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Input Elasticity of Substitution in the Malaysian Manufacturing Sector

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Abstract: In Malaysia, the manufacturing structure and process of production has dramatically changed from labour intensive to more capital intensive as a result of technological expansion that has been extensively undertaken especially after the 1980s. This change is partly attributed to the influx of foreign direct investment together with introduction of modern technology into the Malaysian economy as well as the implementation of numerous technological agreements. Consequently, these changes have resulted in a change in the structure of labour demand in favour of professional and skilled labour. This article attempts to investigate technological expansion in the Malaysian manufacturing sector and its impact on elasticity of substitution between skills and capital. Six manufacturing sub-industries were chosen for the analysis namely food, beverage and tobacco; wood and wood products; transport equipment; non-ferrous metal products; non-metallic mineral products and electrical and electronics. Three job categories covered in the analysis were professionals, skilled workers and unskilled workers. This analysis utilised data from 1980-1994 from the Manufacturing Survey collected by the Department of Statistics of Malaysia.

1. Introduction

Since the 1980s, the Malaysian economic structure has been experiencing a dramatic change. There has been a shift from the agriculture sector being the main contributor to gross domestic product (GDP) to the manufacturing and services sectors playing an increasingly larger role. These last two sectors use high technology to produce higher value-added products compared to the agriculture sector. Their products are also more competitive in the international market and have consistently accounted for a larger share of the GDP. A dynamic technological expansion experienced by these two sectors requires adequate and appropriate manpower to operate the new technology effectively. Consequently, the structure of labour demand has changed towards the need for more professionals and skilled labour. Within these job categories, certain skills are in higher demand (like technical and computer related jobs) in line with changes in production technology.

On the supply side, the development of the Malaysian economy has resulted in the attainment of higher educational levels among its working population. The government's emphasis on education has provided Malaysians with greater accessibility to education. In the workplace, opportunities to further education and training are also more abundant. Emplo-yers are required to provide better training facilities for their workers to enhance their productive capabilities in carrying out their duties.

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One pertinent question related to this scenario is whether the requirements of the job market ore matched by the education system. Viewing from a labour shortage perspective experienced by the Malaysian economy in certain job categories and labour surplus in others, one may say that policy makers need to reassess the country's manpower planning strategies. In fact, shortages in labour supply are more critical in the professional and skilled labour categories despite considerably large government allocations to the educational sector and higher levels of educational attainment among the people in the last two decades. For unskilled labour, shortages have generally been overcome by the influx of foreign labour especially from the middle of the 1980s.

In view of these problems, it is particularly important to look at the demand for labour and the substitutability between various skills and capital. It is important to study labour demand because the effect of any policy change on factor prices faced by the employers will depend on the structure of labour demand. Besides, the impact of skills, human capital improvement, and human capital mix can be assessed only if the underlying structure of substitution among different groups of workers is known. Knowledge of the values of the elasticity of substitution is useful for policy makers for changing the market signals for greater labour absorption and also to identify the appropriateness of techniques being used in the production process. Rosen (1983) and Griliches (1969) for example provide some initial findings on the capital-skill complementarity hypothesis. This finding has major implications for employment effects of such policies as accelerated depreciation, investment tax credits and other attempts to stimulate investment in physical capital suggest that they will increase the demand for skilled rather than unskilled labour.

This article attempts to analyse skills and capital substitution in the manufacturing sub-sectors namely food, beverage and tobacco; wood and wood products; transport equipment; non-ferrous metal products; non-metallic mineral products and electrical and electronics. The rationale for choosing these sub-industries is based on their major contribution to value-added, employment and export. The analysis utilises data obtained from the Manufacturing Survey of 1980-1994 conducted by the Department of Statistics of Malaysia.

2. Research Results from Previous Studies

Earlier studies on elasticity of substitution in Malaysia had focused only on the traditional capital-labour substitution framework in the manufacturing sector. Using the 1968 census data to estimate the elasticity of substitution, Thillainathan (1969) measured the elasticity of substitution using Constant Elasticity of Substitution (CES) model for industries, defined at the two-digit level, including food, timber-based products, chemical products and metal, machinery, electrical goods and transport equipment industries. Thillainathan concluded that the extent of capital-labour substitution was significant given an elasticity range of between 0.45 and 1.18. Based on these estimates, he rejected the proposition that factors were used in fixed proportions in the Malaysian manufacturing sector.

Bhanoji and Ramana (1970), using the same 1968 census data, calculated the elasticity of substitution for 60 manufacturing industries which were made up of 35 four-digit level industries, 11 three-digit level industries, 6 two-digit level industries and eight industry group formed by adding two- or four-digit level industries. However, of the 60 industries con-sidered, only 20 recorded elasticity measures that were statistically significant at the 5 per cent level. They concluded that consumption-oriented industries tend to have relatively higher elasticity than investment-oriented industries.

Maisom (1989) calculated time series estimates of elasticity of substitution for 50 industry groups (five-digit level) for the period 1963-84. The study compared two methods for estimating elasticity– CES and Translog Cost functions. The estimated elasticity using CES ranged between 0.254 and 1.259, whereas the translog cost function gave slightly higher estimates ranging between 0.462 and 1.325 (with the exception of petroleum refineries which had an elasticity of 4.649). Maisom (1989) found elasticity to be quite low– 34 out of the 50 industry groups had elasticity values smaller than one while 16 had values greater than one.

Hoffman and Tan (1980) used four different approaches including the Arrow-Cheney-Minhas-Solow (ACMS) measure, the Diwan method, the Variable Elasticity of Substitution (VES) and the Kmenta measures fitted the regressions to 55 industry group data based on a survey of 338 manufacturing establishments in West Malaysia in 1974. They found that alternative estimates did not produce substantial differences. The results showed that of the 55 industries, 35 had elasticity values of less than one, 17 greater than one and three industries exhibited an elasticity value equal to unity.

Mahani (1993) calculated estimates of elasticity of substitution for the textile and electrical and electronics industry group. This study compared two estimates for the years 1979 and 1985 and found that the elasticity of substitution for the textile industry in general had increased slightly from 0.893 in 1979 to 1.173 in 1985. Product group elasticity was varied in 1979; from a low 0.54 to a high 1.39. But in 1985 the range of elasticity narrowed and most product groups fell between the range of 1.0 and 1.3.

Most of the earlier studies using more than two-factor models were based on manufacturing data in the United States and used two types of labour inputs. The normal trend was to divide labour by occupation – with the majority using a breakdown between production and non-production workers. Undoubtedly, this was largely due to the availability of data from government sources that separate labour by occupation. The results from elasticity of substitution from four studies done in the 1970s and 1980s in the United States are presented in Table 1.

Seven of the eleven studies found that production and non-production workers are substitutes while all studies also found that production workers and capital are substitutes. The results are less clear-cut between non-production workers and capital since all eleven studies found that they are complements.

Table 1: Elasticity of substitution – production and non-production workers

Study	Data and Method	σ_{pk}	σ_{nk}	σ_{pn}
Berndt-White	Manufacturing, 1941-71, translog cost	0.91		
1.09 3.70	Clark-FreemanManufacturing, 1950-76, translog cost	2.10		
-1.98 0.91	Kesselman *et al.*Manufacturing, 1962-71, translog cost	1.28	-	
0.48 0.49	Berndt-ChristensenManufacturing, 1929-68, translog production	2.92		
-1.94 5.51	Dennis-SmithManufacturing 1952-72, translog cost	0.14		
0.38 -0.05	Denny-FussManufacturing 1929-68, translog cost	1.50	-	
0.91 2.06	Freeman-MedoffMaufacturing 1972, translog cost	0.53	-0.02	
-0.24 Grant	SMSA, census of population 1970, translog cost	0,47		
0,08 0.52	Denny-FussManufacturing 1929-68,translog production	2,86	-1.88	
4.76 Woodbury	Manufacturing 1929-71, translog cost	-	-	-0.7
Hensen *et al.*	Manufacturing 1967, translog production.	-	6.0	-1.3

Source: Hamermesh 1984; Berndt and Christensen 1974; Berndt and Wood 1977
Note: The subscript ‘p’ denotes production workers, ‘n’ denotes non-production workers, and ‘k’ denotes capital.

3. Methodology

The traditional capital-labour substitution framework assumes that labour inputs are perfectly substitutable. Therefore, labour can be combined into an aggregate labour index without losing economic information. This assumption allows researchers the luxury of using two-factor production and cost functions to estimate the various combinations of capital and labour needed to produce a given level of output and to determine the optimal combination of capital and labour for a given total of expenditure. However, the assumption that little is lost by aggregating perfectly substitutable labour inputs is no longer true when labour inputs are highly but imperfectly substitutable.

When labour inputs are not perfect substitutes for capital, then it is possible to test the capital-skill complementarily hypothesis. This hypothesis states that the more skills acquired by workers, the more likely they will complement capital in the production process (Griffin, 1992). In order to support this hypothesis, the elasticity of substitution estimates between labour inputs and capital must vary according to skill differences between labour inputs.

3.1 Translog Model

Many studies of production are done in the context of a flexible functional form. Flexible functional forms are used in econometrics because they allow researchers to model second-order effects such as elasticity of substitution which are functions of the second derivatives of production, cost, or utility functions (Greene, 1997). The linear model restricts this to zero whereas the log-linear model (such as Cobb-Douglas model) restricts the elasticity to the values of –1 or +1. Among the most frequently used flexible functional forms in empirical work is the translog function.

A translog function is derived from a Taylor Series expansion and is a flexible functional form used to relax the unitary constraint inherent in Cobb-Douglas functions.

The Cobb-Douglas cost function $C = AW^{\delta_1} R^{\delta_2}$ in log terms is

$$lnC = lnA + \delta_1 lnW + \delta_2 lnR \tag{1}$$

A Taylor Series expansion of (1) to the second moment is

$$lnC = lnA + \delta_1 lnW + \delta_2 lnR + {}^1\!/\!_2\delta_{11}(lnW)^2 + {}^1\!/\!_2\delta_{12}(lnW)(lnR) + {}^1\!/\!_2\delta_{22}(lnR)^2 + {}^1\!/\!_2\delta_{21}(lnR)(lnW) \tag{2}$$

Assuming symmetry ($\delta_{12} = \delta_{21}$), equation (2) takes the form

$$lnC = lnA + \delta_1 lnW + \delta_2 lnR + {}^1\!/\!_2\delta_{11}(lnW)^2 + \delta_{12}(lnW)(lnR) + {}^1\!/\!_2\delta_{22}(lnR)^2 \tag{3}$$

Equation (3) is the translog functional form of a two-factor Cobb-Douglas cost function.

By using a cost minimisation approach and assuming input markets are competitive, Shephard's Lemma demonstrates that

$$\partial lnC/\partial lnP_i = (X_i / P_i) = S_i \tag{4}$$

where X_i = L or K, P_i = W or R, and S_i is the cost share of the input in the total cost to produce at the optimal level of output.

In general, Shephard's Lemma is defined as the derivative of the expenditure function with respect to the price of a good that gives the Hicksian demand for that good. Taking partial logarithmic derivatives and equating them with the cost shares from the cost function (3), we have

$$SL = \partial lnC/\partial lnW = \delta_L + \delta_{LL} lnW + \delta_{LK} lnR \quad (5)$$

$$SK = \partial lnC/\partial lnR = \delta_K + \delta_{LK} lnW + \delta_{KK} lnR \quad (6)$$

For the translog cost specification

$$\sigma_{ij} = (\delta_{ij} + S_i S_j)/ S_i S_j \qquad i \neq j \quad (7)$$

where σ_{ij} is the elasticity of substitution (Allen Elasticity of Substitution) between pairs of factors.

$\sigma_{ij} > 0$ the factors are substitutes
$\sigma_{ij} < 0$ the factors are complements
$\sigma_{ij} = 0$ the factors have no relationship

Expanding the translog model from two factors to four factors requires the cost and production functions to change from two to four-input functions.

$$C = Q f (P_1, P_2, P_3, P_4)$$

$$Q = f (X_1, X_2, X_3, X_4)$$

where P_1 is the average annual wage for professional workers (X_1).
P_2 is the average annual wage for skill workers (X_2).
P_3 is the average annual wage for unskilled workers (X_3).
P_4 is the rental rate for capital (X_4).

As shown for the two-factor model, the Cobb-Douglas cost function has the translog form

$$lnC = lnQ + ln\delta_0 + \Sigma\delta_i ln\, P_i + {}^1/_2\Sigma\Sigma\delta_{ij} ln\, P_i\, P_j \quad (8)$$

where $\delta_{ij} = \delta_{ji}$, technology parameters are δ_0 , δ_i , δ_{ij} and C and P_i represent the total cost and input prices, respectively. If δ_{ij} equals zero, the translog reduces to the standard Cobb-Douglas function.

Once again, Shephard's Lemma demonstrates

$$\partial lnC/\partial lnP_i = (X_i/P_i) = S_I \quad (9)$$

where, $X_i = X_1, X_2, X_3, X_4$, and S_i is the cost share of the input X_i in the total cost of producing Q.

Taking partial logarithmic derivatives and equating them with the cost shares for the cost function, we have

$$S1 = \partial lnC/\partial ln\, P_1 = \delta_1 + \delta_{11} ln\, P_1 + \delta_{12} ln\, P_2 + \delta_{13} ln\, P_3 + \delta_{14} ln\, P_4 \quad (10)$$

$$S2 = \partial lnC/\partial ln\, P_2 = \delta_2 + \delta_{12} ln\, P_1 + \delta_{22} ln\, P_2 + \delta_{23} ln\, P_3 + \delta_{24} ln\, P_4 \quad (11)$$

$$S3 = \partial lnC/\partial ln\, P_3 = \delta_3 + \delta_{13} ln\, P_1 + \delta_{23} ln\, P_2 + \delta_{33} ln\, P_3 + \delta_{34} ln\, P_4 \quad (12)$$

$$S4 = \partial lnC/\partial ln\, P_4 = \delta_4 + \delta_{14} ln\, P_1 + \delta_{24} ln\, P_2 + \delta_{34} ln\, P_3 + \delta_{44} ln\, P_4 \quad (13)$$

In order for the translog cost function to be homogeneous in prices, the cost shares must sum to one. This requires that the following three constraints be imposed:

1. $\delta_1 + \delta_2 + \delta_3 + \delta_4 = 1$
2. $\delta_{11} + \delta_{12} + \delta_{13} + \delta_{14} = 0$
3. $\delta_{ij} = \delta_{ji}$ *(symmetry)*

There are two standard approaches to estimate econometrically the translog function. The first approach is to estimate the translog equation directly and then solve for the cost shares. The second approach is to estimate three of the cost share equations simultaneously and then impose the constraints to solve the fourth cost share equation.

By using the second approach, the cost share equations will provide a seemingly unrelated regression model that can be used to estimate the parameters of the model. To make the model operational, one must impose the constraints and solve the problem of singularity of the disturbance covariance matrix of the share equations. This can be done by eliminating the last term in each row and column of the parameter matrix and by dropping one of the cost share equations.

It is possible to substitute the constraint ($\delta_{11} = - \delta_{12} - \delta_{13} - \delta_{14}$) into the first cost share equation:

$$S1 = \delta_1 + \delta_{12}(ln\, P_2 - ln\, P_1) + \delta_{13}(ln\, P_3 - ln\, P_1) + \delta_{14}(ln\, P_4 - ln\, P_1)$$

Likewise, substituting the fact that ($\delta_{22} = - \delta_{12} - \delta_{23} - \delta_{24}$) into the second cost share equation:

$$S2 = \delta_2 + \delta_{12}(ln\, P_1 - ln\, P_2) + \delta_{23}(ln\, P_3 - ln\, P_2) + \delta_{24}(ln\, P_4 - ln\, P_2)$$

Likewise, substituting the fact that ($\delta_{33} = - \delta_{13} - \delta_{23} - \delta_{34}$) into the third cost share equation:

$$S3 = \delta_3 + \delta_{13}(ln\, P_1 - ln\, P_3) + \delta_{23}(ln\, P_2 - ln\, P_3) + \delta_{34}(ln\, P_4 - ln\, P_3)$$

By estimating three of the four cost share equations using the seemingly unrelated regression technique and using the fact that ($S4 = 1 – S1 – S2 – S3$), it is possible to solve for the fourth cost share.

Once the four cost shares are estimated, the elasticity of substitution (Allen Elasticity of Substitution) between pairs of factors can be calculated.

$$\sigma_{ij} = (\delta_{ij} + S_i S_j) / S_i S_j \qquad i \neq j \tag{14}$$

where, σ_{ij} is the elasticity of substitution (Allen Elasticity of Substitution) between pairs of factors.

$\sigma_{ij} > 0$, the factors are substitutes
$\sigma_{ij} < 0$, the factors are complements
$\sigma_{ij} = 0$, the factors have no relationship

4. Data

Six industries were chosen: food, beverages and tobacco; wood and wood products; non-ferrous metal products; transport equipment; electrical and electronic, and non-metallic mineral industries. For the purpose of analysis, the workers were divided into three groups, namely professionals, skilled workers and unskilled workers. This study used annual time series data for the above mentioned industries for the period 1980-1994. The data was obtained from the annual Manufacturing Survey conducted by the Malaysian Department of Statistics. Though data from the Manufacturing Survey is available up to 1997, the 1995-1997 data had not been classified according to the requirements of this study. For example, data on workers by skills were not reported by subindustries. Data for the period 1980-1994 used in this study were gathered from the raw data at DOS. The raw data provided wage rate by skills and types of industries. The information provided by the Statistics Department includes:

i. Number of employees by job categories and sub-industries,
ii. Wages paid by job categories and sub-industries,
iii. Value of fixed assets by sub-industries. This study utilised net value of fixed assets i.e. value of fixed assets minus depreciation and value of vehicles,
iv. Value-added defined as the value of total product manufactured minus the value of total inputs used

Data on interest rate was obtained from the Annual Statistical Bulletin published by Bank Negara Malaysia (various years). Annual average lending rate was utilised as the factor price for capital in this study.

Before analysing the results of elasticity of substitution estimation, it is worthwhile to look at the capital-labour ratio, input productivity and skills mix in the subindustries covered in the study. Capital-labour ratio is particularly important to reflect the level of technological acquisition in those industries. A higher capital-labour ratio is usually associated with a higher level of technology. It is observed that capital-labour ratio is higher in the non-ferrous metal products, non-metallic mineral products and wood and wood products industries compared to other industries. These ratios had been increasing overtime except in the period of 1985-1990 for the non-metallic industry. The capital-labour ratio for the electrical and electronics industry had been decreasing after 1985 whereas the ratio for transport equipment had increased very slightly during the period under study. The ratio for food industry had been decreasing throughout the entire study period.

Capital and labour efficiency or productivity can be measured by dividing the output value with the value of capital and quantity of labour respectively. Output-capital ratios are higher in the food products, electrical and electronics and transport equipment industries compared to other industries. It is shown that there is no relationship between capital intensity and capital efficiency as the capital-labour ratios of three subindustries are lower than those in other industries in the study. This may be due to technological management and more appropriate choice of technology in relation to skills endowment. Nevertheless, this study also finds that labour efficiency is positively related to capital intensity. Sub-industries with higher capital-labour ratios like non-ferrous metal products, non-metallic mineral products and wood products register higher output-labour ratios. This finding implies that these industries managed to use labour more efficiently through better combinations between capital and labour. Food industry is an exception where high labour efficiency and low capital-labour ratio are observed. The inherent nature of the food industry which requires more labour input may contribute to this higher labour efficiency. Table 2 presents capital-labour ratio, output-capital ratio and output-labour ratio for the various industries.

Table 3 presents skills composition in the six subindustries. It is hypothesised that overtime, industrial technology will be more advanced and the proportion of professionals and skilled workers will increase. From this table, it can be seen that between 1980-1994, the number of professional workers had been increasing in almost all industries except in transport equipment. An industry with a tremendously high percentage of professional workers is non-ferrous metal products, which is consistent with its high capital-labour ratio. In contrast, the non-metallic mineral products industry had a relatively low percentage of professional workers despite a high capital-labour ratio. The exceptional case is found in the food industry where its percentage of professional workers was quite high despite a low capital-labour ratio. These results show that there is no determinate relationship between capital-labour ratio and percentage of professionals needed by the industries. It all depends on the nature of technology adopted by the industries, whether it is skills deepening or otherwise.

Most of the industries under study had a large percentage of skilled and technical workers. The transport equipment and electrical and electronics, in particular, recorded proportions higher than 98 per cent. Other industries with a high proportion of skilled and technical workers were woods products and non-metallic mineral products. As for the unskilled workers, the food industry had the highest percentage at more than 50 per cent whereas for non-metallic mineral products, it was close to 50 per cent. From this observation, it can generally be concluded that industrial expansion in Malaysia has been moving towards a greater requirement for professionals, technical and skilled workers as their percentage comprise between 50 to 90 per cent of total labour requirements, except for the food industry.

5. Estimation Results

This section provides the estimation results from a translog model designed to determine the elasticity of substitution between capital, professional workers, skilled workers, and unskilled workers. This study uses the seemingly unrelated regression approach to estimate the elasticity of substitution between factors. This approach is advantageous for estimating four-factor functions because it provides a straightforward method to impose constraints, and to estimate cost shares simultaneously.

Table 2: Capital-labour ratio, output-capital ratio and output-labour ratio in manufacturing sub-industries (1975-1994)

No.	Type of Industry	Capital/Labour ('000)					Output/Capital					Output/Labour ('000)				
		1975	1979	1985	1990	1994	1975	1979	1985	1990	1994	1975	1979	1985	1990	1994
1.	Food, beverage & tobacco	16.42	12.28	6.47	4.55	2.67	12.67	20.86	40.13	51.55	94.93	208.10	256.12	259.54	234.48	253.75
2.	Wood & wood products	22.44	24.23	60.29	49.30	97.10	2.16	2.88	1.97	2.96	1.96	48.58	69.89	118.83	145.96	189.86
3.	Transport equipment	2.30	2.55	0.46	9.29	9.12	3.71	1.45	11.0	3.71	2.53	8.54	3.70	5.03	34.44	23.06
4.	Non-ferrous metal products	67.39	83.89	130.133	217.69	277.13	1.45	1.48	1.33	1.24	1.18	97.93	124.51	172.90	270.69	271.73
5.	Non-metallic mineral products	49.11	44.82	5.12	10.94	290.73	1.08	1.38	18.28	10.07	1.00	53.32	61.99	93.69	110.18	291.42
6.	Electrical & electronics	7.42	8.18	14.11	12.45	9.83	5.37	5.41	4.29	4.50	6.08	39.86	44.28	60.54	56.11	59.80

Source: Calculated from the Manufacturing Survey. Various years.

Table 3: Skills composition in the manufacturing sub-sectors (1975-1994)

No.	Type of Industry	Professional					Skilled					Unskilled				
		1975	1979	1985	1990	1994	1975	1979	1985	1990	1994	1975	1979	1985	1990	1994
1.	Food, beverage & tobacco	5.69	9.18	12.76	12.36	16.61	72.69	66.58	53.72	41.34	27.12	21.62	24.24	33.52	46.30	56.27
2.	Wood & wood products	2.06	1.93	4.60	7.32	11.05	68.33	68.60	55.86	54.99	62.79	29.60	29.47	39.54	37.68	26.16
3.	Transport equipment	3.29	1.51	0.68	1.20	0.41	86.56	96.39	98.12	96.53	98.91	10.15	2.10	1.20	2.27	0.68
4.	Non-ferrous metal products	1.79	2.05	3.15	3.10	3.39	67.81	68.95	61.62	62.46	53.85	30.40	29.0	35.23	34.44	42.76
5.	Non-metallic mineral products	17.74	25.45	26.77	47.05	55.20	49.20	4341	39.67	19.15	24.3	3.18	31.13	33.55	33.79	20.49
6.	Electrical & electronics	0.82	0.78	0.75	0.58	0.97	67.0	77.86	95.59	97.90	98.01	29.22	21.35	3.66	1.53	1.02

Note: Professional includes jobs like engineers, accountants, architects and others
Skilled Workers include technical and skilled workers based on employer's definition
Unskilled Workers include semiskilled and unskilled workers based on employer's definition.
Source: Calculated from Manufacturing Survey. Various years.

The following three cost share equations were estimated:

$$S1 = \delta_1 + \delta_{12}(ln\,P_2 - ln\,P_1) + \delta_{13}(ln\,P_3 - ln\,P_1) + \delta_{14}(ln\,P_4 - ln\,P_1)$$

$$S2 = \delta_2 + \delta_{12}(ln\,P_1 - ln\,P_2) + \delta_{23}(ln\,P_3 - ln\,P_2) + \delta_{24}(ln\,P_4 - ln\,P_2)$$

$$S3 = \delta_3 + \delta_{13}(ln\,P_1 - ln\,P_3) + \delta_{23}(ln\,P_2 - ln\,P_3) + \delta_{34}(ln\,P_4 - ln\,P_3)$$

The cost share *S1* represents the total cost of employing professional workers to produce at the optimal level of output. Similarly, the cost share *S2* represents the total cost of employing skilled workers to produce at the optimal level of output, and *S3* represents the total cost of employing unskilled workers to produce at the optimal level of output. The technology parameters ($\delta_i + \delta_{ij}$) are estimated by the model using the assumption that they are Hicks-neutral (technology advances that are caused by external factors do not change the relative price between factors).

Table 4 shows the estimates of the elasticity of substitution between capital, professional workers, skilled workers, and unskilled workers in selected Malaysian industries.

Table 4: Estimates of the elasticity of substitution in selected Malaysian manufacturing industries (1985-94)

Industry	σ_{12}	σ_{13}	σ_{14}	σ_{23}	σ_{24}	σ_{34}
Food, beverages and tobacco	-1.378	5.033	1.149**	7.212***	0.102	2.627***
	(0.712)	(1.787)	(2.591)	(4.388)	(0.120)	(9.809)
Wood and wood products	-0.867	-1.091***	0.108	3.068	0.227	2.513***
	(-0.39)	(-3.21)	(1.510)	(0.835)	(0.832)	(7.879)
Transport Equipment	0.142	0.522	1.325	-1.601***	2.410	2.994
	(0.188)	(0.954)	(0.818)	(-4.98)	(1.473)	(1.679)
Non-ferrous metal products	-3.813	-3.423	0.788***	4.0174	2.487***	1.114***
	(-1.12)	(-1.23)	(6.085)	(1.002)	(7.323)	(3.998)
Non-metallic mineral products	2.279	-2.612	3.680***	2.359	-3.483***	1.554
	(1.214)	(-1.01)	(3.601)	(0.875)	(-8.77)	(1.722)
Electrical and electronics	2.174***	4.611*	0.409	-0.399	0.173	1.676
	(3.748)	(1.965)	(1.390)	(-0.31)	(0.307)	(1.006)

Notes: '1' denotes professional workers
'2' denotes skilled workers
'3' denotes unskilled workers
'4' denotes capital
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
The figures in parentheses below the estimated coefficients are the corresponding t-statistics.

The results show that there is no significant substitutability between professional and skilled workers in almost all industries except in electrical and electronics. This shows that both types of workers are still greatly needed in the manufacturing sector and any change in price will not affect demand. The substitution between professionals and unskilled workers is significant in the wood and wood products as well as in the electrical and electronics, but the signs are different. In the wood products, the professional and unskilled workers complement each other reflecting that changes in technology in this industry require much unskilled labour. This is particularly true because the unskilled category also includes semi-skilled workers who are needed in the wood industries to do jobs in the milling and furniture industries. In the electrical and electronics industry, the professional and skilled as well as unskilled labour are substitutes for one another. This indicates that the expansion of this industry requires both skilled and unskilled labour and any wage increase in the professional category will cause substitution in favour of skilled and unskilled workers. Judging capital intensity from Table 2, it is shown that the electrical and electronics industry is quite labour intensive. This implies that moderate technology used in this industry can be operated by both skilled and unskilled workers. Moreover, most electrical and electronics firms in Malaysia are generally assemblers and hire a small proportion of professional workers as shown in Table 3.

Further, the results show that professional workers and capital are substitutes in the three sub-industries namely food, non-ferrous metal products and non-metallic mineral products. This indicates that if the price ratio decreases in favour of capital, these industries will substitute their professional workers with capital implying that their technology is not skills deepening. Although one would expect industrial expansion to substitute unskilled with skilled workers, this study does not find such a relationship in most industries except in the food industry and transport equipment where they complement. Again these results suggest that unskilled workers are still greatly needed in the Malaysian manufacturing sector and this is evidenced by the substantial component of foreign labour in this sector.

The elasticity of substitution between skilled workers and capital is mostly insignificant except in the non-ferrous metal products where they are substitutes and in non-metallic mineral products where they complement. Lastly, as expected unskilled labour and capital are substitutes as observed in the food, wood and non-ferrous metal products.

6. Policy Issues

The findings from this study reveal that in the Malaysian manufacturing sector, few inputs are substitutes. Of 36 combinations of inputs, there are only 13 that have shown significant elasticity of substitution. Of these only three combinations show complementarity whereas other combinations are substitutes. The more capital-intensive industries show more substitutability between capital and unskilled labour but their magnitude is lower than those in the less capital-intensive industry like food. Though elasticity of substitution between professional and unskilled workers is positive, such elasicity is not significant reflecting that industrial expansion in Malaysia still needs unskilled labour. For the professional and skilled workers, the negative sign of the elasticity values indicate complementarity between these two job categories. However, most of these values are not significant.

The substitutability between capital and labour indicates that any change in the price ratio, for example an increase in the interest rate, will increase the demand for labour input and lower the demand for capital. This subsequently may slow down industrial expansion. In view of high growth target in achieving industrial status, Malaysia must not increase the price of capital at a rate higher than the rate of wage increase to the extent that it increases the price ratio.

The complementarity between skills shows that in the Malaysian industrial development process, all categories of labour are still needed by the economy. Therefore, the education system must not totally eliminate the unskilled training facilities. Since the data of unskilled workers includes the semi-skilled, this implies that the semi-skilled workers are still greatly needed in the economy to operate moderate technology especially in the food industry.

The implementation of minimum wage will definitely increase the wage rate especially for the lower rung or unskilled workers. If this policy increases the price ratio between unskilled and skilled workers and between unskilled and professional workers, the unskilled workers will be in less demand, for example in the electrical and electronics industry where they are substitutes. This may lead to unemployment among the unskilled workers. Therefore, the implementation of a minimum wage policy must take into account this possibility to ensure that lower rung jobholders will not be jeopardised.

7. Conclusion

The industrial development process in Malaysia has resulted in changes in the structure of labour demand. However, the extent of substitution between capital, professional, skilled and unskilled workers will all depend on their elasticity of substitution. The results presented in this paper reveal that few inputs are substitutes. Of the elasticity of substitution found to be statistically significant, most are substitutes. This implies that any change in the price ratio for these inputs will shift the demand to more expensive inputs. The value of elasticity of substitution is particularly important for pricing policy in the labour market as well as for designing education policy. From this study, we may conclude that a wage policy that increases the price of unskilled workers will decrease the demand for them and will cause unemployment to increase. Also, as the development of our industrial sector still requires semi-skilled labour, programmes that can enhance their skill must be increased. Most importantly, their skills must be upgraded because of dynamic changes in the production process. Lastly, studies on elasticity of substitution must be carried out continuously due to changes in the production process as well the definition of skills.

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