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ESTIMATING COST SAVINGS THROUGH ADOPTION OF THE BEST PRACTICE

MALAYSIAN MANUFACTURING SECTOR

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ABSTRACT

By using the input-output approach, this article attempts to estimate costs of production by using the 1978 vintage and best-practiced techniques, based on the vintage hypothesis that as time progresses and price rises, adopting the best-practice technique will give more cost saving and use less amount of inputs for each unit of output produced, rather than the old techniques. This paper has identified three component production costs of vintage technology, domestic materials, imported input, and labour. It was found that costs of production for the best-practice technique are less than those of the older one (vintage), supporting the vintage hypothesis. Thus, there is a strong argument for the economy to adopt the best-practice technique because it is absolutely a considerable advantage in terms of saving in the per unit cost of production.

ABSTRAK

Artikel ini cuba menganggarkan kos pengeluaran penggunaan teknik vintaj 1978 dan amalan terbaik dengan mengunakan pendekatan input-output. Ini berdasarkan hipotesis vintaj bahawa apabila harga dan masa meningkat, penggunaan teknik amalan terbaik akan lebih menjimatkan di samping mengunakan amaun input yang sedikit bagi setiap unit output yang dikeluarkan berbanding teknik vintaj. Artikel ini mengenal pasti tiga komponen kos pengeluaran teknologi vintaj iaitu; bahan mentah domestik, input yang diimport dan buruh. Hasil menunjukkan kos pengeluaran mengunakan teknik amalan terbaik lebih menjimatkan daripada teknik lama *(vintaj) seterusnya menyokong hipotesis vintaj. Oleh itu, terdapat kenyataan kukuh untuk menyarankan agar ekonomi mengadaptasikan teknik amalan terbaik kerana ianya memiliki kelebihan dalam menjimatkan kos seunit pengeluaran.*

INTRODUCTION

The embodiment hypothesis introduced by Solow (1957) can be interpreted as technical change embodied in new capital goods. [1] Technical change either be embodied in the new plants and machinery or disembodied in the organisation work which may be resulted from the emergence of successive best-practice techniques and caused exogenously by changes in the state of knowledge or endogenously by changes in relative price (Ahmad, 1966). In a given moment of time with a current price structure, there is a spectrum of techniques in use, ranging from the best-practice technique which yields the maximum surplus to the marginal technique waiting to be discarded.

Changes in the relative prices on the old techniques inevitably affect their viability through increase in costs of production which comprise costs of domestic materials, imported inputs, and labour. The younger techniques may, therefore, have relatively lower costs of production than those of the older ones. Currently, firms would use the best-practice technique where the average cost is lower than that of the old ones and consequently, this would be translated into profitability. Therefore, in this paper, using an inter-industrial framework, we estimated the costs of production of the Malaysian manufacturing sector by using the 1978 vintage technology and best-practice technique. We then compare the costs of production by using the vintage and best-practice technique based on the vintage hypothesis that as time progresses and price rises, adopting the best-practice technique would give more cost saving and use less amount of inputs for each unit of output producing, rather than the old ones. In addressing this issue, this paper assumed that technical change fully embodied in new capital goods and firms will replace the old technology or equipment with new technology which is more productive and cost effective.

The remainder of this paper is organised as follows. Section 2 presents a conceptual framework on technical change induced by improvement in scientific knowledge and changes in price structure. Description of the model and data sources are presented in Section 3. Section 4 presents the results and this is followed by the conclusion in Section 5.

Conceptual Framework

Improvement in scientific knowledge always leads to invention and discovery, adoption and diffusion, and innovation, which when found to be financially viable, will be commercialised. This process would result in a new technique of production that would be introduced and made available in the market. Certainly, this new technique will have higher productivity than its predecessors. Essentially, this explains that a state of knowledge prevailing at any point in time determines the level of output, a view emphasising a Schumpeterian autonomous technical change. Empirically, technical change is measured as a residual between growth rate of output and which is contributed by a weighted sum of inputs using a Solow (1957) type production function.

Indeed, technical change can be induced by changes in relative prices, a view put forward by Ahmad (1966), Fellner (1969), and Hicks (1964), who saw the importance of factor substitution as a result of price changes. Since technical knowledge at each date relates to a number of production functions, a flow of new knowledge leads to a continuous change in the production function. The common characteristics of such advance in knowledge is that they lead to a new production function which is superior to its predecessor in the sense that less of one or more factors of production is required to produce a given output, while the input of other factors remaining unchanged. This process may be formally represented by a series of dated production functions, one for each time period.

In addition to diffusion of technical change among firms in an industry, the interaction among firms itself is an important source of increased productivity. In fact, increase in total factor productivity is accompanied by some retardation of existing industries, and the appearance and growth of new ones. The industries are linked by the input-output relationship which evolves over time or changes greatly when there are important technological breakthroughs or shifts in pattern of final demand.

Productivity increases in one industry are substantially transmitted to other industries in the form of improved quality of materials or external economies (diseconomies). Unfortunately, in most industry productivity studies, material inputs are not considered. Restricting the analysis to only two factors, capital and labour, as in most formulations of the production function, contributed a great source of bias since in practice it involves many other factor inputs that is taken into account in the production function. It is further assumed that output is kept as a constant proportion of raw materials. The evidence, however, suggests that this ratio is not constant. Generally, it has declined due to improvements in technology, better inventory management and substitution of both raw materials and primary inputs. The omission of materials from the production function often leads to a bias in estimates of returns to scale and affect the elasticity of substitution between capital and labour inputs.

In a simplifying case of two factors, capital and labour, the above analysis can be shown by a series of isoquants, but time instead of output would be measured on the third axis and each curve would refer to the same output. Each curve represents the alternative techniques which are available at each date. Besides knowledge, a second factor that determines the flow of new techniques coming into use – the best-practice techniques – is changing relative factor prices. The best-practice technique is the appropriate technique having regard to both economic and technical conditions which yield minimum costs

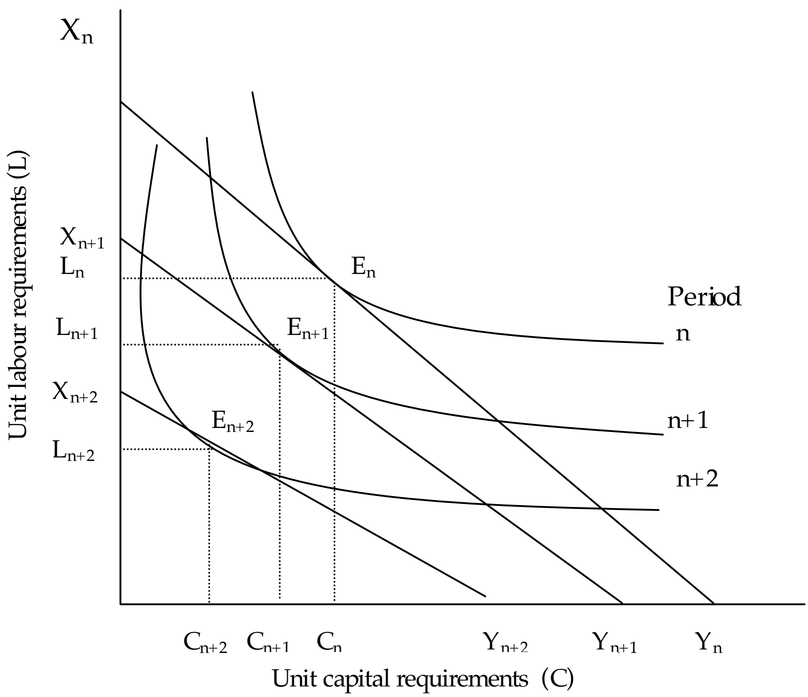


Figure 1
Determination of the best-practice technique

in terms of production function and relative factor prices at each date. Line $X_n Y_n$, $X_{n+1} Y_{n+1}$, and $X_{n+2} Y_{n+2}$ of Figure 1 are price lines, the slope of which equals the ratio of factor prices, which are better known as price relatives.

Point of tangency E_n, E_{n+1} and E_{n+2} correspond to the successive best-practice techniques where the marginal conditions of minimum cost are satisfied. There are two apparent important features of the formulation; (i) today's best-practice technique differs from yesterday's in that it makes use of new knowledge acquired between today and yesterday where today's best-practice technique is superior, shown by the shifts in the isoquants towards the origin (less inputs being required to produce the same amount of outputs); and (ii) a change in relative price would change the slope of the price line by altering the technique which is economically appropriate.

METHODOLOGY AND DATA

Every process of production involves the use of combinations of factors of production, such as materials, labour, and capital. The costs of production are the value of inputs used and may be obtained by multiplying the amount of inputs used by their per unit prices (Rashid, 1989). In an input-output analysis, the input-output coefficients of a structural matrix describe the amount of inputs used per unit of output. These coefficients multiplied by its input prices would give the costs of production per unit costs of output produced. In order to obtain per unit costs for each sector of the economy, we need as many prices as the number of sectors indicated by the tables.

Similarly, the production statement for a particular sector of an economy would have the value of purchases from other sectors. When each of them is divided by the sector's value of output, the results will give the structure of inputs used in production. The costs of production would, therefore, equal the sum of the products of its input coefficients and its respective per unit prices. The costs of production can be represented by:

$$\sum_j \mathbf{a}_{ij} \mathbf{P}_j \tag{1}$$

where a_{ij} and P_j are column vectors of sector *j* input coefficients and the producer prices of the respective input for the total of *n* sectors, and *i* is the sector providing inputs to sector *j*.

The Total Costs

The model has identified three components of total costs, which are domestic materials, imported input, and labour. The structure of each of the first two inputs is represented by their respective input coefficient matrices, namely the structural and imported input matrices. Since labour is not normally aggregated by sector, the structure of labour used in production is represented by its labour coefficient vector. Based on the above formulation, the total cost of production of sector *j* output then can be expressed as;

$$\sum_j P_j a_{ij} + \sum_j w_j L_j + \sum_j {}^{m}P_j {}^{m}a_{ij} \qquad (2)$$

where,

	a_{ij}	=	domestic input coefficient
	L_j	=	labour input coefficient
	${}^{m}a_{ij}$	=	imported input coefficient
	P_j	=	price of domestic input
	w_j	=	price of labour
	${}^{m}P_j$	=	price of imported input

Equation (2) represents the index of per unit costs of production in sector *j* in year *t* for the 1978 vintage technology. This equation implies that costs of production in the manufacturing sectors are using the 1978 price or old technology. At the moment, we also compiled 1978 to 2001 annual data at current price on costs of production and gross output of the manufacturing sector, expressing them in per unit of gross output and also re-expressing in their real 1978 terms. This would give us the per unit costs of production associated to the current best-practice technique or technology advancement. However, due to some limitations in the way the producer prices were provided and the manner in which the model has been developed, all prices of inputs had to be re-expressed in index form.

Furthermore, the study also provides a detailed explanation of how we derived costs of domestic materials, imported inputs, and labour in the following sub-sections.

Cost of Domestic Materials

Let A be the Malaysian 1978 40th order square coefficient matrix[2] whose elements a_{ij} are the amount of output of sector *i* used by sector *j* in order to produce one unit of sector *j* output. Let us further suppose that P is the rectangular matrix[3] of time series producer price indices of domestic materials of order 40 x 24 whose elements p_{tj} are the price index domestic material of year *t* (*t* = 1978, 1979, 1980,…,2001) in sector *j*.

The per unit cost of each sector of the economy can then be represented as:

$$\mathbf{P'A} \tag{3}$$

where P' is the transposed matrix of time series price indices of domestic materials.

The elements of P'A matrix show the annual costs of production for each of the *n* sectors. By transposing the matrix P, we get the cost of sector *j* per unit of its output in year *t*, and is expressed as;

$$\sum_j P_j a_{ij} \tag{4}$$

Cost of Imported Inputs

The import coefficient ${}^{m}a_{ij}$ represents the amount of imported input of sector *i* purchased by sector *j* in order to produce one unit of output. Multiplying by the import price of sector *j* would give the value of imported output of sector *i* purchased by sector *j* for each unit of sector *j* output. Therefore, the total cost of imported inputs in year *t* for producing one unit of *j* output is the column sum of all the value of imported inputs for each unit sector *j* output.

$$\sum_{\mathrm{j}} {}^{m}P_j {}^{m}a_{ij} \tag{5}$$

Cost of Labour

The costs of labour input is treated separately because the labour coefficient, unlike the other two cost items, is represented as a vector because labour cannot be distinguished by sectors. L_j is the labour coefficient representing the amount of salaries and wages paid to produce one unit of sector *j* output. The annual wage rate w_j gives us the value of labour used in order to produce one unit of sector *j*. When sectoral wage rate is multiplied by the labour coefficients, it will give the value of labour used in order to produce one unit of the sectoral output, or simply called the labour costs.

$$w_j L_j \tag{6}$$

In matrix notation, the annual cost of labour for each *n* sector for the entire period is by multiplying the diagonal matrix of the labour coefficient by the matrix of indices of wage rate, that is:

$$L\,W \qquad (7)$$

where $L = \text{diagonal } [L_{ij}]$ and

$W = [w_{ij}]$

In our model, we have determined the total per unit cost of production of each sector by three constants and variables. All the input coefficients that are domestic material, imported inputs, and labour are treated as constants, whereas the variables are the indices of prices of inputs. Since all the three pairs of constants and variables are observable, the total per unit costs of production can be easily determined

Data Sources

In this study, we collected published data from the 1978 input-output tables and various annual issues of Industrial Surveys as well as unpublished annual data on the producer price indices from the Department of Statistics, Malaysia (DOS). Our study used the 1978 input-output table because it was the earliest table published for Malaysia and therefore it would give us a longer time period. Using the Malaysian Industrial Classification (MIC), we have reclassified the published producer price indices at the two-digit level for the domestic production classified by the SIC and SITC. Indices for the non-manufacturing industries are compiled from other independent sources for a particular year. In cases where more than one price indices (SIC or SITC) correspond to a particular sector in the input-output table, a simple average of them represents that industry's index. In the absence of data, in a few cases, we have taken our own estimates by using simple trend line estimation since the DOS did not conduct surveys for 1998 and 2001. They represent the input prices of domestic production. The availability of data on gross output of the respective industries for 1978 base years enabled us to use weighted average index (Lespeyres).

In estimating the wage rates for various industries, we used earnings figures to represent wage rates. However, due to the unavailability of such information, price of labour was defined as the ratio of salary and wages to the number of employees in an establishment. These prices are given in value terms which were converted into indices and based on 1978 values, before it was applied to the model. Then, salary and wage figures were obtained from published figures by the surveys conducted by DOS.

RESULT AND DISCUSSIONS

The manufacturing sector comprises many industries whose producer prices vary annually during the period. Similarly, each industry has its own production function with varying degree of material input used besides primary input, as shown in Table 1. However, each industry in the manufacturing sector experiences different cost changes because each has its own unique production function. Considering different sizes of industries in the manufacturing sector, we calculated weighted average of the manufacturing sector annual cost of production for 1978 technology and found that it rose steadily. We then compared annual production costs of the current best-practice technology with that of the 1978 vintage as shown in Table 1.

Table 1
Index of Total Costs of the 1978 Vintage and Best-Practice Techniques, (1978-2001)

Years	The vintage technology			The best practice	
	Domestic	Imported	Labour	Average	technique
1978	0.1685	0.1506	0.0589	1.0000	1.0000
1979	0.1849	0.1674	0.0629	1.0983	0.9340
1980	0.2019	0.1709	0.0681	1.1665	0.8656
1981	0.2203	0.1772	0.0616	1.2145	0.8288
1982	0.2174	0.1695	0.0761	1.2249	0.8310
1983	0.2157	0.1742	0.0828	1.2504	0.8099
1984	0.2174	0.1772	0.0912	1.2851	0.7784
1985	0.2181	0.1787	0.0935	1.2972	0.7791
1986	0.2181	0.1563	0.0992	1.2529	0.7838
1987	0.2223	0.1650	0.0960	1.2787	0.7892
1988	0.2321	0.1889	0.0942	1.3629	0.7427
1989	0.2428	0.1867	0.0908	1.3766	0.7200
1990	0.2415	0.1830	0.0953	1.3752	0.7094
1991	0.2475	0.1885	0.0955	1.4060	0.6845
1992	0.2538	0.1981	0.1035	1.4693	0.6544
1993	0.2559	0.2004	0.1075	1.4915	0.6454
1994	0.2564	0.2075	0.1188	1.5414	0.6362

(continued Table 1)

Years	The vintage technology			The best practice	
	Domestic	Imported	Labour	Average	technique
1995	0.2601	0.2167	0.1242	1.5899	0.6424
1996	0.2601	0.2189	0.1352	1.6247	0.6160
1997	0.2635	0.2216	0.1495	1.6787	0.6112
1998	0.2798	0.2335	0.1479	1.7492	0.5861
1999	0.2801	0.2368	0.1537	1.7740	0.5964
2000	0.2823	0.2243	0.1458	1.7259	0.5962
2001	0.2806	0.2163	0.1501	1.7116	0.6145

Source : Computed from equations (4), (5), and (7) in the model
Note : * normalised cost

Figure 2, derived from Table 1, shows the result that compares the manufacturing's indices of costs of production for the 1978 vintage technologies with those of the costs of production associated with the current best-practice technology in the manufacturing sector. It can be seen from this figure that both curves began at the initial year 1978 and at the same point because at that year, firms used the current best-practice technique, the vintage technique of 1978 was the current best-practice technique in the year 1978. As time progressed and price increased, the older technology's cost will rise and has a higher cost compared to the new technology.

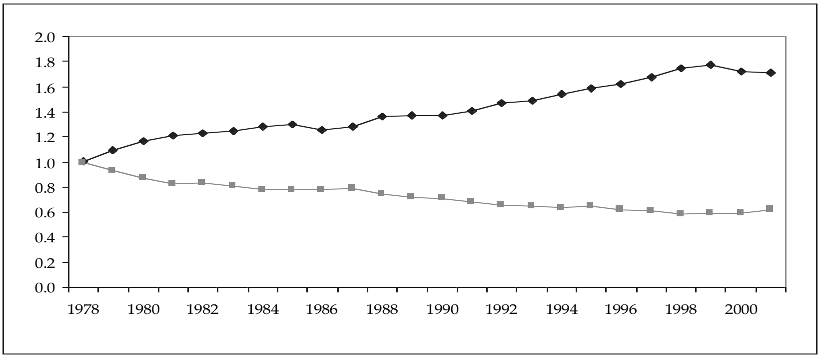


Figure 2
Index of total costs of production for the vintage and best-practice techniques (1978-2001)

The figure also shows that as time progresses and price rises, firms, by adopting the best-practice technology, optimises its production technique, using less amount of inputs for each unit of output produced. The time trend curve for vintage technology is increasing and the best-practice technology is decreasing, which is reflects that the former was experiencing a process of obsolescence while the latter was experiencing a process of improved efficiency and precision. The gap between the curves reflects index of per unit cost savings as a result of a firm's adoption of the current best-practice technology and abandoment the vintage one. Thus, new investment on machinery equipment or capital embodied in capital goods by firms resulted in more production and cost saving.

With the changes in the sectoral producer prices, firms which are still hanging onto the 1978 vintage technique without any investment on capital goods will find that its costs of production is rising rapidly. On average, Table 2 reveals that the manufacturers have to pay about 70 % higher than the 1978 prices of domestic materials and imported inputs and 170 % of the price of labour (wage rate).

Table 2

Sectoral Average Changes in Input Prices (1978-2001)

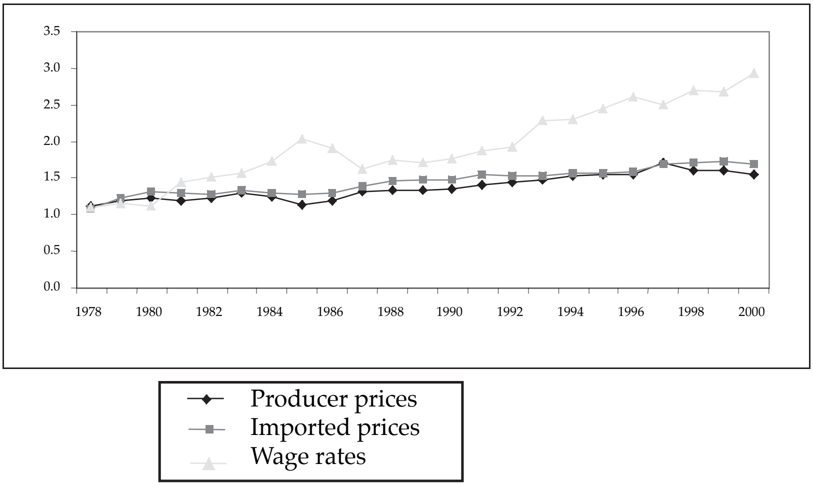
Input prices	**1978-2001***
Domestic materials	1.7673
Imported inputs	1.7206
Wage rates	2.7071

Source : Computed from the model

Note : * Weighted average using sectoral output of 1978 as weight

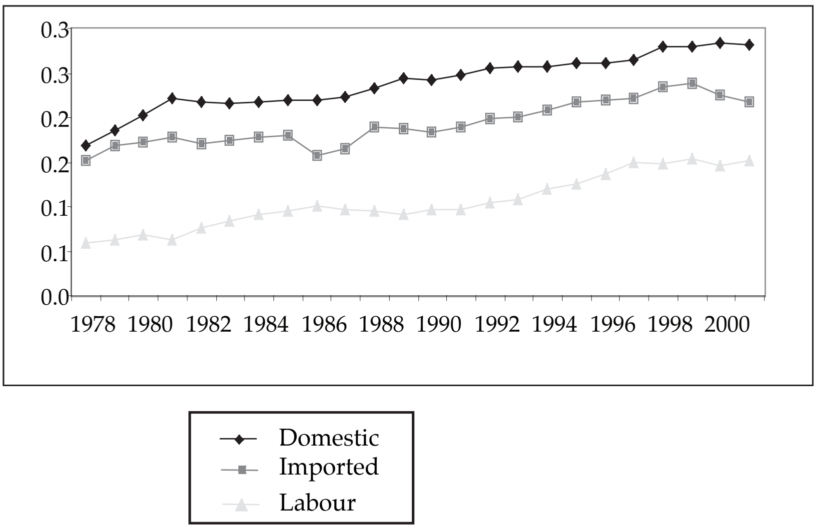
The manufacturers have to pay more on wage rate compared to the rest of the production cost components. Thus, price of labour, which is measured by wage rate, is the main factor that contributed to an increase in the total costs. The wage rate has increased more than two times faster than domestic materials and imported input prices as shown in Figure 3.

The movements in the input prices are expected to show corresponding movements in the costs of production because the latter is derived from the former through an input-output relationship, where the



Source: Derived from equation (2) in the model

Figure 3
Changes in input prices for the manufacturing sector (1978-2001)



Source : Derived from Table 1

Figure 4
Changes in components of costs for the manufacturing sector (1978-2001)

coefficients of which are fixed. The price pattern of the movement however, will depend fundamentally on the changing input structure that may be taken during the period. Despite the fact that wage rate constitutes the highest rate of increase in all the input prices, labour costs do not represent the largest proportion of the total costs. Since domestic material input represents the largest amount of input used in the production for each Ringgit worth of output produced, domestic costs take the largest proportion as shown in Figure 4.

The results also revealed that movements of the costs of production of the vintage technique had dropped in year 1986, and between 2000 and 2001 periods, as shown in Figure 2. Since the input-output coefficients are fixed, the import price is the major player to influence these trends as shown in Figure 4. During these periods, the import prices per unit of output had decreased dramatically to 0.1563, 0.2243, and 0.2163 in year 1986, 2000 and 2001, respectively.

CONCLUSIONS

The paper compared the cost of production of the 1978 Malaysian vintage and current best-practice technologies from the 1978 to 2001 period. Since it uses the input-output analysis as its basic framework, the study took into account the inter-industry transactions in calculating the costs of production for each vintage. The result showed that cost of production for new vintage is less than those of the older one, supporting the vintage hypothesis. By adopting to the current best-practice technique, it also implies that the economy will certainly be experiencing a technological change because of the new technologies that are always embodied in new equipment.

The paper also found that despite the faster growth of wage rate compared to the rest of the cost components, cost of domestic materials still represent the largest component of total cost. Cost of labour which increases rapidly due to the rapid increase in the wage rate may represent the major cause of rapidly increasing production costs.

The above results imply that in the Malaysian manufacturing sector, there is a strong argument for the economy to adopt the best-practice technique available, because there is absolutely a considerable advantage in terms of saving in the per unit cost of production. The paper, however, does not show when a technique should be replaced. Conceptually, replacement of new techniques depends on the price of output, the quantity of material input associated with the existing technique, and the price of the current material input. However, it is worth to note that once a technique is in existence, it is there to be used and the only criterion of its economic usefulness is its ability to earn a surplus over operating cost.

END NOTES

[1] The embodiment hypothesis has been interpreted by Solow as technical change embodied in new capital goods. This hypothesis holds that productivity enhancing technological innovation is, in part, embodied in the design of capital equipment and structures.

[2] The best-practice technique of production is one that gives the highest surplus, given the current price structures. The terminology was first introduced in Salter (1960).

[2] We have reduced the size of the table from the published 60th order matrix by using an aggregation scheme shown in Appendix 1. This will give more focus on the manufacturing sector which comprises sector 8 to sector 38. Sector 1 to sector 7 are primary sectors while sector 39 and 40 are construction and service sectors, respectively.

[3] The annual sectoral indices which were rebased to 1978 constant prices were constructed from the unpublished producer price indices which are classified by SITC 3 digit level. By using annual PPI, we re-expressed them in their real terms, which gave us the per unit cost of materials associated to the current best-practice technology.

REFERENCES

Ahmad, S., (1966). On the theory of induced innovation. *Economic Journal*, *76*, 344-57.

Fellner, W., (1969). Specific interpretations of learning by doing. *Journal of Economic Theory*, *1*, 119-40.

Hicks, J. R., (1964). *The theory of value*. London: Macmillan.

Rashid, Z. A., (1989). Price structure, technological obsolescence and labour productivity-a vintage hypothesis approach. *Singapore Economic Review*, *34*, 50-67.

Salter, W., (1960). *Productivity and technical change*. London: Cambridge University Press.

Solow, R. (1957). Technical change and the aggregate production function. *Review of Economics and Statistics*, *39*, 323-33.

APPENDIX 1

Classification of the input-output table

I-O Table of 40th Order		I-O Table of 60th Order	
1	Other Agriculture	1	Agriculture products others
2	Rubber Plantation	2	Rubber primary prod.
3	Oil Palm	3	Oil Palm primary prod
4	Livestock	4	Livestock etc.
5	Forestry	5	Forestry, logging prod.
6	Fishing	6	Fish etc.
7	Petrol Mining	7	Mining, quarrying prod
8	Dairy Product	8	Meat, dairy products
9	Vegetables and Fruit	9	Preserved food
10	Oil & Fats	10	Oils and fats
11	Grain Mill	11	Grain mill products
12	Baker Confectionery	12	Bakery, confectionary product
13	Other Foods	13	Other foods
14	Animal Feed	14	Animal feed
15	Beverages	15	Beverages
16	Tobacco	16	Tobacco
17	Textiles	17	Textile products
18	Wearing	18	Wearing apparel
19	Sawmills	19	Wooden products
20	Furniture & fixture	20	Furniture & fixture
21	Paper & printing	21	Paper & printing prod.
22	Industrial chemicals	22	Industrial chemicals
23	Paints. Etc	23	Paints & lacquers
24	Other Chemical Product	24	Other chemical prod.
25	Petrol Product	25	Petroleum, coal prod.
26	Rubber Process	26	Processed rubber
27	Rubber Product	27	Rubber prod.
28	Plastic Product	28	Plastic prod.
29	Glass Product	29	China, glass & clay prod.
30	Cement	30	Cement, lime plaster
31	Non Metallic	31	Other non-metal min.prod.
32	Basic Metal	32	Basic metal prod.
33	Other Metal	33	Other metal prod.
34	Non Electric Machinery	34	Non-electric machinery
35	Electric machinery	35	Electric machinery
36	Motor vehicles	36	Motor vehicles
37	Other Transport	37	Others transport equipment
38	Other Manufacturing Product	38	Other manufacturing prod.
39	Constructions	41	Building, construction
40	Others Services	39	Electricity & gas
		40	Water
		42	Wholes are retail trade
		43	Hotel & restaurant

I-O Table of 40th Order	I-O Table of 60th Order	
	44	Transport
	45	Communication
	46	Financial services
	47	Insurance
	48	Real estate. own.occ.dw.
	49	Business services
	50	Private education
	51	Private health
	52	Recreation, culture
	53	Repair vehicles
	54	Other repair, cleaning
	55	Public administration, defense
	56	Government education
	57	Government health
	58	Other government services
	59	Private non-profit service
	60	Other private services