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DETERMINANTS OF TOTAL FACTOR PRODUCTIVITY GROWTH IN MALAYSIA

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This paper attempts to analyse the total factor productivity (TFP) growth rate in Malaysia during 1971 – 2004 and to discuss factors that determine TFP growth. Data envelopment analysis (DEA) approach is used to estimate the changes in the production frontier. The Malmquist productivity index has decomposed total factor productivity into technological change (TECHCH) and technical efficiency change (EFFCH). Empirical results suggest that TFP growth of the Malaysian economy for the entire test period has not been encouraging due to negative contribution from technical efficiency. This result reveals that the economy were able to cause shifts in their own frontier due to innovation. The economy needs an enhancement of their productivity-based catching-up capability, specifically the effective use of human capital in the labor market, increase the number of skilled workers to operate a more sophisticated technology, and the adoption of the new technology. The results of TFP growth model show that openness to foreign companies and world economy, restructuring of the economy through a shift of resources between sectors, and the presence of foreign companies' in Malaysia is believed to be major contributor to TFP growth.

1. Introduction

The spectacular growth of Malaysian economy during 1960-1990 earned Malaysia the designation of being one of the "East Asian Miracles" [World Bank 1993]. The steady rate of growth achieved over such a long period is remarkable. The economy achieved annual growth averaging 6 percent growth per annum in the 1960s, improving to 7.3

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percent during 1970-75. The Malaysian economy performed better in 1976-80 when the GDP growth rate was 8.6 percent per annum. This was followed by a slower growth rate of 5.1 percent per annum in 1981-85 and again picking up to 6.7 percent per annum in 1986-90. During the period 1991-95 the economy grew even faster at 8.7 percent per annum, and then followed by a slower growth rate of 4.6 percent per annum in 1996-2000.

The East Asian Miracles have stimulated quite a number of studies debating the significance of the various factors in explaining East Asia's economic performance. All studies point to agree on one thing – the accumulation of physical and human capital has been the major driver of growth. Countries that invested more in physical and human capital grew faster, a conclusion long predicted by neoclassical growth model. Such a conclusion however has generated some pessimism – if the growth is input rather than productivity driven, then continuing high growth rates are not sustainable in the long run since the returns of capital are subject to diminishing returns.

According to growth accounting method, there are three elements that contribute to the production of goods and services: labour, capital and technology (also known as TFP). Labour and capital, known collectively as the "factor of production", refer to the workforce and the capital goods (buildings, machines, vehicles, etc) that use in producing products or providing services. Technology or TFP refers to all the methods employed by labour and capital to produce goods or services more quickly and more efficiently. No one denies that all three elements must be present to some degree if an economy is to grow. What is subject to debate is the contribution of the factor of production relative to that of technology.

Based on that argument, we can conclude that there are two distinct sources of growth. The first is input-driven, i.e. by adding more and more resources into the same production function. Such growth is hard work and by the law of diminishing returns, cannot be sustained indefinitely. The second is technology-driven, which invokes increasing returns and can be sustained. Technology-driven growth is difficult to measure directly, but what is not input-driven is by default technology-driven, which has come to be called TFP growth.

This paper attempts to analyse the total factor productivity growth rate of Malaysia during 1971- 2004. Based on the research done by World Bank (1993), the situation where the contribution of TFP growth less than 30 per cent of gross domestic products (GDP) growth is considered poor and will be needed a policy review. Besides this, other objectives of this paper will look at factors that determine TFP growth. Knowing what factors will influence TFP growth can lead to useful policy implications.

2. Literature Review

Both theoretical and empirical studies have documented the importance of TFP for long-term growth (Solow 1956). Although there are many ways of measuring TFP, but the two indices most often used in empirical research are Kendrick's arithmetic measure (1961) and Solow geometrix index (1957). Solow's approach to measure TFP is through calculating growth accounting equation. This is called residual approach, whereby, the value of residual is obtained after the contribution of physical inputs is determined. This value will depend on the number of dependent variables incorporated in the production function. The limitation of this approach is, when data on the share of inputs, for example, share of wages and profits in national income are not available. To overcome this problem, an alternative approach is used in the literature, through estimating the regression of growth equation. Through this approach the value of residual will decrease whenever the number of dependent variables increases. For example, in the growth function with two inputs, physical capital and quantity of labour are normally utilized but not their qualities. However, quality of labour can be measured through educational attainment, which can directly be used as one of the independent variables besides capital and labour. These two approaches will produce different value of residual where the smaller residual is found in the latter approach (Denison 1962, 1967; Jamison & Lau 1982; Hector Correa 1970; Hicks 1980; Walter & Robinson 1983; Otani & Villanueva 1990; Lau, Jamison, Liu & Rivkin, 1993).

An increase in the level of productivity reflects an increase in the efficiency of inputs. Hence, the same level of inputs can produce a higher output level, which means that the cost of production reduces. In other words, it reflects an improvement in the quality of inputs. There

are several factors affecting productivity such as level of technology and socio-demographic (Bhatia, 1990). Other factors like human resource development (HRD), human resource management (HRM), institutional restructuring may also influence productivity. Bhatia (1990) argued that lower level of technology and unstable socio-demographic changes causing low productivity in India as compared to the United States and the United Kingdom. In his study of manufacturing sector using 1965-1985 data, it was shown that factor efficiency was influenced by factor of production, workplace and working condition, socio-economic and socio-politics.

TFP does not merely mean technological improvement, but also improvement in quality of inputs due to other factors like HRD and HRM. Many researchers argue that TFP as a contribution of technological advancement (Kartz, 1969, Pickles, 1990). Kartz calculated residual factors to show the contribution of technological progress to output and labour productivity growth in Argentina in the period 1946-1961. He concluded that capital was the major determinant of labour productivity besides TFP. Pickles (1990) looked at the economic growth of Iraq and found that apart from technological improvement experienced by this country, capital was still the main contribution to output growth.

Baier *et al* (2002) examine the relative importance of the growth of physical and human capital and the growth of TFP on 145 countries. They found that TFP growth is an unimportant part of average output growth across all countries. The weighted-average TFP growth is only about 0.13 per cent per year, which is about 8 per cent of growth of output per worker. This hardly is suggestive of technological progress. This world average masks interesting variation across countries and regions. TFP growth accounts for about 25 percent of output growth per worker for the Western countries including United States; 20 per cent for Southern Europe; and 18 per cent for Newly Industrialised countries. On the other hand, Central and Southern Africa, Central and Eastern Europe and the Middle East have negative TFP growth. Across all countries, variation in aggregate input growth per worker could account for as much as 32 percent of the variance of the growth of output per worker across countries; variation in TFP growth could account for as much as 84 percent of that variance. Much of the importance of the

variance of TFP growth appears to be associated with negative TFP growth.

Young (1995) found that the spectacular growth of Singapore over the last thirty years was not due to TFP growth but rather to intensive use of inputs. The annual TFP growth for the entire economy averaged to a mere 0.2 per cent during the 1966-90 period. Even more alarming for Singapore, the same study found her manufacturing sector has experienced a -1 per cent annual growth over the same period.

Ikemoto (1986) provided estimates of the TFP growth rate for 1970-1980 for several Asian economies using the Tornqvist index. He differentiated between the contributions of domestic and imported capital. His results indicate that productivity growth was positive in all economies considered. The contributions of TFP growth to overall growth in Taipei, China and Republic of Korea are very high. On the other hand, those of Hong Kong, China; Malaysia; Philippines; Singapore; and Thailand are much lower. Ikemoto indicates that in the cases of Hong Kong, China; Malaysia; and Singapore these economies already have a high level of technology, and thus it is more difficult to realize productivity gains.

Maisom & Arshad (1992) using data of manufacturing survey in Malaysia from 1973-1989 showed that TFP increased each year but its contribution to the manufacturing sector growth was still small. Further in their study, it was shown that TFP was larger in the foreign owned firms as compared to the local ones. They concluded that foreign investors had achieved higher benefits from technological progress in Malaysia.

Using the same data source, Nik Hashim (1998) focused his study on the contribution of TFP to output or productivity growth in the manufacturing sector in Malaysia as a whole between the period 1985-1994. His study revealed that capital was a major determinant of productivity growth, and TFP still played a very minimal role.

3. Theoretical Framework

There are many ways of measuring TFP, but the method used in this study is the output-oriented model of Data Envelopment Analysis

(DEA). The DEA is a special mathematical linear programming model and test to assess efficiency and productivity. It allows use of panel data to estimate changes in total factor productivity and breaking it down into two components namely, technological change (TECHCH) and technical efficiency change (EFFCH).

TFP growth measures how much productivity grows or declines over time. When there are more outputs relative to the quantity of given inputs, then TFP has grown or increased. TFP can grow when adopting innovations such as electronics, improved design, or which we call "technological change" (TECHCH). TFP can also grow when the industry uses their existing technology and economic inputs more efficiently; they can produce more while using the same capital, labor and technology, or more generally by increases in "technical efficiency" (EFFCH). TFP change from one year to the next is therefore comprised of technological change and changes in technical efficiency.

This study uses the output-oriented model of DEA-Malmquist to put much weight on the expansion of output quantity out of a given amount of inputs. Therefore, TFP index is a ratio of the weighted aggregate outputs to weighted aggregate inputs, using multiple outputs and inputs.

Input and output quantities of a group of firms are sets of data used to construct a piece-wise frontier over the data points. Efficiency measures are then calculated relative to this frontier that represents an efficient technology. The best-practice company determines the production frontier, that is, those that have the highest level of production given a level of economic inputs. Points that lie below the piece-wise frontier are considered inefficient while points that lie on or above the frontier are efficient.

Since many inputs are used, and shared outputs may be produced, the Malmquist approach was developed to combine inputs and outputs and then measure changes. The Malmquist index measures the total factor productivity change (TFPCH), between two data points over time, by calculating the ratio of distances of each data points relative to a common technology.

Fare *et al*. (1994) specify the Malmquist productivity change index as:

$$m_o(y_{t+1}, y_t, x_t) = [\frac{d_o^{t+1}(y_t, x_t)}{d_o^{t+1}(y_{t+1}, x_{t+1})} x \frac{d_o^t(y_{t,} x_t)}{d_o^t(y_{t+1,} x_{t+1})}]^{\frac{1}{2}} \quad (1)$$

The above equation represents the productivity of the production point (x_{t+1},y_{t+1}) relative to the production point (x_t,y_t). This index uses period *t* technology and the other period *t+1* technology. TFP growth is the geometric mean of two output-based Malmquist-TFP indices from period *t* to period *t+1*. A value greater than one will indicate a positive TFP growth from period *t* to period *t+1* while, a value lesser than one will indicate a decrease in TFP growth or performance relative to the previous year.

The Malmquist index of total factor productivity change (TFPCH) is the product of technical efficiency change (EFFCH) and technological change (TECHCH) as expressed (Cabanda, 2001):

$$\text{TFPCH} = \text{EFFCH x TECHCH} \quad (2)$$

The Malmquist productivity change index, therefore, can be written as:

$$m_0(y_{t+1}, x_{t+1}, y_t, x_t) = \text{EFFCH x TECHCH} \quad (3)$$

Technical efficiency change (catch-up) measures the change in efficiency between current (*t)* and next (*t+1)* periods, while the technological change (innovation) captures the shift in frontier technology.

As expressed by Squires and Reid (2004), technological change (TECHCH) is the development of new products or the development of new technologies that allows methods of production to improve and results in the shifting upwards of the production frontier. More specifically, technological change includes both new production processes, called process innovation and the discovery of new products called product innovation.

With process innovation, firms figure out more efficient ways of making existing products allowing output to grow at a faster rate than economic

inputs are growing. The cost of production declines over time with process innovations --new ways of making things.

Technical efficiency change, on the other hand, can make use of existing labor, capital, and other economic inputs to produce more of same product. An example is increase in skill or learning by doing. As producers gain experience at producing something they become more and more efficient at it. Labor find new ways of doing things so that relatively minor modifications to plant and procedures can contribute to higher levers of productivity.

Panel data allow for an estimation of technical progress (the movement of the frontier established by the best-practice firms) and changes in technical efficiencies over time (the distance of the inefficient firms from the best practice firm) or catching up.

3.1 TFP Determinants

Determinants of TFP can be organized into several conceptual variables, each of which can be operationalized with one or more variables:

i. Education and Training. Education and training of the workforce, to upgrade skill and knowledge, will result in higher-skilled and more efficient workers, thus leading to better quality products and services. Manpower development has proved to be an effective means of improving productivity around the world.

ii. Economic Restructuring. Economic restructuring relates to movements of resources from less productive to more productive sectors of the economy. In fact, the various stages of development are associated with restructuring of economies toward higher value added activities.

In agricultural economies and economies with labour intensive manufacturing activities, labour is the critical factor driving growth. As industrialization progresses, the country's comparative advantage shifts toward activities that depend on increasing capital investments. The range of industries broadens. A higher level of capital intensity, as well as higher technical and skills levels of the workforce characterizes these industries.

Finally, as the economy matures, innovation takes over as the engine of growth. At this stage, industrial widening deepening give the country a broad and upgraded industrial mix. The actual pace of progression from one stage to another depends largely on how successful the process of economy restructuring from the less productive to the more productive industries is managed.

iii. Capital Structure**.** Capital structure relates to the production of investment in productive capital inputs. The composition of capital investments has an effect on TFP growth because the yield from investments in machinery and equipment, which are productive capital inputs, yield immediate output, whereas those in infrastructure, plant and buildings undergo a gestation period.

iv. Technical Progress. Technical progress relates to the effective and efficient utilization of technology, capital, work attitudes and management effectiveness. Technical progress arises from improvement made in four major areas: workforce, capital, system and technology. It reflects the impact of a wide range of factors, from individual work attitudes to technology exploitation. Based on the experiences of developed countries such as United States, Japan, France and the United Kingdom, and given the limits of economic restructuring and improvement of the educational profile of the workforce, technical progress should eventually be the main source of TFP growth.

v. Demand Intensity. Demand intensity reflects the extent of the productive capacity of the economy. Demand changes influence TFP through the capacity utilization rates of machinery and equipment. A slowdown in demand intensity will result in lower utilization rates of machinery and equipment.

Hence, the model used in this study is as follows:

$$TFPG = f[CAP, TRADE, FC, MFG, TER] \quad (2)$$

Where:

	TFPG	=	Total factor productivity growth
	CAP	=	Capital per GDP or investment rate
	TRADE	=	Export + Import per GDP or trade ratio to GDP
	FC	=	Percentage of foreign-owned companies
	MFG	=	Annual manufacturing sector output growth
	TER	=	Percentage of employed persons acquired tertiary education

Capital per GDP [CAP] measures investment rate. The theoretical arguments with regard investment is that a high investment rate increases the capital stock and this can permanently increase the growth rate through economic of scale and other beneficial side effects.

The percentage of the presence of foreign companies' in Malaysia [FC] which measures foreign ownership with potential technology transfer, was used as a proxy to technical progress.

Another contributor to TFP growth was the restructuring of the economy through a shift of resources between sectors. A shift of inputs from resource-based sectors to the manufacturing sectors generated higher output. It is believed that manufacturing sector is the main contributor to TFP growth in Malaysia. As manufacturing sector grows, TFP growth is expected to grow in the same direction.

Openness to the world economy is another important factor for explaining rapid TFP growth. The theoretical case for this view rests not only on allocate efficiency, but also on externalities associated with trading activities and on "X-efficiency" gains from creating a more competitive environment for domestic industry. The theoretical argument is that export and import orientation increases the openness of the economy and by exposing it to foreign technology and competition, encourages a rapid rate of technological progress.

The use of 'education level' [TER] is an attempt to test for externalities in human capital formation. The tertiary education can have growth enhancing externalities through the better ability to use and master technology. These externalities may be included in the estimates of TFP change.

3.2 Data Sources

Data on GDP, capital, labour, export and import of Malaysia over the 1970 – 2004 period are obtained from Economic Report published by the Ministry of Finance, Malaysia. All variables in value terms are measured in 1987 Malaysian Ringgit. Data on number of foreign companies, percentage of employed person acquired tertiary education are obtained from Monthly Statistical Bulletin, Quarterly Statistical Bulletin and Yearbook of Statistics published by Department of Statistics, Malaysia.

4. Estimation Results

4.1 TFP Growth of Malaysia

The results of the study reveal that between 1971 and 2004 TFP growth of the Malaysian economy for the entire test period has not been encouraging due to negative contribution from technical efficiency. However, technical change is positive with an index growth of 1.038. This result is consistent with the findings by Mahadevan (2002a) and Rahmah and Nyet (2002). This implies that, in general Malaysian economy is operating at below of its maximum potential output. Source of TFP growth was mainly due to technical progress. This result reveals that the economy were able to cause shifts in their own frontier due to innovation. However, index growth of only 1.005 reflects that level of technology in the economy is still moderate and technological adoption can take place much easier. The economy needs an enhancement of their productivity-based catching-up capability, specifically the effective use of human capital in the labor market, increase the number of skilled workers to operate a more sophisticated technology, and the adoption of the new technology.

4.2 Trends in TFP Growth

There was a significant improvement of TFP growth in the 1970's. The TFP grew faster during 1970s, at an average of 5.5 per cent per year. The TFP growth then slowed down drastically, it registered a negative growth of 5.6 per cent per annum in 1980s and -2.6 in 1990s. During 1971 – 1985, it registered a negative growth of 0.4 per cent per annum. A different picture has emerged for the period 1995 – 2004. The TFP grew at an average of 4.1 percent per annum. For the study period 1971 – 2004, TFP grew at an average 0.5 per cent annually.

Table I: Decomposition of Total Factor Productivity Change

Time period	EFFCH	TECHCH	PECH	SECH	TFPCH
1971-1985	0.915	1.104	0.849	1.079	1.011
1986-2004	1.015	0.983	1.072	0.947	0.998
1971-1979	0.962	1.098	0.856	1.123	1.055
1980-1989	0.898	1.051	0.899	1.000	0.944
1990-1999	1.035	0.941	1.096	0.944	0.974
1995-2004	1.025	1.016	1.138	0.900	1.041
1971-2004	0.969	1.038	0.972	0.997	1.005

4.3 Factors Determining TFP Growth

Results from the estimation of equation (2) are presented in Table III. This is an attempt to test the relationship between various factors and rate of TFP change discussed earlier. The capital per GDP rate has a negative impact on TFP growth. The coefficient is negative and statistically significant at 5 per cent level. The estimate implies that an increase of the investment rate by 1 percentage point leads to a 0.008 percentage point decrease in the TFP growth. The view that the rapid transformation of the Malaysian economy in recent years is due mainly to input growth is further supported by the TFP growth model. From the estimated equation, investment rate has a negative, albeit small, influence on TFP growth. It may be that capital is accumulated at such high speed that the technology is not properly absorbed. In other words, there may be very substantial diminishing returns to capital.

What is surprising is the negative sign of the coefficient of manufacturing output growth rate. The manufacturing sector is expected

to spearhead Malaysia TFP growth whereas the coefficient has a negative sign. The Malaysian economy has undergone structural changes over the last two decades. Until the 1970's, the economy depended mainly on agricultural sector. Beginning from the 1980's, the country focused on changing its economic structure to that of industrial-based. Today, the country continues progressively towards economic development that is driven mainly by the manufacturing sector. The manufacturing sector currently accounts for about one-third of the GDP and more than three-forth of merchandise exports. The restructuring of the economy through a shift of resources between sectors is believed to be another contributor to TFP growth. Between periods 1980 to 2000, there was almost ten-fold increase in capital investment of manufacturing sector. But from the regression results, it appears that manufactured output growth was not accompanied by TFP growth. It appears again that perhaps technology was not properly absorbed.

However, other variables as expected positively influence TFP growth. As the number of foreign-owned company's increases, the higher the TFP growth. This probably because of the advance technology and management skills brought in by the foreign companies.

Export growth rate also positively influence the TFP growth. As export grows, the higher will be the TFP growth. This is presumably because of the pressure from international competition and benefits of economic of scale. This shift from domestic market dependence to production for export market will necessitate firms to venture into large scale operations and increase production capacity in order to enjoy the benefits of economic of scale. Large scale production will induce greater utilization of technology and skilled manpower and through these; efficiency and productivity enhancements will be obtained that will bring about lower unit costs of production.

Table II: Regression Results for TFP Growth

Model: $TFPG_t = \beta_0 + \beta_1 CAP_t + \beta_2 EXPTS_t + \beta_3 FC_t + \beta_4 MANFG_t + \beta_5 TER_t + \mu_t$

Estimated Model	R^2	DW
$TFPG_t$ = -4.3985 - 0.000184CAP_t + 4.3660$EXPTS_t$ (-2.5958) (-2.7148) (2.9557) 3.9254FC_t - 1.3862$MANFG_t$ + 0.1415TER_t (3.7748) (-2.3386) (-0.6081)	0.81458	2.6074

Note: Figures in parentheses are t-statistics

The proportion of labour with tertiary education is also associated with positive TFP growth. With a better quality of workforce, the learning curve and gestation period associated with the acquisition of new technology will be shortened. However, the coefficient is not statistically significant. Hence there is not enough evidence to conclude that tertiary education affects TFP growth.

5. Conclusion

This paper uses standard econometric techniques to estimate TFP growth and a TFP growth model for Malaysia. The results agree with those of previous studies that the fast growing Malaysia was based on the mobilization of inputs, with insignificant contributions from technical change. In other words, Malaysia grew by putting more people to work (from 30.5 per cent in 1970 to 39.8 per cent of the population in 2000) and investing heavily by 'perspiration rather than inspiration'. Growth in TFP attributable to innovative technology only accounts for a small fraction of GDP per labour growth. Malaysia's high growth may not be sustained on a long-term basis. Hence, a better option, as a long-term strategy for Malaysia, is to strive for a productivity-driven economic growth involving accumulation of labour and capital inputs and their qualitative improvements.

The results of TFP growth model show that openness to foreign companies and world economy has a more direct impact on TFP growth. The rapid growth of export as a result of the export-push policies and combined with the superior performance of Malaysia in allowing more

extensive foreign ownership explained the largest part of the TFP growth during 1980 to 2000.

Malaysia needs to improve TFP over time so that the dependence on physical inputs can be reduced. For this to be realized, several steps can be taken including human resource development, sound management system, appropriate technology and research and development. A productivity-driven economy will require higher level of professional and skilled manpower as well as administrative and managerial expertise and fostering cultural values that are inclined towards innovation.

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