PROSIDING PERKEM V, JILID 2 (2010) 392 – 420
ISSN: 2231-962X

ELASTICITY OF SUBSTITUTION AND ECONOMIC GROWTH

PUI KIEW LING

ABSTRACT

Purpose - This paper proposes that the relationship between factor substitution and rate of economy growth depends on the degree of substitutability and complementary between inputs in producing goods.
Theory - Elasticity of substitution is an important factor and positively in influencing economy growth in manufacturing sector in Malaysia.
Design/Methodology/Approach – Transcendental logarithm production function is recognized based on its variable elasticity of substitution. The elasticity of substitution of that production function is to be regressed with the rate of economy growth to examine the relationship between elasticity of substitution and economy growth. Then, the source of economy growth will be accounted to investigate how the economy growth could be increased by elasticity of substitution and factor endowment.
Findings –Supporting the de la Grandville Hypothesis, variable elasticity of substitution of manufacturing sector positively influences economy growth in Malaysia. Capital has been recognized to be the most important factor in influencing economy growth. So, capital accumulation for future investment needs to be encouraged for high factor substitution in the manufacturing sector. The high factor substitution in the manufacturing sector then could improve economy growth and reduce unemployment.
Orignality/Value – The economy growth is related with microeconomics perspective. Particularly, the rapid economy growth rate in Malaysia could be contributed significantly by manufacturing firm applying Transcendental Logarithm technology that posses high and variable elasticity of substitution.

Keywords: Elasticity of Substitution, Transcendental Logarithm production function, Economy Growth

INTRODUCTION

This paper intends to investigate how the elasticity of substitution of inputs in manufacturing industry could affect economy growth in Malaysia. Specifically, this paper examines how the inputs substitutability between capital and labour in the particular sector could affect production, unemployment, balanced growth path, steady state and economy growth.

Background of Study

In theory, elasticity of substitution plays an important role enhancing productivity and quality of input toward higher national economic growth. The productivity growth of Malaysia has been compared with other countries in below table.

This table shows that productivity growth in Malaysia is much lower than China by almost 5%. The productivity growth of Korea, Indonesia India and also Philippines is also higher than Malaysia. Thus, the productivity of inputs such as labour and capital needs to be improved through efficient factor substitution. For this purpose, Malaysia need to optimize the use of factor endowment in profitable industry based on the elasticity of substitution of that particular industry.

The productive input combination will produce output efficiently. The relationship between input and output could be illustrated in below figure.

Manufacturing sector has been recognized as the profitable industry based on its contribution towards economy growth. The significance of contribution of manufacturing sector for Malaysia can be recognized by comparing the contribution of this industry with other industries in gross domestic product.

Since manufacturing sector contributes significantly to gross domestic product in Malaysia, this industry is chosen to analyze how the steady state economy growth could be achieved. The importance of manufacturing sector also could be traced from the main export of Malaysia over time as shown in below table.

Since manufacturing sector significantly influences the gross domestic product in Malaysia, the manufacturing firms need to apply production function that has high and variable elasticity of factor substitution to produce output efficiently. High elasticity of substitution could help firm to produce output with efficient input combination. Thus, this study intends to look for an appropriate production function with high elasticity of substitution for the objective of sustainable economy growth.

Problem Statement

From Tables 2 and 3, the manufacturing sector clearly contributes significantly to gross domestic product in Malaysia. However, the annual change of gross domestic product at purchaser's value in Malaysia has fall to negative in year 2009. Below table shows the annual change of gross domestic product at purchaser's value from 2005 to 2009.

Since gross domestic product in Malaysia is contributed mainly by manufacturing industry, the low and negative annual change of gross domestic product need to be improved by changing the elasticity of substitution in that industry. To suggest, the manufacturing sector needs to apply production function with high elasticity of substitution to produce output efficiently.

In addition, many developing countries including Malaysia cause the "employment problem" by introducing policy that encourages capital-intensive techniques in production.

Analyzing Table 5, the unemployment in Malaysia keeps on increases over time. In year 2000, there is around 286,900 people unemployed in Malaysia. Then, the total amount of people unemployed increases by almost 50 percent in year 2009. Since increases in unemployment could slow down economy growth, the employment needs to be increased. Since Malaysia depends significantly on manufacturing sector, government could increase job in that industry in order to reduce unemployment.

To increase economy growth and unemployment, elasticity of substitution plays an important role. The extent of how economy growth could be increased and unemployment could be reduced depends on degree of factor substitution.

Objective

The overall objective of this paper is to investigate how the elasticity of factor substitution in manufacturing sector could affect economy of Malaysia. In order to reduce increasing unemployment and slow rate of economy growth, the specific objectives will be investigated include:

i. To recognize the suitable production function with high factor substitution.
ii. To examine the relationship between elasticity of substitution and economy growth.
iii. To recognize the important source of economy growth.

Based on the influence of elasticity of substitution in manufacturing sector on speed of convergence in achieving steady-state in Malaysia, the suitable policy will be designed. The proposed policy is suited with endowment and source of economy growth of that sector.

Hypothesis

Elasticity of substitution is an important factor and positively in influencing economy growth in manufacturing sector in Malaysia.

Significance of Study

This paper intends to investigate how the changes in factor price could affect production, balanced growth path, steady state and economy growth. The output will be produced efficiently with high and variable elasticity of substitution. Changes in factor prices of labor and capital, particularly nominal wage and rental rate will influence degree of factor substitutability. It will then change production of firm in order to produce profit-maximizing output that minimizing cost. If profit is maximized or cost is minimized, the output is said efficient. Since output is produced with investment in labor and capital; and investment of capital is a function of saving rate, the saving rate will influence the output level through the choice of capital per worker. The output will then influence the balanced growth path and economy growth. Thus, high elasticity of substitution is needed for rapid speed of convergence to achieve steady state in balanced growth path.

From microeconomics perspective, the changes in input price ratio will affect marginal rate of substitution between factors keeping output constant and then affecting slope of isoquant. It will also change elasticity of substitution, thus affecting curvature of isoquant. In formula, the effect of changes in input price ratio on degree of factor substitution can be traced through own price elasticity, cross price elasticity and Hicks Allen substitution particularly. The factor substitutability will then affect return to scale and cost share in production. Thus, an appropriate form of production functions with high elasticity of substitution for Malaysian manufacturing sector need to be recognized for growing economy.

Meanwhile, in the macroeconomics perspective, since production is a function of investment, the elasticity of substitution is related with changes in saving ratio. The optimal saving rate to produce steady state output capital accumulation can be obtained when consumption per worker is maximized. Output produced at this golden rule is the most efficient and maximized. So, changes in elasticity of substitution will directly contribute to changes in gross domestic product. Relate with Solow model, the elasticity of substitution that changes the steady state output per worker will then affect balanced growth path and economy growth. With the findings of this paper on possibility of capital-labor substitution, consistent production technology with its factor endowments is to be introduced to reduce unemployment in Malaysia.

Realizing the importance of high elasticity of substitution on economy growth, this study intends to study the appropriate technology for manufacturing firm in Malaysia to produce output. In most of the previous study including literature in Malaysia, elasticity of substitution is assumed to be constant by employing the data of labour and capital in Cobb Douglas and constant elasticity of substitution production function. Thus, to expand the past studies, the production function with flexible elasticity of substitution is to be investigated in this paper. The production function with the variable and high elasticity of substitution in manufacturing firm is proposed could fasten the speed of convergence to achieve steady state economy growth in Malaysia.

Organization of Study

The paper will be divided into five sections. The next section explains the theoretical background of production function, the model of economy growth and empirical studies to clarity the flow of thought of this paper. In third section, variable definition, data source and methodology to test the objective and hypothesis are explained. The result of empirically testing the methodology and the finding of the relationship between elasticity of substitution and economy growth is presented in the following section. In this section, the source of economy growth is also being recognized to examine how the elasticity of substitution in manufacturing sector could increase economy growth rate and reduce unemployment. Based on objectives and empirical results, several policy implication and suggestion are listed in last section.

LITERATURE REVIEW

Since production is a function of various combinations of inputs, the production of output will be influenced by capital accumulation through the choice of capital per worker. More output could be produced by incorporating knowledge in production to improve quality of labor and capital. So, output is contributed by both capital accumulation and technical change. The production of output will then influence the balanced growth path and economy growth.

Analytical Framework on Production Function

The objective to reduce unemployment can be begun with the study of the possibilities of substitution between factor inputs. Firm will choose combination of inputs that can achieve profit maximization and cost minimization. The choice of optimum input combination could be obtained when isoquant tangent with isocost line. From the profit maximizing process, profit maximizing competitive firm will pay their input based on their marginal product. It means labour is employed until marginal product of labour equals to real wage while capital is used until marginal product of capital equals to rental rate given a cost level.

As input price changes, firm will substitute cheaper factor for relative expansive factor. Firm will then change the combination of inputs in order to produce output that maximize profit or minimize cost. The change in input price will influence factor substitutability and input combination. The degree of factor substitution thereby will influence marginal product of input, marginal rate of technical substitution and elasticity of substitution. The increase of scale of inputs is said produce output efficiently if same output could be produced at the rate where marginal rate of technical substitution (MRTS) equals new ratio of input prices (w/v).

The influence of input price changes on factor substitution depends on form of production function since the degree of factor substitutability is different in each production function. It is because the substitution possibilities available to the industry are dependent on type of production technology. The possibility of substitution between inputs is described by elasticity of substitution. The possible form of high and variable production functions to be adopted by manufacturing industry include Variable Elasticity of Substitution (VES) production function and transcendental logarithm (translog) production function.

If changes in input price causes firm to substitute cheaper input for more expansive input significantly, the large factor substitution indicates large elasticity of substitution. It implies one input is relatively elastic to be substituted with another input when input price changes. If the elasticity of substitution is large, one input is easy to be substituted with another input. For example, even minor changes in price of labor will lead to substantial change in employment of labor. The elastic factor substitution fastens the effect of capital accumulation in achieving steady state in economy. It then strengthens the sustainability of economy growth in long run. Thus, elasticity of substitution is pivotal in economic growth and distribution of income.

However, if firm is less wiling to substitute cheaper input for more expansive input when input price changes, the small factor substitution indicates small elasticity of substitution. It implies that one input is difficult to be substituted for another input when input price changes.

On the other hand, if the marginal rate of technical substitution only causes little change in the input ratio, the small factor substitution will produce small elasticity of substitution. It implies the substitution between capital and labor is inelastic when input price changes. In small elasticity of substitution, one input is difficult to be substituted with another input. So, even substantial changes in price of labor will only lead to minor change in employment of labor. To restate, elasticity of substitution is large if one input is highly substitutble for another input. Meanwhile elasticity of substitution is small if one input is difficult to substitute another input when input price changes. Elasticity of factor substitution plays a crucial rule in economic growth. Since it is one of the determinants of the level of economic growth, it affects the speed of convergence towards the balanced growth path.

To stress, the different degree of factor substitutability will affect input combination, thus marginal product, output elasticity, return to scale, marginal rate of technical substitution, elasticity of substitution differently in each production function. It is due to the different availability of factor substitutability in different form of production function.

The possibility of changing elasticity of substitution along isoquant is due to changing price of input due to forces of demand and supply of inputs, which vary with economic development. The rapid growth of economy will change the demand and supply of labor and capital. Wage and rental rate will then differs than before economy develops. Thus, the degree of labour-capital substitution is varied along isoquant. The elasticity of substitution will change depends on factor such as the additions to the stock of capital, mobility of labour among sectors and substitutability and complementarily between labor and capital, thereby growth of economy.

Model/Theory

de la Grandville Hypothesis

de la Grandville Hypothesis proposes that elasticity of substitution is an potent explanatory variable for economic growth. Specifically, high elasticity of substitution between factors leads to rapid growing economy. Intuitively, the higher the elasticity of substitution, the more an economy would benefit in term of additional output from a change in input price. For example, decrease in price of capital will redistribute income in factor of capital and thus causes much substitution of capital for labor. Since cost share of labor is reduced now, the economies of scale will encourage firm to produce more. Higher production due to high elasticity of substitution leads to higher economy growth. Similarly, an increase in price of capital tends to lead to substitution of labor for capital. If elasticity of substitution is low, firm is inelastic to reduce factor cost of capital. The increased cost share of capital will cause diseconomies of scale and discourages production. Lower production due to low elasticity of substitution leads to lower economy growth.

It indicates that higher elasticity of substitution tends to associate with higher economic growth. It is because, with increased possibility to produce with greater factor combinations, firm will choose the most efficient factor combination to produce output. The cost minimizing and profit maximizing from the efficient factor combination is hypothesized to lead to high economic growth.

Conversely, lower elasticity of substitution tends to lower down economic growth. It is because, with fewer possibilities to produce output with greater efficient factor combinations, firm tends to produce output inefficiently with higher cost of production. Because the inefficient factor combination breaks down the cost-minimizing and profit-maximizing process of firm, low elasticity of substitution leads to slow economic growth.

Solow Model

Solow model basically is consistent with de la Grandville Hypothesis. The model proposes that elasticity of substitution positively affects economic growth. So, the significance of economic growth depends on elasticity of substitution. In fact, Solow (1956) is one of pioneer economists to relate elasticity of substitution with economic growth. The difference between this hypothesis and Solow model is that Solow relates elasticity of substitution and economy growth with the idea of capital accumulation.

In overall, Solow model studied how elasticity of substitution achieves steady state in economy. Increase in possibility of factor substitution is an important source of economic growth. Elasticity of substitution can alter the behavior of saving rate during the transition in the balanced growth path. It could be traced through changes in capital per worker in balanced growth path below.

The difference of production function and break-even investment or actual investment is consumption. Consumption is maximized when break-even investment intercepts with actual investment. In balanced growth path, steady state is achieved at capital per worker k_0 when break-even investment $(n+d)k$ equals to actual investment sy. If k is initially less than k_0, for example, k_1, firm will increase capital per worker since actual investment exceeds break-even investment. How much capital per worker can increase depends on factor substitution between capital and labor. If elasticity of substitution is high, firm tends to substitute capital for labor in large proportion. It is because marginal productivity of capital tends to increase in increasing rate at a given labor before steady state of capital stock is achieved. Increase in marginal product due to increase in capital stock will lead to increase in level of output and thus economic growth.

However, if elasticity of substitution is low, firm only can substitute capital for labor in small proportion. It is because capital is inelastic to be substituted for capital. Decrease in marginal product of labor due to large factor share of labor will lead to decline in output and thus economic growth.

The factor substitution will stop when the steady state capital per worker is achieved at point k_0. At this level of consumption, the capital used in the production is called golden rule of capital accumulation and the capital per worker is known as golden-rule level of capital stock. With the highest consumption is maximized at this point, golden rule of capital accumulation is achieved since marginal product of capital equals to sum of depreciation and population rate. At this point, the capital accumulation in production has achieved steady state in the economy through the substitution between capital and labor. Consistent with production theory, the degree of factor substitution in capital per worker depends on elasticity of substitution between factors. High elasticity of substitution would converge the economy to steady state faster compared to low elasticity of substitution.

When labor, capital and output grows at the steady state rate, the economy is said achieve balanced growth. In the steady state, capital accumulation to increase actual investment will increase output per worker and economy in level, but not in growth rate in the balanced growth path. It is because increase in the growth rate initially boosted by capital accumulation due to increased saving rate will decrease eventually by diminishing marginal returns of capital. Since capital growth depends negatively on the capital-output ratio, capital accumulation only can produce temporary increases the growth rate of output, but cannot achieve faster steady-state growth rate in economy. To increase level and growth rate in output per worker and economy, Solow model proposes to incorporate technical progress to improve quality of labor. Along that, more output can be produced with positive marginal productivity at a given amount of labor. So, only changes in the rate of technological progress can leave both level and growth effect in output per worker in manufacturing sector and economy growth in the long run.

Thus, the economy growth is caused by two forces: capital accumulation and technical progress. First, increases in capital move the economy along the production function. Greater capital will increase output. Secondly, technical progress shifts the production function upward. Even if capital did not increase, output will increase because the technological progress improves the quality of capital. Thus, elasticity of substitution is not only influenced by capital accumulation, but also technical change. Technical change improves the productivity of capital that is not captured by reported capital stock data. More output can be produced at the same level of labor and capital because both marginal productivity of labor and capital increase with quality of labor.

Mathematically, the source of economic growth can be quantified by Solow growth accounting. Particularly, the contribution of capital and labor in Solow model could be recognized from Solow accounting model. Solow accounting formula also can recognize the effect of total factor productivity on economy growth. It is captured by the portions of output growth that not explained by capital and labor. The unexplained change in output is defined as the technological change. The portion of output that explained by technical progress is called Solow residual. The Solow residual measures effect of technology change/shock on output.

Endogenous Growth Model

Changes in capital per worker can only affect level of output and consumption, not the growth rate due to depreciation rate and growing capital at existing level of worker. Here, the increase in capital per worker due to higher wage and substitution from expansive labor to relative cheaper capital will only cause zero growth rate in output and capital. It implies that economy growth is constant in long run, as shown in balanced growth path.

To explain sustainable long run economy growth, growth of output and consumption need to be changed. Since capital accumulation cannot induce economy growth although it increases level of output, employment and consumption, economy need to achieve higher "steady state" level of capital per worker and output per worker by incorporating technical progress in production. Economy grows by the rate of technical change over time.

In this model, technical change is the factor that causes output growth rate to increase. Without technical change, capital will only grow at population rate. After technical progress is incorporated, capital grows at the sum of population rate and technology growth. It implies that only the growth rate of technology can induce long run economy growth. So, country needs to improve education, knowledge, innovation, research and learning by doing to improve technical progress in production. With better research and development, more output could be produced even with the same amount of labor and capital. Through human capital investment, more advanced technology could be invented and innovated to increase economy growth with existing factor endowment of the particular country.

Overlapping Generation Model (Diamond Model)

Solow model has been improved by overlapping generation model. This model attempts to explain how capital accumulation could affect economy growth through elasticity of substitution by incorporating two periods of life in production. This model assumes firms are owned by households. So, household will decide how much labor and capital to be hired in order to achieve steady state in the economy. In the first period of life, individuals need to work and divide income between consumption and saving. When they get old in the second period of life, they will carry saving in the first period to become capital stock in the second period. In short, capital in second period is substituted with labor in first period. The decision of current consumption and future consumption depends on elasticity of substitution between capital and labor.

Before steady state of economy is achieved, household will increase saving in order to increase capital per worker in the future. For this purpose to be achieved, household will increase labor supply in this period and be substituted with higher capital per worker in the future. How much household increases labor supply and saving depends on elasticity of substation. If elasticity of substitution is high, more current consumption will be reduced in order to substitute for more future consumption. Increase in capital per worker in second period will cause economy to grow faster compared to high elasticity of substitution. So, the substitution between capital and labor this period and next period depends on elasticity of substitution this period.

Empirical Studies

To explain how the factor substitution could affect production function and thereby economy growth, previous literature has been reviewed and analyzed. There are many articles to extend Solow (1956) for empirical practice. One of them, Klump and Preissler (2000) has analyzed the relationship between elasticity of substitution and economic growth. Theoretically, the paper expanded the effect of elasticity of substitution on growth through three effects: threshold effect, effect on the level of steady state and effect on level of convergence. Applying the assumption of Solow neoclassical economy growth where investment to be equal to saving, constant rate of capital depreciation and rate of population growth in these three cases, it can be concluded that elasticity of substitution could affect long term economy growth rate positively. In first two cases, increase in elasticity of substitution will increase long-term rate of sustained growth and steady-state of capital per worker. Meanwhile in third case, change in elasticity of substitution changes speed of convergence depends on the relative scarcity of the factors of substitution. In the three cases, level of steady state is positively related with elasticity of substitution.

Arrow, Chenery, Minhas and Solow (1961) also extends Solow (1956) by proposing to linearize the Constant Elasticity of Substitution using logarithm form. Claiming the original Constant Elasticity of Substitution production function only emphasis the quantity of labor and capital accumulation in production, David and van de Klundert (1965) has proposed to incorporate the effect of technical progress in production. This effect will increase quality of labor and capital, thereby increasing more output without increase quantity of capital and labor.

There are several literatures to estimate factor substitution in production function. One of production function research is Zahid, Akbar and Jaffry (1992) with reference to manufacturing sector in Pakistan. The findings of inelastic capital-labour substitution, high capital intensity and slow technical change have reduced the possibility of changing capital intensity to more labour redundant in manufacturing sector in Pakistan. If government wants to reduce unemployment, technical change to increase the effectiveness of labour need to be incorporated in production. The increased quality of labour will then raise the possibility for capital to be substituted with labours.

The similar study has been adopted by Downes (1987) in manufacturing production in Bardados. Particularly, the labor demand function has been derived from cost minimizing Constant Elasticity of Substitution production function subject to a given targeted output. Although production function experienced return to scale, employment expansion in manufacturing sector was limited due to labour-saving technical change and low level of substitution parameter.

The possibility of factor substitution can influence return to scale in industries and economy growth. As studied by Chen (1977) with reference to Hong Kong manufacturing sector, manufacturing sector is recognized to suffer from decreasing return to scale in the estimated Cobb Douglas production. The lack of scale of economies in manufacturing sector, however, is not consistent with high elasticity of substitution between capital and labor estimated using linear Constant Elasticity of Substitution production function suggested by Arrow, Chenery, Minhas and Solow (1961). It can be interpreted that changes in factor price in Hong Kong manufacturing sector tends to lead to high factor substitution between capital and labor although inputs are less productive. The inefficiency in resource allocation in firm indicates that the major source of growth in manufacturing sector is technical progress, not economies of scale.

A study on time variation in the elasticities of factor substitution applying Variable Elasticity of Substitution production function has been examined by Wang (1995). Meanwhile, labour, capital and material inputs translog cost function had been applied to estimate the elasticities of substitution in Taiwan’s manufacturing sector. Translog cost function was also applied by Truett and Truett (1995) to investigate the existence of economies of scale and direct and cross price elasticities of demand for inputs in the Mexican petroleum industry.

Based on the theory that the elasticity of substitution and return to scale will influence economic growth of a country, several empirical comparison of elasticity of substitution in developed and developing countries have been done using both the time series and cross section data. The findings of the comparison are being cautious about technology importing since it can increase cost of production in developing countries. Instead of relying on technological progress from developed countries, developing countries should develop their own technologies, guided by their factor endowments. For this purpose, developing countries including Malaysia may encourage research and development, investment in human capital, learning by doing, education and knowledge spillover. This knowledge accumulation could increase effectiveness of labor and capital in promoting economy growth.

Specifically, Yuhn (1991) studied the relevance of size of elasticity of substitution between factors on economics factor comparing developed countries, United States and developing countries referred specifically to South Korea using Solow model. Supporting De La Grandville Hypothesis, elasticity of substitution is a significant factor of economic growth in South Korea, but not in United States. The growth rate of Korea real output tends to follow high elasticity of substitution between capital and labor. Fall in labor share due to technical change outpaces the rise in labor share due to high elasticity of substitution.

Meanwhile, the low factor substitutability of labor for capital in United States suggests the economy growth rate in United States depends on technological progress. It suggests that elasticity of substitution after change in input price in higher in Korea compared to United States. The factor substitution is inelastic in United States because government always distort wage to protect worker from unemployment. Worker is increasingly demanding larger factor share in production proportional to economic growth in United States. The subsequent conclusion is that both high growth and balanced growth is difficult to be achieved at the same time. Korean economy only achieves high economy growth while United States only in balanced growth with the backdrop of lackluster growth.

However, Miyagiwa and Papageorgiou (2003) has opposed the monotonic relationship between elasticity of substitution and factor substitutability with economy growth suggested by De La Grandville Hypothesis. Applying Diamond overlapping-generation model, high elasticity of substitution will decrease income per worker and economy growth in transit and in steady state. It is because an increase in wage income will raise substitutability of capital for labor and clearly decrease labor share. Decrease in income of labor will eventually decrease economy growth.

METHODOLOGY

The incorporation of production function in explaining economic growth motivates to study how exactly the elasticity of substitution influence economy growth does. For this purpose, elasticity of substitution in manufacturing sector in Malaysia will be recognized from Transcendental Logarithm production function to study the effect of relatively elastic factor substitution on economy growth. This production function is the most appropriate technology for flexible and high factor substitution and also efficient input combination. Secondly, the elasticity of substitution of the production function will be regressed with rate of economy growth to trace out how high and variable elasticity of substitution in manufacturing sector can affect economy growth. Intuitively, the regression analyzes the possibility of factor substitution in influencing the speed of convergence for promoting rapid economy growth and achieving steady-state in economy. Thirdly, the effect on labor, capital and technical change on economy growth will be examined through Solow Growth Accounting to recognize the source of economy growth. Based on the source, an appropriate price distortion policy will be recommended to improve the manufacturing sector. The contribution of this sector needs to be emphasized to promote rapid economy growth since manufacturing sector accounts for large percentage in Gross Domestic Product in Malaysia.

Variable Definition

Variables used in this paper include labour proxied by number of persons engaged as at 31st December or the last pay period, capital proxied value of assets owned as at 31st December (RM million), population, labour force, investment proxied by approved capital investment in the manufacturing sector (RM million) and output (Y) proxied by Gross Domestic Product in Current Price (RM Million)

Source of Data

The time series data of output, labor, capital and wage from 1970 to 2005 and data population and labour force from 1983 to 2005 are obtained from Department of Statistics, Malaysia. Meanwhile, the data of consumer price index and deposit rate from 1970 to 2005 are obtained from datastream. The data on approved capital investment in the manufacturing sector from 1983 to 2005 and Gross Domestic Product in Current Price are obtained from Central bank of Malaysia.

Transcendental Logarithm Production Function Estimation

Basically, the elasticity of substitution keeps on changing along isoquant in Transcendental Logarithm (translog) production function. It is because translog production functions exhibit more flexibility and variability in profit maximizing and cost minimizing subject to output compared to firm applying Cobb Douglas or Constant Elasticity of Substitution production function. From this production function, marginal product, marginal rate of technical substitution and elasticity of substitution will be obtained. If translog production functions yields high elasticity of substitution, this production function is suggested for manufacturing firm in Malaysia to produce output.

Assumes manufacturing industry only employs two inputs, labour (L) and capital (K) to produce output (Q). The estimated translog production function is as below.

$$Q_t = K^{\beta K}L^{\beta L}(K)^{2\beta KK}(L)^{2\beta LL}(KL)^{\beta KL} \quad (1)$$

After the production function is transformed into logarithm form,

$$\text{Log}Q = \beta_K \text{Log}K + \beta_L \text{Log}L + \beta_{KK}(\text{Log}K)^2 + \beta_{LL}(\text{Log}L)^2 + \beta_{KL}(\text{Log}K)(\text{Log}L) \quad (2)$$

The data on inputs and output were transferred to logarithm. Equation (2) could be estimated using Ordinary Least Square. Marginal product, output elasticity, return to scale, marginal rate of technical substitution and elasticity of substitution in translog production function will be calculated from estimation of equation (2). Marginal product of labor and capital in translog production function can be calculated using below formula:

$$f_L = \frac{\partial Q}{\partial L} = \beta_L(\frac{Q}{L}) \qquad f_K = \frac{\partial Q}{\partial K} = \beta_K(\frac{Q}{K})$$

The output elasticity for labour and capital in translog production function could be obtained by differentiating the translog production function with respect to each input.

$$\varepsilon_L = \frac{\delta \ln Q}{\delta \ln L} = \beta_L + 2\beta_{LL}\text{Log}L + \beta_{KL}\text{Log}K \quad (3)$$

$$\varepsilon_K = \frac{\delta \ln Q}{\delta \ln K} = \beta_K + 2\beta_{KK}\,\text{Log}K + \beta_{KL}\text{Log}L \quad (4)$$

In the equation (3) and (4), β_L represents the average cost share of labor while β_K represents the average cost share of capital. Meanwhile, β_{LL} and β_{KK} measure the own price elasticities. Particularly β_{LL} measures the labour share elasticity with respect to labour and β_{KK} measures the capital share elasticity with respect to capital respectively. More intuitively, β_{LL} measures the percentage change in quantity of labour caused by a percentage change in the price of labour (wage) and β_{KK} measures the percentage change in quantity of the capital caused by a percentage change in the price of capital (rental rate). β_{KL} measure the cross price elasticity. Particularly, β_{KL} measures the one input share elasticity with respect to another input. More intuitively, β_{KL} measures the percentage change in quantity of one input caused by a percentage change in price of another input[i].

Marginal rate of technical substitution between labor and capital could be obtained through the ratio of marginal product of labor and capital as shown in below formula.

$$\text{MRTS (K for L)} = -\frac{dK}{dL}\Big|_{dq=0} = \frac{MP_L}{MP_K} = \frac{f_L}{f_K} = \frac{\beta_L \frac{Q}{L}}{\beta_K \frac{Q}{K}}$$

In translog case, the ratio of marginal products is

$$\text{MRTS} = \frac{f_L}{f_K} = \frac{\beta_L}{\beta_K}\frac{K}{L}$$

From the estimation of β_{KK}, β_{LL} and β_{KL}, Allen partial elasticities of substitution (AES) could be obtained to measure the degree of substitutability or complementarily among factors of production.

$$\sigma_{LK} = \frac{\gamma_{LK} + S_L S_K}{S_L S_K}$$

where S_L = cost share of input $_L$
S_K = cost share of input $_K$

γ_{LK} can be obtained from cost function[ii]. The estimated cost function is as below.

$$LogC = \alpha_0 + \alpha_Y LogY + \phi(LogY)^2 + \gamma_L Logw + \gamma_K Logr + \text{э}Logwlnw + \text{Ə}Logwlnr + \text{ə}Logrlogr + \text{Ə}LogrLogw + \gamma_{QL}LogYognw + \gamma_{QK}LogYLogr$$

The Allen elasticity of substitution could be obtained from cost share and own and cross price elasticities of inputs estimated from the above cost function.

Regression

The elasticity of substitution of Transcendental Logarithm will be regressed with rate of economy growth to recognize how the flexible elasticity of substitution could affect the convergence of rate of economy growth toward steady state. Controlled variables include capital-labour ratio, investment, population rate and rate of growth of labor force. The estimation model to test the relationship between elasticity of substitution and rate of economy growth is

$$EG_t = \alpha_0 + \alpha_1 \frac{K}{L}_t + \alpha 2LogI_t + \alpha_3 n_t + \alpha_4 lf_t + \alpha_5 \sigma_t + u_t$$

where EG = rate of economy growth
$\frac{K}{L}$ = capital-labour ratio
I = investment
n = population rate
lf = labour force rate
σ = elasticity of substitution

The capital-labour ratio, investment and elasticity of substitution are expected to positively influence the rate of economy growth. According to economic theory, country with high capital accumulation and emphasize on capital investment will produce more output compared to country with low capital accumulation. Meanwhile, following the de la Grandville Hypothesis, high elasticity of substitution are positively influencing rate of economic growth with the reason that increased possibility to produce with greater factor combinations will help firm to choose the most efficient factor combination to produce output. Intuitively, the higher the elasticity of substitution, the greater the possibility of input combination for producing a given level of output. Thus, high elasticity of substitution can fasten the speed of economic growth in order to converge to steady state.

Meanwhile, the population rate and labour force rate negatively influence the rate of economy growth. In developing countries such as Malaysia, manufacturing firm usually have larger labor share compared to capital share. The increase in population rate and labour force is expected to decrease the rate of economy growth due to two intuitive reasons. Firstly, due to lack of knowledge in technology invention and government policy to decrease unemployment, increase in population rate and labour force will reduce capital per worker and thus reduce the possibility of substitution of capital for labour in large percentage. As an impact, the reduced elasticity of substitution will decrease the rate of economy growth. Secondly, the growing quantity of labour implies more capital is needed to keep the capital stock per unit of effective labour constant at its existing level. Since more capital accumulation is placed for break-even investment, the actual investment will reduce. Graphically, the shift up in break-even investment line and shift down in actual investment line in balanced growth path will reduce the capital per worker that are needed for rapid growth of economy growth. So, the sign of coefficient of both population rate and labour force rate are negative. The model will be regressed with data from 1983 to 2006.

Economy Growth Model (Solow Model)

According to Solow model, the contribution of labour, capital and technical change in manufacturing sector could be accounted from Solow Accounting Formula. The effect of factor substitution on economy growth can be traced through production function Q = f (L, K). Since d(ln X) = dX / X that can be interpreted as the percentage change in X, the production function can be written in growth term as below.

$$\frac{\Delta Q}{Q} = \frac{\Delta A}{A} + (1-\alpha)\frac{\Delta K}{K} + \alpha\frac{\Delta L}{L}$$

where $\frac{\Delta Q}{Q}$ = growth of output

$\frac{\Delta A}{A}$ = change in growth of total factor productivity

$\frac{\Delta K}{K}$ = change in growth of capital

$\frac{\Delta L}{L}$ = change in growth of labor

Mathematically, $\frac{\Delta A}{A}$ is the percentage of technological progress, $\frac{\Delta K}{K}$ is the percentage change in capital while $\frac{\Delta L}{L}$ is the percentage change of labor. This formula is often used to account the portions of real output growth due to increases in labor and capital inputs and also technical growth. Contribution of capital to economy growth could be expressed by $\alpha\frac{\Delta K}{K}$ while contribution of labor to economy growth is expressed by $(1-\alpha)\frac{\Delta L}{L}$. The remaining percentage of economy growth that is not explained by capital and labor is contributed by technical progress. Since it is changes in aggregate output minus the sum of the weighted contribution of labor and capital inputs, the portion of output that contributed by factor other than capital and labor is known as Solow residual. So, Solow residual measures the contribution of technical progress on economy growth. Elasticity of substitution due to technical progress tends to be low in Malaysia because of the use of imported technology that gives only very limited possibilities of factor substitution and also due to limited possibility of inputs mix. To recognize this possibility, the rate of technical progress is calculated in below formula. Rearrange to solve for Solow residual,

$$\frac{\Delta A}{A} = \frac{\Delta Q}{Q} - [\alpha\frac{\Delta K}{K} + (1-\alpha)\frac{\Delta L}{L}] \qquad (5)$$

The translog technology will be analyzed on how capital accumulation and technical change in manufacturing sector could increase rate of economy growth and to reduce unemployment in that sector in Malaysia. For this purpose, price distortion policy[iii] will be designed based on factor endowment and also relative contribution of capital accumulation and technical progress. It can be traced out from contribution of inputs and technical change in production. The final objective of the country is to increase both level and growth rate of output per worker and economy based on the source of economy growth.

FINDINGS AND DATA ANALYSIS

To recognize how economy growth could be increased through contribution in manufacturing sector, marginal product, return to scale, marginal rate of technical substitution and elasticity of substitution will be obtained from translog production function. These estimators capture the effect of factor substitution on growth in manufacturing sector. Then, elasticity of substitution will be regressed with rate of economy growth to recognize the relative significance of contribution of capital accumulation and technical progress in manufacturing sector toward rapid economy growth and reducing unemployment. Thirdly, the Solow accounting formula will be applied to trace out the source of economy growth in order to examine the relative significance of capital accumulation and technical progress in increasing rate of economy growth. The contribution of labour, capital and technical progress is accounted in order to analyze the relative significance of contribution of capital accumulation and technical progress in manufacturing sector toward rapid economy growth and reducing unemployment rate.

Based on the findings on relation between elasticity of substitution and relative contribution of factor traced out in the Solow accounting formula, price distortion policy will be designed to employ the available factor endowment in the country to increase rate of economy growth and reduce unemployment.

Transcendental Logarithm (Translog) Model Estimation

The estimation result of Transcendental Logarithm production function is as follows:

$$LogQ = 3.8564LogK - 2.3531LogL + 0.1795(LogK)^2 + 0.2980(LogL)^2 - 0.5038(LogK)(LogL)$$

SE	(1.7350)	(1.2994)	(0.0822)	(0.1419)	(0.2504)
t statistic	(2.2227)	(-1.8109)	(2.1842)	(2.1004)	(-2.0117)

The average product of labour could be obtained by dividing the average value of output with average value of labour. Using the information of average product of labour, the marginal product of the labour could be obtained as follows.

$$f_L = (-2.353)\left(\frac{163556}{833684}\right)$$
$$= -0.4616$$

The average product of capital could be obtained by dividing the average value of output with average value of capital. Using the information of average product of capital, the marginal product of the capital could be obtained as follows.

$$f_K = 3.8564\left(\frac{163556}{60668}\right)$$
$$= 10.3965$$

Comparing both the marginal product, capital is more important than labour in manufacturing firm. Average value of LogL and LogK are 10.1184 and 13 respectively. Output elasticity for labour in translog production function could be obtained as follows.

$$\varepsilon_L = -2.3531 + 2(0.2980)(10.1184) - 0.5038(13)$$
$$= -2.8719$$

Output elasticity for capital could be obtained as follows.

$$\varepsilon_K = 3.8564 + 2(0.1795)(13) - 0.5038(10.1184)$$
$$= 3.4258$$

Consistent with the comparison between two marginal products, the output elasticity shows that output increases in larger percent when capital increases by one percent compared to when labour increases by once percent.

Before proceeding for elasticity of substitution, cost function hast to be estimated. The estimation result of translog cost function is

$$LogC = 6.1425 - 0.9895LogY - 0.5086(LogY)^2 + 1.3946Logw - 0.3230Logr -$$

SE	(6.7691)	(3.6891)	(0.2956)	(3.5279)	(1.5398)
t statistic	(0.9076)	(-0.2682)	(-1.7204)	(0.3953)	(-0.2098)

$$0.9247LogwLogw - 0.0591Logwlogr - 0.0790LogrLogr - 0.0591LogrLogw +$$

SE	(0.3771)	(0.8849)	(0.1504)	(0.8849)
t statistic	(-2.4524)	(-0.0667)	(0.5251)	(-0.0667)

$$1.4066LogYLogw + 0.1743LogYLogr$$

SE	(0.6187)	(0.7920)
t statistic	(2.2736)	(0.2201)

The every year cost share of labour[iv] is shown in the Appendix 3a. The every year cost share of capital is shown in the Appendix 3b. The cost share of labour and capital in Appendix 3a and 3b is used to calculate elasticity of substitution, shown in Appendix 4. The fourth appendix shows that the elasticity of substitution is relatively high if manufacturing firm applies translog technology to produce output. Thus, the translog production function is suggested[v] to be employed to produce manufacturing output since the high elasticity of substitution fastens the speed of convergence towards steady state economy growth.

Regression

The elasticity of substitution in Appendix 3 is regressed with rate of economy growth to recognize how high the elasticity of substitution is needed to increase economy growth towards steady states. The regression result is demonstrated as below.

$$EG_t = -42.7208 - 125.1190\frac{K}{L}_t + 4.4326LogI_t - 0.2397n_t + 0.5840lf_t + 30.8157\sigma_t$$

SE	(23.0077)	(55.7522)**	(2.2635)*	(1.2313)	(0.7355)	(14.5000)**
t statistic	(-1.8568)	(2.2635)	(1.9583)	(-0.1947)	(0.7940)	(2.1252)

where * = significant at 10 percent significant level
** = significant at 5 percent significant level

The coefficient of investment, population rate and elasticity of substitution are correctly signed. However, only investment and elasticity of substitution are significant in influencing economic growth at 10 and 5 percent respectively. To explain the sign of elasticity of substitution, when elasticity of substitution in manufacturing sector increases 1 percent, the economy growth will increase 30.8157 percent significantly at 5 percent significant level. Similarly, when elasticity of substitution in manufacturing sector decreases 1 percent, the economy growth will decrease 30.8157 percent significantly at 5 percent significant level. The capital-labour ratio is significantly influences the rate of economic growth although this variable is wrongly signed.

To intuitively analyze the positive sign of elasticity of substitution, it can be said that the factor substitution did significantly increase rate of economy growth. By looking at elasticity of substitution of Transcendental Logarithm production function in Appendix 4, it can be sated more specifically that the high and positive variable elasticity of substitution could promote relatively rapid economic growth compared to low and negative variable elasticity of substitution.

Thus, supporting the de la Grandville Hypothesis, higher elasticity of substitution does influences rate of economy growth positively. The high r square in the estimated model suggests manufacturing firm should base on Transcendental Logarithm production function to substitute capital and labour and to produce output. So, firm should change the input substitution between labour and capital through adjusting the cost share of labour and input instead of adjusting the capital-labour ratio. Applying factor substitution using this technology, the cost share of inputs in manufacturing firm will interact with level of economic development to achieve higher economy growth.

To analyze the input substitution using translog technology, the manufacturing firm is advised to substitute inputs with cross price elasticity of -0.1182. To explain the negative cross price elasticity, the manufacturing firm could substitute cheaper input with more expansive input since both inputs are substitute. Particularly, the manufacturing firm will respond to increase demand of labour by 0.1182 percent when rental rate increases by 1 percent. Similarly, the manufacturing firm will respond to reduce the quantity of labour by 0.1182 percent when rental rate decreases by 1 percent.

Due to symmetry of cross price elasticity of inputs, $\gamma_{LK} = \gamma_{KL}$. The elasticity of capital with respect to wage is also 0.1182. Again, labour and capital are still substituring each other even though rental rate changes. Particularly, the manufacturing firm will respond to increase demand of capital by 0.1182 percent when wage increases by 1 percent. Similarly, firm will respond to reduce the quantity of capital by 0.1182 percent when wage decreases by 1 percent. Since output elasticity of capital is higher than output elasticity of labour, capital is more responsive than labour in producing output. So, firm tends to substitute capital for labour in large percentage when input price changes. The high output elasticity of capital and elasticity of substitution will promote rapid economy growth rate. From the above regression, Transcendental Logarithm production function is suggested as the appropriate production function for manufacturing sector in this country to produce output.

Solow Accounting Model

To drawn the role of factor substitution in economic growth, the source of economy growth is recognized through Solow accounting Model. Since Transcendental Logarithm is chosen as the appropriate production function to produce output in manufacturing sector, this model is used to account for the contribution of labour, capital and technical change. The contribution of each factor will be compared to determine whether capital accumulation or technical progress should be emphasized for promoting rapid economy growth. The contribution of labour, capital and technical progress in manufacturing sector towards economy growth is shown in Appendix 5.

To recognize which factor is the most important in contributing to economy growth, average of contribution of each factor is calculated.

Average $\frac{\Delta A}{A} = 0.0128$

Average $(1-\alpha)\frac{\Delta K}{K} = 0.1047$

Average $\alpha\frac{\Delta L}{L} = 0.0116$

Average $\frac{\Delta Q}{Q} = 0.1292$

Intuitively, productivity was largely due to the vast capital accumulation, follows by technical progress and lastly by labor. From the average contribution of each factor, it can be interpreted that the weighted contribution of labour in manufacturing industry to economy growth is 0.0128 and weighted contribution of capital in manufacturing industry to economy growth is 0.1047. The remaining contribution of economy growth that is not explained by capital and labour is contributed by technical progress. In Solow terms, the Solow residual in manufacturing sector in this country is 0.016. From here, clearly that economy growth is accounted more by capital accumulation rather than technical progress since $\frac{\Delta A}{A}$ is much smaller than $\alpha\frac{\Delta K}{K}$. It can be interpreted that economy growth is said contributed significantly more by capital accumulation rather than technical progress. This finding is consistent with marginal product and output elasticity estimated above.

Using the assumption that firm applies Transcendental Logarithm technology to produce output, so capital is more important than labour in increasing productivity in manufacturing industry as shown in the Solow accounting model. Technical progress is less significant to increase economy growth may be interpreted that the sector have not converge to steady state in balanced growth path. Graphically, the actual investment is above than break-even investment as shown below.

This balanced growth path suggests that economy growth could be increased and unemployment rate could be reduced by capital accumulation since steady state is not yet achieved. So, capital accumulation still can increase rate of economy growth, not only the level of economy performance in the current economy.

Consistent with this finding on high elasticity of capital for labour, price distortion policy with the objective to increase capital accumulation and investment is to be designed. A price distortion policy that can increase capital accumulation and investment could be introduced. It is based on the rationale that capital accumulation still significant increases economy growth. For example, the country could increase investment in plant and machinery in order to avoid depreciation in capital and provides more capital for growing amount of labor. Graphically, as break-even investment curve shifts down, the level of output per worker increases. Secondly, the country could also increase saving rate to accumulate investment for plant and machinery. Graphically, as actual investment moves up, the level of output per worker increases although growth rate of output per worker on the balanced growth path keeps unchanged. Since labor is equipped with more efficient and sufficient capital, unemployment could be decreased. Capital should be raised until steady state capital per worker is achieved at the intersection of break-even investment and actual investment. As actual investment moves up in balanced growth path, the level of output per worker increases. It is for the purpose for increasing economy growth and reduce unemployment.

For this purpose, Central Bank of Malaysia could increase saving rate to influence current period consumption and saving decision of household. The capital accumulation will increase investment in plant and machinery in order to avoid depreciation in capital and provides more capital for growing amount of labor. Capital should be raised until steady state of capital per worker is achieved at the intersection of break-even investment and actual investment. So, Malaysia could encourage investment for capital accumulating in increasing the contribution of manufacturing sector on economy growth. Through the effect of capital accumulation on investment, manufacturing firm will be more capital intensive. If capital accumulation could be raised until labor is equipped with sufficient capital, unemployment could be reduced and higher rate of economy growth could be achieved. In addition, since contribution of technical progress less than contribution of capital accumulation, scale of economies has to be increased for further growth of manufacturing sector.

To summarize, manufacturing firm could choose to produce output with Transcendental Logarithm model since the elasticity of substitution in this technology is variable and high. The de la Grandville Hypothesis is strongly supported in order to increase the contribution of manufacturing sector on economy growth towards steady state. Based on relative significance of the three factors in Solow accounting formula, capital has been identified more important than labour and technical progress. The rate of technical progress to contribute less than capital accumulation in economy growth may due to high import of new technology from developed countries and low degree of factor substitution between capital and labor. In order to increase the contribution of capital in manufacturing sector, price distortion policy to encourage capital accumulation for increasing investment needs to be designed. Specifically, since elasticity of substitution is relatively high, policy-makers can increase economic growth through capital accumulation and adopting new techniques of production to complement quality labor in production. It will then increase the speed of convergence to achieve steady-state in economy.

CONCLUSIONS

This paper intends to investigate how the changes in inputs price and marginal product of inputs could affect elasticity of substitution of inputs in manufacturing industry and thus economy growth. For this purpose, an appropriate production function and price distortion policy that maximizes the use the endowments have been suggested for achieving higher rate of economy growth. In order to optimize the use of endowment, the source of economy growth has been traced out through Solow accounting model so that the industry could optimize the efficiency of inputs based on the source of economy growth in producing output. The input optimization could then improve the economy growth towards steady state.

After estimation, it is found that Transcendental Logarithm is the most appropriate technology for the manufacturing firm to produce output. The variable and high elasticity of substitution in this technology could increase the possibility to produce with most efficient factor combinations. As an impact of the high elasticity of substitution, the economy could achieve relatively fast speed of convergence to achieve steady state level. The steady state economy growth could be converged by increasing the capital accumulation for future capital investment and research and development. It is also suggested that the country could change saving rate to encourage capital accumulation in the manufacturing industry.

From the findings, policymaker could implement several suggestions as below to sustain economy growth in long run. First, the manufacturing firm could employ Transcendental Logarithm technology to produce output. Variable elasticity of substitution is needed to substitute inputs in manufacturing sector. The firm could decide the factor substitutability and input combination based on the Transcendental Logarithm technology. The high elasticity of substitution in this technology could optimize the inputs in order to produce more output. Secondly, although capital is the most important source in increasing economy growth in the short run, firm should incorporate technical progress in production due to depreciation of capital. It can be done by increasing the number of effective labor through investment in education and research in manufacturing sector. For further growth of manufacturing sector, unexploited source of growth that can improve scale of economies has to be discovered.

Since steady state is not achieved yet and thus economy growth rate still can be increased through changes in saving rate, the manufacturing firms no need to incorporate technical progress in the near term. However, manufacturing firms need to incorporate technical progress later since contribution of technical progress increase with economy growth in Solow accounting formula in order to improve economy growth rate when economy has achieved steady state.

REFERENCE

Arrow, Chenery, Minhas and Solow. 1961. Capital-Labour Substitution and Economic Efficiency, *Review of Economics and Statistics*, 43, 225-250.

Chen. 1977. Economies of Scale and Capital-Labour Substitution in Hong Kong Manufacturing, *Hong Kong Economic Papers*, 11, 42-47.

Christensen and Greene. 1976. Economies of Scale in U.S. Electric Power Generation, *The Journal of Political Economy*, 84(4), 655-676.

Christensen, Jorgenson and Lau. 1973. Transcendental Logarithmic Production Frontiers, *The Review of Economics and Statistics*, 55(1), 28-45.

Gomez, 2008. Dynamics of the Saving Rate in the Neoclassical Growth Model with CES Production, *Macroeconomic Dynamics*, 12, 195-210.

Guilkey and Lovell. 1980. On the Flexibility of the Translog Approximation, *International Economic Review*, 21(1), 137-147.

Hsing. 1996. An Empirical Estimation of Regional Production Functions for the U.S. Manufacturing Industry, *Ang Reg Sci*, 30, 351-358.

Irmen, Andreas. 2010. Steady-State Growth and the Elasticity of Substitution, University of Heidelberg, Discussion Paper Series No. 496.

Kazi, Umar A. 1980. The Variable Elasticity of Substitution Production Function: A Case Study of Indian Manufacturing Industries, *Oxford Economic Papers*, 32(1), 163-175.

Kemp, Sheshinski, Thanh. 1967. Economic Growth and Factor Substitution, *International Economic Review*, 8 (2), 243-251.

Khalil, Ali M. A Cross Section Estimate of Translog Production Function: Jordanian Manufacturing Industry, Unpublished Paper.

Kim, 1992. The Translog Production Function and Variable Returns to Scale, *The Review of Economics and Statistics*, 74(3), 546-552.

Klump and Preissler. 2000. CES Production Functions and Economic Growth, *Scand. J. of Economics*, 102(1), 41-56.

Kymn and Hisnanick. 2001. The CES- Translog Production Function, Returns to Scale and AES, *Bulletin of Economic Research*, 53(3), 207-214.

Lovell, C. A. Knox. 1973. Estimation and Prediction with CES and VES Production Functions, *International Economic Review*, 14(3), 676-692.

Miyagiwa and Papageorgiou. 2003. Elasticity of Substitution and Growth: Normalized CES in the Diamond Model, *Economic Theory*, 21, 155-163.
Multairi and Burney. 2007. Factor Substitution and Economies of Scale and Utilisation in Kuwait's Crude Oil Industry, *Energy Economics*, 24, 337-354.
Sato and Hoffman. 1968. Production Functions with Variable Elasticity of Factor Pollak, Sickles and Wales (1984). The CES-Translog: Specification and Estimation of a New Cost Function, *The Review of Economics and Statistics*, 66(4), 602-607.
Philpot, Gordon. 1970. Labour Quality, Returns to Scale and the Ealsticity of Factor Substitution, *The Review of Economics and Statistics*, 52(2), 194-199.
Substitution: Some Analysis and Testing, *The Review of Economics and Statistics*, 50(4), 453-460.
Solow. 1956. A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, 70(1), 65-94.
Truett and Truett. 1998. Production, Cost and Input Substitution in the Mexican Petroleum Industry, *North American Journal of Economics and Finance*, 9(1), 67-87.
Urguhart, M. C. 1959. Capital Accumulation, Technological Change and Economic Growth, *The Canadian Journal of Economics and Political Science*, 25(4), 411-430.
Wang, Eric C. 1995. Factor Substitution Approach to Testing the Time Variations in Production: The Case of Taiwan's Manufacturing, Applied Economics, 27, 107-116.
Yuhn. 1991. Economic Growth, Technical Change Biases and the Elasticity of Substitution, A Test of the de la Grandville Hypothesis, *The Review of Economics and Statistics*, 340-345.
Zahid, Akbar and Jaffry. 1992. Technical Change, Efficiency, and Capital-labour Substitution in Pakistan's Large-scale Manufacturing Sector, *The Pakistan Development Review*, 31(2), 165-188.

FIGURE 1: Relationship between Input and Output

Inputs
Capital and Labour

→

Economic Restructuring
- Higher and excellent quality products
- Lower cost
- Efficient input combination
- High customer satisfaction
- Productivity-driven growth

→

Higher GDP
- Sustainable economic growth
- Higher wealth
- Higher standard of living

Source: Productivity Report 2008, Malaysia Productivity Corporation

FIGURE 2: Balanced Growth Path in Solow Model

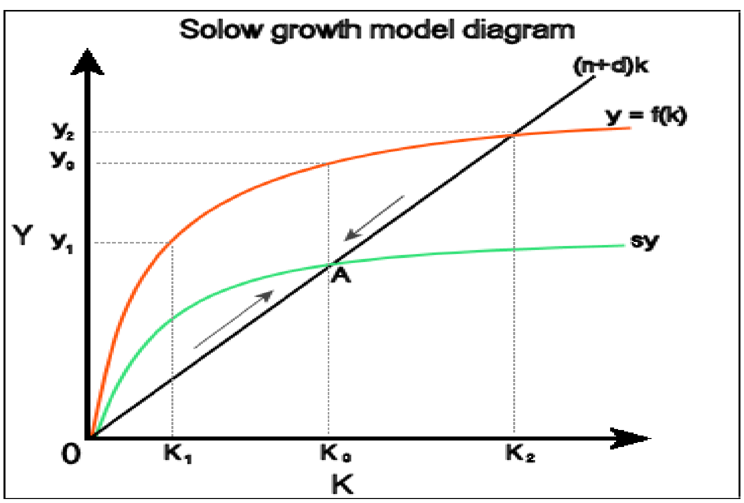

FIGURE 3: Balanced Growth Path in Malaysia

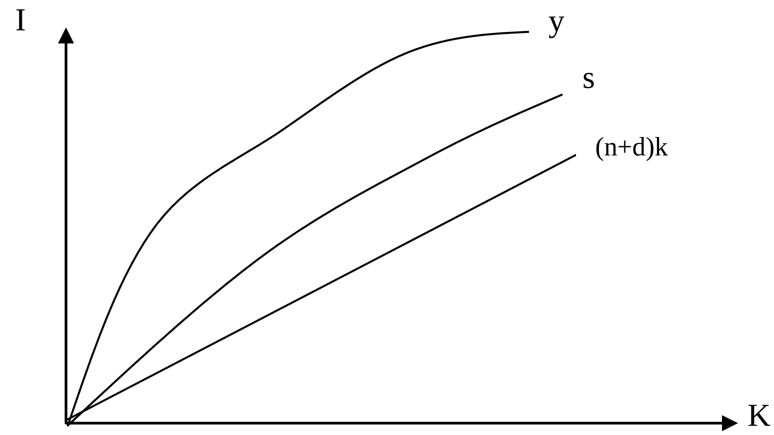

TABLE 1: Productivity Growth (%) in 2008

Country	Productivity Growth (%)
China	**7.8**
Korea	3.6
Indonesia	3.5
India	3.4
Philippines	3.0
Malaysia	**2.9**

Source: Productivity Report 2008, Malaysia Productivity Corporation

TABLE 2: Gross Domestic Product by Kind of Economic Activity at Current Price

Year	Kind of Economic Activity			
	Agriculture	Mining and Quarrying	Manufacturing	Construction
2005	43,854	75,062	**154,657**	15,680
2006	50,436	85,566	**168,736**	15,976
2007	65,032	92,402	**178,705**	17,645
2008	75,657	127,210	**194,103**	19,581
2009	64,651	87,722	**172,696**	21,165

Source: Monthly Statistical Bulletin February 2010**,** Central Bank of Malaysia

TABLE 3: Main Exports of Malaysia

Exports	RM Million		
	1999	2004	2008
Manufactured goods	**272,653**	**395,127**	**491,930**
Palm oil (crude and processed)	14,475	20,047	64,808
Crude petroleum	9,306	21,762	43,698
Liquefied natural gas	6,349	17,079	40,732
Total	321,181	480,740	663,494

Source: Productivity Report 2008, Malaysia Productivity Corporation

TABLE 4: Annual Change of Gross Domestic Product at Purchaser's Value (%)

Year	Annual Change of Gross Domestic Product at Purchaser's Value (%)
2005	10.2
2006	10.0
2007	11.4
2008	15.5
2009	**-8.7**

Source: Monthly Statistical Bulletin February 2010**,** Central Bank of Malaysia

TABLE 5: Unemployment in Malaysia

Year	Unemployment('000)
1998	284.0
1999	313.7
2000	286.9
2001	342.4
2002	343.5
2003	369.8
2004	366.6
2005	368.1
2006	353.6
2009	**418.0**

Source: Department of Statistics, Malaysia

APPENDIX

APPENDIX 1: Translog Production Function

Dependent Variable: LOGY
Method: Least Squares
Date: 04/19/10 Time: 13:32
Sample: 1970 2006
Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGK	3.856365	1.734973	2.222724	0.0334
LOGL	-2.353061	1.299418	-1.810857	0.0796
LOGK2	0.179534	0.082198	2.184164	0.0364
LOGL2	0.298040	0.141895	2.100421	0.0437
LOGKLOGL	-0.503787	0.250431	-2.011680	0.0527

R-squared	0.994929	Mean dependent var	11.15830
Adjusted R-squared	0.994295	S.D. dependent var	1.490011
S.E. of regression	0.112542	Akaike info criterion	-1.405888
Sum squared resid	0.405304	Schwarz criterion	-1.188197
Log likelihood	31.00893	Hannan-Quinn criter.	-1.329142
Durbin-Watson stat	0.686978		

APPENDIX 2: Translog Cost Function

Dependent Variable: LOGTC
Method: Least Squares
Date: 04/19/10 Time: 15:08
Sample: 1970 2006
Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.143471	6.769140	0.907570	0.3721
LOGY	-0.989534	3.689146	-0.268228	0.7906
LOGY2	-0.508597	0.295630	-1.720383	0.0968
LOGW	1.394646	3.527869	0.395322	0.6957
LOGR	-0.322999	1.539787	-0.209769	0.8354
LOGW2	-0.924714	0.377060	-2.452434	0.0209
LOGWR	-0.059059	0.884864	-0.066744	0.9473
LOGR2	-0.078976	0.150399	-0.525108	0.6038
LOGYW	1.406638	0.618682	2.273604	0.0312
LOGYR	0.174325	0.791956	0.220119	0.8274

R-squared	0.996146	Mean dependent var	11.83602
Adjusted R-squared	0.994862	S.D. dependent var	1.510004
S.E. of regression	0.108241	Akaike info criterion	-1.383461
Sum squared resid	0.316333	Schwarz criterion	-0.948078
Log likelihood	35.59403	Hannan-Quinn criter.	-1.229968
F-statistic	775.4596	Durbin-Watson stat	0.714486
Prob(F-statistic)	0.000000		

APPENDIX 3A : Cost Share of Labour in Translog model

Year	γ_L	γ_{LL}	w	logw	γ_{LL}logw	γ_{LK}	NR	logr	γ_{LK}Logr	γ_{QL}	Q	LogQ	γ_{QL}LogQ	S_L
1970	1.39	-1.85	363	5.89	-10.90	-0.12	5.50	1.70	-0.20	1.4066	4316	8.37	11.77	2.07
1971	1.39	-1.85	405	6.00	-11.10	-0.12	5.50	1.70	-0.20	1.4067	4560	8.43	11.85	1.94
1972	1.39	-1.85	474	6.16	-11.39	-0.12	5.00	1.61	-0.19	1.4068	5627	8.64	12.15	1.96
1973	1.39	-1.85	641	6.46	-11.95	-0.12	6.00	1.79	-0.21	1.4069	8322	9.03	12.70	1.93
1974	1.39	-1.85	783	6.66	-12.32	-0.12	6.50	1.87	-0.22	1.4070	11008	9.31	13.09	1.94
1975	1.39	-1.85	871	6.77	-12.52	-0.12	5.50	1.70	-0.20	1.4071	11339	9.34	13.14	1.81
1976	1.39	-1.85	1080	6.98	-12.92	-0.12	5.50	1.70	-0.20	1.4072	14373	9.57	13.47	1.75
1977	1.39	-1.85	1259	7.14	-13.20	-0.12	5.00	1.61	-0.19	1.4073	16504	9.71	13.67	1.67
1978	1.39	-1.85	1456	7.28	-13.47	-0.12	5.50	1.70	-0.20	1.4074	19468	9.88	13.90	1.62
1979	1.39	-1.85	1803	7.50	-13.87	-0.12	5.50	1.70	-0.20	1.4075	25906	10.16	14.30	1.63
1980	1.39	-1.85	2315	7.75	-14.33	-0.12	8.50	2.14	-0.25	1.4076	32092	10.38	14.61	1.42
1981	1.39	-1.85	2827	7.95	-14.70	-0.12	10.00	2.30	-0.27	1.4077	38278	10.55	14.85	1.28
1982	1.39	-1.85	3009	8.01	-14.81	-0.12	9.00	2.20	-0.26	1.4078	37627	10.54	14.83	1.15
1983	1.39	-1.85	3177	8.06	-14.91	-0.12	8.50	2.14	-0.25	1.4079	41474	10.63	14.97	1.20
1984	1.39	-1.85	3509	8.16	-15.10	-0.12	10.50	2.35	-0.28	1.4080	46256	10.74	15.12	1.14
1985	1.39	-1.85	3622	8.19	-15.16	-0.12	7.25	1.98	-0.23	1.4081	45586	10.73	15.11	1.11
1986	1.39	-1.85	3632	8.20	-15.16	-0.12	6.25	1.83	-0.22	1.4082	42427	10.66	15.01	1.02
1987	1.39	-1.85	3872	8.26	-15.28	-0.12	2.50	0.92	-0.11	1.4083	50700	10.83	15.26	1.26
1988	1.39	-1.85	4426	8.40	-15.53	-0.12	3.25	1.18	-0.14	1.4084	65197	11.09	15.61	1.34
1989	1.39	-1.85	5340	8.58	-15.87	-0.12	4.80	1.57	-0.19	1.4085	80802	11.30	15.92	1.25
1990	1.39	-1.85	6674	8.81	-16.29	-0.12	6.80	1.92	-0.23	1.4086	95814	11.47	16.16	1.04
1991	1.39	-1.85	8411	9.04	-16.71	-0.12	7.93	2.07	-0.24	1.4087	120298	11.70	16.48	0.91
1992	1.39	-1.85	9830	9.19	-17.00	-0.12	7.85	2.06	-0.24	1.4088	134150	11.81	16.63	0.78
1993	1.39	-1.85	11688	9.37	-17.32	-0.12	6.37	1.85	-0.22	1.4089	164974	12.01	16.93	0.78
1994	1.39	-1.85	12397	9.43	-17.43	-0.12	5.27	1.66	-0.20	1.4090	196912	12.19	17.18	0.94
1995	1.39	-1.85	13603	9.52	-17.60	-0.12	6.64	1.89	-0.22	1.4091	246923	12.42	17.50	1.06
1996	1.39	-1.85	16466	9.71	-17.96	-0.12	7.21	1.98	-0.23	1.4092	273439	12.52	17.64	0.85
1997	1.39	-1.85	19171	9.86	-18.24	-0.12	9.06	2.20	-0.26	1.4093	297130	12.60	17.76	0.66
1998	1.39	-1.85	20500	9.93	-18.36	-0.12	5.83	1.76	-0.21	1.4094	329260	12.70	17.91	0.73
1999	1.39	-1.85	20972	9.95	-18.40	-0.12	3.33	1.20	-0.14	1.4095	361389	12.80	18.04	0.89
2000	1.39	-1.85	21443	9.97	-18.44	-0.12	3.48	1.25	-0.15	1.4096	440005	12.99	18.32	1.12
2001	1.39	-1.85	26123	10.17	-18.81	-0.12	3.21	1.17	-0.14	1.4097	395995	12.89	18.17	0.62
2002	1.39	-1.85	24571	10.11	-18.70	-0.12	3.20	1.16	-0.14	1.4098	456542	13.03	18.37	0.93
2003	1.39	-1.85	27214	10.21	-18.89	-0.12	3.00	1.10	-0.13	1.4099	516857	13.16	18.55	0.93
2004	1.39	-1.85	28137	10.24	-18.95	-0.12	3.00	1.10	-0.13	1.4100	601799	13.31	18.76	1.08
2005	1.39	-1.85	30259	10.32	-19.08	-0.12	3.02	1.11	-0.13	1.4101	654682	13.39	18.88	1.07

APPENDIX 3B : Cost Share of Capital in Translog model

Year	γ_K	γ_{KK}	r	logr	γ_{KK}logr	γ_{LK}	W	logw	γ_{LK}Logw	γ_{QK}	Q	LogQ	γ_{QK}LogQ	S_K
1970	-0.32	-0.16	5.50	1.70	-0.27	-0.12	363	5.89	-0.70	0.17	4316	8.37	1.46	0.17
1971	-0.32	-0.16	5.50	1.70	-0.27	-0.12	405	6.00	-0.71	0.17	4560	8.43	1.47	0.17
1972	-0.32	-0.16	5.00	1.61	-0.25	-0.12	474	6.16	-0.73	0.17	5627	8.64	1.51	0.20
1973	-0.32	-0.16	6.00	1.79	-0.28	-0.12	641	6.46	-0.76	0.17	8322	9.03	1.57	0.20
1974	-0.32	-0.16	6.50	1.87	-0.30	-0.12	783	6.66	-0.79	0.17	11008	9.31	1.62	0.22
1975	-0.32	-0.16	5.50	1.70	-0.27	-0.12	871	6.77	-0.80	0.17	11339	9.34	1.63	0.23
1976	-0.32	-0.16	5.50	1.70	-0.27	-0.12	1080	6.98	-0.83	0.17	14373	9.57	1.67	0.25
1977	-0.32	-0.16	5.00	1.61	-0.25	-0.12	1259	7.14	-0.84	0.17	16504	9.71	1.69	0.27
1978	-0.32	-0.16	5.50	1.70	-0.27	-0.12	1456	7.28	-0.86	0.17	19468	9.88	1.72	0.27
1979	-0.32	-0.16	5.50	1.70	-0.27	-0.12	1803	7.50	-0.89	0.17	25906	10.16	1.77	0.29
1980	-0.32	-0.16	8.50	2.14	-0.34	-0.12	2315	7.75	-0.92	0.17	32092	10.38	1.81	0.23
1981	-0.32	-0.16	10.0	2.30	-0.36	-0.12	2827	7.95	-0.94	0.17	38278	10.55	1.84	0.21
1982	-0.32	-0.16	9.00	2.20	-0.35	-0.12	3009	8.01	-0.95	0.17	37627	10.54	1.84	0.22
1983	-0.32	-0.16	8.50	2.14	-0.34	-0.12	3177	8.06	-0.95	0.17	41474	10.63	1.85	0.24
1984	-0.32	-0.16	10.5	2.35	-0.37	-0.12	3509	8.16	-0.96	0.17	46256	10.74	1.87	0.21
1985	-0.32	-0.16	7.25	1.98	-0.31	-0.12	3622	8.19	-0.97	0.17	45586	10.73	1.87	0.27
1986	-0.32	-0.16	6.25	1.83	-0.29	-0.12	3632	8.20	-0.97	0.17	42427	10.66	1.86	0.28
1987	-0.32	-0.16	2.50	0.92	-0.14	-0.12	3872	8.26	-0.98	0.17	50700	10.83	1.89	0.44
1988	-0.32	-0.16	3.25	1.18	-0.19	-0.12	4426	8.40	-0.99	0.17	65197	11.09	1.93	0.43
1989	-0.32	-0.16	4.80	1.57	-0.25	-0.12	5340	8.58	-1.01	0.17	80802	11.30	1.97	0.38
1990	-0.32	-0.16	6.80	1.92	-0.30	-0.12	6674	8.81	-1.04	0.17	95814	11.47	2.00	0.33
1991	-0.32	-0.16	7.93	2.07	-0.33	-0.12	8411	9.04	-1.07	0.17	120298	11.70	2.04	0.32
1992	-0.32	-0.16	7.85	2.06	-0.33	-0.12	9830	9.19	-1.09	0.17	134150	11.81	2.06	0.32
1993	-0.32	-0.16	6.37	1.85	-0.29	-0.12	11688	9.37	-1.11	0.17	164974	12.01	2.09	0.37
1994	-0.32	-0.16	5.27	1.66	-0.26	-0.12	12397	9.43	-1.11	0.17	196912	12.19	2.12	0.43
1995	-0.32	-0.16	6.64	1.89	-0.30	-0.12	13603	9.52	-1.13	0.17	246923	12.42	2.16	0.42
1996	-0.32	-0.16	7.21	1.98	-0.31	-0.12	16466	9.71	-1.15	0.17	273439	12.52	2.18	0.40
1997	-0.32	-0.16	9.06	2.20	-0.35	-0.12	19171	9.86	-1.17	0.17	297130	12.60	2.20	0.36
1998	-0.32	-0.16	5.83	1.76	-0.28	-0.12	20500	9.93	-1.17	0.17	329260	12.70	2.21	0.44
1999	-0.32	-0.16	3.33	1.20	-0.19	-0.12	20972	9.95	-1.18	0.17	361389	12.80	2.23	0.54
2000	-0.32	-0.16	3.48	1.25	-0.20	-0.12	21443	9.97	-1.18	0.17	440005	12.99	2.26	0.57
2001	-0.32	-0.16	3.21	1.17	-0.18	-0.12	26123	10.17	-1.20	0.17	395995	12.89	2.25	0.54
2002	-0.32	-0.16	3.20	1.16	-0.18	-0.12	24571	10.11	-1.19	0.17	456542	13.03	2.27	0.57
2003	-0.32	-0.16	3.00	1.10	-0.17	-0.12	27214	10.21	-1.21	0.17	516857	13.16	2.29	0.59

2004	-0.32	-0.16	3.00	1.10	-0.17	-0.12	28137	10.24	-1.21	0.17	601799	13.31	2.32	0.61
2005	-0.32	-0.16	3.02	1.11	-0.17	-0.12	30259	10.32	-1.22	0.17	654682	13.39	2.33	0.62

APPENDIX 4 : Hicks-Allen Elasticity of Substitution in Translog model

Year	γ_{LK}	S_L	S_K	S_LS_K	$\gamma_{LK}+S_LS_K$	σ_{LK}
1970	-0.1182	2.07	0.17	0.35	0.23	0.66
1971	-0.1182	1.94	0.17	0.32	0.20	0.63
1972	-0.1182	1.96	0.20	0.39	0.27	0.70
1973	-0.1182	1.93	0.20	0.39	0.27	0.70
1974	-0.1182	1.94	0.22	0.42	0.30	0.72
1975	-0.1182	1.81	0.23	0.42	0.31	0.72
1976	-0.1182	1.75	0.25	0.44	0.32	0.73
1977	-0.1182	1.67	0.27	0.45	0.34	0.74
1978	-0.1182	1.62	0.27	0.44	0.32	0.73
1979	-0.1182	1.63	0.29	0.48	0.36	0.75
1980	-0.1182	1.42	0.23	0.33	0.21	0.64
1981	-0.1182	1.28	0.21	0.27	0.15	0.57
1982	-0.1182	1.15	0.22	0.25	0.14	0.53
1983	-0.1182	1.20	0.24	0.29	0.17	0.59
1984	-0.1182	1.14	0.21	0.24	0.13	0.51
1985	-0.1182	1.11	0.27	0.29	0.18	0.60
1986	-0.1182	1.02	0.28	0.28	0.16	0.58
1987	-0.1182	1.26	0.44	0.56	0.44	0.79
1988	-0.1182	1.34	0.43	0.58	0.46	0.80
1989	-0.1182	1.25	0.38	0.48	0.36	0.75
1990	-0.1182	1.04	0.33	0.35	0.23	0.66
1991	-0.1182	0.91	0.32	0.29	0.18	0.60
1992	-0.1182	0.78	0.32	0.25	0.13	0.53
1993	-0.1182	0.78	0.37	0.29	0.17	0.59
1994	-0.1182	0.94	0.43	0.40	0.28	0.71
1995	-0.1182	1.06	0.42	0.44	0.33	0.73
1996	-0.1182	0.85	0.40	0.34	0.22	0.65
1997	-0.1182	0.66	0.36	0.24	0.12	0.50
1998	-0.1182	0.73	0.44	0.32	0.20	0.63
1999	-0.1182	0.89	0.54	0.48	0.36	0.75
2000	-0.1182	1.12	0.57	0.63	0.52	0.81
2001	-0.1182	0.62	0.54	0.33	0.21	0.64
2002	-0.1182	0.93	0.57	0.53	0.41	0.78
2003	-0.1182	0.93	0.59	0.55	0.43	0.78
2004	-0.1182	1.08	0.61	0.66	0.54	0.82
2005	-0.1182	1.07	0.62	0.66	0.54	0.82

APPENDIX 5 : Solow Accounting Formula

Year	Y	L	K	ΔL	ΔL/L	δ(ΔL/L)	ΔK	ΔK/K	(1-δ)(ΔK/K)	ΔQ	ΔQ/Q	ΔA/A
1970	4,316	175,216	1,231									
1971	4,560	193,529	1,377	18,313	0.09	0.02	146	0.11	0.08	244	0.05	-0.05
1972	5,627	226,782	1,771	33,253	0.15	0.03	394	0.22	0.18	1,067	0.19	-0.02
1973	8,322	323,304	2,429	96,522	0.30	0.06	658	0.27	0.22	2,695	0.32	0.05
1974	11,008	303,624	3,186	-19,680	-0.06	-0.01	757	0.24	0.19	2,686	0.24	0.07
1975	11,339	311,009	3,759	7,385	0.02	0.00	573	0.15	0.12	331	0.03	-0.10
1976	14,373	350,950	4,592	39,941	0.11	0.02	833	0.18	0.15	3,034	0.21	0.04
1977	16,504	375,606	5,023	24,656	0.07	0.01	431	0.09	0.07	2,131	0.13	0.05
1978	19,468	406,751	5,527	31,145	0.08	0.02	504	0.09	0.07	2,964	0.15	0.06
1979	25,906	450,556	6,419	43,805	0.10	0.02	892	0.14	0.11	6,438	0.25	0.12
1980	32092	515298	8,443	64,742	0.13	0.03	2,024	0.24	0.19	6,186	0.19	-0.02
1981	38,278	580,039	10,467	64,742	0.11	0.02	2,024	0.19	0.15	6,186	0.16	-0.02
1982	37,627	520,914	11,634	-59,125	-0.11	-0.02	1,167	0.10	0.08	-651	-0.02	-0.07
1983	41,474	493,158	15,792	-27,756	-0.06	-0.01	4,158	0.26	0.21	3,847	0.09	-0.11
1984	46,256	498,952	18,199	5,794	0.01	0.00	2,407	0.13	0.11	4,782	0.10	0.00
1985	45,586	476,260	21,386	-22,692	-0.05	-0.01	3,187	0.15	0.12	-670	-0.01	-0.12
1986	42,427	478,920	21,383	2,660	0.01	0.00	-3	0.00	0.00	-3,159	-0.07	-0.08
1987	50,700	517,773	23,032	38,853	0.08	0.02	1,649	0.07	0.06	8,273	0.16	0.09
1988	65,197	598,578	24,752	80,805	0.13	0.03	1,720	0.07	0.06	14,497	0.22	0.14
1989	80,802	698,060	27,809	99,482	0.14	0.03	3,057	0.11	0.09	15,605	0.19	0.08
1990	95,814	844,733	35,463	146,673	0.17	0.03	7,654	0.22	0.17	15,012	0.16	-0.05
1991	120,298	976,937	45,944	132,204	0.14	0.03	10,481	0.23	0.18	24,484	0.20	-0.01
1992	134,150	1,034,084	56,404	57,147	0.06	0.01	10,460	0.19	0.15	13,852	0.10	-0.06
1993	164,974	1,266,727	67,449	232,643	0.18	0.04	11,045	0.16	0.13	30,824	0.19	0.02
1994	196,912	1,225,396	80,777	-41,331	-0.03	-0.01	13,328	0.16	0.13	31,938	0.16	0.04
1995	246,923	1,389,545	98,749	164,149	0.12	0.02	17,972	0.18	0.15	50,011	0.20	0.03
1996	273,439	1,448,771	112,831	59,226	0.04	0.01	14,082	0.12	0.10	26,516	0.10	-0.01
1997	297,130	1,411,447	127,855	-37,324	-0.03	-0.01	15,024	0.12	0.09	23,691	0.08	-0.01
1998	329260	1,384,812	135,867	-26,636	-0.02	0.00	8,012	0.06	0.05	32,130	0.10	0.05
1999	361,389	1,358,176	143,879	-26,636	-0.02	0.00	8,012	0.06	0.04	32,130	0.09	0.05
2000	440,005	1,574,797	164,077	216,621	0.14	0.03	20,198	0.12	0.10	78,616	0.18	0.05
2001	395,995	1,392,172	160,095	-182,625	-0.13	-0.03	-3,982	-0.02	-0.02	-44,010	-0.11	-0.07
2002	456,542	1,489,056	176,999	96,884	0.07	0.01	16,904	0.10	0.08	60,547	0.13	0.04
2003	516,857	1,502,928	183,597	13,872	0.01	0.00	6,598	0.04	0.03	60,315	0.12	0.09
2004	601,799	1,542,542	184,838	39,614	0.03	0.01	1,241	0.01	0.01	84,942	0.14	0.13
2005	654,682	1,675,221	191,007	132,679	0.08	0.02	6,169	0.03	0.03	52,883	0.08	0.04

APPENDIX 6 : Regression for Transcendental Logarithm model

Dependent Variable: EG
Method: Least Squares
Date: 04/20/10 Time: 15:25
Sample: 1983 2005
Included observations: 23

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-42.72078	23.00767	-1.856806	0.0808
K_L	-125.1190	55.75219	-2.244199	0.0384
LOGI	4.432636	2.263513	1.958299	0.0668
N	-0.239733	1.231304	-0.194699	0.8479
LF	0.584010	0.735501	0.794031	0.4381
E	30.81569	14.50001	2.125219	0.0485

R-squared	0.338859	Mean dependent var	9.620992
Adjusted R-squared	0.144405	S.D. dependent var	6.429755
S.E. of regression	5.947418	Akaike info criterion	6.623250
Sum squared resid	601.3202	Schwarz criterion	6.919465
Log likelihood	-70.16737	Hannan-Quinn criter.	6.697747
F-statistic	1.742623	Durbin-Watson stat	1.802894
Prob(F-statistic)	0.178822		

Endnote

[i] Cost share of labor and capital in translog production function are

$$s_L = \frac{\delta \ln Y}{\delta \ln L} = \beta_L + 2\beta_{LL}\text{Log}L + \beta_{KL}\text{Log}K$$

$$s_K = \frac{\delta \ln Y}{\delta \ln K} = \beta_K + 2\beta_{KK}\text{Log}K + \beta_{KL}\text{Log}L$$

where s_L = cost share of labor
s_K = cost share of capital

[ii] This paper follows the translog cost function introduced by Christensen, Jorgenson and Lau (1973). Below translog cost function will be estimated to obtain conditional input demand function, cost share, own and cross price elasticities and elasticity of substitution.

$$\text{Log}C = \alpha_0 + \alpha_Y\text{Log}Y + \frac{1}{2}\gamma_{YY}(\text{Log}Y)^2 + \sum_i \gamma_i \text{Log}P_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij}\text{Log}P_i\text{Log}P_j + \sum_i \gamma_{Qi}\text{Log}Y\text{Log}P_i$$

This cost function is derived as a second-order Taylor series approximation of the logarithm of equation (2). Since input i is labor and input j is capital, the price of labor (P_i) is wage while the price of capital (P_j) is capital. The cost function could be written as

$$\text{Log}C = \alpha_0 + \alpha_Y\text{Log}Y + \frac{1}{2}\gamma_{YY}(\text{Log}Y)^2 + \gamma_L\text{Log}w + \gamma_K\text{Log}r + \frac{1}{2}\gamma_{LL}\text{Log}w\text{Log}w + \frac{1}{2}\gamma_{LK}\text{Log}w\text{Log}r + \frac{1}{2}\gamma_{KK}\text{Log}r\text{Log}r + \frac{1}{2}\gamma_{LK}\text{Log}r\text{Log}w + \gamma_{QL}\text{Log}Y\text{Log}w + \gamma_{QK}\text{Log}Y\text{Log}r$$

This cost function could be written as below.

$$\text{Log}C = \alpha_0 + \alpha_Y\text{Log}Y + \phi(\text{Log}Y)^2 + \gamma_L\text{Log}w + \gamma_K\text{Log}r + \text{э}\text{Logwlnw} + \text{Ə}\text{Logwlnr} + \text{ə}\text{Logrlogr} + \text{Ə}\text{LogrLogw} + \gamma_{QL}\text{LogYognw} + \gamma_{QK}\text{LogYLogr}$$

where ф = $\frac{1}{2}\gamma_{YY}$

э = $\frac{1}{2}\gamma_{LL}$

Ә = $\frac{1}{2}\gamma_{LK}$

ә = $\frac{1}{2}\gamma_{KK}$

[iii] To recognize growth of manufacturing sector is contributed by which factor, the contribution of each factor will be compared. Particularly, if $\frac{\Delta A}{A}$ is smaller than $\alpha\frac{\Delta K}{K}$, economy growth is contributed more significantly by capital accumulation rather than technical progress. Consistent with this finding, price distortion policy with the objective to reduce unemployment will be designed.

However, if $\frac{\Delta A}{A}$ is larger than $\alpha\frac{\Delta K}{K}$, economy growth is said contributed more significantly more by technical progress compared to capital accumulation. Consistent with this finding, price distortion policy to increase output per worker in both level and growth rate in long run and also to reduce unemployment through increased quality and effectiveness of labor will be designed. For example, the country could invest more in education, knowledge, innovation, research and learning by doing to improve technical progress in production. The less significance of capital accumulation in contributing to economy growth might due to constant growth rate of output per worker. So, technical progress needs to be incorporated into production in order to increase economy growth.

Finally, the existence of steady state of output, consumption and capital per worker will be recognized by plotting production function, break-even investment and actual investment. From the balanced growth path, government needs to increase job vacancy and economy growth based on its endowment recognized from Solow Accounting Formula. If steady-state output per worker is less than the point where break-even investment intercepts with actual investment in growth path, investment and employment should be increased by either increasing capital or technology invention. However, if the plotted intercepts is on the right of point where break-even investment intercepts with actual investment, government needs to decrease inflation and economy bubble by either increasing interest rate or encourage export.

[iv] To obtain cost share of labour and capital, own and cross price elasticity for labour and capital is obtained respectively. Since ф = $\frac{1}{2}\gamma_{YY}$, э = $\frac{1}{2}\gamma_{LL}$, Ә = $\frac{1}{2}\gamma_{LK}$, ә = $\frac{1}{2}\gamma_{KK}$, the value of γ_{YY}, γ_{LL}, γ_{LK}, γ_{KK} and γ_{KL} could be calculated as below.

ф = $\frac{1}{2}\gamma_{YY}$

$-0.5086 = \frac{1}{2}\gamma_{YY}$

$\gamma_{YY} = -1.0172$

The own price elasticity for labour is as follows.

э = $\frac{1}{2}\gamma_{LL}$

$0.9247 = \frac{1}{2}\gamma_{LL}$

γ_{LL} = -1.8494

The cross price elasticity for labour is as follows.

$$Ə = \frac{1}{2}\gamma_{LK}$$

$$-0.0591 = \frac{1}{2}\gamma_{LK}$$

γ_{LK} = - 0.1182

The own price elasticity for capital is as follows.

$$ə = \frac{1}{2}\gamma_{KK}$$

$$-0.0790 = \frac{1}{2}\gamma_{KK}$$

γ_{KK} = -0.158

The cross price elasticity for capital is as follows.

$$Ə = \frac{1}{2}\gamma_{KL}$$

$$-0.0591 = \frac{1}{2}\gamma_{KL}$$

γ_{KL} = - 0.1182

Due to symmetry of cross price elasticity of inputs, $\gamma_{LK} = \gamma_{KL}$. The information on own and cross price elasticity of labour is used to obtain cost share of labour. Meanwhile, the information on own and cross price elasticity of capital is used to obtain cost share of capital.

[v] There is another technology that posses flexible elasticity of substitution – Variable Elasticity of Substitution (VES) production function. Assuming there are two factor inputs and one output, the Variety Elasticity of Substitution production function could be specified as below:

$Q = f(K,L) = K^{\gamma v}[L + b\gamma K]^{\alpha v}$

where γ = factor share of capital

α = factor share of labor

v = scale parameter

Since the manufacturing industry is assumed to employ two inputs in production, factor share of capital could be expressed as 1-α. Thus, the production function could be written as:

$Q = f(K,L) = K^{(1-\alpha)v}[L + b(1-\alpha)K]^{\alpha v}$

For estimation, assume factor share of labor is 0.2 and factor share of capital is 0.8 in production. Elasticity of substitution (σ) between capital and labor can be obtained through the below formula:

$$\sigma(k) = -\frac{f'(k)}{kf(k)}\frac{f(k)-kf'(k)}{f''(k)} > 0$$

After manipulation, the elasticity of substitution is

$\sigma(k) = 1 + bk$

where k = capital-labour ratio

To obtain the value of b for the estimation of elasticity of substitution, $f_L = \frac{w}{p}$ for labour under the implication of profit maximization. This elasticity of substitution clearly varies with the level of per capital capita, an index of economic development. So, factor substitution affects development process and economic growth.

To incorporate the elasticity of substitution into this production function,

$Q = K^{1-\alpha}L^{\alpha}[\alpha+(1-\alpha)\sigma(k)]^{\alpha}$

This production function could be decomposed into two parts: Cobb Douglas part, $AK^{1-\alpha}L^{\alpha}$ and a part that depends on the variable elasticity of substitution, $[1-(1-\alpha)+(1-\alpha)\sigma(k)]^{\alpha}$. The second part corrects the departure of the elasticity of substitution from unity.

In the special case of constant return to scale of v=1, the marginal product of capital and labor are

$$f_K = \frac{\partial Q}{\partial K} = (1\text{-}\alpha)\frac{Q}{K} + \alpha[b(1\text{-}\alpha)]\frac{Q}{L+b(1\text{-}\alpha)K} = \frac{r}{p}$$

$$f_L = \frac{\partial Q}{\partial L} = \frac{\alpha Q}{L+b(1-\alpha)K} = \frac{W}{p}$$

The formula of obtaining marginal rate of technical substitution in this technology is as below.

$$\text{MRTS} = \frac{f_L}{f_K} = \frac{\alpha}{1-\alpha}\left(\frac{K}{L+b(1-\alpha)K}\right) + \frac{1}{b(1-\alpha)}$$

After manipulation, the elasticity of substitution is

$\sigma(k) = 1 + bk$

where k = capital-labour ratio

For estimation of b, $f_L = \frac{w}{p}$ under implication of profit maximization. Since $\alpha = 0.2$ and $1\text{-}\alpha = 0.8$,

$$b = \frac{0.2QP - LW}{0.8WK}$$

Using this equation, the value of b is obtained. Then, the ratio of capital-labour each year is calculated by dividing capital with labour every year to obtain capital-labor ratio (k) each year. Then, the capital-labor ratios will be multiplied with b and add the number of one to obtain elasticity of substitution every year. Since the value of b is negative, the elasticity of substitution is less than one.

Comparing the elasticity of substitution between Variable Elasticity of Substitution and Transcendental Logarithm production function, it is found that the factor substitution between labour and capital for firm applying Transcendental Logarithm production function is easier than Variable Elasticity of Substitution production function. According to de la Grandville Hypothesis, Transcendental Logarithm production function is more suitable for manufacturing firm to produce output compared to Variable Elasticity of Substitution production function. It is because firm applying Transcendental Logarithm production function could maximize profit or minimize cost by changing its input combination more efficiently compared to firm applying Variable Elasticity of Substitution. The inelastic factor substitution in Variable Elasticity of Substitution suggests that the manufacturing firm in Malaysia only can reduce the use of capital and increase the employment of labour in small percentage when marginal product of labour increases or wage decreases. Similarly, the manufacturing firm will only increase the use of capital and reduce the labour share in production in small percentage when marginal product of labour reduces or wage rises. It leads to slower convergence toward steady state and growth of economy.

Since the smaller elasticity of substitution in Variable Elasticity of Substitution implies that manufacturing firm is quiet difficult to substitute one input for another input when marginal product or price of inputs change, Transcendental Logarithm technology is better than Variable Elasticity of Substitution technology. Thus, Transcendental Logarithm production function is chosen for analyze in this study.