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TOTAL FACTOR PRODUCTIVITY GROWTH IN MALAYSIAN MANUFACTURING SECTOR: EMPHASIS ON HEAVY INDUSTRIES

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ABSTRACT

This study utilizes the standard growth accounting model to estimate Total Factor Productivity (TFP) growth for Malaysian manufacturing industries during 1982-1997 which includes two cyclical sub-periods 1982-1986 and 1987-1997. The estimates show high TFP growth among the heavy industries as compared to the medium and light industries. The average TFP growth for the manufacturing sector as a whole was found to be negative during 1982-1986. However, it improved in the second sub-period of 1987-1997 and recorded positive annual growth of 4.05 percent. This improvement presumably reflects to some extent the success of government policy changes which have taken place since 1985. Still, the growth of the Malaysian manufacturing sector was governed by the input-driven growth rather than the productivity-driven growth.

JEL classification: D24

Key words: Total factor productivity, Heavy industry, Government policy

1. INTRODUCTION

The growth of an economy is governed by two distinct sources of growth that is, input–driven and productivity–driven. The input–driven

growth is achieved through the increase in factors of production which is inevitably subjected to diminishing returns and is not sustainable in the long run (Young, 1992; Krugman, 1994 and Kim and Lau, 1994). The productivity-driven growth is the growth in output that cannot be explained by the growth in total inputs. It is normally attributed to the advancement of knowledge or technology, efficient use of factors of production, improvements in organizational structure and human resources management, gains from specialization, learning-by-doing, skill acquisition and enhancement of information technology.

Thus the growth in productivity, which is also known as Total Factor Productivity (TFP) growth, is the difference between the actual growth of output and the growth due to a composite of all factor inputs. It measures the overall efficiency with which products are produced and thus enable the economy to generate a larger output from the same available resources. In other words, TFP growth would bring the economy to a higher production frontier with more efficient use of factor inputs. Hence it is an important source of sustainable long-term economic growth.

In the past, the growth of Malaysian economy was mainly input-driven particularly through investments, with capital accumulation contributing almost half of the potential output growth. Due to limited resources and capacity in capital accumulation and stiff competition in attracting foreign investments, the government decided to shift the economic growth strategy from input-driven to productivity-driven by enhancing the contribution of TFP from 28.7 percent of gross domestic product (GDP) in the Sixth Malaysia Plan period (1991-1995) to 41.3 percent in the Seventh Malaysia Plan period (1996-2000). The TFP is expected to grow from 2.5 percent in the Sixth Malaysia Plan period to 3.3 percent in the Seventh Malaysia Plan period. But the policy to shift to the productivity–driven strategy was severely affected by the East Asian financial crisis which occurred at the end of 1997. As a result, during 1996-2000 TFP grew at only 1.2 percent and contributed only 24.8 percent of GDP growth, while the contributions of labor and capital were 25.0 and 50.2 percent, respectively (Malaysia, 2001). This indicates that Malaysian economic growth continued to be input-driven, particularly by capital.

The domination of input-driven growth in the Malaysian economy seemed to exhibit similar pattern with the growth experienced by other

East Asian Newly Industrialized Countries (Young, 1992; Krugman, 1994; Kim and Lau, 1994). Studies indicate that the growth in these countries was mainly input-driven through massive factor accumulation rather than to productivity-driven. Kim and Lau (1994) in their study on economic growth of four Asian 'tiger economies' and five OECD countries found that capital accumulation accounted for 80 percent of the growth of the Asian 'tigers' with negligible contribution from technical progress. The same pattern of growth also appeared in Latin American countries. Elias (1978), for instance, found that TFP contributed only about 20 percent to output growth during 1940-1970, while capital contributed more than 50 percent of output growth.

This growth phenomenon is somewhat different from the growth pattern observed in developed countries (Solow, 1956, 1957; Denison, 1967; Nadiri, 1972; Kim and Lau, 1994). In a study on sources of growth in nine Western countries, Denison (1967) found that advanced knowledge, improved allocation of resources and economies of scale accounted for almost 60 to 90 percent of the growth in income per capita, with factor inputs (labor, capital and land), explaining a relatively small percentage of the overall economic growth. This implies that the growth of the Western countries is mainly driven by productivity gain rather than growth in factor inputs. Nadiri (1972) also pointed out to the important role of TFP growth in contributing towards economic development of industrialized countries. The finding is supported by another study conducted by Kim and Lau (1994) which found that almost 45 to 70 percent of the economic growth in five OECD countries is due to productivity growth.

Most of past studies on the sources of growth in Malaysia were conducted either for the overall economy using the country's aggregate data or focused specifically on the manufacturing sector. Included in the first category, among others, were the studies by Ikemoto (1986), World Bank (1993), Gan and Robinson (1993), Kawai (1994), Tham (1997), Gan and Soon (1998), Taylor and Lewis (2001), and Jenny (2001). Despite differences in data, period of study and methodology employed, the findings lead to a similar conclusion. The rapid transformation of the Malaysian economy has been almost entirely due to the growth in factor inputs, particularly through capital accumulation.

Studies that attempt to measure sources of growth for the manufacturing sector benefited from the work done by the World Bank

(1989); Maisom and Arshad (1992); Maisom and Ariff (1993); Maisom, Ariff and Nor Aini (1994); Okamoto (1994); Tham (1997, 1998); Rahmah (1999); Rahmah and Idris (2000) and Zulaifah and Maisom (2001).

In an earlier study on TFP growth in Malaysian manufacturing industries during 1982-1984, the World Bank (1989) found poor productivity performance of the capital-intensive industries. Resources have not been utilized efficiently, especially in iron and steel, glass, non-ferrous metals and non-metallic minerals industries. Similarly, Maisom, Ariff and Nor Aini (1994) found that over the period of 1974-1989 the TFP growth was the highest among the medium industries as compared to the heavy and light industries.

In another study, Maisom and Ariff (1993) estimated TFP growth for 43 five-digit resource-based industries for the period 1968-1988. They observed higher productivity growth in the consumer-oriented labor-intensive, and export-oriented industries, and those with lower effective protection rates.

Rahmah and Idris (2000) studied sources of growth in large scale industries (LSI) for the period of 1982-1994 and found that many LSI enjoyed greater efficiency or TFP growth. In contrast to this finding, Rahmah (1999) found that the contribution of TFP in small and medium industries (SMI) were still low, especially in the more labor-intensive enterprises. These results are not surprising since it is well recognized that as compared to SMI, LSI enjoy benefits from technological advancement, better human resource and organizational management which lead to higher efficiency gains.

Tham (1997) utilised the four-input model to estimate sources of growth in the manufacturing sector and found that TFP grew at only 0.3 percent for the period of 1986-1991. She also found that the major source of output growth in the manufacturing sector was input-driven, particularly from capital which contributed 22.4 percent of the growth as compared to the contribution from TFP of only 2.2 percent. In another study, Tham (1998) also obtained a very low TFP growth of 0.1 percent for the manufacturing sector for the period of 1986-1993.

From the above results, two general conclusions can be drawn. Firstly, the growth of Malaysian economy and its manufacturing sector is input-driven, particularly through capital accumulation, rather than through productivity. Secondly, the productivity performance of the heavy

industries in the 1970's and 1980's was not encouraging. Thus, the objective of this paper is to obtain the latest estimates on the TFP growth performance of the heavy industries and to identify the sources of output growth in manufacturing. The results obtained will be compared with earlier empirical results to provide some insights on long term patterns of productivity performance of the heavy industries and the manufacturing sector as a whole.

Malaysia started to adopt a new industrialization strategy in the 1980's by emphasizing on the development of heavy industries, which was formally incorporated in the Fourth Malaysia Plan (1980-1985). There is no internationally recognized definition of heavy industries, but the term is sometimes used to denote capital intensive industries, capital goods industries or the new high-technology industries (UNIDO, 1985). In general, heavy industries are characterized by projects with high capital intensity, substantial economies of scale, high risk and longer gestation period. These projects might not be so attractive to private enterprises and thus require greater government participation.

Through Heavy Industry Corporation Malaysia (HICOM), the government ventured into a number of large scale capital intensive industries, such as non-metallic mineral, ferrous (iron and steel) and non-ferrous metals, paper and paper products, petrochemicals and transport equipment. The development of these industries is expected to reduce the dependency on foreign countries for the supply of industrial raw materials, intermediate inputs, machinery and capital goods. In addition, it should expand and diversify the manufacturing base, promote spin-off effects, forward and backward linkages and develop the technological capability.

Further structural transformation of industry was carried out in the beginning of 1996 by shifting towards technology-intensive industrial activities (Malaysia, 1996). By emphasizing on the utilization and application of new and improved technologies, it is expected that it would boost overall productivity, growth and diversification of the manufacturing sector.

The productivity and efficiency of the heavy and high technology industries require not only a high level of investment in human and physical capital, but also improvements in intangible elements or TFP growth. These include among others improvements in government policy instruments, economic organization and management practices,

innovation, absorption of technology and mobilization of human resources in terms of proper work ethics and values, hard work, determination, initiative and loyalty to the enterprise. Thus, a study of total factor productivity of heavy or high technology industries is particularly relevant since it would contribute to a greater understanding of the long term TFP performance of these industries.

This paper is divided into six parts. Part 2 discusses the theoretical framework and sources of data. Characteristics of the Malaysian manufacturing industries are presented in Part 3. Part 4 analyzes and compares the main sources of output growth for the Malaysian heavy- and non-heavy manufacturing industries and finally Parts 5 and 6 present interpretations of results and conclusion, respectively.

2. THEORETICAL FRAMEWORK AND DATA

The concept of TFP growth and its measurement was first developed by Solow (1957) in his conventional growth accounting framework. Basically, the framework developed was based on the assumptions of competitive equilibrium and constant returns to scale. In essence, the framework decomposed the rate of growth of output into the contribution of rate of growth for labor and capital inputs, plus a residual term, typically referred to as the rate of growth of TFP. This framework was further elaborated by other scholars, such as Kendrick (1961), Denison (1967), Christensen, Cummings and Jorgenson (1980), Gollop and Jorgenson (1986) and Maddison (1987).

Three methodologies that are normally adopted in estimating TFP growth for the Malaysian manufacturing sector are the Gollop and Jorgenson model (1986), the Dollar and Sokoloff model (1990) and the econometric estimation of the production function (World Bank, 1993). In estimating TFP growth, Gollop and Jorgenson apply both the growth accounting framework and the Divisia index approach. The Divisia index of TFP growth is calculated as a residual between the Divisia index of output growth and the weighted sum of Divisia indexes of the growth of factor inputs.

Dollar and Sokoloff (1990) introduced an alternative methodology to estimate TFP growth. The model decomposed labor productivity growth into the contribution of capital deepening plus a residual, which is TFP growth. Thus, TFP growth is the residual of the actual growth in

labor productivity less the amount of the advance due to capital deepening. The World Bank (1993), on the other hand, utilized the Cobb-Douglas production function approach to estimate TFP growth based on the growth accounting framework. The TFP growth is the residual obtained by subtracting the contributions of human and physical capital accumulation from the growth of output.

Following World Bank (1993), we estimate the TFP growth for the Malaysian manufacturing using the econometric estimation of the production function approach. Given the neoclassical Cobb-Douglas production function:

(1) $Q = Ae^{mt}L^{á} K^{â}$

where Q is output, L is labor, K is capital and t is time period. A is the technology level and the exponential time trend term in equation (1) accounts for disembodied technical change. Expressing equation (1) in logarithmic form:

(1) $\log Q = \log A + á \log L + â \log K + mt$

and differentiating equation (2) with respect to time, t, we obtain:

(3) $$\frac{1}{Q}\frac{dQ}{dt} = \alpha \frac{1}{L}\frac{dL}{dT} + \beta \frac{1}{K}\frac{dK}{dt} + m$$

or

$$G_Q = \alpha G_L + \beta G_K + m$$

where:

$\frac{1}{Q}\frac{dQ}{dt} = G_Q$ = the growth rate of output

$á$ = the elasticity of output with respect to labor

$â$ = the elasticity of output with respect to capital

$\frac{1}{L}\frac{dL}{dt} = G_L$ = the growth rate of labor inputs

$\frac{1}{K}\frac{dK}{dt} = G_K$ = the growth rate of capital inputs

m = the rate of disembodied technical change or TFP growth

Equation (3) shows the contribution of capital and labor (each weighted by their respective shares in the total output) and the contribution of TFP growth to the output growth. Thus, the TFP growth is the residual that is obtained by subtracting the growth rates of labor and capital inputs from the total growth of output. TFP growth is thus given by:

(4) $m = G_Q - \acute{a}G_L - \hat{a}G_K$

The residual-based methodology has a shortcoming in that it includes not only the effect of technical change, but also other elements such as improvement in managerial practices, qualitative improvement in human and capital resources, economies of scale, imperfect factor and product markets, X-inefficiency, poor measurement of capital and labor inputs and other omitted factors.

In the present study, we estimate equation (3) using the ordinary least-squares (OLS) technique for the time-series data for the period 1982-1997. The OLS estimation to this equation yields estimates of *á* and *â*. The multiplication of the coefficients of *á* and *â* with their respective growth in labor and capital measures the contribution of these inputs to the output growth. The contributions of labor, capital and TFP to the output growth were obtained not only for the whole period of 1982-1997, but also for two distinct cyclical phases, 1982-1986 and 1987-1997. The first sub-period of 1982-1986 can be characterized by rather low-growth period with an average annual growth rate of only 4 percent, whereas in the second sub-period, the Malaysian economy experienced rapid economic growth at an average of 8.4 percent per year.

This study utilizes an aggregated annual data on value added, labor and capital for 28 three-digit manufacturing industries obtained from the Yearbook of Statistics published by the Department of Statistics. Number of persons employed is used as labor input, and value of fixed

assets as capital input. All data on value added and capital are in real terms, which have been deflated by the producer price index with 1989 as the base year.

3. CHARACTERISTICS OF THE MALAYSIAN MANUFACTURING INDUSTRIES

Table 1 presents some basic descriptive statistics of the Malaysian manufacturing industries for the period 1982-1997. Following Maisom, Ariff and Nor Aini (1994), we use the index of capital intensity, measured by the value of fixed assets per worker to categorize the industries into heavy, medium and light industries. Industries having capital intensity index of 120 or higher are categorized as heavy industries. Industries with capital intensity index between 60 and 120 are classified as medium industries, while those with an index of less than 60 are light industries.

The cut-off point of 120, instead of 150 as chosen by Maisom, Ariff and Nor Aini (1994), was used to classify the heavy industries to take into consideration the definition of heavy industries given by UNIDO (1985). In the Medium and Long Term Industrial Master Plan report, UNIDO (1985) defined petroleum and coal products, and transport equipments (comprising of road transport equipments and ship building industries) as heavy industries. In their four major group categories (heavy, medium, light and resource based industries), Maisom, Ariff and Nor Aini (1994), on the other hand, categorized petroleum and coal products as resource-based industries and transport equipments as medium industries.

The results as given in Table 1 reveal large variations in the capital intensity index across the manufacturing industries. The capital intensity index ranges from as high as 2380 in crude oil to as low as 40 in the light industries. With an index of 1260, industrial chemicals industry is also categorized as highly capital-intensive industry.

With respect to the average shares of the total manufacturing value added and employment, Table 1 shows that during 1982-1997, electrical machinery seems to dominate the manufacturing sector with its largest shares in value added and employment of 26.16 and 25.74 percent, respectively. This was followed by food and industrial chemicals industries which together accounted for almost 16 percent of the total

TABLE 1
Characteristics of Malaysian Manufacturing Industries, 1982-1997

Industry	Capital Intensity Index (average)	(Average) Share of Total Manufacturing (%)	
		Value Added	Employment
Heavy Industries			
Crude Oil Refineries	2380	2.39	0.19
Industrial Chemicals	1260	7.43	1.12
Iron & Steel	380	2.46	1.73
Glass & Glass Products	320	0.88	0.47
Non-Metallic Mineral	220	4.48	3.21
Paper & Paper Products	220	1.57	1.60
Non-Ferrous Metal	200	0.86	0.61
Beverage	180	1.23	0.60
Petroleum & Coal Products	120	0.36	0.11
Transport Equipment	120	5.16	3.51
Medium Industries			
Tobacco Products	100	1.51	0.80
Textiles	100	3.17	4.42
Other Chemicals Products	100	2.33	1.53
Rubber Products	80	4.87	6.07
Fabricated Metal Products	80	3.93	4.44
Machinery	80	4.71	3.79
Wood Products	60	5.94	10.96
Furniture and Fixtures	60	1.19	2.36
Printing and Publishing	60	2.86	2.92
Plastic Products	60	3.28	4.42
Pottery, China & Earthenware	60	0.30	0.64
Electrical Machinery	60	26.16	25.74
Light Industries			
Food	40	8.72	8.88
Leather & Fur	40	0.09	0.21
Professional & Scientifi Equipment	40	1.04	1.55
Apparel	40	2.10	6.09
Footwear	40	0.07	0.18
Other Manufacturing	40	0.91	1.85
Total Manufacturing	100	100.00	100.00

manufacturing's value added. In terms of employment shares, wood products surpassed the employment share of food industry by only 2.08 percent.

Due to higher cost of production among the capital intensive industries, it is thus not surprising to observe the existence of negative relationship between the capital intensity and the share of manufacturing's value added. The two extreme examples are worth mentioning. Crude oil refineries, the most highly capital intensive industry, contributed only 2.39 percent to the total manufacturing's value added as compared to electrical machinery, the less capital intensive industry, which contributed the highest value added of 26.16 percent. However, despite higher cost and highly capital intensive, industrial chemicals was the third largest contributor to the manufacturing's value added at 7.43 percent, suggesting higher overall efficiency in its production process.

4. SOURCES OF OUTPUT GROWTH

4.1 MANUFACTURING INDUSTRIES

Table 2 presents our estimates on sources of output growth for 28 three-digit level manufacturing industries for the period 1982-1997. Except for the beverage industry, all other industries experienced double-digit growth rates. The rapid growth of output in majority of these industries was primarily due to the rapid growth in capital. The contribution from technical progress or improvement in efficiency in the use of factor inputs (TFP growth) to output growth, on average, was low for the majority of industries. Only five industries recorded an average annual TFP growth above four percent. These were petroleum and coal products (18.19 percent), industrial chemicals (9.46 percent), professional and scientific equipment (4.90 percent), iron and steel (4.44 percent), and machinery (4.04 percent).

Relative to the medium and light industries, the heavy industries exhibited higher growth performance whereby 70 percent of the sub-industries recorded an average growth rate of more than 20 percent. Petroleum and coal products enjoyed a high average annual growth rate of 39.97 percent followed by industrial chemicals at 37.55 percent.

The contribution of capital to output growth was found to be higher than the contribution of labor in 80 percent of the heavy industries, excluding the crude oil refineries, and paper and paper products industries. Despite being highly capital intensive, capital contribution in these industries seemed to be very low, contributing only 23.87 and 27.78 percent, respectively.

Of the three industries with relatively high TFP growth, only petroleum and coal products indicated TFP growth as the major source of output growth, contributing 45.47 percent to the total output growth, while industrial chemicals placed TFP as the second major source of growth contributing 25.19 percent to the output growth. TFP is regarded as a minor source of growth in the iron and steel industry. Petroleum and coal products have proven to be very efficient not only during our period of study in the 1980's and 1990's, but also during 1970's. World Bank (1989) found that petroleum and coal products was the most dynamic industry during 1975-1979. Our finding also supports the earlier result by Maisom and Ariff (1993) that industries downstream activities, such as petroleum and coal products, and industrial chemicals, experienced higher productivity growth than upstream activities such as crude oil refineries. The contribution of TFP was low in paper and paper products, and negative in three other industries.

In contrast to the heavy industries, the medium and light industries exhibited slower growth performance with only 33 and 25 percent, respectively, achieving more than 20 percent growth rate. Among the medium industries, electrical machinery, machinery, and plastic products registered growth rate of more than 20 percent. In terms of efficiency, only professional and scientific, and machinery recorded an average annual TFP growth rate above 4 percent. Contribution of TFP to output growth was very low in fabricated metal products, rubber products, and food, and negative in four industries, namely, furniture and fixture, leather and fur, and wearing apparel and footwear. The industries which experienced poor TFP growth performance were also found to be the industries with relatively smaller shares of total manufacturing value added or employment. Industries such as wearing apparel, leather and fur, and footwear are known to be dependent on manual and small batch operations rather than mass mechanization and automation. Thus, poor productivity level observed in these industries reflects low rate of

TABLE 2
Sources of Output Growth in Malaysian Manufacturing Industries, 1982-1997 (percent per annum)

Industry	Value Added Growth Rates	Growth by Sources			Percentage Contribution on Growth		
		Capital	Labor	TFP	Capital	Labor	TFP
Heavy Industries							
Crude Oil Refineries	22.50	5.37	15.43	1.70	23.87	68.57	7.56
Industrial Chemicals	37.55	21.44	6.65	9.46	57.10	17.71	25.19
Iron & Steel	21.16	9.89	6.83	4.44	46.74	32.28	20.98
Glass & Glass Products	21.60	16.76	7.14	-2.30	77.59	33.06	-10.60
Non-Metallic Mineral	15.78	9.04	4.23	2.51	57.29	26.81	15.90
Paper & Paper Products	20.45	5.68	13.77	1.00	27.78	67.33	4.89
Non-Ferrous Metal	18.89	15.04	5.14	-1.29	79.62	27.21	-6.83
Beverage	7.98	6.36	0.51	1.11	79.70	6.39	13.91
Petroleum & Coal Products	39.97	14.53	7.15	18.19	36.35	17.89	45.47
Transport Equipment	19.60	12.31	9.17	-1.88	62.80	46.80	-9.59
Medium Industries							
Tobacco Products	11.87	6.10	2.48	3.29	51.39	20.89	27.72
Textiles	13.29	10.84	0.43	2.02	81.57	3.23	15.20
Other Chemicals Products	13.67	11.30	0.57	1.80	82.66	4.17	13.07
Rubber Products	12.09	7.94	3.27	0.88	65.67	27.05	7.28

TABLE 2 (continued)

Fabricated Metal Products	18.86	14.40	3.93	0.53	76.35	20.84	2.81
Machinery	23.63	9.14	10.45	4.04	38.68	44.22	17.20
Wood Products	11.52	5.49	3.93	2.10	47.66	34.11	18.23
Furniture and Fixtures	19.28	16.56	5.15	-2.43	85.89	26.71	-12.60
Printing and Publishing	11.90	8.28	2.42	1.20	69.58	20.34	10.08
Plastic Products	21.96	13.76	6.00	2.20	62.66	27.32	10.02
Pottery, China & Earthenware	17.60	12.35	3.49	1.22	72.39	20.46	7.15
Electrical Machinery	23.75	17.35	5.02	1.36	73.11	21.15	5.73
Light Industries							
Food	11.01	7.46	2.71	0.84	67.79	24.61	7.63
Leather & Fur	18.99	18.81	0.82	-0.64	99.05	4.32	-3.37
Professional & Scientific Equipment	20.85	6.79	9.16	4.90	32.57	43.93	23.50
Apparel	14.51	11.09	4.35	-0.93	76.43	29.98	-6.41
Footwear	14.15	12.65	1.64	-0.14	89.40	11.59	-0.99
Other Manufacturing	20.92	7.48	10.92	2.52	35.76	52.20	12.04
Total Manufacturing	15.48	9.25	6.68	-0.45	59.75	43.15	-2.90

technical progress and is consistent with an earlier finding by Khor and Maisom (2001).

Table 3 presents the estimates of TFP growth for the two sub-periods 1982-1986 and 1987-1997. During 1982-1986, TFP performance of the Malaysian manufacturing industries was rather poor, with 19 out of 28 industries experiencing negative TFP growth as compared to only three industries during 1987-1997. Significant improvement in TFP growth during the second sub-period was indicated by the performance of 22 industries which experienced an increase in TFP growth rate. More than half of the industries which experienced negative TFP in 1982-1986 shifted their efficiency frontiers in 1987-1997 and exhibited positive TFP growth. One of the industries which experienced severe deterioration in TFP growth was tobacco products, from 13.41 percent in 1982-1986 to 1.32 percent in 1987-1997.

During 1982-1986, sixty percent of the heavy industries experienced negative TFP growth as compared to only one percent during 1987-1997. Substantial improvement in TFP growth between the two sub-periods were recorded in the heavy industries such as glass and glass products, crude oil refineries, non-ferrous metal, transport equipment and furniture and fixtures.

The rapid TFP growth in these industries was accompanied by rapid growth in the average establishment size (measured by average value added per establishment), indicating existence of substantial opportunities to improve productivity by expanding the scale of operation and adopting advanced techniques of production. This was particularly obvious in the crude oil industry, which has experienced the fastest growth in the average establishment size from a negative growth during 1982-1986 to an average of 36.16 percent per annum during 1987-1997. Transport equipment, and glass and glass products were two other industries with high rates of TFP growth and rapid growth in average establishment size. This is consistent with studies in other countries which found that growth in firm size leads to rapid increases in productivity (Nelson, 1968; Dollar and Sokoloff, 1990).

Despite differences in the methodology adopted, our results complement earlier studies by World Bank (1989) and Maisom, Ariff and Nor Aini (1994) by providing a longer time perspective on the pattern of TFP growth performance of the heavy industries in Malaysia.

Maisom, Ariff and Nor Aini (1994), for instance, found that the productivity performance of the heavy industries during 1974-1989 were not encouraging as compared to the medium and light industries. Similarly, World Bank (1989) found that during 1975-1984, despite substantial investment resources, capital-intensive industries performed poorly with excess capacity, low rates of labor absorption and declining productivity. The average TFP growth for crude oil refineries, and iron and steel during 1981-1984, for example, was found to be -11.4 and -21.0 percent, respectively. Our study also indicated negative TFP growth for these two industries during 1982-1986. However, we observed substantial improvement in TFP growth in these two industries in particular and among the heavy industries in general during 1987-1997.

This seems to suggest that the effect of large injections of capital in the heavy industries in the middle of 1970's and early 1980's to raise productivity was realized in the later periods. This is due to the fact that the nature of capital-intensive processes involve longer gestation periods. The efficiency in the utilization of new technology acquired increases and the difficulties in its adaptation are overcome as workers become knowledgeable and skillful in the long run.

4.2 MANUFACTURING SECTOR

As for the manufacturing sector as a whole, the value of output grew at 15.48 percent per annum during 1982-1997 (Table 4). Capital accumulation accounted for 9.25 percent (contributing 59.75 percent of output growth), with the remaining 6.68 percent being attributable to employment growth. However, the contribution from TFP growth was negative. Hence, with an average annual TFP growth rate of -0.45 percent as compared to 15.93 percent in the physical inputs growth, the growth of Malaysian manufacturing sector during the period of 1982-1997 was input-driven rather than efficiency- or productivity-driven. The finding of input-driven growth was also observed by other researchers (World Bank, 1989; Maisom and Arshad, 1992; Tham, 1997, 1998).

To get a clear insight on the efficiency performance of the manufacturing sector, we consider two cyclical sub-periods of 1982-1986 and 1987-1997. The TFP growth was -10.34 percent during 1982-

TABLE 3
Growth Rates of TFP and Establishment Size (percent per annum)

	TFP		Growth in Establishment Size	
	1982-1986	1987-1997	1982-1986	1987-1997
Heavy Industries				
Crude Oil Refineries	-21.68	12.33	-6.62	36.16
Industrial Chemicals	18.16	5.50	100.54	7.45
Iron & Steel	-4.96	8.71	27.98	12.36
Glass & Glass Products	-26.36	8.64	-0.76	14.56
Non-Metallic Mineral	1.43	3.01	15.34	8.66
Paper & Paper Products	3.52	-0.14	17.15	10.27
Non-Ferrous Metal	-16.16	5.46	7.59	8.04
Beverage	-7.61	5.08	6.15	4.69
Petroleum & Coal Products	18.93	18.00	35.24	19.55
Transport Equipment	-16.59	4.81	-1.04	19.23
Medium Industries				
Tobacco Products	13.41	-1.32	150.82	-4.98
Textiles	-1.47	3.60	19.51	6.51
Other Chemicals Products	1.81	1.79	14.12	5.05
Rubber Products	-5.95	3.98	19.36	6.66
Fabricated Metal Products	-1.58	1.49	9.49	11.89
Machinery	-1.41	6.52	8.77	19.48
Wood Products	-6.21	5.88	11.40	8.94
Furniture and Fixtures	-16.59	4.00	10.54	12.65
Printing and Publishing	-5.16	4.09	20.81	5.42
Plastic Products	2.05	2.27	16.78	10.90
Pottery, China & Earthenware	2.48	0.65	21.46	2.98
Electrical Machinery	-0.89	2.39	13.99	10.00
Light Industries				
Food	-1.92	2.09	10.28	3.11
Leather & Fur	-10.01	3.62	-0.58	12.87
Professional & Scientific Equipment	-0.81	7.49	29.65	9.79
Apparel	-8.70	2.60	25.18	-0.22
Footwear	-0.15	-0.14	18.24	-2.31
Other Manufacturing	0.84	3.29	18.72	3.12

1986, following estimates of negative TFP growth obtained for 19 industries under consideration. The very low TFP growth observed during this sub-period could also be attributed to data inaccuracies due to changes in capacity utilization. A decline in capacity utilization during the recession period in 1985 would lead to a downward bias in TFP growth estimate.

The downward bias in TFP growth estimate can be overcome if capital is valued at its shadow rental price rather than its market price. By measuring capital at its shadow value, Berndt and Fuss (1981) found that 25 percent of decline in TFP growth estimate for the US manufacturing sector during 1973-1977 was due to a decline in capacity utilization. However, due to unavailability of data, this could not be done in this study. Besides, problems inherent in the residual-based methodology, such as omitted factors and poor measurement of inputs, would also lead to the downward bias in TFP growth estimates.

Substantial improvements in the efficiency performance occurred in 1987-1997. The average annual TFP grew from -10.34 percent during the low period of economic growth of 1982-1986 to 4.05 percent during the rapid economic growth period of 1987-1997. Our results seem to support the general hypothesis that TFP growth is higher in a fast-growing economy as being postulated by Verdoorn's Law. It is also in accordance with the results obtained from studies in other high-growth countries such as South Korea and Japan (Nishimizu and Hulten, 1978; Christensen and Cummings, 1981 and Nishimizu and Robinson, 1984).

Cornwall (1977) argued that a higher TFP growth due to technical progress would contribute significantly to an increase in labor productivity and output growth. This phenomenon appeared in the Malaysian manufacturing sector as depicted in Table 5. During the first sub-period of low growth rates, the increase in labor productivity (7.70 percent) was due to a large increase in capital intensity (18.57 percent) with negligible contribution from improvement in efficiency (TFP growth was -10.34 percent). However, the situation in the second sub-period of high growth rates was different. The increase in labor productivity (7.58 percent) during this period was not solely due to the increase in capital intensity (6.91 percent), but was also due to a large improvement in efficiency (4.05 percent).

The comparison of our estimates of TFP growth in industries at the 3-digit level with past studies is not appropriate due to differences in

TABLE 4
Contribution to Growth of Malaysian Manufacturing Sector, 1982-1997 (percent per annum)

	1982-1997	1982-1986	1987-1997
Value Added Growth Rates	15.48	-3.15	23.95
Growth by Sources:			
Capital	9.25	7.62	9.99
Labor	6.68	-0.43	9.91
TFP	-0.45	-10.34	4.05

methodology, sample coverage, level of industrial aggregation and period of analysis. However, in order to arrive at some general conclusions on TFP growth performance over a longer time period in the Malaysian manufacturing sector, an attempt is made to compare the results with earlier empirical studies which utilized the same level of industrial aggregation. As can be seen from Table 6, there are currently six studies on TFP growth using either two, three or four-input model at 3-digit level industries. Our estimates are quite comparable to the estimates obtained by World Bank (1989) and Zulaifah and Maisom (2001).

Prior to 1980, manufacturing industries experienced a positive TFP growth with the highest estimate of about 8.1 percent per annum. Beginning 1980, the efficiency performance of the manufacturing sector deteriorated until the middle 1980s and recorded a negative growth rate. However, from 1986 onwards the productivity performance improved with an average TFP growth of about 4 percent during 1990's.

5. INTERPRETATION OF RESULTS

Our analysis of the productivity performance for the manufacturing sector in the previous section reveals negative TFP growth in the first half of 1980's which may be due to the poor performance of the heavy industries, particularly for crude oil refineries, and glass and glass products. The early 1980's was the period of transition from export-oriented growth towards the development of heavy industries. Also, the 1980's witnessed heavy involvement of the public sector in the capital-intensive projects through the establishment of various public

TABLE 5
Annual Growth Rates of Labor Productivity, Capital Intensity and TFP in Malaysian Manufacturing Sector, 1982-1997 (percent)

Year	Labor Productivity	Capital Intensity	TFP[1]
1982	1.53	13.04	-18.99
1983	19.18	43.38	-10.24
1984	14.85	13.90	1.59
1985	3.17	23.11	-11.20
1986	-2.04	-2.60	-12.84
1987	1.35	-0.37	-16.75
1988	5.61	-7.04	-2.41
1989	8.60	-3.66	4.40
1990	-1.56	5.38	-15.00
1991	9.77	12.02	-1.01
1992	6.48	15.98	-0.40
1993	7.32	7.44	4.46
1994	10.97	12.49	11.31
1995	6.16	7.81	10.27
1996	15.00	8.78	25.36
1997	13.66	17.18	24.30
Averages			
1982-1997	7.62	10.55	-0.45
1982-1986	7.70	18.57	-10.34
1987-1997	7.58	6.91	4.05

Notes: [1]Estimated from equation 3.

enterprises (Rugayah, 1991). However, many of these public enterprises were not performing well (Ismail and Osman Rani, 1991 and Ismail and Meyanathan, 1993), operating inefficiently, causing wastage of investment resources, imposing greater fiscal burden and slowing down the economic growth (Salih and Yusof, 1989), thereby contributing to the deterioration of the total factor productivity performance.

To overcome the problems associated with the public enterprises and to minimize the size of public sector, the government announced its privatization policy in 1983. Privatization has been viewed as the means to introduce new dynamism through organizational reforms and new production methods as well as to improve efficiency. The Fifth Malaysia Plan (1986-1990) placed more demanding tasks and challenges to the

private sector as the country progressed to achieve further growth and deepening of its industrial base. The private sector was required to play a more active role in the development, diversification and upgrading of resource-based industries and selected heavy industries. A thorough assessment of investment incentives and export promotion policies were undertaken in 1983 (Malaysia, 1986). The incentive system, especially tariffs, was reformulated to give it an outward-oriented direction, and to increase competition and encourage entrepreneurs to initiate change to achieve higher efficiency.

TABLE 6
TFP Growth Estimates of Malaysian Manufacturing Industries

Period of Study	Annual TFP Growth	Author	Level of Aggregation and Model
1975-1979	3.8 percent	World Bank (1989)	27 three-digit industries three-input model
1975-1979	8.1 percent	Maisom, Ariff & Nor Aini (1994)	23 three-digit industries two-input model
1980-1983	6.4 percent	Maisom, Ariff & Nor Aini (1994)	
1981-1984	-1.9 percent	World Bank (1989)	
1982-1986	-10.3 percent	Our result	28 three-digit industries two-input model
1984-1986	4.1 percent	Maisom, Ariff & Nor Aini (1994)	
1986-1989	0.9 percent	Tham (1998)	28 three-digit industries three-input model
1987-1989	13.5 percent	Maisom, Ariff & Nor Aini (1994)	
1986-1990	0.3 percent	Okamoto (1994)	27 three-digit industries three-input model
1986-1991	0.3 percent	Tham (1997)	28 three-digit industries four-input model
1985-1995	4.3 percent	Zulaifah & Maisom (2001)	29 three-digit industries two-input model
1987-1997	4.1 percent	Our result	

Source: Compiled by authors.

Thus, improvement in efficiency performance in the manufacturing sector during 1987-1997 presumably reflects to some extent the success of government policies in managing productivity and economic growth. Most of the policy changes took place after the 1985 recession, which included among others, improvements in research and development, human capital formation, and liberalization of trade and investment policies.

5.1 RESEARCH AND DEVELOPMENT

Technological progress is seen as crucial element in enhancing the total productivity and growth of the manufacturing sector. Technological improvements can be acquired either through the transfer of technology from abroad or the development of indigenous technology. Transfer of technology involves four components, namely, techno-ware, human resources, information and organizational structures (Anuwar, 1992). Thus, the transfer of technology requires not only mere importation of plant, machinery and equipment, but also considerable investments in research and development (R&D) of the other components of technology. The development of indigenous technology would also require vigorous R&D efforts.

Empirical studies indicated that R&D expenditures and foreign transfer of technology had a positive impact on productivity change. Mansfield (1980), for example, found a direct relationship between the amount of basic research carried out by an industry or firm and its rate of increase of TFP. A study by Leung (1997) found that industries with greater foreign ownership enjoyed faster TFP growth because of the transfer of technology brought in by the multinational corporations.

Realizing the importance of R&D in generating better efficiency, improving total factor productivity, and increasing competitiveness of all sectors in the economy, the government started to give greater emphasis on the development of science and technology (S&T) in the Fifth Malaysia Plan (1986-1990) and the Industrial Master Plan (1986-1995) in early 1986.

The commitment of the government to build and develop indigenous technology and improve S&T capabilities is shown in Table 7. There was tremendous increase in the allocation for S&T infrastructure and development. The allocation for R&D was increased by 52 percent

from RM413.8 million in 1981-1985 to RM629.0 million in 1986-1990 and by a further 60 percent to RM1,000.0 million in 1991-1995. Besides the commitment to build and develop indigenous technology, the transfer of technology from abroad becomes increasingly important. Malaysia has sought foreign technology through a variety of mechanisms, such as technical assistance and know-how, joint ventures, trade marks, patents and turnkey. The transfer of technology is mostly focused on the technical assistance and know-how. The composition of imported technology also reflected the movement towards investment in high value-added and capital-intensive industries, such as transport equipment and industrial chemicals (Malaysia, 1996).

5.2 HUMAN CAPITAL FORMATION

Economists have long stressed the importance of human resource development in influencing productivity and growth of a country (Nelson and Phelps, 1966; Denison, 1967; Barro, 1991; and Haskel and Martin, 1993). Productivity-driven economy requires highly skilled, trainable and knowledgeable workers, as well as administrative and managerial expertise. Adequate supply of competent and skilled manpower is essential for a country not only to utilize new technology, but also to adapt to imported technology. Nelson and Phelps (1966) have argued that a country with larger human capital stock would be able to absorb new products and technology discovered elsewhere. Hence, a country with more human resource would grow faster because of the ability to catch up rapidly to the technological leader country. Apart from the ability to absorb foreign technology, the availability of highly educated workforce contributes to the development of R&D to propel technological innovation and productivity growth (Romer, 1990; Grossman and Helpman, 1991).

Realizing the importance of human capital in enhancing productivity of the manufacturing sector, the government has taken various measures to improve training and educational facilities and has given emphasis on science and technical education. These include among others, the establishment of Human Resource Development Fund (HRDF) in 1993, the liberalization of education policy in 1996 and an increase in allocation for education and training. The HRDF provides fund for employers to

TABLE 7
Development Allocation for R&D and Technological Transfer by Type of Agreement, 1981-1995

Programme	1981-1985	1986-1990	1991-1995
Allocation (RM million)			
Direct R&D	413.8	629.0 (52.0%)	1,000.0 (59.0%)
S&T Infrastructure & Development	126.7	807.7 (537.5%)	1,749.0 (116.5%)
Types of Agreement			
Technical Assistance & Know-how	278	331	418
Joint Venture	76	72	31
Management	45	39	12
Trademarks & Patents	46	194	179
Service	19	21	27
Turnkey & Engineering	19	4	9
Others	118	76	21
Total	601	737	697

Note: Figures in brackets refer to percentage increase.
Source: Malaysia (1986, 1991 & 1996).

retrain and upgrade the skills of their workforce through in-house training, apprenticeship training and retraining of retrenched workers. Advanced skill training centers offering courses in specialized trades were set up to equip workers with the skills required for the use and adaptation of modern and high technology production methods and processes.

The introduction of the Private Higher Educational Institution Act in 1996 allows the private sector to establish institutions offering full-degree courses, and foreign universities to set up branch campuses in Malaysia. To further increase accessibility to higher education, the government through the National Higher Education Fund has also extended financial assistance to students in private institution of higher learning.

Table 8 shows that the percentage of trainees completing their training programs in the field of engineering, building trades and skill upgrading increased by 42.1 percent between 1981-1985 and 1986-1990 and by 96.2 percent between 1986-1990 and 1991-1995. The success of the efforts to encourage student enrollment in science and

technical courses is shown by the ratio of science and technical, to arts graduates, which has increased from 50:50 during 1981-1990 to 65:35 in 1991-1995. The positive impact of human capital formation in enhancing TFP growth in Malaysia is revealed in the empirical evidence presented by Gan and Soon (1998). They found that a 10 percent increase in the primary and upper secondary enrollment rate enhanced TFP growth by 0.3 and 0.4 percent, respectively, during 1974-1994.

5.3 OUTWARD-ORIENTED TRADE POLICY

Malaysia has adopted an inward-oriented trade policy during her second round of import substitution policy in the early 1980's, concentrating on the substitution of intermediate and capital goods industries. To encourage the development of these industries, the government adopted the import-restriction trade policy by raising the degree of protection. Trade restriction has resulted in an increase in both nominal and effective rates of protection for the majority of intermediate and capital goods industries during 1982-1985, especially in non-metallic mineral products, fabricated metal products and transport equipment, (Okamoto, 1994).

However, these heavily protected industries were not performing well as expected (Malaysia, 1989). Protection makes them complacent within the domestic market and there is a lack of interest to improve productivity in order to be internationally competitive. Existing empirical literature on the relationship between trade policies and productivity change indicate that trade restrictiveness tend to have a negative impact on TFP growth (Krueger and Tuncer, 1982; Nishimizu and Robinson, 1984). Industries which are heavily protected will experience lower productivity growth as compared to those with lower effective rates of protection (Edwards, 1991; Maisom and Ariff, 1993). The adoption of import-substitution policy trapped the country into a vicious cycle characterized by inflation, stagnant exports, imports and investment and slow productivity growth (Kawai, 1994). Hence, it is not surprising to find very poor TFP growth performance for the manufacturing sector as a whole during 1982-1986.

Poor economic performance of the import-substituting industries, declining prices of primary commodities, accumulation of public debt and limited domestic investment due to worldwide economic recession in 1985 forced the government to shift to export-oriented trade. Since

TABLE 8
Degree and Diploma Graduates from Public Institution and Skilled and Semi-Skilled Manpower from Public Training Institution, 1981-1995

Course	1981-1985		1986-1990		1991-1995	
	Total	%	Total	%	Total	%
Course						
Arts	24,610	49.5	46,230	51.5	56,960	25.1
Science	14,953	30.1	25,460	28.4	81,390	50.1
Technical	10,123	20.4	18,000	20.1	23,950	14.8
Total	48,686	100.0	89,960	100.0	162,300	100.0
Skilled and Semi-skilled Manpower						
Mechanical Engineering	24,778		28,240		71,300	
Electrical Engineering	13,543		21,110		46,610	
Civil Engineering	8,621		13,440		13,030	
Building Trades	8,162		12,850		16,750	
Skill-Upgrading	1,437		4,730		10,000	
Total	56,541		80,370	42.1[1]	157,690	96.2[1]

Note: [1]percentage increase
Source: Malaysia (1986, 1991 & 1996)

most rapid efficiency gains are said to occur when barriers to trade, such as tariffs, quotas and other protective devices are absent (World Bank, 1989), the government then took the initiative to implement an import liberalization policy. As a result, between 1985 and 1987, both nominal and effective rates of protection declined for the majority of industries, especially beverage, tobacco, footwear, rubber products, pottery, non-metallic mineral products, fabricated metal products and transport equipment industries (Okamoto, 1994). Thus, the export-oriented trade policy enables Malaysia to enjoy the benefit of a virtuous cycle through increases in export, import and investment, and a rise in productivity (Okamoto, 1994; Kawai, 1994).

Export-orientated trade policy, which exposes firms to international competition, raises productivity as firms are forced to reduce X-inefficiency. In addition, a larger export market allows firms to realize economies of scale and provide opportunities to invest in new plants and equipment. In fact, the empirical evidence presented by Gan and Soon (1998), Taylor and Lewis (2001), and Rahmah (2003) showed that greater openness through trade had favorable impact on productivity growth in Malaysia. Gan and Soon (1998), for example, found that a 10 percent increase in export ratio raised TFP growth by 0.7 percent during 1974-1994.

5.4 LIBERALIZED FOREIGN DIRECT INVESTMENT POLICY

Worldwide economic recession in the mid 1980's forced the government to adopt a more liberalized foreign direct investment (FDI) policy. Several changes were made in 1986 to liberalize FDI policy such as the introduction of new fiscal incentives and equity guidelines. Among the significant policy changes were licence exemption for manufacturing companies with shareholder's funds of less than RM2.5 million or 75 workers, and allowing 100 percent foreign ownership of capital to companies which export more than 50 percent (previously 80 percent) of their products. Changes in the FDI regulations have successfully attracted a large inflow of FDI into the manufacturing sector especially for the export-oriented foreign companies, and thus improved the production efficiency (Malaysia, 1991).

Two mechanisms have been identified by Okamoto (1994) through which FDI liberalization policy tend to have favorable impact on the

level of TFP in the Malaysian manufacturing sector. First, foreign companies entering Malaysia are more productive in comparison with local companies. This is because most of them are export-oriented companies and to compete successfully in the international market, they must be more superior in terms of production technology and management know-how, and thus are more productive than the locals firms.

Second, the entry of foreign companies may create spillover-effects which will improve the productivity performance of companies in general. Stiff competition from foreign companies will encourage the local companies to improve their production and management technology and take advantage from the direct and indirect transfer of technology from foreign companies. Furthermore, the creation of new business opportunities to the local companies due to the entry of foreign companies increases capacity utilization of the locals and improve their productivity performance.

The discussion above reveals that most of the drastic policy changes were introduced during the implementation of the Fifth Malaysia Plan in 1986. Hence, it is not surprising to find that TFP growth in the manufacturing sector rose from -10.34 percent during 1982-1986 to 4.5 percent during 1987-1997.

6. CONCLUSION

The study utilized the standard growth accounting model to estimate TFP growth for 28 three-digit level manufacturing industries during 1982-1997 and the two cyclical sub-periods 1982-1986 and 1987-1997. We found that the rapid growth of output in the majority of industries during 1982-1997 was derived mainly from the growth of capital with little contribution from TFP growth. However, TFP growth was found to be higher among the heavy industries, particularly petroleum and coal products, and industrial chemicals. Poor TFP growth performances were recorded among the less capital-intensive industries, such as wearing apparels, leather and fur and footwear.

The average TFP growth for majority of the industries and for the manufacturing sector as a whole was found to be negative during 1982-1986. However, TFP improved in the second sub-period of 1987-1997 and recorded an average positive growth of 4.05 percent for the

manufacturing sector. Improvements in TFP growth reflect to some extent the success of government policy changes which took place since 1985. These included the shift in emphasis from public sector to private sector led-growth, improvement in R&D and human capital formation, outward-oriented trade policy and liberalization of FDI policy.

To conclude, we found that the growth of the Malaysian manufacturing industries and the overall manufacturing sector during the period of 1982-1997 was still input-driven rather than the productivity-driven. However, the TFP performance is expected to improve as the country moves towards the high-technology and knowledge-driven growth.

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