ASEAN Economic Bulletin Vol. 28, No. 3 (2011), pp. 360–73 ISSN 0217-4472 print / ISSN 1793-2831 electronic

DOI: 10.1355/ae28-3e

The Malaysian Path to Sustainable Development in the Manufacturing Sector

Renuka Mahadevan

This paper examines the two sources of total factor productivity growth (TFP), namely technological progress (TP) and technical efficiency (TE) in the Malaysian manufacturing sector. This sector's TFP growth was found to be below 1.5 per cent over 1970–2002, and while TE was negative, TP although positive was decreasing over time. Factor accumulation resulted in some TP but this was at the expense of TE. Other factors such as foreign direct investment and market power influenced TP and TE in opposing directions, highlighting the need to consider the impact of various policies on the trade-offs and dynamics underlying TP and TE for optimal TFP growth. Thus, policy coordination is crucial for sustainable growth but at the same time leapfrogging into advanced sectors without sufficient learning-by-doing need to be avoided.

Keywords: Total factor productivity, technological progress, technical efficiency, stochastic production frontier, Malaysia.

I. Introduction

Malaysia has come a long way from being a low-income developing economy to that of a high middle-income export-oriented economy. Its real per capita GDP has more than doubled from US$1,750 in 1975 to US$4,650 in 2004. Despite the 1997/98 financial crisis, the September 11 attacks in 2001 and the SARS epidemic in 2003, Malaysia's GDP has grown at an annual average of 4.6 per cent during 1996–2005. In addition, inflation rate averaged 3.2 per cent over 1996–2000 and 1.8 per cent over 2000–05, and unemployment rate has not exceeded 3.5 per cent over the last decade. As early as 1993, the World Bank hailed Malaysia as the next Asian newly industrializing country (World Bank 1993). Thus it is undeniable that the Malaysian economic story so far is a good news story. However, it remains to be seen if Malaysia can sustain its growth momentum to enter the league of developed industrial nations by 2020, envisaged as Vision 2020 in 1991.

The challenges facing the rapidly developing Malaysia in fulfilling its vision are different from those that developed countries of today faced in their times. Thus limited lessons can be drawn from the earlier experiences of the developed nations. Given Malaysia's openness and highly trading environment,[1] the vulnerability of the economy to external shocks necessitates rethinking of strategies for sustainable growth and development. The next phase of its transition to a developed country lies in Malaysia's ability to achieve global competitiveness as outlined in the Third Industrial Malaysian Plan 2006-2020. While Malaysia's global competitiveness rank of 23 out of 117 economies in 2005[2] is quite impressive, the recent Industrial Plan has identified total factor productivity (TFP) growth as holding the key for continued growth in the face of the more liberalized global economic environment of today.

While there have been numerous studies which have computed TFP growth measures for Malaysia and discussed policy-making, this paper differs in two aspects where policy analysis is concerned. By decomposing TFP growth into technical efficiency (TE) and technological progress (TP),[3] current policies are evaluated to highlight some flaws in policy thinking, and suggestions on how policy-making can be made more effective by appropriate policy coordination are discussed. This is done by first establishing the relationship between the two sources of TFP growth given by TP and TE in order to achieve optimal TFP growth. Second, as TP and TE are conceptually different, the implementation of a certain policy is shown to have opposing effects on TFP growth. Thus, the failure of current policies to take explicit account of these two types of policy analysis has major repercussions on the long term objective of achieving sustainable growth.

The above policy-making aspects are applied to the manufacturing sector (using 3-digit industry level data) which contributes about 30 per cent of the economy's GDP. The rest of the paper is organized as follows. The next section briefly reviews the Malaysian manufacturing sector. Section III sets out the theoretical framework underlying the stochastic production frontier to obtain measures of TFP growth and the two sources of TFP growth while section IV explains data sources and the variables used. The causality links between the sources of TFP growth are established in section V and the differing impact of polices are discussed in section VI. The last section summarizes the key findings of the paper.

II. The Malaysian Manufacturing Sector

The Malaysian manufacturing sector has undergone significant structural changes since the 1970s. Table 1 shows some summary statistics on the manufacturing sector.

The gross output shares indicate that the electrical and non-electrical machinery are important contributors and they also have the highest share of intermediate inputs. These are in part due to the large presence of foreign direct investment (FDI) in these industries since the mid 1980s. In particular, these industries are responsible for the production of semiconductors, integrated circuits, consumer electronics and electrical appliances. The highly capital-intensive industries are seen to comprise the petroleum refineries, industrial chemicals, and iron and steel. In the 1970s and 1980s, through the Heavy Industry Corporation Malaysia, the government ventured into a significant number of large-scale projects in these industries in a move to reduce dependency on foreign companies and in the hope that this would promote backward and forward linkages in the economy. However, this industrial policy was not successful and was discarded by the late 1980s.

The current industrial policy since the mid-1990s has been to attract FDI to industrial clusters set up in order to foster industrial linkages and competition. There is also a deliberate attempt to establish biotechnology and information and communication technologies (ICT) as new engines of growth.

III. The Stochastic Production Frontier Model

The frontier concept initiated by Farrell (1957) emphasizes the idea of maximality which it embodies, and represents the "best practice" technology. The frontier estimates a relationship

TABLE 1
Characteristic of Malaysian Manufacturing Industries
(Averaged over 1970–2002)

Industries	*Average shares in total manufacturing (%)*		*RM$'000*
	Gross Output	*Intermediate Inputs*	*Fixed Capital Assets Per Worker*
Food Products	4.89	7.17	45.76
Beverages	1.15	0.41	112
Tobacco	1.63	0.57	64.87
Textiles	3.07	1.01	80.82
Wearing Apparel except Footwear	0.32	0.05	13.97
Leather Products	0.29	0.07	15.87
Footwear	0.35	2.65	24.09
Wood Products except Furniture	3.98	1.41	39.40
Furniture	2.02	1.29	6.62
Paper	3.65	0.81	113.98
Printing and Publishing	3.11	3.79	62.17
Industrial Chemicals	4.89	2.89	569.04
Other Chemicals	3.06	7.47	125.69
Petroleum Refineries and Products of Petroleum and Coal	5.23	3.47	1339.86
Rubber Products	5.16	2.32	36.24
Plastic Products	2.35	2.66	34.46
Pottery, China & Earthenware	0.58	0.08	23.96
Glass Products	1.95	0.59	149.96
Non-Metallic Mineral Products	4.36	2.87	124.47
Iron and Steel	2.68	2.85	202.26
Non-Ferrous Metal	1.36	1.54	98.72
Fabricated Metal Products	5.69	2.35	36.03
Machinery except Electrical	7.52	14.98	30.09
Electrical Machinery	22.12	31.39	44.93
Transport Equipment	4.35	6.06	57.18
Professional and Scientific Equipment	2.0	1.26	11.11

SOURCE: Computed from UNIDO data set.

that provides a benchmark of a most efficient industry. The generalized version of the random coefficient frontier model (Kalirajan and Shand 1994) can be written as:

$$\ln Y_{it} = \gamma_{1i} + \sum_{j=1}^{n} \gamma_{ij} \ln X_{ijt} \qquad (1)$$

where i represents no. of industries;
j represents no. of inputs used;
t represents time period;
Y = output;
= inputs;
= intercept term of the i^{th} industry; and

= actual response of output to the method of application of the j^{th} input used by the i^{th} industry.

Since intercepts and slope coefficients can vary across industries, we can write:

$$\gamma_{ij} = \bar{\gamma}_j + u_{ij}$$
$$\gamma_{1i} = \bar{\gamma}_1 + v_{1i} \quad (2)$$

where $\bar{\gamma}_j$ is the mean response coefficient of output with respect to the j^{th} input;
u_{ij} and v_{1i} are random disturbance terms; and
$\mathrm{E}(\gamma_{ij}) = \bar{\gamma}_j$, $\mathrm{E}(u_{ij}) = 0$, $\mathrm{Var}\,(u_{ij}) = \sigma_{uit}$
for $j = t$ and zero otherwise.

Combining equations (1) and (2):

$$\mathrm{Ln}\, Y_{it} = \bar{\gamma}_1 + \sum_{j=1}^{k} \bar{\gamma}_j \,\mathrm{Ln}\, X_{ijt} + \sum_{j=1}^{n} u_{ij} \,\mathrm{Ln}\, X_{ijt} + v_{1i} \quad (3)$$

Following Aitken's generalized least squares method suggested by Hildreth and Houck (1968) and the estimation procedure by Griffiths (1972), the industry input-specific response coefficient estimates of the above model can be obtained. The highest magnitude of each response coefficient and intercept form the frontier coefficients of the potential production function. If γ^* are the parameter estimates of the frontier production, then, $\gamma^*_j = \max\,\{\gamma_{ij}\}$ where $i = 1, \ldots n$ and $j = 1, \ldots k$. The potential output of the industry can be realized when the best practice techniques are used and this is given by

$$\mathrm{Ln}\, Y^*_{it} = \gamma^*_1 + \sum_{j=1}^{k} \gamma^*_j \,\mathrm{Ln}\, X_{ijt} \quad (4)$$

Based on the above, the model to be estimated is:

$$\mathrm{Ln}\, Y = a_0 + a_1 T + (\beta_0 + \sum_{m=1}^{7} \beta_m D_m)\,\mathrm{Ln}\, L_{it} + (\alpha_0 + \sum_{m=1}^{7} \alpha_m D_m)\,\mathrm{Ln}\, K_{it} + (\gamma_0 + \sum_{m=1}^{7} \gamma_m D_m)\,\mathrm{Ln}\, M_{it} + u_{it} + v_{it}$$

where Y = Gross output;
T = Time trend;
D_m = Industry slope dummies grouped at the 2-digit industry level;
L = Labour;
K = Capital;
M = Intermediate input;
$i = 1, \ldots 26$ and $t = 1970, \ldots 2002$.

The input shares of the manufacturing industries given by α, β and γ vary with the use of industry slope dummies.[4] The time trend on the other hand captures all variations that affect industries' output over time.

IV. Data Sources and Variables

Data for the 26 three-digit manufacturing industries (see Appendix 1) are drawn from the United Nations Industrial Development Organization (UNIDO) data base. These include gross output, intermediate inputs, fixed capital assets, and workers employed. All data on deflators are obtained from the Department of Statistics, Malaysia. The variables are expressed in constant 1987 prices.

Gross output of all industries was deflated using the manufacturing production index. The expenditure on intermediate inputs was deflated using the producer price index, and the expenditure on fixed capital assets was deflated using the gross domestic fixed capital formation deflator. It is acknowledged that these deflators may not necessarily be ideal but the choice was based on the lack of more appropriate deflators.

V. Empirical Results

Initially, the more general translog model was estimated but as the second order conditions were not found to be significant, the Cobb-Douglas model was considered the better model to fit the data. The coefficients obtained from the generalized least squares estimation of the stochastic frontier model are summarized in Table 2.

Dummies for the oil price shocks in 1974 and 1975, 1979 and 1980, as well as the Asian

TABLE 2
Estimates of the Stochastic Production Frontier Model

Variables	*Parameter*	*Parameter Estimates*
Constant	a_0	1.63 (0.891)*
Time Trend	a_1	1.07 (0.351)*
Labor (Industry 31)	β_0	0.25 (0.087)*
Labor (Industry 32)	β_1	–0.0034 (0.0062)*
Labor (Industry 33)	β_2	0.0172 (0.0011)*
Labor (Industry 34)	β_3	0.0141 (0.0482)
Labor (Industry 35)	β_4	0.0028 (0.0012)*
Labor (Industry 36)	β_5	0.0145 (0.0058)*
Labor (Industry 37)	β_6	0.0137 (0.0036)*
Labor (Industry 38)	β_7	–0.0161 (0.0041)*
Capital (Industry 31)	α_0	0.331 (0.0219)*
Capital (Industry 32)	α_1	0.0412 (0.0084)*
Capital (Industry 33)	α_2	0.0065 (0.0017)*
Capital (Industry 34)	α_3	0.0151 (0.0009)*
Capital (Industry 35)	α_4	0.0076 (0.0276)
Capital (Industry 36)	α_5	0.0163 (0.0044)*
Capital (Industry 37)	α_6	–0.0054 (0.0037)*
Capital (Industry 38)	α_7	0.0025 (0.0006)*
Intermediate Input (Industry 31)	γ_0	0.39 (0.0413)*
Intermediate Input (Industry 32)	γ_1	0.0316 (0.0072)*
Intermediate Input (Industry 33)	γ_2	0.0059 (0.0007)*
Intermediate Input (Industry 34)	γ_3	0.0048 (0.0021)*
Intermediate Input (Industry 35)	γ_4	0.0045 (0.0165)
Intermediate Input (Industry 36)	γ_5	–0.0014 (0.0028)
Intermediate Input (Industry 37)	γ_6	0.0031 (0.0008)*
Intermediate Input (Industry 38)	γ_7	0.0025 (0.0006) *

NOTE: Figures in parenthesis are asymptotic standard errors.

financial crisis in 1997 and 1998 were included in the estimation. These were found to be insignificant and hence dropped from the model. The input shares are not identical across the majority of the industries as seen by the significance of the slope dummies. Intermediate input has the largest input share followed by capital and labour input shares. The null hypothesis that technical inefficiency does not exist is rejected at the 1 per cent level of significance.[5] This indicates the need to model the production behaviour using the stochastic frontier model instead of the Tornqvist index approach or the ordinary least square estimation of the average production function, both of which unrealistically assume the existence of technical efficiency (Mahadevan 2004).

V.1 Identifying the Sources of Output and TFP Growth

The sources of output and TFP growth are shown in Tables 3 and 4 respectively. Similar to previous studies, it can be seen that throughout 1971–2002,

TABLE 3
Sources of Manufacturing Output Growth (%)

Period	*Gross output growth*	*Relative contribution to total input growth*			*TFP growth*
		Capital	*Labour*	*Intermediate Inputs*	
1971–79	8.29	32	41	27	0.94
1980–89	7.64	36	34	30	1.37
1990–99	9.89	33	28	39	0.88
2000–02	5.76	33	24	43	0.61
1971–02	7.12	34	29	37	1.01

Note: The above are average annual growth rates.

TABLE 4
Sources of Manufacturing TFP Growth (%)

Period	*TFP growth*	*Gains in technical efficiency*	*Technological progress*
1971–79	0.94	–0.31	1.25
1980–89	1.37	–0.57	1.94
1990–99	0.88	–0.28	1.16
2000–02	0.61	–0.36	0.97
1971–02	1.01	–0.40	1.41

NOTE: The above are average annual growth rates.

input growth plays a major role in contributing at least 80 per cent of the gross output growth in Malaysia's manufacturing sector while TFP growth accounted for less than 20 per cent of output growth. Amongst the inputs, intermediate inputs have seen a steady increase in their share of contribution while labour share has declined and capital share has somewhat stabilised contributing to a third of total input growth. Average annual TFP growth hardly exceeded 1.5 per cent in any of the periods shown, although it increased slightly in the decade of 1980 but has decreased since then.

What is more interesting, however, is the reason for the low and declining trend in TFP growth. Table 4 shows that not only has TP been decreasing since 1990 but there have also been losses in TE over time. In other words, although there is technology accumulation, the gains from that shown by the production frontier's outward shifts over time have been decreasing. The situation is worsened by these gains being outweighed by the deteriorating performance in the efficient use of resources and technology. This is reinforced by the causality relationships seen in Table 5.

At the disaggregated level (not shown here to conserve space), there was no discernible pattern in the TFP growth over time except for a general decline in most industries performance since 1990 or mid 1990. Also, the annual average TFP growth over 1971–2002 was low and did not go beyond 2.5 per cent for any one industry.

TABLE 5
Causality Results

Null hypothesis	*P-value*
ΔX → ΔTFP	0.195
ΔTFP → ΔX	0.225
ΔX → ΔTP	0.072**
ΔTP → ΔX	0.246
ΔX → ΔTE	0.038*
ΔTE → ΔX	0.662
ΔTP → ΔTE	0.312
ΔTE → ΔTP	0.514

NOTES: → means 'does not Granger-cause'.
* and ** denotes significance at the 5 per cent and 10 per cent level respectively.

V.2 Causality Links between the Sources of Output Growth

Here, causality links between TFP growth, TP, TE, and input growth are empirically investigated. The causality model used here is based on the approach suggested by Toda and Yamamoto (1995) which uses the modified Wald test for restrictions on the parameters of the first k lags in a VAR (k + d_{max}) where k refers to lag length and d_{max} is the maximum order of integration that occurs in the system.

To illustrate, we consider the hypothesis that there is a relationship between the growth of the variables of total inputs, TFP, TP and TE. The empirical model for estimation is the following 4-equation VAR model:

$$\begin{bmatrix} \Delta X_t \\ \Delta TFP_t \\ \Delta TP_t \\ \Delta TE_t \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ A_{30} \\ A_{40} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) \end{bmatrix} \times \begin{bmatrix} \Delta X_{t-k} \\ \Delta TFP_{t-k} \\ \Delta TP_{t-k} \\ \Delta TE_{t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (6)$$

where X refers to total inputs;
Δ is a difference operator;
k is the optimal number of lags;
A_{i0} are the parameters representing intercept terms;
$A_{ij}(L)$ are the polynomials in the lag operator L; and
ε_{it} are white-noise disturbances that may be correlated.

The optimal lag length is chosen by minimizing the values of the Akaike Information (AIC) and Schwartz Bayesian Criteria (SBC). In order to gain efficiency in the coefficient estimates, the method of seemingly unrelated regression estimation is used. Taking a VAR model with two lags as an example and looking at equation (6), a given variable does not Granger-cause X if and only if all the coefficients of $A_{1j}(L)$ are equal to zero. In the reverse case, X does not Granger-cause the variable if and only if all the coefficients of $A_{j1}(L)$ are equal to zero. Therefore, in a 4-equation model with two lags, the hypotheses to be tested are

$$H_0: a_{1j}(1) = a_{1j}(2) = 0 \quad (7)$$

$$H_0: a_{j1}(1) = a_{j1}(2) = 0 \quad (8)$$

where a_{1j}(i) are the coefficients of the given variable in the first equation and a_{j1}(i) are the coefficients of X in the j^{th} equation in the VAR model of equation (6). The unit root results (not shown here to conserve space) indicate that the first differences of the variables are stationary.[6] The causality results in Table 5 show the p-value underlying the modified Wald test of the Toda and Yamamoto procedure. The p-value represents the level at which the null hypothesis of "does not Granger-cause" may be rejected.

It can be seen that input growth and TFP growth do not affect each other but when the two sources of TFP growth given by TP and TE are considered, the results provide some important insights. Factor accumulation is seen to Granger-cause TP (due to embodied technology especially in capital and intermediate inputs[7] that enable increases in output when technology is adopted) albeit at a weak level of significance.

However, factor accumulation has a negative impact on TE.[8] In other words, when there is factor accumulation, gains from TP are obtained at the expense of TE. This is a major concern as the high adoption rate of new technology has not been accompanied by technological mastery in the Malaysian manufacturing sector. The lack of learning-by-doing gains has hampered the exploitation of the full benefits of the adopted technology that is obtained via factor accumulation. Furthermore, TP can be expected to continue declining in the long run because the scope for obtaining newer and more advanced technology via FDI becomes more limited, if Malaysia keeps to the same level of technology-oriented manufacturing activities.

There is, however, no causal relationship between TP and TE and neither TP nor TE affects factor accumulation. This may seem unusual, since, with the advancement of technology and efficient use of resources, more inputs can be used to increase output more than proportionally. But in the case of Malaysia, both TP and TE are at very low levels and factor accumulation is already at very high levels, thus it is not surprising there is no causal relationship from TP or TE to input growth.

V.3 Determinants of TFP Growth, TP and TE

This section provides the empirical analysis on the determinants of the two sources of TFP growth trends. The choice of factors affecting TP, TE and TFP growth are described in Table 6, and this is dictated by what was available in the UNIDO data set.

The capital-labour (K/L) ratio is a measure of capital intensity of the industry and to some extent reflects technology-intensity[9] as well. It is expected that an increase in this ratio would have a positive effect on TP if the capital equipment is technologically advanced. A positive effect on TE can also be expected if this results in the better use of inputs to produce more output. It is hypothesized that industries with higher capital intensities are likely to use resources more efficiently because they cannot afford the rental cost of unused capital and thus have the incentive to economise on the cost of capital. However, there is also the possibility that if the cost of capital becomes relatively cheap due to subsidized credit at low interest rates, then industries may accumulate more capital than is required and under-utilize it, thereby lowering TE.

A high proportion of female workers in the workplace is reflective of a low level of skill amongst workers (Booth, Francesconi, and Frank 2003, Magnani 2003) and this is more so in the

TABLE 6
Inter-industry Determinants of TFP Growth

Variable	*Symbol*	*Description*
Capital-Labour Ratio	K/L	Stock of physical capital per unit of person employed.
Female Worker Efficiency	FEMALE	Ratio of the number of female employees to total number of employees.
Number of Firms	FIRMNO	Number of firms in industry.
Foreign Ownership	FOREIGN	Share of foreign capital assets in total fixed capital assets.

manufacturing sector. Due to family commitments or lack of opportunity for females to upgrade themselves, this ratio is expected to adversely affect TE and is unlikely to affect TP as the less skilled female workers are unable to be involved in product innovation and equipment modification. More skilled workers or better educated workers raise TE as these workers contribute effectively to the acquisition and combination of productive resources and they are more receptive to new approaches to production and management.

The number of firms in an industry is a proxy for the industrial concentration in the industry. The larger the number of firms, the lower the market power but their effect on TP and TE is unclear. In the standard industrial organization paradigm, a high concentration ratio is expected to diminish competitive rivalry among industries with the likelihood of under utilizing the production capacity of resources. But some reason that a high concentration ratio brings about sufficient greater innovation (and hence TP) to offset the adverse effects of high concentration, and that concentrated industries suffer less uncertainty of demand than other firms and can plan better for higher utilization of productive capacities.

The foreign ownership variable is measured by the ratio of foreign-owned to total fixed assets. Often, FDI is said to stem from ownership advantages like specific knowledge of the use of resources due to research and development (R&D) experience and/or exposure to international competition. Thus, FDI can be expected to have a positive effect on TE as well as TP as the import of more advanced technology embodied in capital often accompanies FDI. However, the literature to date on many countries provides mixed empirical evidence of the impact of foreign ownership on the host country.

As some of the data on the determinants are only available for selected years, the sample year starts from 1983. The equations for TFP, TP and gains in TE as dependent variable are estimated in semi-logarithms with all but the foreign ownership independent variable being logged. The estimation results are summarized in Table 7. Although a battery of diagnostics tests did not reveal problems of misspecification, heteroscedasticity and autocorrelation, the of the equations ranging from 0.6 to 0.68 are not high, reflecting the need for more determinants to be included in the equation.

TABLE 7
Regression Results on TFP Growth and its Sources

Variable	*TP*	*Gains in TE*	*TFP Growth*
Constant	1.42*	1.67*	0.98*
	(0.512)	(0.648)	(0.44)
K/L	0.12*	–0.36**	0.26
	(0.014)	(0.212)	(0.167)
FEMALE	0.28	–0.084*	–0.059**
	(0.191)	(0.041)	(0.031)
FIRMNO	–0.17	–0.451**	–0.192
	(0.108)	(0.266)	(0.128)
FOREIGN	0.33*	0.062	0.418**
	(0.08)	(0.042)	(0.224)

NOTES: Figures in parenthesis are standard errors.
* and ** indicates that the estimated coefficient is significant at the 5 per cent and 10 per cent level of significance respectively.

The K/L ratio is seen to affect TP positively. It is possible that industries with high capital intensities have more incentive to use the best technology available or to invest in heavy capital that embodies technology. However, this ratio has a negative (although not strong since it is significant only at the 10 per cent level) impact on TE. There are two possible reasons for this. First, the speed of transformation in industries with newly adopted capital-intensive technology may have brought sufficiently high profits to weaken the incentive for industries to use the new technology efficiently. Also, in order to qualify for various incentives from the government, many industries could have accumulated capital which they did not have sufficient knowledge to use efficiently.

Second, labour as well as skill deepening did not match the rate of capital deepening. Shortage of labour has been a problem in Malaysia since the early 1990s, and by 2000 the manufacturing sector had the largest share of foreign workers but 67 per cent of them had no formal or primary education (Ministry of Finance 2004/05). Furthermore, in 1975, while 2.5 per cent of the labour force had tertiary education, this proportion only increased to about 17 per cent in 2003 (Department of Statistics). This is low compared with other NIEs, Japan and the United States. The FEMALE variable suggests a similar point in that a large proportion of females employed, means a generally low level of skill, which then adversely affects TE.

The empirical results also show that foreign ownership has a positive impact on TP as foreign-owned companies have the resources to invest in high technology capital and are able to enjoy the benefits of R&D undertaken in their home country. However, foreign ownership has no apparent impact on TE. This stems from the lack of skilled workers employed and the poor competition from local firms (Noor, Clarke, and Driffield 2002).

Lastly, market power as measured by the number of firms in an industry does not affect TP but improves TE. It can be said that such firms have an incentive to provide training to workers so as to ensure technology and inputs are used efficiently as the resulting benefit in the form of lower cost is a competitive advantage that is worthwhile as these firms cater to a significant market share.

With the regression results on TFP growth, there is no effect from the K/L ratio as the separate and opposing impacts of capital deepening on TP and TE counteract one another. Although the effect of FEMALE and FIRMNO on TE is negative and significant, the overall effect of these variables on TFP growth is weakened by the non-impact of these variables on TP. The same is true of the effect of foreign ownership on TFP growth but with the signs reversed. Similar factors are seen to have different effects on TP and TE as the two concepts are conceptually different and the overall effect on TFP growth is determined by the strength of these impacts on TP and TE. Studies that regress factors on TFP growth as a single entity miss out on understanding these dynamics underlying policy effects on TFP growth.

V.4 Policy Making

The different and sometimes opposing impacts of various factors on TP and TE make policy prescription problematic. For instance, should the Malaysian government continue providing incentives in the form of tax deductions related to capital expenditure? Should there be more aggressive wooing of FDI? Being aware of the trade-offs in the consequences of these actions on TP and TE is a first step towards finding a solution to such policy-making conundrums. The next step is to ensure policy coordination so that implemented policies do not pull in different directions and at the very least, do not undermine the attainment of the two (in this case) or more objectives it involves so as to provide maximum benefits.

For the Malaysian manufacturing sector, maximizing TP at the expense of improving technical efficiency or vice versa is not an optimal strategy. This is not to say, for example, that capital deepening embodying new technology should not be encouraged because it raises TP. Rather, the form this takes in providing increasing rates of return should be the focus. One solution is for Malaysia to concentrate on higher value-added manufacturing operations at the top end of the technology ladder. Evidence from Noor, Clarke, and Driffield (2002) suggest there is continued involvement in assembly-line production and medium-level value-added manufacturing activities in the electronics and electrical sector which is the driving force in the manufacturing sector. Thus incentives provided need to be sufficiently strong to encourage both local and foreign producers in upgrading to higher value added production.

While the Malaysian government has attempted to do this with the establishment of the Multimedia Super Corridor in 1996, various technology parks since 1990, and the BioValley in 2004, these industrial clusters have yet to show success (Jussawalla and Taylor 2003; Wahab 2003). In fact, there is concern that leapfrogging into these areas without sufficient learning-by-doing gains can bring more harm than benefit in the long run in spite of the short-run advantages Malaysia would enjoy as a later-comer in this field. This represents a slack in policy coherence as the mechanisms to support the transformation to the high valued-added activities are not sufficiently in place.

One such support stems from the level of R&D undertaken within an economy which is reflective of the absorptive capacity of the economy. With increasing R&D expenditure, the availability of better technology or modifying existing technology in the long run is a good possibility. But research intensity, as measured by the share of R&D expenditure in GDP has increased rather slowly from 0.37 per cent in 1992 to 0.65 per cent in 2002. The targets set by the National Plan of Action of 1990 of 1.5 per cent in 1995 and 2 per cent in 2000 proved to be unrealistic and have been revised downwards, with 1.5 per cent being set as the new target for 2010. Thus, Malaysia is still in its infancy stage of building its R&D capacity. Not only are India and China's ratio of 0.78 per cent and 1.09 per cent respectively in 2001 higher but Malaysia does not come anywhere near that of the first-tier newly industrializing countries' average of at least 2.4 per cent in 2002 (MASTIC 2004).

Another problem is seen in the slow pace of the improvements in the quantity and quality of the labour force. It has been argued earlier that capital deepening must be accompanied by sufficient labour and skill deepening to allow a more effective adaptation and application of new technology. But the increase in education expenditure as a percentage of GDP has not been rapid in Malaysia — the 1980–99 average being only 5.4 per cent compared with an average of 5.3 per cent in the 1970s. At 6.6 per cent, the figure for 2000–03 shows some improvement but more remains to be done. The 2010 target to have 35 per cent of the work force with tertiary level education is still below the levels already achieved in 2003 by developed countries such as Japan (36 per cent), the United States (41 per cent), Ireland (43 per cent) and Finland (36 per cent).[10]

Lack of training is also yet to be addressed by appropriate policy even though industrial training accounts for the bulk of the government's development allocation for training, and this allocation has increased from RM580 million in 1991–95 to RM3,760 million in 2001–05. Tan and Gill (2000) report that public training institutes continue to play a relatively minor role in meeting the in-service training needs of private firms since their focus is on pre-employment training. Tan and Gill also find that only one-fifth of the manufacturing firms in their extensive survey provide formal training while half the firms rely on informal training. Official statistics indicate that, in 2002, only slightly more than half of the Human Resources Development Fund set aside for this purpose has been utilized (Ministry of Human Resources' Annual Report 2004).

Recognizing the lack of domestic skills, the Malaysian government must be given credit for its short- and medium-term efforts to improve the quantity and quality of the labour force as seen in its foreign worker policy and brain gain initiatives at the same time. Unfortunately, even in these attempts, there is a lack of policy coordination. For instance, Pillai (1995) describes Malaysia's foreign labour policy as having "many twists and turns" and after 1991, it possessed a "stop-go" quality. This was attributed to various unpredictable changes reflecting a reaction to short-term needs and comprising frequent changes in foreign worker levy and the application of different criteria of employment in different sectors. The share of unskilled workers among foreign workers has always been more than 90 per cent and this does not augur well for the upgrade to higher value added manufacturing activities.

With regards to attracting skilled foreign labour, the government must be more open to embracing foreign talent and lower the skilled worker levy accordingly. There is also a need to coordinate policies to stem brain drain and implement "brain gain" initiatives. While there are no official data on out-migration available,[11] Pillai (1995) estimates that at least 40,000 Malaysians or on average 5,000 per year migrated to Australia, New Zealand, Canada and the United States between 1983 and 1990. To encourage Malaysians to return home, since 2001, there have been exemptions from income tax, duty-free import of motorcars and possessions from abroad, and the granting of permanent resident status to spouses and children. By September 2001, 356 applications were received from professionals working overseas (Economic Report 2001/02) and as of 2004, the programme has granted approvals to 246 Malaysian experts overseas.

While the above situation calls for an urgent need to re-examine the efficiency of Malaysia's "brain gain" initiatives and to develop a compelling value proposition to attract, develop and retain talented Malaysians both within and outside the country, it must, however, be acknowledged that this is not an easy task. Perhaps the more effective way is to nip the problem in the bud by attempting to discourage people from leaving by ensuring there are sufficient and equal opportunities for jobs and education in Malaysia. In this regard, the New Economic Policy initiatives favouring *bumiputeras* need to be carefully revisited. They do not sit well in the globalization era where competitiveness is crucial. This has been recognized and concern raised by the ex-prime minister, Mahathir Mohamad, when he was reported by Somun (2003) to have said that said that, "Malays lean on the crutches of Malay privileges in order to protect themselves. Malays consider these crutches as symbols of their superior status in the country. The sad thing is that they are not even using the crutches properly."

Lastly, the policy variable that affects TP but not TE is FDI. Most FDI in Malaysia is export-oriented and although FDI brings in better technology, it does not necessarily ensure that the technology and the inputs are efficiently used. Thus the government needs to be selective about the type of FDI Malaysia is attracting for three reasons. First, to sustain TP, FDI must be in higher value added activities as well as be encouraged to undertake R&D in Malaysia. This, however, requires appropriate infrastructure and a ready pool of R&D personnel to be available.

Second, there needs to be some form of formal agreement that foreign-owned firms provide training to their locally employed workers where necessary. Third, government must take greater effort to benefit from spillover FDI effects by encouraging and providing strong incentives for MNCs to foster backward and forward linkages with local firms. This will improve the productivity growth of domestic firms as well.

VI. Conclusion

Malaysia's past strategy of focusing on factor accumulation has led to some gains provided by technological progress at the expense of technical efficiency. But in order to sustain growth, it is optimal to focus on both technological progress and technical efficiency.

Current industrial policy to spearhead the economy by leapfrogging into biotechnology and information and communication technologies without having a strong base of local talent and support may only improve productivity growth in the short run. Such rapid structural transformation will bring technological progress but does not allow sufficient learning-by-doing gains for long-term benefits. But policy prescription is not made easy as capital deepening and foreign ownership are found to increase technological progress but decrease technical efficiency, while greater market power does not promote the former but positively affects the latter.

Hence, capital deepening must be accompanied by increases in the quality and quantity of the workforce and improvements in these areas must move in tandem. Human capital investment (related to both education and training)[12] and technology development policies need to be aligned to productivity growth needs. This requires a reassessment of a whole range of factors — foreign worker policies, provision of hard and soft infrastructure as well as incentives conducive for higher levels of R&D in the private sector, training incentives to continuously upgrade workers, "brain gain" initiatives, and selective FDI policies based on high valued-added activities and potential to foster backward and forward linkages with the local firms. There is also a need for business accelerator programmes to foster entrepreneurship as it is not possible to keep relying on foreign talent if the domestic sector's participation remains limited as this will adversely affect the building of its own technological capabilities.

While the above analysis is based on the manufacturing sector, it is equally crucial that a holistic approach to policy making is undertaken to ensure sustainable growth that is balanced and contributed by all three growth sectors. Thus, a similar analysis to the above should be undertaken for the other two pillars of growth, the agricultural and services sectors. In particular, causality links should be investigated between all three engines of growth for output and TFP growth to identify spillover policy effects if any, as this has implications for policy-making.

Also, heavy reliance on the manufacturing sector as well as services such as banking and financial services increase the vulnerability to external shocks given the level of global integration of the Malaysian economy. This was seen during the 1985 world recession, the early 1990s slump in the electronics market, and the 1997/98 financial crisis. But fortunately, Malaysia is in a unique position of having a comparative advantage in its primary sector. The development of the resource-based industries primary commodities sector has great potential of increasing value added in manufacturing activities while the modernization of agriculture has been given priority in the government's budget via agro industrialization and agro biotechnology.

In conclusion, the 2020 Vision and the elaborate plans set out in the Third Industrial Plan, however well laid out, may not bear the desired results for sustainable growth unless proper mechanisms are in place to ensure effective implementation, monitoring and evaluation of various strategies and policies. For instance, the pace and sequencing of appropriate support policies must be carefully thought through and more importantly, there must be transparency and accountability on the part of the Malaysian government in objectively assessing their policy initiatives to continuously improve their policy making efforts.

NOTES

1. Malaysia was the nineteenth largest trading nation in 2004.
2. See *Global Competitiveness Report 2006–07.*
3. Technological progress results from the advanced technology embodied in capital and is represented by outward shifts in the production frontier over time. Increased technical efficiency, on the other hand, results from the more efficient use of technology and inputs (due to the accumulation of knowledge in the learning-by-doing process, diffusion of new technology, improved managerial practice, etc.) and is represented by movements towards the production frontier.
4. The estimation using dummies at the 3-digit level did not provide plausible and significant input shares. Hence dummies at the 2-digit level were used.
5. The test statistic of 118.38 was larger than the critical value of 6.63 from the chi-square distribution.

6. This gives a maximum order of integration of one. The optimal number of lags chosen by the AIC and SBC was 2, thus a VAR of order 3 was estimated.
7. On average, capital and intermediate inputs have in total, a high share of about 74 per cent of total merchandise imports since 1990.
8. This cannot be seen from the p-values in Table 5 but from the VAR mode, estimates which are not shown here to conserve space.
9. This is seen when measures of K/L ratios for the manufacturing industries are compared with the OECD product classification for technology profile for Malaysia in UNIDO (1985).
10. See MASTIC (2004).
11. Mainly because Malaysia does not have a formal policy nor does it impose controls on nationals working abroad.
12. In his speech at the National Economic Action Council in Jan 2004, Prime Minister Badawi notes that, "we need nothing less than an 'education revolution' to instill a new performance culture to nurture a new kind of human capital for the tasks and challenges ahead."

REFERENCES

Booth, A.L., M. Francesconi, and J. Frank. "A Sticky Price Floors Model of Promotion, Pay and Gender". *European Economic Review* 47 (2003): 295–322.

Farrell, M.J. "The Measurement of Productive Efficiency". *Journal of the Royal Statistical Society A*, General 120, no. 3 (1957): 253–81.

Griffiths, W.E. "Estimation of Actual Response Coefficients in the Hildredth-Houck Random Coefficient Model". *Journal of The American Statistical Association* 67 (1972): 633–35.

Hildredth, C. and J.K. Houck. "Some Estimators for Linear Model with Random Coefficients". *Journal of The American Statistical Association* 63 (1968): 764–68.

Jussawalla, M. and R. Taylor, eds. *Information Technology Parks of the Asia Pacific: Lessons for the Regional Digital Divide*. New York: M.E. Sharpe Inc., 2003.

Kalirajan, K.P. and R. Shand. *Economics in Disequilibrium: An Approach from the Frontier*. India: Macmillan, 1994.

Magnani, E. "The Productivity Slowdown: Sectoral Re-allocations and the Growth of Atypical Employment". *Journal of Productivity Analysis* 20, no. 2 (2003): 121–42.

Mahadevan, R. *The Economics of Productivity in Asia and Australia*. Cheltenham: Edward Elgar, 2004.

Malaysian Science and Technology Centre (MASTIC). *National Survey of Research and Development Report 2004*.

Ministry of Finance. *Economic Report*. Kuala Lumpur: Ministry of Finance, Malaysia, various years.

Noor, H.M., R. Clarke, and N. Driffield. "Multinational Enterprises and Technological Effort by Local Firms: A Case Study of the Malaysian Electronic and Electrical Industry". *Journal of Development Studies* 38, no. 6 (2002): 129–41.

Pillai, P. "Malaysia". *ASEAN Economic Bulletin* (Special issue on Labour Migration in Asia), vol. 12, no. 2 (1995): 221–36.

Somun, H. *Mahathir: The Secret of Success*. Malaysia: Pelanduk Publications, 2003.

Tan, W. and I.S. Gill. "Malaysia". In *Vocational Education and Training Reform: Matching skills to Markets and Budgets*, edited by Gill, F. Fluitman and A. Dar. Oxford University Press, New York, 2000.

Toda, H.Y. and T. Yamamoto. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes". *Journal of Econometrics* 66 (1995): 225–50.

United Nations Industrial Development Organisation (UNIDO). *Medium and Long Term Industrial Master Plan Malaysia 1986–1995*, vol. 3, part 3, 1985.

Wahab, A.A. *A Complexity Approach to National IT Policy Making: The Case of Malaysia's Multimedia Super Corridor*. Unpublished PhD thesis, University of Queensland, 2003.

World Bank. *The East Asian Miracle*. New York: Oxford University Press, 1993.

World Economic Forum. *The Global Competitiveness Report 2006–07*. London: Palgrave Macmillan, 2007.

Renuka Mahadevan is Associate Professor at the School of Economics, The University of Queensland, Australia.