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Total Factor Productivity in the Malaysian Manufacturing Sector: Some Preliminary Results

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ABSTRACT

In view of the increasing importance of the manufacturing sector in Malaysia, this paper seeks to measure the rate of growth in total factor productivity (TFP) and its contribution to the growth of this sector. Using the Divisia index approach, the results of this study indicate that the rate of growth of TFP averaged at 0.64 per cent per annum between 1986-90. Further the average contribution of the growth in TFP to the growth of the manufacturing sector is only 4.67 per cent for the period of this study. The major contributor to manufacturing growth was found to be the growth in intermediate inputs.

ABSTRACK

Memandangkan kepentingan semakin bertambah sektor perkilangan di Malaysia, kajian ini cuba mengukur kadar pertumbuhan daya pengeluaran keseluruhan faktor (PDPKF) dan sumbangannya kepada pertumbuhan sektor ini. Dengan menggunakan pendekatan Indeks Divisia, hasil kajian ini menunjukkan bahawa PDPKF purata setahun adalah 0.64 peratus antara 1986-90. Tambahan lagi, sumbangan purata PDPKF kepada pertumbuhan sektor perkilangan adalah 4.67 peratus untuk tempoh kajian ini. Penyumbang utama kepada pertumbuhan sektor perkilangan ialah pertumbuhan input perantaraan.

INTRODUCTION

The emergence of the manufacturing sector as the leading sector in the development of the Malaysian economy has led to the need to develop a deeper understanding of the sources of growth of this sector. In particular, there is increasing recognition of the necessity to assess the productivity performance of the manufacturing sector. The conventional measures of productivity are labour and capital productivity as these measures offer insights on the contribution of input growth to output expansion. However, due to the limitations of these partial productivity measures,[1] total factor productivity (TFP) has been utilised in an attempt to isolate the changes in output which are not accounted for by changes in input. This type of productivity measure is basically a composite measure of changes in technology as well as changes in efficiency[2] with which known technology is applied to production. Hence, estimates of the rate of growth of TFP are not only of interest in their own right as descriptive statistics, but at the same time, these estimates may help to explain the growth of a given sector. In line with this argument, the objective of this paper is to measure the rate of growth in TFP (or TFPG) for the Malaysian manufacturing sector in order to understand its contribution to the growth of that sector.

This paper is divided into 5 main sections. The introduction is given in Section I while Section II outlines some past findings as well as the analytical framework used in the estimation of TFPG. The results are presented in Section III. In Section IV, policy implications are discussed while further extensions to this study are suggested as a conclusion in Section V.

SELECTED PAST FINDINGS AND ANALYTICAL FRAMEWORK

There has been extensive work expanded on both the theoretical foundations as well as the estimation of TFPG. A comprehensive discourse on the research in this area can be obtained in the survey reviewed by Nelson (1981), and the book by Jorgenson, Gollop and Fraumeni (1987). Hence this section will only highlight a few studies which have been conducted for India, Singapore and Malaysia.

Ahluwalia (1991), in her detailed disaggregated study on the organized section of Indian manufacturing over two and a half decades found negligible growth in TFP up to the end of the seventies. However there appears to be an improvement in TFPG in the first half of the eighties, largely due to the improvements in infrastructure and a reorientation in the policy framework. Further, her comparison of India's productivity growth performance with other developing economies,[3] revealed that India's productivity growth is at par with that of China's.

For the case of Singapore, Tsao (1985)'s pioneering study found negligible productivity growth (0.08 per cent) in the seventies for the Singaporean manufacturing sector despite the rapid growth in her industrial exports. This result is surprising in the light of the general tendency to associate high TFP growth with a rapidly expanding output.[4] A subsequent study by Gan, et. al. (1993) indicates a change in the pattern found by Tsao. Using the same analytical framework as Tsao, Gan et. al., found that TFP growth was the second major source of growth of the manufacturing sector after the growth of material input, during the 1986-90 sub-period.

For Malaysia, three studies on TFP have been conducted so far. Gan and Robinson's (1993) study on the overall economy between 1975-91 concluded that TFP growth for the first half of the eighties was negative but contributed positively to the growth in potential output after the 1985 recession with the exit of inefficient firms and rationalization of the remaining ones. In contrast, Zarina Zainal Abidin and Shariman Alwani's (1994) study on the same issue produced negative TFPG for the period 1978-92. The difference in their results from the prior study may possibly be due to both methodological and data differences.

At the sectoral level, Maisom Abdullah and Arshad Marsidi (1992) measured the growth in TFP for the Malaysian manfacturing sector at the 2 digit level between 1973-89. Using the Divisia Index approach, their studies yielded negative TFPG for all the industries for the overall period of their study. It is possible that their measures may have been affected by the aggregative nature of the data as well as the use of nominal values for both inputs and outputs. Furthermore, the use of value-added for measuring output due to the omission of intermediate inputs may have distorted their measure of TFPG.[5] Therefore in this study, TFPG is measured at the 5 digit level between 1986-90 using real values for both the measure of inputs and outputs as well as taking into account the contribution of intermediate inputs.

The analytical framework used in this study is the Divisia Index approach that was developed by Jorgenson, Gollop and Fraumeni (1987). Under assumptions of competitive equilibrium (where factors of production are paid the value of their respective marginal products) and constant returns to scale, the Divisia Index basically decomposes the growth of output into the contribution of changes in inputs and in TFP. In other words, considering the data at any two discrete points of time, say T and T-1, the growth rate of output Q, for industry i can be expressed as a weighted average of the growth rates of intermediate (X), capital (K), and labour (L) inputs plus the average rate of productivity growth. Hence the TFP growth of each industry i is computed as the difference between the rate of growth of output and the weighted average of the growth in intermediate, capital, and labour inputs where the weights are the respective shares of each input in the industry's gross output:

$$\begin{aligned}\overline{V}^i_T = {} & [\ln Qi\,(T) - \ln Qi\,(T-1)] - \overline{V}^i_X\,[\ln\ Xi\,(T) \\ & -\ln Xi\,(T-1)] - \overline{V}^i_K[\ln Ki\,(T) - \ln Ki\,(T-1) \\ & -\overline{V}^i_L\,[\ln Li\,(T) - \ln Li\,(T-1)]\end{aligned} \qquad (1)$$

where the weights are given by the average value shares:

$$\overline{V}^i_x = \tfrac{1}{2}\,[V^i_x\,(T) + V^i_x\,(T-1)],$$
$$\overline{V}^i_k = \tfrac{1}{2}\,[V^i_k\,(T) + V^i_k\,(T-1)],$$
$$\overline{V}^i_L = \tfrac{1}{2}\,[V^i_v\,(T) + V^i_v\,(T-1)], \text{ and}$$
$$\overline{V}^i_T = \tfrac{1}{2}\,[V^i_T\,(T) + V^i_T\,(T-1)] \text{ or the}$$

Divisia Index of productivity growth.[6]

Given a linearly homogeneous production function,

$$Q_i = Fi(Xi, Ki, Li, T) \qquad (i = 1, 2, \ldots n)$$

where T is time, under producer equilibrium, the share of each input in the value share of output is equal to the elasticity of output with respect to each input, that is:

$$V^i_x = \frac{\delta \ln Qi}{\delta \ln Xi}$$

$$V^i_k = \frac{\delta \ln Qi}{\delta \ln Ki}$$

$$V_L^i = \frac{\delta \ln Qi}{\delta \ln Li}$$

Based on equation (1), the growth of TFP is estimated for 61 manufacturing industries in Malaysia.[7] A discussion of the data construction can be found in Appendix II.

RESULTS

The average annual rates of growth of real gross output, inputs and the productivity of the overall manufacturing sector over the period of study are shown in Table 1. During this period, the growth in gross output increased steadily from 1986-89, registering only a slight decrease in the rate of growth by less than 1.3 per cent between 1989-90. The average annual growth rate of output over this period is 13.7 per cent as the economy emerged from the 1985 recession. The recovery of the economy can also be seen in the rapid growth in inputs with the average growth in intermediate inputs exceeding that for capital and labour for both the weighted and unweighted cases.[8] On the other hand, the rate of growth of TFP is considerably smaller, averaging at 0.64 per cent per annum for the same period. From Table 2, in terms of the average annual contribution to growth, the growth of intermediate input is the largest source of growth, followed by the growth of capital and labour while the average contribution of TFP is only 4.67 per cent.

The relatively larger contribution of intermediate input to the growth in manufacturing output was also obtained in several other studies. For example, Tsao (1982) found that in general, the average value share of intermediate input in manufacturing output growth of Singapore between 1970-79 was the highest among all the inputs. Similarly, Nishimizu and Robinson (1984)'s study also indicates the same results for Japan between 1955-73, Korea (1960-77), Turkey (1963-76) and Yugoslavia (1965-78). In the same way, Gan et al.,'s (1993) more recent study on the Singaporean manufacturing sector yields similar results, that is the major source of growth of output between 1986-90 is the growth in material input. Moreover, in all these studies, input growth has contributed relatively more to output growth than the average rate of growth of TFP.

However, the average contribution of TFP estimated for Malaysia for the period of this study is quite low compared to the

TABLE 1. Aggregate output, inputs and productivity: rates of growth (per cent)

	1986	1987	1988	1989	1990	Average over period (1986-1990) per cent
Gross output	2.78	13.60	17.55	17.96	16.68	13.7
Capital input	0.67	3.91	7.02	14.99	33.04	11.9
Labour input	0.99	7.98	14.87	15.56	19.66	11.8
Intermediate input	-1.92	16.49	20.67	17.55	15.77	13.7
Weighted capital input	0.18	1.07	1.84	3.88	8.65	3.12
Weighted labour input	0.08	0.65	1.07	1.04	1.34	0.84
Weighted inter-mediate input	-1.25	10.65	13.75	11.83	10.57	9.11
TFPG	3.77	1.23	0.88	1.20	-3.88	0.64

Source: Computed based on data from the Department of Statistics

TABLE 2. Average annual contribution of TFP and factor inputs to output growth, 1986 - 1990 (per cent)

	1986 - 1990
Rate of growth of gross output	13.70
Contribute to growth due to:	
Weighted capital input	22.77
Weighted labour input	6.13
Weighted intermediate input	66.50
TFPG	4.67

Source: Table (1)

estimates of these studies – 9.6 per cent for the Singaporean manufacturing sector (1970-79) according to Tsao's study, and 17.6 per cent for Japan (1955-73), 20.7 per cent for South Korea (1960-77), 12.4 per cent for Turkey (1963-76) and 4.9 per cent for Yugoslavia (1965-78) in Nishimizu and Robinson's study. Further, Gan et. al.'s study revealed a contribution of 24.25 per cent for the manufacturing sector of Singapore between 1981-90 and an even higher contribution of 33.3 per cent for the sub-period of 1986-90.[9]

The rather low contribution of TFPG to output growth in this study may be due to the upsurge in the growth rate of capital in 1990 which far exceeded the rate of growth of output of that year (Table 1), thereby causing a negative TFPG in the same year. It is possible that excess capacity will emerge when the increase in capital exceeds the increase in output. The underutilisation of capacity may be due to the lumpiness in investment. With excess capacity, the contribution of TFP to growth is likely to be understated. For example, if the contribution of TFP to growth is recomputed based on the overall period of 1986-89 instead of 1986-90, then the contribution of TFPG increases by almost three-fold to 13.6 per cent. The possibility of excess capacity in the Malaysian economy was also postulated in Zarina Zainal Abidin and Shariman Alwani's study (1994). In that study, the authors demonstrated that the actual output was below the level of potential output for the period 1978-92 except for the early years in the estimation. This negative output gap together with the negative TFPG estimated in their study and an unemployment rate which is lower than the non-accelerating wage rate level of unemployment (NAWRU) led the authors to conclude that the capital stock in Malaysia may not be utilised at its full capacity level. This possibility is further examined in analysing the pattern of TFPG across the industries.

The detailed estimates of the TFPG for the 61 industries groups together with their growth in output, intermediate input, labour and capital over the period of study are presented in Table 3. From this table, it can be seen that the range in the growth of TFP between these industries can be quite broad with the manufacture of biscuits attaining a rate of growth of 40.62 per cent while the manufacture of industrial gases, whether compressed, liquified or in solid state is at the other end of the spectrum (-16.56 per cent). The frequency distribution of TFPG is given in Table 4.

TABLE 3. Averagge annual rates of growth of real output, intermediate input, labour, capital and TFPG by industry, 1986 - 1990 (per cent)

Industry	Output	Inter-mediate Input	Labour	Capital	TFPG
Other dairy products	2.76	4.32	2.55	-0.31	0.65
Coconut oil manufacturing	-3.59	-7.21	-11.11	-17.10	5.79
Palm oil manufacturing	11.37	10.85	-1.70	-5.58	3.47
Flour mills	12.55	15.28	5.91	12.64	-0.77
Sago & Tapioca factories	7.44	8.90	-3.42	-5.69	2.84
Biscuit factories	19.86	15.01	12.38	-65.67	40.62
Bakeries	9.45	7.92	5.63	20.65	-2.25
Tea factories off-estate	16.67	17.03	15.00	15.50	-0.14
Meehoon, noodles and related products	3.05	4.19	-0.26	4.25	-0.73
Spices and curry powder	19.76	16.86	7.03	4.78	7.07
Soft drinks and carbonated water industries	12.46	8.27	-4.33	3.59	7.84
Tobacco manufacture	-6.23	-4.20	0.03	-6.56	-1.23
Handicraft spinning and weaving	13.74	14.10	20.30	31.30	-4.50
Synthetic textile mills	15.17	14.65	4.45	-0.63	5.63
Knitting mills	29.46	31.35	14.25	28.91	0.57
Cordage, rope and twine industries	14.80	14.62	6.12	9.70	2.83

(continued to next page)

TABLE 3. (*Continued*)

Industry	Output	Inter-mediate Input	Labour	Capital	TFPG
Clothing factories	22.45	22.96	14.33	22.37	1.00
Manufacture of products of leather and leather substitute, except footwear and wearing apparel	26.49	29.81	21.85	27.70	-1.26
Manufacture of footwear except vulcanised or moulded rubber or plastic footwear	1.17	3.49	1.57	-1.36	-0.77
Sawmills	6.61	7.36	3.30	-1.33	2.26
Planning mills, window & door mills & joinery works	17.27	16.73	12.98	18.38	0.46
Manufacture of pre-fabricated wooden houses	3.01	5.21	0.64	-7.04	1.15
Manufacture of other wood products	6.01	-3.28	8.60	19.54	-0.62
Manufacture of furniture and fixtures, except primarily of metal	12.35	13.07	12.65	23.91	-3.64
Manufacture of pulp, paper and paperboard articles, n.e.c.	19.76	21.28	7.09	14.37	1.65
Printing, publishing and allied industries	4.96	7.00	1.61	14.09	-3.66
Manufacture of industrial gases, whether compressed, liquified or in solid state	15.75	2.19	25.19	43.65	-16.56

(continued to next page)

TABLE 3. (*Continued*)

Industry	Output	Inter-mediate Input	Labour	Capital	TFPG
Manufacture of fertilizers and pesticides	3.21	2.39	0.18	-1.69	1.44
Manufacture of drugs and medicines	6.18	10.09	4.06	18.55	-7.25
Manufacture of soap and cleaning preparations	13.67	15.20	5.60	26.88	-7.23
Manufacture of perfumes, cosmetics and other toilet preparations	8.33	10.07	6.09	27.68	-12.81
Petroleum refineries	2.78	2.34	-4.45	-6.84	2.21
Manufacture of miscellaneous products of petroleum & coal	-1.31	-1.38	-3.54	-1.39	0.39
Rubber remilling and rubber latex processing off estates	5.78	6.56	6.73	7.24	-0.85
Rubber smokehouses	-12.49	-11.98	-6.56	-16.01	-0.35
Manufacture of rubber footwear	13.10	15.00	9.61	7.62	2.74
Manufacture of plastic products n.e.c.	20.03	20.38	18.47	21.93	-0.63
Manufacture of pottery, china and earthenware	22.54	23.46	24.06	27.12	-3.00
Manufacture of glass and glass products	18.64	14.05	8.19	6.11	9.69

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TABLE 3. (*Continued*)

Industry	Output	Inter-mediate Input	Labour	Capital	TFPG
Manufacture of hydraulic cement	7.09	5.25	0.89	2.74	4.17
Manufacture of lime & plaster	13.98	8.65	8.79	18.46	0.79
Other non-metallic mineral products n.e.c.	20.42	22.08	3.57	43.14	-5.51
Primary iron & steel industries	19.11	20.32	8.96	4.61	3.31
Other non-ferrous metal basic industries	37.02	39.59	11.46	13.90	5.08
Manufacture of structural metal products	26.23	24.43	10.98	33.06	0.39
Manufacture of tin cans & metal boxes	14.24	15.54	8.31	19.68	-1.43
Manufacture of brass, copper, pewter and aluminium products	5.72	5.19	10.21	7.32	-0.79
Manufacture of engines and turbines	-39.13	-59.90	-13.30	-45.97	-0.52
Manufacture of special industrial machinery & equipment except metals & wood working machinery	21.63	24.56	9.15	-2.63	6.78
Manufacture of referige-rating, exhaust, ventilating & air-conditioning machinery	31.23	31.79	20.01	41.23	-2.71

(continued to next page)

TABLE 3. (*Continued*)

Industry	Output	Inter-mediate Input	Labour	Capital	TFPG
Manufacture of electrical industrial machinery & apparatus	27.05	33.51	31.86	44.87	-9.28
Semi-conductors & ether electronic components & communication equipment & apparatus	18.83	21.22	14.55	33.33	-5.75
Manufacture of dry cells and storage batteries	16.32	20.60	5.87	1.38	3.50
Manufacture of electric lamps and tubes	5.35	8.44	10.41	-5.54	0.42
Shipbuilding and boat-building & repairing	-29.66	-28.18	-25.34	-61.99	13.26
Manufacture of motor vehicle bodies	8.70	11.20	2.46	-11.62	3.40
Manufacture & assembly of motor vehicles	23.19	24.69	5.03	-10.86	8.64
Manufacture of profes-sional & scientific & measuring & controlling equipment, n.e.c.	10.97	14.91	14.94	13.23	-3.51
Manufacture of photo-graphic and optical goods	32.41	34.40	28.31	52.46	-5.21
Manufacture of sporting & atheletic goods	9.96	13.63	25.18	36.41	-13.05
Manufacture of brooms, brushes and mops	13.14	0.73	-0.22	-4.80	5.84

Source: Computed based on data from the Department of Statistics.

TABLE 4. Frequency distribution of TFPG (1986 - 90)

	Number of industries
TFPG < - 9.0%	4
- 9.0% < TFPG < - 6.0%	2
- 6.0% < TFPG < - 3.0%	8
- 3.0% < TFPG < - 0.0%	15
0.0% < TFPG < 3.0%	16
3.0% < TFPG < 6.0%	9
6.0% < TFPG < 9.0%	4
9.0% < TFPG	3

Source: Table 3

A few salient features on the pattern of the average growth rate of TFP can be ascertained from Table 3. Firstly, out of the 61 industries, 29 of these registered negative TFPG for overall period. Out of these 29 industries, 23 industries had an average annual growth rate of capital which is higher than the average annual growth rate of output. Conversely, industries which attained an average annual TFPG of over 6 per cent experienced either an average annual growth in output which is higher than the average annual rate of growth of capital (for example, the manufacture of spices and curry powder, the manufacture of soft drinks and carbonated water industries, and the manufacture of glass and glass products) or experienced a decline in the average annual rate of growth of capital as in the case of the manufacture of biscuits and the manufacture of special industrial machinery and equipment except metals and wood working machinery. In the case of shipbuilding and boat-building and repairing, both the average annual rate of growth of inputs and outputs decreased but the decrease in the rate of output is less than that of capital. Therefore the data displayed in Table 3 reveals a possibility that industries exhibiting a negative TFPG may be underutilising their capital.

Salim Uddin Chishti (1979) suggested that in the event that direct data on the utilisation of capital is not available, then an alternative way to verify the underutilization of capital is to test Verdoon's Law. This law states that the growth of productivity is positively related to the growth of output. This is because the expansion in output enables an industry to exploit economies of scale, both static and dynamic. In turn this enables productivity to increase. Hence, higher output growth leads to higher productivity growth. Salim further noted in his thesis that an alternative line of interpretation of Verdoon's Law reverses the line of causation, that is, it is the autonomous technical progress which causes increases in labour productivity which in turn causes costs to fall, followed by prices which then generates an expansion of demand and output. However, regardless of the direction of causation, the absence of a statiscally significant relationship between the growth rates of output and productivity implies that scale economies have not been realized. Salim asserts that scale economies are not achieved when the utilization rate of capital is low.

Based on Salim's argument, the correlation coefficient[10] between output growth and TFPG is computed using the data in Table 3. The correlation coefficient obtained is 0.03 and this is found to be statistically insignificant at the 10 per cent level. Hence, the data in Table 3 does not support Verdoon's Law which implies that the 61 Malaysian manufacturing industries did not realize economies of scale for the overall period of this study. The Verdoon Law was also found not to hold in the case of Singaporean manufacturing (Tsao 1982) and for Pakistan (Salim 1979).

Finally, Table 5 displays the contribution of TFPG and input growth to output growth across the 61 industries. From this table, only 7 out of the 61 industries attained a contribution of TFPG of more than 40 per cent. These are the manufacture of biscuits, the manufacture of soft drinks and carbonated water, the manufacture of fertilizers and pesticides, petroleum refineries, the manufacture of glass and glass products, the manufacture of hydraulic cement and the manufacture of brooms, brushes and mops. Out of these 7, the manufacture of biscuits, the manufacture of fertilizers and pesticides, petroleum refineries, and the manufacture of brooms, brushes and mops actually experienced a decrease in the growth rate

TABLE 5. Average annual contribution of TFPG and factor inputs to the growth of output, 1986 - 1989 (per cent)

Industry	TFPG Output growth	Input growth (weighted) Output growth
Other dairy products	23.55	76.45
Coconut oil manufacturing	-161.28	261.28
Palm oil manufacturing	30.52	69.48
Flour mills	-6.14	106.14
Sago & Tapioca factories	38.17	61.83
Biscuit factories	204.53	-104.53
Bakeries	-23.81	123.81
Tea factories off-estate	-0.84	150.84
Meehoon, noodles and related products	-23.93	123.93
Spices and curry powder	35.78	64.22
Soft drinks and carbonated water industries	62.92	37.08
Tobacco manufacture	19.74	80.26
Handicraft spinning and weaving	-32.75	132.75
Synthetic textile mills	37.11	62.89
Knitting mills	1.93	98.07
Cordage, rope and twine industries	19.12	80.88

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TABLE 5. (*Continued*)

Industry	TFPG Output growth	Input growth (weighted) Output growth
Clothing factories	4.45	95.55
Manufacture of products of leather and leather substitute, except footwear and wearing apparel	-4.76	104.76
Manufacture of footwear except vulcanised or moulded rubber or plastic footwear	-65.81	165.81
Sawmills	34.19	65.81
Planning mills, window & door mills & joinery works	2.66	97.34
Manufacture of prefabricated wooden houses	38.21	61.79
Manufacture of other wood products	-10.32	110.32
Manufacture of furniture and fixtures, except primarily of metal	-29.47	129.47
Manufacture of pulp, paper and paperboard articles, n.e.c.	8.35	91.65
Printing, publishing and allied industries	-73.79	173.79
Manufacture of industrial gases, wether compressed, liquified or in solid state	-105.14	205.14

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TABLE 5. (*Continued*)

Industry	TFPG Output growth	Input growth (weighted) Output growth
Manufacture of fertilizers and pesticides	44.86	55.14
Manufacture of drugs and medicines	-117.31	217.31
Manufacture of soap and cleaning preparations	-52.89	152.89
Manufacture of perfumes, cosmetics and other toilet preparations	-153.78	253.78
Petroleum refineries	79.50	20.50
Manufacture of miscellaneous products of petroleum & coal	-29.77	129.77
Rubber remilling and rubber latex processing off-estates	-14.71	114.71
Rubber smokehouses	2.80	97.20
Manufacture of rubber footwear	20.92	79.08
Manufacture of plastic products n.e.c.	-3.15	103.15
Manufacture of pottery, china and earthenware	-13.31	113.31
Manufacture of glass and glass products	51.98	48.02

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TABLE 5. (*Continued*)

Industry	TFPG Output growth	Input growth (weighted) Output growth
Manufacture of hydraulic cement	58.82	41.18
Manufacture of lime & plaster	5.65	94.35
Other non-metallic mineral products n.e.c.	-26.98	126.98
Primary iron & steel industries	17.32	82.68
Other non-ferrous metal basic industries	13.72	86.28
Manufacture of structural metal products	1.49	98.51
Manufacture of tin cans & metal boxes	-10.04	110.04
Manufacture of brass, copper, pewter and aluminium products	-13.81	113.81
Manufacture of engines and turbines	1.33	98.67
Manufacture of special industrial machinery & equipment except metals & wood working machinery	31.35	68.65
Manufacture of referigerating, exhaust, ventilating & air-conditioning machinery	-8.68	108.68

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TABLE 5. (*Continued*)

Industry	TFPG Output growth	Input growth (weighted) Output growth
Manufacture of electrical industrial machinery & apparatus	-34.31	134.31
Semi-conductors & ether electronic components & communication equipment & apparatus	-30.54	130.54
Manufacture of dry cells and storage batteries	21.45	78.55
Manufacture of electric lamps and tubes	7.85	92.15
Shipbuilding and boat-building & repairing	-44.71	144.71
Manufacture of motor vehicle bodies	39.08	60.92
Manufacture & assembly of motor vehicles	37.26	62.74
Manufacture of professional & scientific & measuring & controlling equipment, n.e.c.	-32.00	132.00
Manufacture of photo-graphic and optical goods	-16.08	116.08
Manufacture of sporting & atheletic goods	-131.02	231.02
Manufacture of brooms, brushes and mops	44.44	55.56

Source: Computed based on Table 3.

of capital and an increase in the growth rate of output. Thus it is clear from Table 5 that the majority of the industries shown experience a higher contribution of input growth to output growth.

POLICY IMPLICATIONS

The two main results of this study indicate that firstly, the major source of growth to manufacturing output between 1986-90 is the growth in intermediate inputs. Secondly, the relatively low contribution of TFPG in this period may be due to the rapid increase in capital in response to the buoyant growth in the economy, thereby leading to the probable underutilization of capital.

The important contribution of intermediate input is supported by Zainal Aznam Yusof and Phang's study (1994) which demonstrated that the largest component of cost in the Malaysian manufacturing sector is the cost of raw materials. This can have serious adverse impact on the Malaysian Balance of Payments as shown in the Annual Report of Bank Negara (1991) which reported that imported raw materials constituted 20 per cent of the raw materials utilized by resource-based industries while non-resource-based industries import as much as 60 per cent of the required raw materials. In particular, leading industries in the manufacturing sector such as electronics and electrical machinery can have an imported raw-materials content as high as 70 per cent of the total cost of inputs. Tsao (1982) explains that this dependance on imported raw materials is characteristic of multi-national companies in Singapore that are engaged in processing industries which import unfinished components and export finished products. This results in weak intra-manufacturing linkages or linkages with non-manufacturing sectors while linkages within the multinationals' network of plants located throughout the world tend to be stronger. Therefore, the relatively higher contribution of intermediate input growth together with the high dependance on imported inputs reinforces the need to create more linkages in order to stimulate the growth of the domestic input industries. It further lends weight to the emphasis in promoting resource-based industries such as the wood-based and rubber-products industries as these industries utilise the locally available raw materials such as timber and natural rubber. In turn, the promotion of linkages and resource-based industries require a re-evaluation of the investment policy of the government. The government has actively courted foreign direct investment (FDI); indeed the promotion of FDI is still an important component of government policy. However, the dominance of FDI in non-resource-based industries (Anuwar Ali and Tham 1993) and a greater tendency for foreign-controlled companies to import inputs (O'Brien 1993) requires a need for the government to promote *domestic investment* besides foreign investment.

Besides decreasing the dependence on imported raw materials, there is also a pressing need to increase the value added content of production in order to improve the utilization of factors other than raw materials and energy inputs. Hence the present call of the government to increase the value-added content of the Malaysian manufacturing industries is a move in the right direction.

Secondly, the underutilisation of capital in the industries requires a two-prong attack. Salim (1979) explained that the shortage of skilled labour may cause a serious constraint on capital utilization. Zarina and Shariman (1994) made a similar observation for the case of Malaysia, that is, skilled labour is required to operate the new technologies embodied in new plants and equipments so that the current capital stock may be utilised efficiently. Hence skills training and the deepening of skills is of vital importance for the full utilisation of capital. The current shortage of skilled labour requires not just government action to address the issue but also active private sector participation. While government sponsored training programs can help to alleviate some of these needs, private sector-initiated training programs are more practical as the specific training needs of a particular industry are best identified by the industry itself. As an example, the setting up of a training institute by the Malaysian Plastics Manufacturers Association demonstrates the use of industrial associations to address this issue. The government can help to facilitate this process via the provision of fiscal incentives to defray some of the expenses.

Apart from the shortage of skilled labour, the expansion of demand is also necessary. The indivisibilities of plant and machinery may necessitate the creation of capacity ahead of demand. Excess capacity in this instance may be temporary as new demand is being generated. Thus, the creation of demand can help to absorb the excess capacity. In this respect, export promotion is important due to the smallness of the Malaysian market. In order to expand exports, Malaysian producers need to improve product quality, as well as technical and marketing assistance. Consistency in quality of products can be aided by automation and mechanization. Hence reinvestment in plant and machinery should be encouraged. Further, innovation can help the producers to stay ahead in the international market. Therefore, fiscal incentives as well technical support from government aided research institutes can help to promote the much needed applied research and development work necessary for the development of new products. Finally, market research and exposure to foreign markets is also needed to help the firms market their products. Trade fairs sponsored by the government can facilitate the introduction of Malaysian products to foreign countries. Thus the expansion of demand, together with improvements of the supply of skilled labour can help to increase the utilisation of capital.

CONCLUSION

In conclusion, the estimates of TFPG in this study can be refined in a few ways. An important omission in the measurement of the input data is the differentiation in the quality of capital and labour. For example, changes in the composition of capital and labour can affect the residual estimated (Tsao 1982). This is especially important if the study of TFPG covers a longer period than the period in this study. In general, the measurement of TFPG as a residual in the Divisia Index approach is sensitive to the measurement of inputs and all the measures of inputs in this study can be improved subject to data availability. Other than measurement errors, alternative methods of measuring TFPG such as the production function approach or the Malmquist Index can also be utilised in order to compare the results with the results obtained using the Divisia Index approach. But, over and above measurement and methodological issues, the causes of TFPG growth is still unknown and therefore remain a critical vacuum in the understanding of manufacturing growth in Malaysia. The importance of this issue especially in terms of policy implications, makes this a research challenge that should be undertaken in the near future.

NOTES

[1] For example, where the capital-labour ratio is increasing, partial productivity measures such as labour productivity may not indicate pure productivity increases but rather the positive impact on labour productivity as capital-intensity increases.

[2] Some examples of changes in efficiency are changes in operating methods, utilization rates, managerial efficiency and others.

[3] The countries listed in her comparison are as follows: Hong Kong, Singapore, Taiwan, Korea, Turkey, China, Yugoslavia, Argentina, Portugal, Hungary, Mexico, Chile, Thailand, Egypt, Philippines, Indonesia and Zambia.

[4] Tsao suggested three hypotheses as possible reasons for her results; (i) the predominance of foreign capital in Singaporean manufacturing, (ii) the government's low-wage policy combined with the inflow of low-skilled foreign labour and, (iii) the relatively low level of industrial competence in Singapore.

[5] See Tsao (1982) and Sudit (1984) for a discussion on the relative merits of value-added vs. gross output.

[6] See Appendix I for the derivation of equation (1).

[7] The total number of industries in each sub-sector of the manufacturing sector was first ranked by the value of their respective gross output and every third industry was then selected to ensure that the sample of industries chosen encompassed both small and large industries as measured by output size.

[8] The weights are given by the average relative shares of the respective inputs.

[9] This is calculated based on the ratio of TFPG to gross output growth rates as likewise computed in Nishimizu and Robinson's study and Tsao's thesis.

[10] The simple correlation coefficient computed here is based on the formula given in Koutsoyiannis (1977).

Appendix I

The derivation of the formula in equation (1) is based on the Gollop and Jorgenson model as outlined in Gollop, Jorgenson and Fraumeni (1987).

Consider a production function for the i th industry where output Qi is a function of sectoral intermediate input, Xi, capital input Ki, labour input Li, and time T.

$$Qi = F^{i}(Xi, Ki, Li, T) \qquad (i = 1, \ldots, n)$$

Then,

$$\frac{d \ln Qi}{dT} = \frac{\delta \ln Qi}{\delta \ln Xi} \frac{d \ln Xi}{dT} + \frac{\delta \ln Qi}{\delta \ln Ki} \frac{d \ln Ki}{dT} + \frac{\delta \ln Qi}{\delta \ln Li} \frac{d \ln Li}{dT} + \frac{\delta \ln Qi}{\delta T} \qquad (i = 1, \ldots, n)$$

where the rate of growth in output over time is a function of the rate of growth of inputs over time multiplied by their output elasticities, and the rate of growth in output due to time alone.

Under the assumption of producer equilibrium,

$$\frac{\delta \ln Qi}{\delta \ln Xi} (Xi, Ki, Li, T) = \frac{P^i_X Xi}{qi\, Qi} = V^i_X,$$

$$\frac{\delta \ln Qi}{\delta \ln Ki} (Xi, Ki, Li, T) = \frac{P^i_K Ki}{qi\, Qi} = V^i_K,$$

$$\frac{\delta \ln Qi}{\delta \ln Li} (Xi, Ki, Li, T) = \frac{P^i_L Li}{qi\, Qi} = V^i_L,$$

where $\{qi\}$, $\{P^i_X\}$, $\{P^i_K\}$, $\{P^i_L\}$ denote the prices of outputs, intermediate, capital and labour inputs respectively. Hence, the output elasticities with respect to each input are each equal to their respective value shares V^i_X, V^i_K, V^i_L.

The assumption of constant returns to scale implies that the sum of the value shares of the sectoral inputs is equal to unity:

$$V^i_X + V^i_K + V^i_L = 1 \qquad (i = 1, 2, \ldots, n)$$

The rate of technical change, V^i_T, is defined as:

$$V^i_T = \frac{\delta \ln Qi}{\delta T} (Xi, Ki, Li, T) \qquad (i = 1, \ldots, n)$$

Therefore, the rate of change of output over time can be expressed as follows:

$$\frac{d \ln Qi}{dT} = V^i_X \frac{d \ln Xi}{dT} + V^i_K \frac{d \ln Ki}{dT} + V^i_L \frac{d \ln Li}{dT} + V^i_T \qquad (i = 1, \ldots, n)$$

where V^i_T is the Divisia quantity index of rates of technical change. Or,

$$V^i_T = \frac{d \ln Qi}{dT} - V^i_X \frac{d \ln Xi}{dT} + V^i_L \frac{d \ln Li}{dT} + (1 - V^i_X - V^i_L) \frac{d \ln Ki}{dT}$$

The Divisia index is usually formulated in terms of continuous time.

However, available data is usually in the form of discrete time. The discrete version of the Divisia Index as developed by Tornquist (Sudit 1984) shows how the indexes of the sectoral rates of technical change for two discrete points of time, T and (T – 1) can be derived from the following:

$$\overline{V}_T = \{\ln Qi\,(T) - \ln Qi\,(T-1)\}$$

$$-\overline{V}^i_X\,\{\ln Xi\,(T) - \ln Xi\,(T-1)\}$$

$$-\overline{V}^i_L\,\{\ln Li\,(T) - \ln Li\,(T-1)\}$$

$$-(1 - \overline{V}^i_X - \overline{V}^i_L)$$

where

$$\overline{V}^i_X = \tfrac{1}{2}\,\{V^i_X\,(T) + V^i_X\,(T-1)\}$$

$$\overline{V}^i_L = \tfrac{1}{2}\,\{V^i_L\,(T) + V^i_L\,(T-1)\}$$

$$\overline{V}^i_T = \tfrac{1}{2}\,\{V^i_T\,(T) + V^i_T\,(T-1)\}$$

Or the average rate of technical change, $\overline{V}^i_T$, is the difference between the rate of growth in output between time (T – 1) and time (T) and the weighted sum of the rates of growth of the three inputs, with the weights being the average value share of the inputs.

Appendix 2

This appendix discusses the construction of the data base, which is obtained from the Department of Statistics. All inputs and output are stated in 1978 prices.

1. Output

The gross value of output is obtained from the Annual Industrial Surveys published by the Department of Statistics (DOS). This is then deflated with the sectoral producer price index from DOS.

2. Capital

Usually, capital is measured by the perpetual inventory method. However due to the lack of data on the suitable benchmark year and the economic rates of depreciation, capital input is measured as the value of fixed assets as at the end of a calender year, based on DOS data. Furthermore, the unavailability of suitable deflators for land and building resulted in the omission of these two assets from the value of fixed assets. Hence, capital in this study constitues 2 main items only, that is transport equipment and machinery and equipment which is then deflated with the producer price index for machinery and transport equipment. Using constant returns to scale, the share of capital service in taken to be one minus the price of labour and share of intermediate inputs.

3. Labour

The lack of data on man-hours of work resulted in the measurement of labour by the number of full-time and past-time workers with two part-time workers as equivalent to one full-time worker. The share of labour is the ratio of total salaries and wages, bonus, cash allowances and overtime pay to the value of gross output.

4. Intermediate inputs

These comprise of raw materials, electricity water, fuel and lubricants deflated by the respective sectoral producer price index. The share of intermediate input is measured by the ratio of the value of intermediate inputs to the gross value of output.

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