Malaysian economist (Maisom, 1998), has gained some attention from established researchers. However in this research, the contribution of human capital has been totally neglected. Therefore once again the prescribe estimation of TFP value will be biased.

4.3.2.3 Measurement of Labour

Labour contributes a significant role in estimating the TFP in many productivity studies conducted. The complete distinguished of labour source for the purpose of the study has been neglected due to the summation between citizen and non-citizen labour in RBIs. However, skills of labour were also neglected. Therefore when labour is measured as the number of employees or workers, then unmeasured fluctuations in work efforts and differences in productive capacities of different categories of workers will results in biases in TFP estimates (Maisom, 1998).

4.4 Source of Data and Measurement

This research involved 17 years observation started in 1981 to 1997 using neoclassical framework namely the Cobb-Douglas production function. Data is taken from various publication of Department of Statistics (DOS), Malaysia, namely Annual Survey of Manufacturing Industries started in 1981 until 1997. All data used in this research are in nominal values and no efforts taken to make any changes of the data. Therefore the available aggregate data suffer in terms of some measurement errors as well as quality and composition of output and input mix within each sub-sector.

4.4.1 Value Added

Data on value added in this research is calculated by extracting value of gross output minus cost of input. Several DOS publication has already calculated the value added while some other not. Therefore efforts to calculate value added only involved several years especially data in early 80s. Data on value added is in RM million.

4.4.2 Capital Input

Data on capital input is a proxy data of fixed assets owned by the industries as at 31st December each year. Therefore some measurement errors still occurred especially in estimating the parameter. Data on capital (fixed assets) is in RM million.

4.4.3 Labour Input

Labour input used in the model is a total numbers of persons engaged in the typical industries during December or the last pay periods, including all types workers namely unskilled, semi-skilled and skilled workers in the industries. Therefore once again bias estimators for each parameter cannot be avoid.

4.5 Statistical Package

Model estimation and hypothesis testing for the purpose of analysis is using E-views version 1.0.

4.6 Estimation Step and Procedure

Based on Jorgenson *et. al* model, firstly an aggregate estimation of TFP for all RBIs will be conducted using estimated equation (4). This will therefore give an overview explanation of TFP growth in RBIs by using two-input model encompassing value added, capital and labour. Then TFP growth for 14 RBIs (3-digits levels) will be conducted as a second step using the same estimation procedure and finally followed by 61 industries in broad categories (5-digits levels).

4.7 Determinants Factor of TFP Growth

In this research, factor that would determine TFP growth will also be conducted using multiple regression equation models for the periods 1982-1997. The multiple regressions will only conducted for 3-digits level of RBIs since secondary data for the selected variables is not available to perform a similar test for 5-digits levels. The estimation model is using Ordinary Least Squared (OLS) methods.

The multiple regression model proposed is as follow.

$TFP_i = F^i\ (+Gy_i, +Gexp_i, +Gw/l_i, -Gcvar_i)$

Or $TFP_i = \alpha_0 + \alpha_1 Gy_i + \alpha_2 Gexp_i + \alpha_3 Gw/l_i - \alpha_4 Gcvar_i + \varepsilon_i$

Where	TFP	total factor productivity growth estimated from equation (5)
	Gy	growth of value added
	Gexp	growth of exports
	Gwl	growth of wage per unit labour
	Gcvar	growth of capital-value added ratio,

The plus-minus sign beside of each the explanatory variable exhibits that the selected explanatory variables are hypothesized with positive or negative relationship with dependent variable (TFP). The explanations of each explanatory variable are discussed below.

4.7.1 Explanation of explanatory variables

4.7.1.1 Value added growth

Growth of value added is expected to leave positive impact on TFP, as the value added increase TFP growth would increase through the technological process. Since there is not clear mechanism on what extant it operates, but theoretically the technology advancement effect would improve over time.

4.7.1.2 Exports growth

Since competitiveness is one of the important factors in product development, therefore to further explain the competitiveness in RBIs, exports data is the best ever to become a proxy of the competitiveness. Larger export (growth per year) implies greater competitiveness that facilitates the industry's adoption of more efficient techniques of production, leading to faster growth of TFP.

4.7.1.3 Wage per unit Labour

Wage per unit labour (w/L) for the RBIs industry is another important factor that would explicitly contributes to TFP growth. Obviously, wage per unit labour is look as a signaling to the industry (employer) of effective cost involved directly to the industry as well as incentives for workers to work harder. As wages per unit labour increase, TFP would increase as the workers now become more productive (incentive effect) and at the same time the industry operates optimally (labour cost effective).

4.7.1.4 Capital-to-value added Ratio (CVAR)

Capital-to-value-added ratio (CVAR) is another important factor that influence TFP growth. Since technology advances (through technological transfer) in industry are determined by the number of investment received, therefore CVAR is the proxy data of capital utilization gained by the industry. This ratio is refers to the amount of capital (investment) required to produce one additional unit of output. Which means CVAR and TFP growth has inverse relationship. The lower the CVAR, the higher the TFP growth since CVAR now is deflated by value-added growth.