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Contribution of Technical Efficiency Change and Technical Change to Total Factor Productivity Growth in Electrical and Electronics Industry in Malaysia

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ABSTRACT

The electrical and electronics (E&E) industry contributes more than 60% of Malaysian manufacturing exports. The emergence of trade liberalization through Asian Free Trade Association (AFTA), North American Free Trade Association (NAFTA) and European Unions (EU) creates stiffer trade competition amongst the E&E industry in the region and to be at the competitive edge, this industry must increase its efficiency. In this regards, total factor productivity (TFP) growth becomes relevant. An increase in TFP growth through technical efficiency change (TEC) will reduce cost of production and make the industry more competitive because it can produce higher output using same level of inputs. There are two components of TFP growth, namely, technical efficiency change (TEC) and technical change (TC). The impact of TFP growth on output growth will be more meaningful if contribution of TEC supersedes contribution of TC because TEC will not incur additional cost of production. This paper attempts to analyze TFP growth in the E&E industry at five digits of Malaysian Standard Industrial Classification (MSIC). Fifteen types of industries are covered in the analysis. The analysis will be based on the Manufacturing Survey data between 1995 and 2003 collected by the Department of Statistics Malaysia. The method of Data Envelopment Analysis (DEA) is utilized to get TEC and TC. The results from this study show that, contribution of TC is higher than that of TEC in all sub industries under study. Nevertheless, trend analysis shows that during 1998 - 2000 period TEC is higher than TC.

ABSTRAK

Industri elektrik dan elektronik menyumbang lebih 60% daripada eksport Malaysia. Kewujudan liberalisasi perdagangan seperti AFTA, NAFTA dan Kesatuan Eropah (EU) membawa kepada persaingan perdagangan yang hebat di kalangan industri E&E di wilayah ini dan untuk lebih berdaya saing, industri ini perlu meningkatkan kecekapan masing-masing. Dalam hubungan ini, pertumbuhan produktiviti faktor keseluruhan (TFP) menjadi penting. Peningkatan dalam pertumbuhan TFP melalui perubahan kecekapan teknikal (TEC) akan menurunkan kos pengeluaran dan menjadikan industri lebih berdaya saing kerana dapat mengeluarkan lebih banyak output dengan menggunakan jumlah input yang sama. Terdapat dua komponen pertumbuhan TFP, iaitu perubahan kecekapan teknikal (TEC) dan perubahan teknikal (TC). Sumbangan pertumbuhan TFP terhadap pertumbuhan ekonomi menjadi lebih bermakna sekiranya sumbangan TEC melebihi sumbangan TC kerana TEC tidak melibatkan kos pengeluaran tambahan. Kertas ini cuba menganalisis pertumbuhan TFP dalam industri E&E pada 5 digit MSIC. Terdapat lima belas jenis sub industri E&E. Data yang digunakan dalam analisis ini adalah Penyiasatan Industri Pembuatan 1995-2003 dari Jabatan Pertangkaan Malaysia. Pendekatan DEA digunakan dalam mendapatkan nilai TEC dan TC. Hasil kajian ini menunjukkan sumbangan TC adalah lebih tinggi daripada TEC dalam semua sub industri yang dikaji. Walau bagaimanapun, analisis trend menunjukkan antara tahun 1998 - 2000, TEC lebih tinggi daripada TC.

INTRODUCTION

The electrical and electronics (E&E) industry has played an important role in the development of manufacturing sector in Malaysia and contributes major portion of national exports. In 2005, percentage export from this industry was about three quarter of total manufacturing exports at 65.8% (Ministry of Finance 2004). The emergence of AFTA, NAFTA, and European Union (EU) in tandem with trade liberalisation has an impact on Malaysian trade in terms of stiffer trade competition with other countries in the world. In facing this situation, Malaysian E&E must increase its efficiency and gain more from technical efficiency change (TEC).

Trade liberalization that emerged as a result of globalisation was in the first place aimed to lessen problems facing the countries in trade activities. There are at least four trade organisations that significantly affect trade flow under liberalisation, ie ASEAN Free Trade Association (AFTA), North America Free Trade Association (NAFTA), Asian Pacific Economic Cooperation (APEC) and World Trade Organisation (WTO). The main objective of their establishment, is to speed up the growth of members' economies. Malaysia being one of the AFTA members will definitely be affected by the implementation of this organization.

Malaysia is moving towards achieving an industrialized country status by the year 2020. In relation to this, productivity - driven growth has been becoming its growth strategy since the Sixth Malaysia Plan. This strategy becomes more relevant when knowledge-based economy become the prime target of Malaysian development after the 1990s. One of the pertinent aspects that related to productivity is total factor productivity (TFP) growth. An increase in TFP growth which is contributed by two components, namely, technical efficiency change and technical change will make the industry more profitable since the same value of inputs can now produce higher value of output. This achievement will definitely lower the average cost; hence uplift level of industry competitiveness.

The E&E industry conributes significantly to Malaysian exports. As major exporter, it is necessary for this industry to spear ahead and able to continuously compete at global market. There are many sub industries in the E&E industry. Therefore, the export strategy must be selective that is to choose industry with greater competitive edge. In this context, efficiency level of the industry becomes the benchmark for selecting the industry to be emphasised. As shown by the data, the most important sub industry with regard to export is semiconductors and related products. However, to determine whether this industry is the most efficient requires detail research. Other benefit from this kind of research is to provide information for the investors when planning their investments. The sub industries with higher external market demand may need to strengthen their level of efficiency to continuously be competitive.

This paper attempts to examine contribution of technical efficiency change (TEC) and technical change (TC) to TFP growth in the E&E industry in Malaysia using Data Envelopment Analysis (DEA) of Malmquist through output oriented procedure. The data used for the analysis is taken from the Industrial Manufacturing Survey, Department of Statistics Malaysia E&E at 5 digits MSIC level between 1995 and 2003. This analysis will compare level of TFP growth for various E&E sub industries and TFP growth trend for selected time periods. This paper is organized into six sections. The following section explains the development of E&E industry in

Malaysia, followed by theoretical framework and model specification; the description of data; the findings; conclusion and policy implication.

THE DEVELOPMENT OF ELECTRICAL AND ELECTRONICS INDUSTRY IN MALAYSIA

In 2004, E&E industry contributed about RM183.1 billion of total output and provided a total of 369,488 job opportunity or 36.6% of total employment in Malaysia (MIDA 2006). During the period of Second Outline Perspective Plan (OPP2), the manufacturing sector growth was 10.4% per annum with the export-oriented manufacturing industries played as a leading sector. The E&E industry contributes a major portion of export volume in the manufacturing sector as well in the nation.

Table 1 shows value of manufacturing export by sub industries. In 2000 the E&E industry recorded RM230,429 million worth of exports or

TABLE 1. Manufacturing Export by Sub industry, 2000-2005

Industry	RM Mill		% of Total		Average Annual Growth Rate (%)
	2000	2005	2000	2005	RMK8
Resource- based	44,321	77,280	18.0	13.9	11.8
Food	4,509	8,488	2.0	1.4	13.5
Beverage and Tobacco	1,209	1,701	0.4	0.4	7.1
Wood Products	6,801	8,860	2.1	2.1	5.4
Paper and Paper Products	1,397	2,073	0.5	0.4	8.21
Petroleum Products	8,131	16,729	3.9	2.6	5.51
Chemical and Chemical Products	15,011	29,718	6.9	4.7	4.6
Rubber Products	4,695	6,777	1.6	1.5	7.6
Non-metallic Mineral Products	2,571	2,934	0.77	0.87	2.7
Non Resource Based	252,383	317,499	3.8	9.4	4.7
Textiles, Wearing Apparel and Shoes	10,433	10,520	2.4	3.3	0.11
Metal Products	8,618	17,157	4.0	2.77	4.8
Electrical & Electronics	230,429	282,77	65.8	2.5	4.21
Transport Equipment	2,903	96,993	1.6	0.9	9.21
Others	21,205	35,144	8.2	6.7	0.6
Total	317,908	429,873	100.0	100.0	6.2
% of Total Gross Export	85.2	80.5			

Source: Malaysia 2006

72.5% of total manufacturing exports. Percentage of exports of this industry slightly reduced to 65.8% 2005 despite of higher export value. This is due to an increase in other industries exports like metal products and chemical industries.

Table 2 shows destination of exports for Malaysian manufacturing products. The most important destination is the ASEAN followed by the United States, European Union (EU), Japan, Hong Kong and Republic People of China. Singapore being the closest neighbourhood in the south becomes the main destination within ASEAN, while the second highest percentage of export goes to Thailand.

TABLE 2. Major export destinations for manufactured products, 2000-2005 (%)

Country	2000	2005
	RM317.9 billion	RM429.9 billion
ASEAN	27.7	27.2
Brunei	0.8	0.9
Vietnam	1.8	3.2
Indonesia	5.8	8.1
Philippines	6.3	4.6
Thailand	11.6	18.2
Singapore	73.3	64.2
United States	23.4	23.4
Eurpean Unions	14.9	10.4
Japan	11.3	7.4
Hong Kong	5.0	7.0
China	2.5	6.1
Others	5.1	18.5

Source: Malaysia 2006.

During the Ninth Malaysia Plan, Malaysian manufacturing exports are expected to spur further as a result of increasing expected world output growth to 4.3% per annum. The Malaysian volume of trade is expected to be greater than RM1 trillion, while gross export is expected to grow at 8.5% per annum (MIDA http://bmweb.mida.gov.my/ 2006).

Foreign direct investment (FDI) plays a significant impact on Malaysian economic growth especially through technology transfer and export activity. It is commonly observed that in the developing countries the major portion of exports come from the Multinational Corporation (MNCs) or Transactional Corporation (TNCs). In Malaysia these types of companies contribute about 90% of total exports. The MNCs and TNCs firms, which are normally bigger in size produce higher volume of output, using more sophisticated technology and more able to export as compared to the smaller local firms. Therefore, the existence of FDI is very much influenced the export volume in the developing countries. Malaysia is not exceptional. In 2000, Malaysia became a major destination of FDI especially from the United States, Japan, Holland, Singapore and Germany. The E&E industry is the most attractive to the investors in setting up their plants, which are mostly using high technology and more capital- intensive. In 2004, the amount of FDI in this industry was RM6,825,977,633. Other industries that attracted quite substantial amount of FDI are petroleum products, chemical and chemical products and food industries (Table 3).

TABLE 3. Approved FDI by industry, 2004 and 2005

Industry	FDI (RM)	
	2004	2005
Electrical & Electronics	6,825,977,633	6,232,402,079
Basic metal Products	264,730,325	356,650,119
Chemical & Chemical Products	556,259,776	782,225,171
Food	384,769,419	466,696,699
Transport Equipments	254,619,447	408,846,729
Plastic Products	274,552,821	524,192,582
Scientific Tools & Measures	49,496,000	691,865,170
Fabricated Metal Products	736,284,361	201,549,328
Petroleum Products	812,355,202	21,514,949
Machines	116,137,237	185,807,598
Rubber Products	109,840,085	33,497,779
Furniture	102,020,329	53,429,894
Non Metallic Mineral Products	380,686,263	55,558,653
Textile &Textiles Products	368,543,030	140,528,843
Wood & Wood Products	236,052,059	71,456,597
Paper, Printing and Publishing	1,361,767,436	81,011,870
Beverage &Tobacco	282,471,813	77,447,600
Leather & Leather Products	5,378,489	3,586,448
Others	21,984,700	5,502,653
Total	13,143,926,425	10,393,770,760

Source: MIDA 2006

LITERATURE REVIEW

Overtime the concept of total factor productivity (TFP) growth is being more emphasized in research. The advantage of this concept relies on its ability to explain productivity for the whole inputs used in the production process. TFP can also reflect technological progress that takes place in a country. Even though TFP growth does not merely mean technological improvement, but also improvement in the quality of inputs or efficiency due to other factors like HRD and HRM, many researchers argue that TFP growth is an approximate measure of technological advancement (Solow 1957; Katz 1969; Abdul khadirin and Pickles 1990).

The latest empirical research on productivity includes the effect of technical efficiency change (TEC) as a major component of TFP growth, where the frontier approach and Data Envelopment Analysis (DEA) will be essential in this concern. The importance of these approaches is its ability to decompose TFP growth into many components. Such components could be stated as TEC change and Technical Change (TC) as proposed by Nishimizu and Page (1982) or TEC, TC and scale effect as proposed by Lansink (2000).

The contribution of TFP growth to output growth and the contribution of TEC and TC to TFP growth may differ from one industry to another. Some industries may enjoy higher TFP growth as a result of higher contribution from TEC, whereas others may gain more from TC. Export activity may induce efficiency and lead greater contribution from TFP growth to industry output growth. Xiaolan Fu (2005) measured the influence of export on growth using industry panel data of Chinese manufacturing sector between 1990 and 1997. The TFP growth was measured using DEA or "non-parametric" approach. His result do not show any significant evidence to support that export will induce productivity of the industry but export has a positive impact on TFP growth. Chuang (1996) studied the source of growth in Taiwan's manufacturing industry and found that trade-induced learning, accounted for about three-fourth of the measured external effect, between two digits industries. The study showed that trade- induced learning variable explained over 40% of Taiwan's manufacturing output growth. Mahadevan (2002a) using the South Korean Manufacturing Industry data of 1980-1994 estimated TFP growth and found that the export-oriented industry experienced higher TFP growth.

Earlier studies of TFP growth in Malaysia were more concerned about the contribution of TFP growth to output growth without decomposed it into TEC and TC. Maisom and Arshad (1992) using data of manufacturing survey in Malaysia from 1973-1989 showed that TFP growth increased each year but its contribution to the manufacturing sector growth was still small. Further in their study, it was shown that TFP growth was larger in the foreign owned firms as compared to the local ones. They concluded that foreign investors had benefited more from technological progress in Malaysia. Tham (1997) supported the above claims. She found that the main contributors to TFP growth in the manufacturing sector in Malaysia were export and foreign direct investment. In this respect, the E&E industry, where foreign investors own the majority of the firms may have greater contribution from TFP growth to its output growth. However, there are very few studies in Malaysia focus on the E&E industry. Furthermore, study of E&E industry at five digits Malaysian Standard Industrial Classification (MSIC) in Malaysia using stochastic frontier or DEA is almost non-existence. Few researchers include E&E industry at 3 digits MSIC along with other industries when study TFP growth (see for example Rahmah & Nyet 1999; Rahmah & Idris 2000). There are also few studies of TFP growth using stochastic frontier and DEA but exclude the E&E industry (see for example Idris & Rahmah 2005; Zulridah & Rahmah 2004; Rahmah & Noorasiah 2005)

Rahmah and Idris (2000), for example, study the contribution of TFP growth to output of the large-scale enterprises in Malaysia using data of 1982-1994 for E&E industry at 3 digits MSIC. They found that E&E industry experience a relatively high TFP growth. Other industries like chemical, non-metallic mineral products, transport equipment and rubber products also enjoyed high TFP growth. But TFP growth in the light industries such as food, textiles and plastics products was quite low. Rahmah and Idris (2001) studied TFP growth in the small and medium scale industries using the same source of data as in the earlier study. They found that TFP growth in the heavy industry like non-metallic mineral products; was high but TFP growth was higher in the light industries like food and plastics products. The export-oriented labour intensive industry like electrical and electronics industry also experience high TFP growth.

In the latter study, Nik Hashim and Basri (2004) measured TFP growth of Malaysian manufacturing sector using stochastic frontier approach with translog production function. They found that between 1990 and 2000 TFP growth was very low for some industries at below unity or even negative for E&E, transport and food industries. The positive growth was achieved in chemical, textiles, rubber, petroleum and wood. Further, this study found that technical efficiency change was the main contributor to TFP growth except for chemical, paper and petroleum industries. The highest technological progress was attained in petroleum industry. The technical efficiency change was the highest for the electrical and electronic industry, while the lowest was for food industry.

DEA FRAMEWORK AND MODEL

The Data Envelopment Analysis (DEA) is a special mathematical linear programming model to assess efficiency and productivity. It allows the use of panel data to estimate changes in total factor productivity and breaking it down into two components, namely, technical change (TC) and technical efficiency change (TEC).

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

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

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

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

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

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

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

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

$$\text{TFPCH} = \text{TEC} \times \text{TC}. \quad (2)$$

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

$$M_0(y_{t+1}, x_{t+1}, y_t, x_t) = \text{TEC} \times \text{TC}. \quad (3)$$

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

As expressed by Squires and Reid (2004), technical change (TC) is the development of new products or the development of new technologies that allows methods of production to improve and results in the shifting upwards of the production frontier. More specifically, technical change includes new production processes, called process innovation and the discovery of new products called product innovation. With process innovation, firms figure out more efficient ways of making existing products allowing output to grow at a faster rate than economic inputs are growing. The cost of production declines over time with process innovations, i.e. new ways of making things.

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

SOURCE AND DESCRIPTION OF DATA

The analysis in this paper uses the data of Industrial Manufacturing Survey collected by the Department of Statistics Malaysia of between 1995 and 2003. The study uses industry code at 5 digits level and there are 15 E&E sub industries. Before we proceed to analysis results from the estimation, it is worthwhile to view data descriptive for some variables like number of establishment, output, number of labour and some competitiveness indicators like labour productivity, capital productivity, and labour cost productivity. Table 4 shows percentage of various variables from the original data. It is shown that sub industry (10) (semi conductors and other electrical components, communication equipment and apparatus)

TABLE 4. Percentage of important varibales for E&E, 2003

Num	Sub industry	Number of establish-ment	Out-put	Value added	Fixed asset	Employ-ment	Wages
1	Manufacture of engines and turbines	2.75	0.18	0.36	0.34	0.55	0.57
2	Manufacture of agricultural machinery and equipment	2.68	0.13	0.26	0.23	0.29	0.31
3	Manufacture of metal and wood working machinery	4.27	1.11	1.90	2.78	1.55	2.34
4	Manufacture of special industrial machinery and equipment except metal and wood working machinery	2.55	0.05	0.10	0.14	0.14	0.13
5	Manufacture of office, computing and accounting machinery	3.79	28.75	19.07	10.67	12.17	12.55

TABLE 4 (cont.)

Num	Sub industry	Number of establish-ment	Out-put	Value added	Fixed asset	Employ-ment	Wages
6	Manufacture of refrigerating exhaust, ventilating, and air conditioning machinery	3.92	1.68	2.83	1.89	2.28	2.85
7	Machinery and equipment	30.83	1.25	2.36	2.15	3.60	3.81
8	Manufacture of electrical industrial machinery and apparatus	3.44	0.89	1.25	1.29	3.55	2.46
9	Radio and television set, sound reproducing and recording equipment	9.15	23.40	18.30	10.75	24.22	21.97
10	Semi-conductors and other electric components and communication equipment and apparatus	13.70	36.15	44.21	57.95	38.86	40.63
11	Manufacture of electrical appliances and house wares	3.37	1.14	1.25	1.28	1.80	1.87
12	Cables and wires	7.36	2.32	3.09	5.99	5.03	4.52
13	Manufacture of dry cells and storage batteries	1.17	0.28	0.48	0.80	0.65	0.60
14	Manufacture of electric lamps and tubes	2.20	0.91	1.56	1.59	1.58	1.64
15	Manufacture of miscellaneous electrical apparatus and supplies	8.81	1.77	2.99	2.14	3.73	3.75

Source: Department of Statistics Malaysia 2004.

forms highest percentage of output, and value added, fixed asset, employment and wages. Other important sub industries are 9 (radio and television set, sound reproducing and recording equipment). Even though machinery and equipment sub industry (7) forms highest percentage of number of establishment, its contribution to other varibles is very small. This may due smaller firm size that operating within this sub industry as compared to other industries.

Table 5 presents five key indicators for E&E by sub sectors. These indicators are crucial to evaluate industrial efficiency and competitiveness. The capital-labour ratio, which indicates capital intensity, is the highest

TABLE 5. Comparison of key indicator for sub industry E&E, 2003

Num	Sub industry	Capital-labour ratio (RM'000)	Value added per labor (RM'000)	Value added per capital (RM)	Value added per wages (RM)
1	Manufacture of engines and turbines	144.30	54.75	1.06	2.51
2	Manufacture of agricultural machinery and equipment	188.25	73.91	1.16	3.37
3	Manufacture of metal and wood working machinery	309.73	102.26	0.69	3.27
4	Manufacture of special industrial machinery and equipment except metal and wood working machinery	153.83	60.26	0.69	2.96
5	Manufacture of office, computing and accounting machinery	1024.27	130.47	1.80	6.10
6	Manufacture of refrigerating exhaust, ventilating, and air conditioning machinery	319.88	103.33	1.51	3.99
7	Machinery and equipment	150.79	54.61	1.11	2.49
8	Manufacture of electrical industrial machinery and apparatus	108.28	29.45	0.98	2.05
9	Radio and television set, sound reproducing and recording equipment	418.86	62.91	1.72	3.35

TABLE 5. (cont.)

Num	Sub industry	Capital-labour ratio (RM'000)	Value added per labor (RM'000)	Value added per capital (RM)	Value added per wages (RM)
10	Semi-conductors and other electric components and communication equipment and apparatus	403.49	94.77	0.77	4.37
11	Manufacture of electrical appliances and house wares	273.86	57.87	0.99	2.69
12	Cables and wires	200.06	51.12	0.52	2.74
13	Manufacture of dry cells and storage batteries	186.90	61.85	0.61	3.25
14	Manufacture of electric lamps and tubes	250.59	82.26	0.99	3.82
15	Manufacture of miscellaneous electrical apparatus and supplies	205.87	66.75	1.41	3.20

Source: Computed from Industrial Manufacturing Survey, Department of Statistics Malaysia

for sub industry 5 (manufacture of office, computing, accounting machinery followed by sub industry 9 (radio and television set, sound reproducing and recording equipment), and sub industry 10 (semi conductors and other electric components and communication equipment and apparatus). This is consistent with their higher value of output and value added. However, in terms of value added per labour, which measures labour productivity is not found to be higher in the last two sub industries. Instead, the sub industry 5 and 6 (manufacturing of office, computing and accounting machinery; and manufacture of refrigerating exhaust, ventilation and air conditioning machinery) gain higher labour productivity. For sub industry 5, it consistently shows high value added per capital and value added per wages. The value added per capital, which measures capital productivity is also shown to be high in the sub industry 9, while value added per wages that measures industry competitiveness is seen to be higher in the sub industry 5, 6, 10 and 14 as compared to other industries.

TABLE 6. Mean efficiency growth for E&E industry, 1995 - 2003

Number	Sub industry	Mean Efficiency TEC	TC	TFPCH
1	Manufacture of engines and turbines	0.793	0.896	0.710
2	Manufacture of agricultural machinery and equipment	0.913	1.143	1.043
3	Manufacture of metal and wood working machinery	0.995	1.150	1.144
4	Manufacture of special industrial machinery and equipment except metal and wood working machinery	0.889	0.976	0.868
5	Manufacture of office, computing and accounting machinery	1.067	1.131	1.206
6	Manufacture of refrigerating exhaust, ventilating, and air conditioning machinery	0.893	1.140	1.018
7	Machinery and equipment	1.009	1.093	1.103
8	Manufacture of electrical industrial machinery and apparatus	0.987	1.050	1.036
9	Radio and television set, sound reproducing and re cording equipment	0.997	1.071	1.068
10	Semi-conductors and other electric components and communication equipment and apparatus	0.960	1.153	1.107
11	Manufacture of electrical appliances and house wares	0.903	1.126	1.017
12	Cables and wires	0.865	1.153	0.997
13	Manufacture of dry cells and storage batteries	0.924	1.153	1.065
14	Manufacture of electric lamps and tubes	1.074	1.131	1.215
15	Manufacture of miscellaneous electrical apparatus and supplies	1.004	1.073	1.078
	Mean	0.949	1.093	1.037

THE FINDINGS

The results of the study reveal that between 1995 and 2003 TFP growth of the E&E industry for the entire test period is positive due positive contribution from technical change with the overall mean index growth of 1.037. The mean of technical change index is 1.093 but technical efficiency change is negative with the mean value of 0.949. Even though

TFP growth is positive but the value of less than unity of TEC implies that the overall E&E industry is not operating efficiently at maximum potential level and the use of intensive technology contributes to its output growth (Table 6).

Taking the individual firm, TFP growth are found to be positive in all sub industries except sub industry 1 (manufacture of engines and turbines) and sub industry 12 (cables and wires). The highest TFP growth is achieved in the sub industry 14 (manufacture of electric lamps and tubes) followed by sub industry 5 (manufacture of office computing and accounting machinery). Other sub industries that experience high TFPG are sub industry 10 (semi-conductors and other electric components and communication equipment and apparatus), 7 (machinery and equipment), and 3 (manufacture of metal and work working machinery).

With regards to technical change, most industries experience positive change except for sub industry 1 (manufacture of engines and turbines) and 4 (manufacture of special industrial machinery and equipment except metal and wood working machinery). On the other hand, only three sub industries that operating at above maximum potential level, ie sub industry (5), (7) and (14) with growth index of 1.067, 1.009 and 1.074 respectively. The least efficient industry is sub industry 1, which could increase its output by 20.7 per cent without increasing the use of its inputs. Other inefficient sub industries are sub industries (4), (6) and (12). Source of TFP growth for all sub industries under study is due to technical change, with an index growth ranging from 0.896 to 1.153. This result reveals that the growth of E&E sub industries is boosted by the enhancement of technological progress. The sub industries 5, 9 and 10 are highly capital-intensive as indicated by their capital-labour ratio reflecting of high expenses on physical asset and they are optimally benefit from technological progress. However the sub industry 8 (manufacture of electrical industry machinery and apparatus) also benefits from technological progress despite of less capital-intensive. This may due to the fact that this industry has better adoption of new technology and enough skilled labour. The finding also shows that the sub industries that less capital- intensive like sub industry 1 and 4 experience negative growth of technical change.

The ability of sub industry with very low capital-labour ratio like sub industry 7 (machinery and equipment) to benefit from high efficiency indicates even though it spends less on buying new technology but its present technology is very efficient. Some of the capital intensive sub industry like sub industry 5 (manufacture of office computing, and accounting machinery) is seen to be very efficient in both TEC and TC and enjoys high TFP growth. The result reflects with high level of technology, this industry can operate efficiently above its maximum potential output. Even though sub industry 9 and 10 are capital intensive, the efficiency growth is negative and the positive TFPG are mainly contributed by technical change.

Table 7 shows mean efficiency growth rates for the industries over various time periods to investigate the trend of the change in the efficiency measures. It can be seen that TFP growth had unstable trend. Index of TFP growth has been changing from 1.109 in 1995 - 1997 to 0.780 in 1998 - 2000 and 1.074 in 2001 - 2003. This trend was heavily influenced by the trend in the technological change, with an index score also experiencing unstable trend from 1.253 in 1995 - 1997 to 0.472 in 1998 - 2000 and 1.229 in 2001 - 2003. The change in technical efficiency is also unstable with the highest index in 1998 - 2000. During 1998 - 2000 as the economy was heated by the financial crises the gain from technical change was very low. This is consistent with the remarkable drop in FDI during that period, which induces firms to operate more efficiently.

TABLE 7. Trend of efficiency for electrical and electronics industry, 1995-2003

Period	TEC	TC	TFPCH
1995 - 1997	0.885	1.253	1.109
1998 - 2000	1.652	0.472	0.780
2001 - 2003	0.874	1.229	1.074

CONCLUSION AND POLICY IMPLICATION

The results from this study show that TFP growth is mainly contributed by technical progress. However, trend of technical change declined and negative during 1998 - 2000 period. On the contrary, the technical efficiency change was negative except during 1998 - 2000 period. Trend of efficiency was also declining during of 2001 - 2003 period despite of improvement in the Malaysian economy growth especially after the financial crises. Even though the growth of technical efficiency was positive during 1998 - 2000, the TFP growth was negative due to negative growth of technical change. The positive growth of technical change reflects improvement in technological transfer or development that yields new innovation and better technological adoption amongst companies.

But during the financial crises the pooling of substantial amount of FDI brings about remarkable drop from technical change contribution. Analysis by sub industries shows that most industries enjoy positive contribution from technical change but technical efficiency change are mostly negative. Also the result shows that there is positive relationship between capital intensity and efficiency, technological change and TFP growth.

These findings are an outcome of the input-augmented industrialisation in Malaysia that can be attributed to the way Malaysia industrialises as follows. The legacy of British colonisation left an independent Malaysia in 1957 as the world's largest exporter of tin and rubber. The crash in commodity prices led to economic recession in Malaysia in 1985 that triggered the government to embark on trade and investment policy reforms in favour of a more liberalised regime in order to attract FDI into the manufacturing sector.

Coincidently, there was the Plaza Accord signed on September 22, 1985 by the G-5 (France, West Germany, Japan, the US and the UK) who agreed, among other things, to *depreciate* the US *dollar* in relation to the Japanese *yen* and German *Deutsche Mark* by intervening in currency markets. The exchange rate value of the Japanese yen went up by some 51% against the US dollar over the two years after the Accord. The Plaza Accord effectively made the Japanese with huge trade surplus became suddenly rich.

In the Southeast Asian region, with a well developed physical and institutional infrastructures and political stability, Malaysia stood out from the rest as an attractive FDI location. What more with the Look East Policy initiated in 1983 by then Prime Minister Mahathir, Malaysia became a darling for Japanese FDI. Beginning with economic recovery in 1987, the country experienced a decade of unprecedented double digit economic growth on the back of export-oriented industrialisation that saw electrical and electronics goods replacing tin and rubber as its major exports, a good ten year run only interrupted by the 1997-1998 East Asian financial crises.

Rapid industrialisation that took place in 1987-1997 has turned Malaysia akin to a platform for Japanese production intended for mainly for the American market. The period later saw the influx of American FDIs into the Malaysian electrical and electronics industries with exports intended back to the US as well as to Europe. In a regional term this FDI-based industrialisation and trade flows worked out in a *triad:* fed by FDI from Japan and the US in the 1980s and 1990s Malaysia's manufactured exports are largely electrical and electronics goods that depend mainly on the American market.

In terms of benefit to Malaysia, although Malaysia is now one of the world's top twenty trading nations and its exported products do not suffer the kind of negative image currently faced by the Made-in-China goods, in reality there has been a mixed feeling when it comes to technology transfer, learning/innovation, and value added. Indications are rampant that Malaysian small and medium industries (SMI) are yet to be on par with that of other countries such as Taiwan in all aspects above.

The development strategy for the E&E industry must concentrate on how to increase efficiency. The positive contribution from technical change implies this industry is very much relying on technological transfer that will substantially increase cost of production if not supported by an increase in efficiency. In order to increase competition through quality and price reduction, this industry must increase its efficiency. Perhaps a good strategy is to concentrate on some sub industries that have greater benefits from both efficiency and technical change like sub industry 5 (manufacture of office, computing and accounting machinery) and 10 (semiconductors and related). The strength of the Malaysian E&E industry is on sub industry 10, that has major contribution to export value.

Since TFP growth is a yield of two components, namely, technical efficiency change and technical change, these two elements must be improved. An improvement in technical efficiency change requires upgrading in quality of inputs like capital and labour. In order to improve labour quality, human resource development, through training is the best strategy. Training will enhance workers productivity and efficiency. In terms of capital, management aspect is very important.

The E&E industry is very relevant when discussing export strategy in Malaysia. In the era of globalisation, with the emergence of trade liberalisation requires the industry to be more competitive and in this context technical efficiency becomes crucial. Even though technological progress that remarkably taking place in the E&E industry through FDI, technology alone without efficiency will jeopardise industry competitiveness since it requires a substantial increase in cost of production. The E&E industry must re formulate its strategy to enhance efficiency especially in the sub industries where their external demand is high.

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