Research Journal of Applied Sciences, Engineering and Technology 7(23): 4999-5005, 2014
DOI:10.19026/rjaset.7.891
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: February 06, 2014 Accepted: March 24, 2014 Published: June 20, 2014

Research Article

Total Factor Productivity and Its Contribution to Malaysia's Economic Growth

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Abstract: This study examines Total Factor Productivity (TFP) growth of the Malaysian economy from 1971 to 2007. By using the method of Data Envelopment Analysis (DEA), this study estimates the contribution of technological change and technical efficiency change to the TFP growth and further identifies the determinants of TFP. The results from this study show that for the overall periods between the years 1971 and 2007, the contribution of technological change to TFP is higher than the contribution of technical efficiency change. Similar results are found for the periods 1971-1985 and 1999-2007. Only for the period 1986-1998, the contribution of technical efficiency change exceeds that of technological change. The study found that even though TFP growth is a significant contributor to the economic growth, but its contribution is still lower than the capital and labor. In contrast, capital is the most important contributor to the economic growth of Malaysia. Further, the result shows that the manufacturing output growth is the main contributor to the growth of TFP, followed by the percentage of foreign-owned companies. The percentage of workers with tertiary education is not a significant determinant of TFP growth despite having a positive and the highest coefficient.

Keywords: Capital, labor, technical efficiency change, technological change, total factor productivity growth

INTRODUCTION

Total Factor Productivity (TFP) refers to total productivity of all input including physical inputs like capital and labor, input quality like technology and skills and management of inputs like total quality management and human resource management. TFP is often regarded to be relatively more important than the productivity of separate inputs like labor productivity and capital productivity since through this approach, the efficiency of inputs is measured in a composite manner and also by taking into account their quality. In other words, in measuring the contribution of input to output, elements other than the quantity of input will be included when measuring TFP. TFP growth is closely associated with technological change and they are mutually affective. Technological advancement is essentially a part of TFP growth since technology is an input in production process and TFP measures total productivity of inputs associated with the production process. Hence, an improvement in the level of technology naturally leads to increase in TFP growth.

An increase in productivity reflects improvements in efficiency of usage of each input. On the other hand, TFP is an improvement in overall efficiency of input use. Therefore, when TFP increases using the same input, production can be increased and simultaneously, the production cost can be reduced. There are number of factors which can influence efficiency such as technological level, socio-demographic, development and management of human resource as well as restructuring of institutions. They can affect efficiency in different ways and at varying degrees (Bhatia, 1990). Many researchers relate TFP growth to technological advancement (Kartz, 1969). To be more precise, TFP growth is not only a result of technological improvement, but enhancement in the quality of input, for example, through the development and management of human capital for labor quality.

Malaysia's rapid economic growth between the years 1960 and 1990 led to economists and analysts dubbing it as amongst the "East Asian Miracles" (World Bank, 1993). The rates of economic growth that achieved during some periods were impressive despite being punctuated by low growth rates during periods of economic crises. Malaysia's economy grew at an average rate of 6% per annum during the 1960s and rose to 7.3% for the period 1970-1975. In fact, its economic performance continued to improve during the 1976-1980 period with 8.6% annual growth rate. A slower growth rate of 5.1% per annum ensued for the

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1981-1985 period and from 1986 until 1990, the growth rate picked up to 6.7% per year. Further improvement was recorded for the period of 1991-1995 as the growth rate of the Malaysian economy increased at 8.7% a year. However, the pace lowered as the economy grew at only 4.6% for the period 1996-2000.

The term East Asian Miracles inspired many researchers to debate on the factors contributing to the economic growth of East Asian countries. All these researchers agree that physical and human capital accumulation were key determinants of economic growth. Countries that invest heavily on these two forms of capital have seen faster economic growth, a fact that is in line with the neoclassical growth model. However, the question arises on whether input or productivity that has more influences on economic growth. In other words, it is a question on the relative significance between quantity and quality. An input-driven growth is not sustainable since the returns to inputs naturally will diminish and it is followed by increased in the production costs.

The role of TFP growth to the growth of the Malaysia's economy has been gaining more attention. Initially, the growth of the Malaysia's economy was more driven by the contribution of the input quantities such as capital, labor and raw materials. To accelerate growth rate, the government had to shift its growth strategy towards the importance of the contribution of input quality and productivity, including TFP. Malaysia's economic growth strategy has shifted from input-driven growth to one driven by productivity and knowledge. These two aspects are becoming increasingly important contributors to economic growth of Malaysia.

This change of strategy by the government is aimed at accelerating economic growth to achieve developed nation status by 2020. The aim is to ensure that all processes of production are based on input quality and advanced technology to drive growth of output as well as reducing dependence on low-skilled labor. Besides, the contribution of TFP is seen as imperative since it signifies efficiency which can reduce cost because the same amount of input can be used to produce more output when there is an increase in TFP.

In Malaysia, the concept of TFP growth is relatively new. It was first mentioned in the Sixth Malaysia Plan (6MP) in line with the strategy of productivity-driven output growth. Nonetheless, technological improvements through technology transfer or technology development have received its deserved attention some time before that. The history of technology transfer is as old as the history of foreign investment in Malaysia which saw an influx of foreign capital into the country in the 1980s. When Malaysia introduced policies to augment secondary export and heavy industries in the 1990s, the emphasis on technological development intensified. Such emphasis was evident with large allocation of funds to Research and Development (R&D) activities.

Current economic growth strategy is to find new sources of economic growth based on the strategies outlined in the New Economic Model. The contribution of TFP growth is much more relevant in this approach. The main objective of this model is to identify new sources for Malaysia's economic growth which include measures to improve efficiency of input use in production. The services sector has been identified as a major contributor to growth in this model and thus it must seek to reduce production costs through improving input efficiency.

The objective of this study is to examine Total Factor Productivity (TFP) growth of the Malaysian economy from 1971 to 2007. Further, the study aims to investigate the effect of TFP growth on the Malaysia's economic growth and to identify the determinants of TFP growth.

CONTRIBUTION OF TFP TO THE ECONOMIC GROWTH OF MALAYSIA

As we progress towards the achievement of the vision of being an industrialized country by 2020, the performance of the Malaysian economy need to be at par with other industrialized countries. Table 1 and Fig. 1 show the comparison between the contribution of TFP growth in Malaysia and several selected New Industrial Countries (NICs). Based on the Table 1, Malaysia's GDP growth rate is recorded at a moderate rate, but it is higher in terms of percentage compared to the NICs such as South Korea and Hong Kong. Singapore is ahead with growth of 5.8%, followed by Indonesia with a growth rate of 5.4%. However, in terms of TFP growth, Malaysia recorded a lower percentage (1.6%) compared with NICs, namely Singapore (1.9%), South Korea (1.8%) and Hong Kong (2.5%). Malaysia's TFP growth is only ahead of Thailand (1.5%) and Indonesia (1.10%).

In reference to Fig. 1, the contribution of TFP growth to output growth of Malaysia is far behind, i.e., only at 31.6% compared to NICs, with Hong Kong (59.1%), South Korea (40.0%) and Singapore (32.8%). Thailand also recorded higher percentage than Malaysia at 33.3%. China as an emergent economy recorded a significant GDP growth rate (10.9%) with TFP growth rate of 3.9% and TFP contribution to output of 35.8%. Therefore, Malaysia really need to keep competing with the selected NICs and in fact has to overtake regional neighbors in TFP growth achievement to really become an industrialized country.

The contribution of TFP growth to the growth of the Malaysian economy has been addressed starting

Table 1: Comparison of sources of economic growth in selected countries, 2000-2012

	Period 2000-2012						
	Sources of economic growth (%)				Contribution to GDP (%)		
Countries	GDP	Labor	Capital	TFP	Labor	Capital	TFP
Malaysia	5.07	1.47	2.00	1.60	29.11	39.34	31.55
South Korea	4.50	1.00	1.70	1.80	22.22	37.78	40.00
Hong Kong	4.30	0.80	1.00	2.50	18.60	23.26	58.14
Singapore	5.80	2.70	1.20	1.90	46.55	20.69	32.76
Indonesia	5.40	1.20	3.10	1.10	22.22	57.41	20.37
Thailand	4.50	1.40	1.60	1.50	31.11	35.56	33.33
China	10.9	0.90	6.10	3.90	8.26	55.96	35.78

Adapted from MPC productivity report 2013

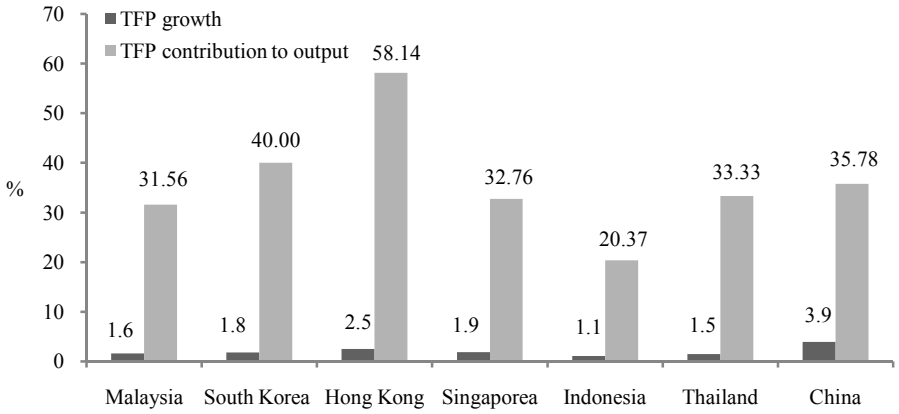

Fig. 1: TFP growth and contribution of TFP to output in selected countries, 2000-2012

Table 2: Growth in labor, capital, TFP and output

	Growth in (%)			
Period	Labor	Capital	TFP	GDP
1999-2003	1.22	2.18	1.88	5.24
2004-2008	1.58	2.27	2.14	6.98
2008-2012	1.49	2.00	0.76	4.25

Adapted from MPC productivity report, 2008 and 2013

with the Sixth Malaysia Plan (SMP) report. From Table 2, for the period 1999-2003, the contribution of TFP growth to GDP growth was 1.9 from 5.2% GDP growth. This contribution has increased to 2.1% for the period 2004-2008. The largest contributor to the growth of the Malaysian economy is capital input for all of the periods mentioned. However, the contribution of labor input growth was still relatively small at around 1.5%, while the contribution of TFP growth has shown a drop to just 0.8% for the period 2008-2012.

Between the years 2004-2008, TFP in Malaysia has been contributed by five main factors: the development of human capital, technological progress, economic structure, capital structure and intensity of demand (MPC, 2008). Among the five, the three most important factors contributing to the growth of TFP are the intensity of demand, followed by capital structure and human capital development. Although the development of technological progress become one of the core element in national policy, its contribution to TFP growth was the lowest among these factors.

LITERATURE REVIEW

Both theoretical and empirical studies have documented the importance of TFP for long-term growth (Solow, 1956, 1957). There are many ways of measuring and 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. 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, through estimating the neoclassical exogenous growth model. For example, in the growth model with two inputs, physical capital and quantity of labor are normally utilized without considering their qualities. However, quality of labor that can be measured through educational attainment can directly be used as one of the independent variables besides capital and labor in estimating the endogenous growth model (Denison, 1962, 1967; Jamison and Lau, 1982; Correa, 1970; Hicks, 1980; Walters and Rubinson, 1983; Otani and Villanueva, 1990; Lau *et al*., 1993). Other approaches

are using Stochastic Frontier Approach (SFA) and DEA (Coelli, 1996).

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. 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 efficiency was influenced by factor of production, workplace and working condition, socio-economic and socio-politics.

Baier *et al*. (2002) examines the relative importance of the growth of physical and human capital and the growth of TFP on 145 countries. They found that TFP growth plays an important role on average output growth across all countries. However, the contribution of TFP on economic growth varies across countries and regions. TFP growth accounts for about 25% of output growth per worker for the Western countries including United States; 20% for Southern Europe; and 18% for NICs. On the other hand, Central and Southern Africa, Central and Eastern Europe and the Middle East have 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% during the 1966-90 periods. Even more alarming for Singapore, the same study found her manufacturing sector has experienced a negative one 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. The study differentiated between the contributions of domestic and imported capital. The results indicate that productivity growth was positive in all economies under study. 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 (1986) 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.

In Malaysia, a number of studies on the TFP growth have focused on the manufacturing sector, while in the context of Malaysia as a whole is very limited. Idris (2007), who conducted a study on the period of 1971 to 2004 for the Malaysian economy argued that the low TFP growth was due to the negative contribution from technical efficiency. By using panel data, the study revealed that the economy was able to shift its own frontier, based on innovations and concluded that the presence of foreign companies in Malaysia was believed to be a major contributor to the TFP growth. Another study on the TFP for Malaysia covered the period from 1997 to 2006 obtained the growth in TFP at 1.6%, contributing 29.0% to GDP growth (Zaffrulla, 2007).

The studies in Malaysia for the manufacturing sector revealed that TFP growth of this sector even though positive, but it was substantially low, less than 0.5% (Mahadevan, 2002; Tham, 1997). By utilizing the same data on a different model to measure TFP growth, in contrast the results of the SFA model demonstrated that the TFP growth was consistently negative during the period from 1981 to 1996 (Mahadevan, 2001).

METHODOLOGY

DEA for TFP growth: The method used to measure TFP growth in this study is the output-oriented model of 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, 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, labour and technology, or more generally by increases in "Technical Efficiency" (EFFCH). TFP change from 1 year to the next is therefore comprised of technological change and changes in technical efficiency.

Malmquist Index for Change in or growth of TFP (TFPCH) is the product of Change in technical Efficiency (EFFCH) multiplied with Technological Change (TECHCH) which can be presented as (Cabanda, 2001):

$$TFPCH = EFFCH \times TECHCH \quad (1)$$

Therefore, the Malmquist productivity change index can be presented as:

$$m_0 (y_{t+1}, x_{t+1}, y_t, x_t) = EFFCH \times TECHCH \quad (2)$$

Fare *et al*. (1994) and Coelli (1996) argue that the output oriented Malmquist Productivity Index (MPI) can be defined as geometric mean of two indices based on period s and period t technologies. We have:

$$m_0(y_s, y_t, x_s, x_t) = [m_0^s(y_s, y_t, x_s, x_t) m_0^t(y_s, y_t, x_s x_t)]^{1/2} \quad (3)$$

$$= [\frac{d_0^s(x_t, y_t)}{d_0^s(x_s, y_s)} x \frac{d_0^t(x_t, y_t)}{d_0^t(x_s, y_s)}]^{1/2} \quad (4)$$

Equation (2) assumes no technical inefficiency. However, it is common to observe some degree of inefficiency in the operation of most firms (Coelli, 1996). Therefore, Eq. (2) can re written as:

$$m_0(y_s, y_t, x_s, x_t) = \frac{d_0^t(x_t, y_t)}{d_0^s(x_s, y_s)} [\frac{d_0^s(x_t, y_t)}{d_0^t(x_t, y_t)} x \frac{d_0^s(x_s, y_s)}{d_0^t(x_s, y_s)}]^{1/2} \quad (5)$$

Where the first ratio outside the bracket measures technical efficiency change between the two periods, s and t and the two ratios inside the bracket measure the shift in technology between the two periods or referred as technological change. The equation above represents productivity for production point (x_s, y_s) comparative to production point (x_t, y_t). Values more than one indicates positive TFP growth for time periods to time period and value less than one indicates negative TFP growth, or decline in performance compare to previous period.

As presented by Squires and Reid (2004), TECHCH is the new production development or new technological development that enables improved production methods and consequently moves production frontiers upwards. Specifically, technological change includes new production processes i.e., innovation and finding of new product i.e., product innovation. Through innovation, firms have succeeded in finding more efficient methods to produce existing products and with it more expansion in output than increase in input.

Innovation also opens the doors to new, more efficient, methods in production which decreases average cost of production. Change in technical efficiency, meanwhile, is the more efficient use of existing capital, labor and other economic input to produce more output. A good example is improvements in skills and experience among workers.

This method requires firm's data to get better results. This is because the aggregate data cannot segregate the difference in technology used by each firm and assuming the firm in the same industry using the same technology. However, in reality, they are not homogenous. Nonetheless, difficulties in getting data prompted many researchers to use aggregated data. The study uses DEA approach since the analysis involve a macro level time series data using package introduced by Coelli (1994, 1996).

Models for output and TFP determinants: When the value of TFP change obtained from the DEA, the study will look at the effect of TFP to economic change using regression model:

$$lnY_t = \beta_0 + \beta_1 lnCAP_t + \beta_2 lnLAB_t + \beta_3 TFP_t + \mu_t \quad (6)$$

where,

Y = The GDP, CAP representing capital
LAB = The number of workers
TFP = The growth of total factor productivity

In order to identify the determinants of TFP, we use the equation as follow:

$$TFPG_t = \alpha_0 + \alpha_1 CGDP_t + \alpha_2 MOG_t + \alpha_3 EXM_t + \alpha_4 TER_t + \alpha_5 FOC_t + \varepsilon_t \quad (7)$$

where,

TFPG = Growth in total factor productivity
CGDP = The ratio of capital to GDP
MOG = The output growth of the manufacturing sector
EXM = The ratio of export plus import to the GDP
TER = The percentage of workforce with tertiary education
FOC = The percentage of companies with foreign ownership

Source of data: Data on GDP, capital, labor, export and import of Malaysia over the 1970-2007 periods are obtained from Economic Report published by the Ministry of Finance, Malaysia. All the value terms variables are measured in real using 1987 as base year. 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.

RESULTS

Value of TFP: According to the DEA approach and stochastic frontier, two important components contributing to the growth in TFP are technical efficiency change and technological change. Results of the estimations are reported in Table 3. Overall, between the years 1971 and 2007, the contribution of technological progress to TFP is higher than technical efficiency. The fact applied for the periods 1971-1985 and 1999-2007. Only for period 1986-1998 the contribution of technical efficiency exceed that of technological advancement. This period contain two episodes of economic crises those are in 1985/86 and 1997/98. This may explain the difference recorded in this period compared to others. The economic hardship hindered technological progress with foreign investors pulling out funds from the economy resulting in less

Table 3: Technical efficiency, technological change and TFP growth in Malaysia, 1971-2007

	Technical efficiency	Technological change	Growth in TFP
1971-1985	0.915	1.104	1.011
1986-1998	1.026	0.963	1.018
1999-2007	0.979	1.062	1.061
Overall 1971-2007	0.964	1.042	1.033

Table 4: Results of estimation of output growth model

Variable	Coefficient	t-value
Constant	-2.2246	-4.1709***
ln CAP	0.3677	5.4518***
ln LAB	0.1962	7.0122***
TFP	0.0750	2.0690**
R^2	0.9968	
N	27	

***: Significant at 1% significance level; **: significant at 5% significance level

Table 5: Determinants of TFPG

Variable	Coefficient	t-value
Constant	-4.409000	-2.5811**
CGDP	0.000186	2.6987**
MOG	0.358800	2.2888**
EXM	4.337000	2.9150**
TER	0.526000	0.4338
FOC	3.977400	3.8222***
R^2	0.811800	
N	27	

***: Significant at 1% significance level; **: significant at 5% significance level

purchase of new machinery and equipments. However, this difficulty forced the production sector to find ways to operate with more efficiency by reducing input while maximizing output as well as employing new production strategies. The economic uncertainty has forced producers to intensify their efforts to regain the losses and their former level of performance.

TFP and output change: Table 4 presents the results of the estimation of Eq. (4). The study found that TFP is a significant contributor to the economic growth of Malaysia. However, it is still much less influential relative to other inputs of production, namely, labour and capital. Capital elasticity was found to be the highest, seconding the finding by MPC (2013) which indicated that capital is the most important contributor to the economic growth of Malaysia. The contribution of factors including TFP growth towards economic growth of Malaysia is illustrated in Fig. 2.

Determinants of TFP growth: Table 5 presents the results of the estimation of Eq. (6). The most important factor contributing to the growth of TFP in Malaysia is manufacturing output growth, followed by the percentage of foreign-owned companies. The percentage of workers with tertiary education is not significant despite having a positive and the highest coefficient. The ratio of trade to GDP and the percentage of foreign-owned companies are very much related to the development and transfer of technology. For a company that imports and foreign-owned companies which are mostly larger or medium sized

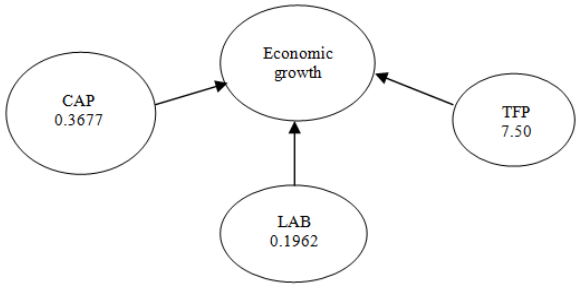

Fig. 2: Elasticity of output to input

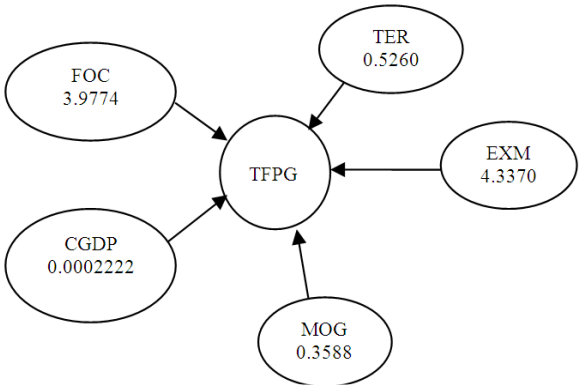

Fig. 3: Determinants of TFP growth

companies, technology can expand more rapidly either through transfer of technology or technology development. They also record better efficiency in input use due to the influence of more local and foreign expertise working for them. It explains their more significant role in influencing TFP growth. Figure 3 describes the role of each factor in determining TFP growth.

CONCLUSION

Overall, economic growth in Malaysia has been dependent on capital and labor input, while TFP contribution is still very small. A host of factors in turn determines TFP with the most important ones being the export-import ratio to GDP and the percentage of foreign-owned companies operating in the country. Output growth of the manufacturing sector is also very important as a factor in TFP growth.

These findings imply that Malaysia needs to augment TFP growth to increase its contribution to output growth.TFP grow this essential as it involves efficiency in input use and this is related to reducing the cost of production. One most important step is to improve technical efficiency in using production inputs. There are a number of methods to do this. One of the most obvious measures is to improve labor efficiency which can be done through training. Quality of labor is of great importance since it is much more effectual than its quantity.

For capital, its efficiency can be improved through better management. Purchasing more suitable machinery can help the cause. Efficiency in using machinery and equipment is also closely related to the skills of available labor. A worker equipped with better skills can handle machines more efficiently and maximize output. Since acquisition of state-of-the-art machinery and equipment is one of the method to improve technology, capital input efficiency and technological progress must go hand in hand in order to increase TFP growth.

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