CHAPTER 3

METHODOLOGY

This chapter presents the definition and measurement of TFP. The limitations of the study are also covered in this chapter.

3.1 Defining Total Factor Productivity (TFP)

TFP stands for the **intangible gains in productivity** not accounted for by increased labor and capital. TFP represents the share of output attributable to innovation and other influences that enhance the productivity of those inputs.

Basically, it is a measurement of efficiency. It measures the efficiency of the utilization of both capital and labor. Higher TFP growth indicates efficient utilization of inputs necessary for the production of goods and services.

The fundamental relation in productivity measurement is the production function:

$$\mathbf{Y = A\ f(K,L)}$$

where Y = output or GDP

K = capital (building, equipment, machine, etc)

L = labor (number of people working)

A = TFP (a higher value of A means that the same inputs lead to more output)

A that enters in this fashion is known as Hicks-neutral*.

This function says that we get higher output for three reasons:

a) more capital to work with (higher K)

b) more people are working (higher L)

c) K and L are used more productively (higher A, a catchall category)

*If A enters in the form of Y = F(AK, L), AK = effective capital, A is capital-augmenting
If A enters in the form of Y = F(K, AL), AL = effective labor, A is labor-augmenting

At the national level, TFP growth reflects the portion of the growth in the GDP that is not explained by the growth in inputs such as employment and capital investment.

3.2 Measuring Total Factor Productivity (TFP)

There are many ways of measuring TFP, but the method used in this research is R. Solow's geometric measure. Solow's measure is based on the Cobb-Douglas production function with constant returns to scale and neutral technological change.

The equation that computes the sources of production growth uses an aggregate production function as the starting point, assuming that the aggregate production function exists and is specified accurately, and the inputs are properly measured and homogeneous:

$$\mathbf{Y = f(K, L)} \quad \text{-----------------------------------} \quad (1)$$

where Y = output or GDP

K = capital

L = labor

Assuming the technical progress is both neutral and disembodied (Solow, 1957), the production function (1) can be express as:

$$\mathbf{Y = A\, f(K, L)} \quad \text{-----------------------------------} \quad (2)$$

where A = TFP

Solow's measure is based on the Cobb-Douglas production function:

$$\mathbf{Y = A\, K^{\alpha} L^{\beta}} \quad \text{-----------------------------------} \quad (3)$$

Assuming the parameters of the production function remain fairly constant over time. Under the assumption of constant returns to scale, the parameters satisfy the restriction : $\alpha + \beta = 1$.

where α = elasticity of output with respect to K

β = elasticity of output with respect to L

or equivalently, assuming perfect competitive, the share of each input in total factor payments.

Therefore, growth in aggregate output is

$$dY/Y = dA/A + \alpha\, dK/K + \beta\, dL/L \qquad \text{------------- (4)}$$

where dX/X represent the percentage rate of change of variable X over the period considered.

In practice, we know all the terms but A, which we compute as a residual. TFP change can then be expressed as the residual of growth of output after deducting the contributions of K and L.

$$dA/A = dY/Y - \alpha\, dK/K - \beta\, dL/L \qquad \text{------------- (5)}$$

Since income share data are not available, α and β are estimated directly using a simple production function: regress annual log output growth on log capital growth and log labor growth, constraining their coefficients to sum to unity[8] (i.e. specifying the production function to be Cobb-Douglas).

$$\ln [Y(t)/Y(t-1)] = TFPG + \alpha \ln[K(t)/K(t-1)] + \beta \ln[L(t)/L(t-1)]^{*} \qquad \text{---------- (6)}$$

where $\alpha = 1 - \beta$

With little change, we can use this to account for growth in output per labor, Y/L. Given the structure of the production function, this can be written as

$$Y/L = A\,(K/L)^{\alpha} \qquad \text{------------------------------ (7)}$$

[8] Method used in the World Bank study

* property: the logarithm of 1+x, where x is small, is approximately x [log(1+g) = g]

And growth decompose into

$$d(Y/L)/(Y/L) = dA/A + \alpha d(K/L) / (K/L) \quad \text{-----------------} (8)$$

What this says is that output per labor can rise for two reasons: because TFP (A) is increasing and because the amount of capital per labor (K/L) is increasing.

Since α are not available, it is estimated directly using a simple production function: regress annual log output per labor growth on log capital per labor growth.

$$\ln [y(t)/y(t-1)] = \text{constant} + \alpha \ln[k(t)/k(t-1)] + \text{error} \quad \text{---------------------} (9)$$

where y(t) = output per labor of current year

y(t-1) = output per labor of preceding year

k(t) = capital per labor of current year

k(t-1) = capital per labor of preceding year

Using the parameter estimated (α), TFPG can then be calculated as a residual of growth of output per labor after deducting the contribution of capital per labor.

$$TFPG = \ln [y(t)/y(t-1)] - \alpha \ln[k(t)/k(t-1)] \quad \text{--------------------------} (10)$$

3.3 Limitations of the Model

3.3.1 Problem of Production Function

The TFPG estimates are based on the particular specification of the neoclassical production function. It is worth noting that the assumption underlying neoclassical production function – namely constant returns to scale, perfect competition and long-run equilibrium with variability of all factor inputs are typically unsuitable for the estimation of a rapidly growing dynamic economy. A real economy is based on millions of interacting productive units and the technical mathematical conditions for aggregating those millions of separate activities into a single function are generally not fulfilled. The aggregate production function Y=Af(K,L) is of course merely a fable, not a real production process.

3.3.2 Problem of Interpreting

Through standard techniques introduced by Solow (1956), it is possible to decompose the contributions of K, L and A to overall changes in Y. Note that even if we can get a meaningful measure of changes in A, we still have the problem of interpreting such changes as due to policy reforms or technological improvements (assume the geographic and resource structure of the economy may not necessarily contribute much to changes in A).

3.3.3 Problem of Getting a Meaningful estimates of changes in A

Since it is calculated as the residual of the growth accounting exercises, what is labeled as TFP is actually a combination of errors in the data, omissions of other factors that should be included in the growth equation, as well as efficiency gains. As a result, there is a danger of reading too much into these data. Indeed, the residual has been referred to as a measure of our ignorance about growth.

Clearly, this procedure is fraught with error, in particular, since technical change induces capital accumulation. The coefficient on capital per labor will tend to overstate the elasticity of output with respect to capital input. Nevertheless, the results of this simple, back-of-the-envelope, computation is worth examining (Alwyn Young, 1994).

3.4 Data Sources

Secondary data on gross domestic product (GDP), capital and labor of Malaysia economy over the 1970 to 1999 period are obtained from Monthly Statistic Bulletin, published by Bank Negara Malaysia, and Economic Report (1970-1999), published by Ministry of Finance. Variables in value terms are deflated to 1990 price level using the consumer price index.

3.5 Definition

3.5.1. Gross Domestic Product (GDP)

GDP comprises of agriculture, forestry & fishing, mining & quarrying, transport, storage & communication, wholesale & retail trade, hotels & restaurants, finance, insurance, real estate & business services, government services & other services sector. GDP is measured in million of 1990 Malaysian Ringgit.

3.5.2 Capital

Capital is defined as gross fixed capital formation of private and public sector (e.g. capital goods, machinery for industry and transport equipment) plus a change in stocks. Capital is measured in million of 1990 Malaysian Ringgit.

3.5.3 Labor

labor is defined as all persons who, at anytime during the reference week did any work for pay, profit or family gains (as an employer, employee, own-account worker or unpaid family worker). Labor is measured in million of employed persons.

3.6 Computer Analysis

Using E-Views (version 1) to generate Ordinary Least Square (OLS) and some hypothesis testing.