# Elasticity of Substitutions between Foreign and Local Workers in the Malaysian Manufacturing Sector

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ABSTRAK

Proses perindustrian yang berlaku di Malaysia telah membawa masuk ramai pekerja asing untuk bekerja di negara ini. Mereka telah memenuhi kekosongan pekerjaan di pelbagai kategori dan kebanyakan mereka memegang pekerjaan di peringkat rendah. Namun demikian penglibatan buruh asing di peringkat pekerjaan tinggi atau pegawai dagang tidak kurang pentingnya. Salah satu isu penting dalam pasaran buruh berhubung pekerja asing adalah sama ada mereka merupakan pengganti atau penggenap kepada pekerja tempatan. Peluang pekerjaan rakyat tempatan akan terjejas sekiranya mereka dengan mudahnya dapat digantikan dengan pekerja asing. Kesannya kadar pengangguran di kalangan pekerja tempatan akan meningkat. Artikel ini menganalisis keanjalan penggantian antara pekerja tempatan dengan pekerja asing dan antara pekerja dengan modal bagi pelbagai kategori pekerjaan. Analisis adalah berdasarkan kepada data Penyiasatan Perkilangan antara tahun 1985 hingga 1996 yang telah dikutip oleh Jabatan Perangkaan Malaysia. Analisis merangkumi empat kategori pekerjaan, iaitu pekerja tempatan separuh mahir, pekerja asing separuh mahir, pekerja tempatan tidak mahir dan pekerja asing tidak mahir. Lima jenis industri telah dipilih bagi tujuan analisis ini, iaitu industri berasaskan kayu, keluaran kertas, keluaran kimia, keluaran galian bukan logam dan keluaran logan asas. Dalam mendapatkan nilai keanjalan penggantian, fungsi kos translog telah digunakan. Hasil analisis ini menunjukkan pekerja tempatan dan pekerja asing adalah lebih merupakan pengganti. Selanjutnya hasil kajian ini menunjukkan keadaan penggantian atau penggenap tidak bergantung kepada jenis industri, tetapi bilangan nilai keanjalaan yang signifikan didapati lebih besar dalam industri ringan.

ABSTRACT

Industrialization has brought many foreign labours into Malaysia. They have fulfilled job vacancies at various levels and the majority of them are at the lower job rank. Nonetheless, the involvement of expatriates is also of significant. One of the pertinent labour market issues regarding foreign labours is their substitutability or complementarities with the local labours. Job opportunities for the local labours will be jeopardized when they can easily be substituted by these foreigners. Consequently, the unemployment rate among the locals would increase. This paper investigates the substitutability between local and foreign labours at various job categories and with capital. The data from the Manufacturing Survey of 1985 to 1996 collected by the Department of Statistics, Malaysia is used for the analysis. Four job categories covered in this analysis are semi-skilled local and foreign workers, unskilled local and foreign workers. Five sub industries are selected for the analysis, namely, wood-based, paper products, chemical products, non-metallic mineral products and basic metal products. The translog cost function is used to derive the elasticity of the substitutions. The results from this study show that both the local and foreign workers are more substitutes. Further, the study finds that the substitutability or complementarity does not depend on the types of industry but the number of statistically significant elasticity of substitutions is bigger in the light industry.

## INTRODUCTION

During the 1980s, Malaysian economy experienced a dramatic change in its structure, a shift from dependence on the role of agriculture towards manufacturing and services sectors. High growth rates in these two sectors resulted in a substantial increase in the demand for labour, which consequently, led to the problem of labour shortages at all levels of job categories. The shortage was more severely felt by the manufacturing sector than other sectors due to its faster growth especially at the beginning of 1980s when the export-oriented industrialization and heavy industry were introduced. To overcome this problem, the Malaysian economy began to rely on foreign labours. The situation was seen as an opportunity for the excess supply of unskilled workers of the neighbouring countries like Indonesia, the Philippines, Thailand and Myanmar.

The economic transformation has also changed the structure of labour demand. The fast changing manufacturing and services sectors require more professional and skilled workers to cope with the rapid change in technological adoption. However, the demand for semi skilled and unskilled labours is still high due to the fact that total number of employment increases. In this regard, Malaysia faces two different economic scenarios. Firstly, the labour surplus in certain job categories is a reflection of improvement in the educational attainment amongst the citizens and the difficulties encountered in the human resource planning in meeting labour requirement. Furthermore, jobless are becoming choosier to accept jobs offered to them. Secondly, the shortage of labour exists especially at the lower job rank due to reluctance of the local labours to take these jobs (Rahmah 1997; Zulkifly and Rahmah 1997).

Despite of the business cycle experienced by the manufacturing sector, labour requirement in this sector is always large and the reliance on foreign labours is inevitable. Rapid technological advancement in this sector has changed the pattern of its labour demand towards more skilled workers. However, a dramatic increase in demand for labour has resulted in the shortages for jobs at the upper rank as well as the lower rank. Changes in the demand structure for the foreign labours in Malaysia are preceded by changes in policy for foreign labour that can be arbitrarily divided into three phases. Firstly, an introduction of heavy and export-oriented industrialization at beginning of the 1980s, which has led to substantial job opportunities. Secondly, an introduction of new policy in the mid 1980s that restricted the hiring of foreign workers to only certain sectors. Thirdly, another policy was introduced in 1992 to limit the hiring of the foreign workers to only skilled workers.

On the supply side, the development of the Malaysian economy has resulted in a great improvement in the educational attainment among its working population. The emphasis made by the government on education provides greater accessibility for Malaysians to acquire education. At the workplace, opportunities to further education and training are also greater. Employers are required to provide better training facilities to their workers to enhance their capabilities in carrying out duties and be more productive.

It is particularly important to look at the demand for labour and the substitutability between various skills, and with capital. It is important to study the 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 skill, human capital improvement and human capital mix can be assessed only if one knows the underlying structure of substitutions among different groups of workers. Knowledge of the values of the elasticity of substitution is useful for policy makers in 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 Grilliches (1969) for example, provide some initial findings on the capital-skill complementarity hypothesis. This finding has major implications on the employment effects of such policies as accelerated depreciation, investment tax credits and other attempts to stimulate investment in physical capital, suggesting that they will increase the demand for the skilled-related to unskilled labours. The elasticity of the substitution also has a positive relationship with output and productivity (Granville 1989; Klump and Granville 2000; Dupuy and deGrip 2002).

This article attempts to analyze elasticity of substitution between local and foreign labours

and with capital in five manufacturing sub-sectors, namely, wood-based, paper products, chemical products, non-metallic mineral products and metal products. The rationale for choosing these sub-industries is based on their large involvement in hiring foreign labours. The first two industries are regarded as light industry and the other three industries are categorized as heavy industry. The analysis utilizes data obtained from the Manufacturing Survey of 1985-1996 conducted by the Department of Statistics, Malaysia. This paper is organized into six sections. The following write-up contains the review of foreign labour in the manufacturing sector, literature review, theoretical framework and model specification, analysis of the results and summary and conclusion.

## FOREIGN LABOUR IN THE MANUFACTURING SECTOR

In most manufacturing sub-industries, the annual growth rate of the foreign workers was higher than that of local workers. This reflects that in a task to cut cost of production, many firms prefer hiring foreign workers especially the unskilled ones. In the light industry, for example, during 1985-1996, the average annual growth rate of the foreign workers was 26.1% as compared to 7.1% of the local workers. In the same vein, the annual growth rate of the foreign workers in the heavy industry was 32.8% as compared to 12.9% of the local workers during the same period. Some sub-industries that experience high growth rate of foreign workers are rubber products; textiles; publishing industry; and paper products, machinery and equipment and metal products. The growth rate of local workers is higher in the rubber products; paper products; fabricated metals, machinery and equipment, at above 10.0% that due to their high export contents.

It is particularly important to note that during 1985-990 and 1990-1996, annual growth rates of local workers decreased in both categories of industry. In contrast, the growth rate of foreign workers increased dramatically. In the light industry, growth rate increased from 18.5% during 1985-1990 to 32.8% during 1990-1996 and in the heavy industry, the rate increased from 11.2% to 53.9% during the same period. These statistics clearly indicate that the expansion of the Malaysian manufacturing sector

increases the reliance on foreign labours. Technological advancement particularly in heavy industry requires more expatriates that may bring together their foreign direct investment (FDI). The detail distribution of the foreign labour in the Malaysian manufacturing sector is presented in Table 1.

Between 1985 and 1996 the largest percentage of foreign labours was unskilled. In the light industry, the percentage of unskilled labours increased from 27.9% in 1985 to 40.4% in 1990 but decreased to 33.3% in 1996. In this industry, the semi-skilled foreign workers formed the second largest percentage at 20.0% in 1985, but this decreased to only 19.5% in 1990 and 13.8% in 1996. The involvement of foreign labours in the professional, technical and supervisory employment is very minimal at less than 10.0%. They are commonly called expatriates.

The same scenario is observed in the heavy industry, with the largest percentage of the foreign workers is the unskilled. However, the percentage of the professionals in this industry is higher due to more advanced technology. Furthermore, it was also obvious that in both light and heavy industries, the percentage of the skilled workers increased substantially due to the technological advancement especially in the era of liberalization and globalization in the 1990s where production of export goods are more emphasized (refer to Table 2). A greater involvement of foreign labours at lower job categories implies that they are receiving lower wage rate. As a result, the bargaining power of local labours for wage increase is becoming lesser.

## LITERATURE REVIEW

Most of the earlier studies using more than two-factor models were done using manufacturing data in the United States. Normally, they used two types of labour inputs that are to divide labour by occupation – with the majority using breakdown between production and non-production workers. Undoubtedly, this is largely due to the availability of data from government sources that separates labours by occupation. However, a study by Dupuy and deGrip (2000) in Denmark divided workers by their educational level and occupation as low, medium and high based on their educational achievement and

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TABLE 1

Malaysia: Foreign labour in the manufacturing sector by sub industry 1985-1996

| Code | Malaysian Industry Classification (MIC) | 1985 | | 1990 | | 1996 | | Annual growth rate | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % | 1985-90 | 1990-96 | 1985-96 |
| A. | Light Industry | 5,305 | 69.6 | 12,407 | 75.9 | 67,904 | 56.4 | 18.5 | 32.8 | 26.1 |
| 31 | Food, beverage & tobacco | 1,607 | 14.0 | 1,671 | 10.2 | 6,924 | 5.8 | 9.4 | 26.7 | 18.5 |
| 32 | Textiles, wearing apparel & leather | 372 | 4.9 | 372 | 2.3 | 17,772 | 14.8 | 0.0 | 90.5 | 42.1 |
| 33 | Wood, wood products and furniture | 3,548 | 46.6 | 9,881 | 60.4 | 19,607 | 16.3 | 22.7 | 12.1 | 16.8 |
| 342 | Publication and publishing | 41 | 0.5 | 29 | 0.2 | 1,087 | 0.9 | -6.7 | 82.9 | 34.7 |
| 355/56 | Rubber & plastic products | 230 | 3.0 | 372 | 2.3 | 21,296 | 17.7 | 10.1 | 96.3 | 50.9 |
| 39 | Others | 47 | 0.6 | 82 | 0.5 | 1,218 | 1.0 | 11.8 | 56.8 | 34.4 |
| B. | Heavy Industry | 2,314 | 30.4 | 3,939 | 24.1 | 52,426 | 43.6 | 11.2 | 53.9 | 32.8 |
| 341 | Paper and paper products | 20 | 0.3 | 61 | 0.4 | 2,478 | 2.1 | 25.0 | 85.4 | 55.0 |
| 351/54 | Chemical, petroleum & coal | 287 | 3.8 | 216 | 1.3 | 1,617 | 1.3 | -5.5 | 39.9 | 17.0 |
| 36 | Metal products | 541 | 7.1 | 1,035 | 6.3 | 4,931 | 4.1 | 13.8 | 29.7 | 22.2 |
| 37 | Basic metals products | 135 | 1.8 | 116 | 0.7 | 3,783 | 3.1 | -3.0 | 78.7 | 35.4 |
| 38 | Fabricated metals, machinery, electronic & equipment | 1,331 | 17.5 | 2,511 | 15.4 | 39,627 | 32.9 | 13.5 | 58.4 | 36.1 |
| Total | | 7,619 | 100 | 16,346 | 100 | 120,340 | 100 | 16.5 | 39.5 | 28.5 |

*Source:* Department of Statistics, various years

TABLE 2
Malaysia: Foreign labour by job category 1985-1996

| Num | Job Category | 1985 | | 1990 | | 1996 | | Annual Average Growth Rate | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % | 1985-90 | 1990-65 | 1985-96 |
| A. | Light Industry | 5,305 | 69.6 | 12,407 | 75.9 | 67,904 | 56.4 | 18.5 | 32.8 | 26.1 |
| 1. | Professional | 355 | 4.7 | 547 | 3.3 | 807 | 0.7 | 9.0 | 6.7 | 7.8 |
| 2. | Technical and supervisor | 174 | 2.3 | 312 | 1.9 | 622 | 0.5 | 12.4 | 12.2 | 12.3 |
| 3. | Skilled | 522 | 6.9 | 933 | 5.7 | 12,120 | 10.1 | 12.3 | 53.3 | 33.1 |
| 4. | Semi skilled | 1,524 | 20.0 | 3,182 | 19.5 | 16,606 | 13.8 | 15.9 | 31.7 | 24.2 |
| 5. | Unskilled | 2,126 | 27.9 | 6,601 | 40.4 | 36,503 | 30.3 | 25.4 | 33.0 | 29.5 |
| 6. | Others | 504 | 6.6 | 832 | 5.1 | 1,246 | 1.0 | 10.5 | 7.0 | 8.6 |
| B. | Heavy Industry | 2,314 | 30.4 | 3,939 | 24.1 | 52,436 | 43.6 | 11.2 | 53.9 | 32.8 |
| 1. | Professional | 668 | 8.8 | 1,437 | 8.8 | 3,284 | 2.7 | 16.6 | 14.8 | 15.6 |
| 2. | Technical and supervisor | 108 | 1.4 | 181 | 1.1 | 627 | 0.5 | 10.9 | 23.0 | 17.3 |
| 3. | Skilled | 152 | 2.0 | 288 | 1.8 | 10,191 | 8.5 | 13.6 | 81.2 | 46.6 |
| 4. | Semi skilled | 574 | 7.5 | 710 | 4.3 | 12,388 | 10.3 | 4.3 | 61.0 | 32.2 |
| 5. | Unskilled | 592 | 7.8 | 993 | 6.1 | 24,734 | 20.6 | 10.9 | 70.9 | 40.4 |
| 6. | Others | 220 | 2.9 | 330 | 2.0 | 1,212 | 1.0 | 8.4 | 24.2 | 16.8 |
| | Total | 7,619 | 100 | 16,346 | 100 | 120,340 | 100 | 16.5 | 39.5 | 28.5 |

*Source:* Department of Statistics of Malaysia, various years.

TABLE 3
Elasticity of substitution – Production and non-production workers

| Study | Data and Method | $S_{pk}$ | $S_{nk}$ | $S_{pn}$ |
|---|---|---|---|---|
| Berndt-White (1978) | Manufacturing, 1941-71, translog cost | 0.91 | 1.09 | 3.70 |
| Clark-Freeman (1977) | Manufacturing, 1950-76, translog cost | 2.10 | -1.98 | 0.91 |
| Kesselman et al. (1977) | Manufacturing, 1962-71, translog cost | 1.28 | -0.48 | 0.49 |
| Berndt-Christensen (1974) | Manufacturing, 1929-68, translog production. | 2.92 | -1.94 | 5.51 |
| Dennis-Smith (1978) | Manufacturing 1952-72, translog cost | 0.14 | 0.38 | -0.05 |
| Denny-Fuss (1977) | Manufacturing 1929-68, translog cost | 1.50 | -0.91 | 2.06 |
| Freeman-Medoff (1982) | Maufacturing 1972, translog cost | 0.53 | -0.02 | -0.24 |
| Grant (1979) | SMSA, census of population 1970, translog cost | 0.47 | 0.08 | 0.52 |
| Denny-Fuss (1977) | Manufacturing1929-68,translog production | 2.86 | -1.88 | 4.76 |
| Woodbury (1978) | Manufacturing 1929-71, translog cost | - | - | -0.7 |
| Hensen et al. (1975) | Manufacturing 1967, translog production. | - | 6.0 | -1.3 |
| Dupuy & deGrip (2002) | Manufacturing, 1992-1995, translog cost | [a]1.73, [b]1.67, [c]1.63 | [a]1.48, [b]1.53, [c]1.52 | [a]1.43, [b]1.49, [c]1.56 |

*Notes:* The subscript 'p' denotes production workers, 'n' denotes non-production workers, and 'k' denotes capital. For the study by Dupuy and deGrip production workers are defined as workers with low education and low occupation, non-production workers are defined as workers with intermediate and high education in intermediate and high occupation. [a]denotes small size firms, [b] denotes medium size firms and [c] denotes large size firms.

*Source:* Hamermesh 1984, Dupuy & deGrip 2002

sector involved. The elasticity of substitution results from twelve studies in the United States is presented in the Table 3.

Ten of fourteen value of elasticity of substitution showed that production and non-production workers were substitutes. All studies in the table found that production workers and capital were substitutes. The results are less clear-cut between non-production workers and capital since four of the studies found that they were complements. The study by Dupuy and deGrip (2002) also found that the larger firms had a higher elasticity of substitution between skilled (non-production) workers in skilled jobs and capital than smaller firms. The elasticity of substitution between skilled and unskilled (production) workers in skilled jobs was also larger in the large firms. Fallon and Layard (1975) found that the substitutability between the combination of capital and skilled workers and workers with low and no education was higher than the substitutability between capital alone and workers with low or no education.

This shows that the capital and skilled labour are more complement in the production process.

The earlier studies on elasticity of substitution in Malaysia had only focused on the traditional capital-labor substitution framework in the manufacturing sector. Thillainathan (1969) used the 1968 census data to estimate the elasticity of this substitution. The study measured the elasticity of substitution by using Constant Elasticity of Substitution (CES) model. The elasticity were measured for industries, defined at the two-digit level, including food, timber-based, chemical products and metal, machinery, electrical goods and transport equipment industries. Thillainathan concluded that the extent of the capital-labour substitution was significant, of which the elasticity range 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.

Using the same 1968 census data, Bhanoji and Ramana (1970) calculated the elasticity of

substitution for 60 manufacturing industries 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 considered, only 20 recorded elasticity measures that were statistically significant at the 5 percent level. They concluded that consumption-oriented industries tend to have a relatively higher elasticity than investment-oriented industries.

Maisom (1989) calculated time series estimates of elasticity of substitution. Estimates were made for 50 industry groups (five-digit level) for the period 1963-84. The study compared two methods for estimating the elasticity; CES and Translog Cost functions. The estimated elasticity using CES ranged between 0.254 and 1.259, where as translog cost function gave slightly higher estimates that the ones ranged between 0.462 and 1.325 (with the exception petroleum refineries, which had an elasticity of 4.649). Maisom also found that the elasticity to be quite low: 34 out of the 50 industry groups had their elasticity values smaller than one while 16 had 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. Regressions were fitted to 55 industry group data based on a survey of 338 manufacturing establishments in West Malaysia in 1974. They found that the alternative estimates did not produce substantial differences. The results showed that of the 55 industries, 35 had elasticity of less than one, 17 greater than one and three industries exhibited elasticity equal to unity.

Mahani (1993) calculated estimates of elasticity of substitution for the textile and electrical and electronic industry group. The study compared two estimates for the years between 1979 and 1985. The study 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. The product group elasticity was varied in 1979; from a low 0.54 to a high 1.39. Nevertheless, the range of elasticity narrowed in 1985 and most product groups fell between the range of 1.0 and 1.3. Rahmah and Idris (2001) studied elasticity of substitutions between skills and with capital in

the Malaysian manufacturing sector. In this study, workers were not divided into local or foreign categories but they were streamed into three groups, i.e. professional, skilled and unskilled. Their study found that the majority of elasticity of substitutions was greater than unity and there were substitutability and complementarities between skills.

Studies on the impact of foreign labor on local labor job opportunity can reflect their complementarities or substitutability. A study by Zimmermann (1995) in Europe and Dickson (1975), Norman and Meikle (1985) in Australia, Lalonde and Topel (1991), Simon et al. (1993), Winter and Zweimuller (1999) in Austria and Muller and Espenshade (1985), Grossman (1982) and Freeman and Medoff (1979) in the United States showed that both the foreign and local labours were complement. In contrast, Greenwood and Mc Dowell (1986) in the United States, Baker (1987) in Australia, Baker and Benjamin (1994) in Canada found that foreign labours affect job opportunities of local labours, indicating they are substitute.

Winegarden and Khor (1991) found that impact of foreign labour on job opportunities in the United State differed for Black and White workers. Their study showed that the foreign workers and Blacks were substitute, while foreign and Whites were complement. This is due the fact that the Whites are more skilful and cannot be substituted by the foreign labours that are mostly unskilled. Venturini (1999) found that in Italy, the substitutability (complementarities) between foreign and local labour was very much dependent on workers' geographical mobility and government policy on foreign labour. He argued that the higher was workers' mobility and the more stringent government policy resulted in complementarities between the foreign and local labour.

In contrast, when workers were less mobile and the government policy was more lenient, foreign and local workers tend to be more substitute. Markusen et al. (2000) found that inflow of foreign labour through foreign direct investment on the demand for domestic skilled labour was uncertain. They could be substitute or complement depending on at what equilibrium we are looking at. They may be substitute at partial equilibrium but complement at general equilibrium. On the other hand, Federico and Minerva (2005) found that there

were complementarity between domestic and foreign employment in the case of advanced countries and substitute in the case of Western Europe countries. These results are contrary from what were found in the studies by Brainard and Riker (1997), Braconier (2000), Konings and Murphy (2001). These studies found that employment in foreign affiliates located in low wage countries is complementary to home employment, while there is substitution in advanced countries. The international trade especially in the form of outsourcing will also influence the elasticity of substitution. Rodrik (1997) and Senses (2004) argued that the increased possibility of substituting foreign labour for domestic should make labour demand more elastic. Therefore, understanding the substitutability between foreign and local labour will provide the policy makers the information on how wage change affect resulting from inflow of foreign labour will affect the demand for local labour.

## THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

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 researcher 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 substitute 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.

### 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. Model with Two Inputs

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

$$\ln C = \ln A_0 + \delta_1 \ln W + \delta_2 \ln R \qquad (1)$$

Where, C is cost of production, W is price of labor and R is price of capital.

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

$$\ln C = \ln A + \delta_1 \ln W + \delta_2 \ln R + \frac{1}{2}\delta_{11}(\ln W)^2 + \frac{1}{2}\delta_{12}(\ln W)(\ln R) + \frac{1}{2}\delta_{22}(\ln R)^2 + \frac{1}{2}\delta_{21}(\ln R)(\ln W) \qquad (2)$$

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

$$\ln C = \ln A + \delta_1 \ln W + \delta_2 \ln R + \frac{1}{2}\delta_{11}(\ln W)^2 + \delta_{12}(\ln W)(\ln R) + \frac{1}{2}\delta_{22}(\ln R)^2 \qquad (3)$$

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

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

$$\partial \ln C / \partial \ln P_i = (X_i / P_i) = S_i \qquad (4)$$

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 from the cost function (3) and equating them with the cost shares, we have

$$SL = \partial \ln C / \partial \ln W = \delta_1 + \delta_{11} \ln W + \delta_{12} \ln R$$
(5)

$$SK = \partial \ln C / \partial \ln R = \delta_2 + \delta_{12} \ln W + \delta_{22} \ln R$$
(6)

Where, SL is share of labour and SK is share of capital.

For the translog cost specification

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

Where, $\sigma_{ij}$ 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

b. Model with More than Two Inputs
Expanding the translog model from two factors to five factors requires the cost and production functions to change from two to five-input functions.

$$C = Q f (P_1, P_2, P_3, P_4, P_5)$$
$$Q = f (X_1, X_2, X_3, X_4, X_5)$$

Where, $P_1$ is the average annual wage for local semiskilled workers ($X_1$).
$P_2$ is the average annual wage for foreign semiskilled workers ($X_2$).
$P_3$ is the average annual wage for local unskilled workers ($X_3$).
$P_4$ is the average annual wage for foreign unskilled workers ($X_4$).
$P_5$ is the price of capital ($X_5$).

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

$$\ln C = \ln Q + \ln \delta_0 + \Sigma \delta_i \ln P_i + \frac{1}{2} \Sigma \Sigma \delta_{ij} \ln P_i P_j$$
(8)

Where, $\delta_{ij} = \delta_{ji}$, technology parameters are $\delta_0$, $\delta_i$, $\delta_{ij}$ and C and $P_i$ represent the total cost

and input prices, respectively. If $\delta_{ij}$ equals zero, the translog reduces to the standard Cobb-Douglas function.

Once again, Shephard's Lemma demonstrates

$$\partial \ln C / \partial \ln P_i = (Xi / Pi) = S_i$$
(9)

Where, $X_i = X_1, X_2, X_3, X_4, X_5$, 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

$$S_1 = \partial \ln C / \partial \ln P_1 = \delta_1 + \delta_{11} \ln P_1 + \delta_{12} \ln P_2 + \delta_{13} \ln P_3 + \delta_{14} \ln P_4 + \delta_{15} \ln P_5$$
(10)

$$S_2 = \partial \ln C / \partial \ln P_2 = \delta_2 + \delta_{21} \ln P_1 + \delta_{22} \ln P_2 + \delta_{23} \ln P_3 + \delta_{24} \ln P_4 + \delta_{25} \ln P_5$$
(11)

$$S_3 = \partial \ln C / \partial \ln P_3 = \delta_3 + \delta_{31} \ln P_1 + \delta_{32} \ln P_2 + \delta_{33} \ln P_3 + \delta_{34} \ln P_4 + \delta_{35} \ln P_5$$
(12)

$$S_4 = \partial \ln C / \partial \ln P_4 = \delta_4 + \delta_{41} \ln P_1 + \delta_{42} \ln P_2 + \delta_{43} \ln P_3 + \delta_{44} \ln P_4 + \delta_{45} \ln P_5$$
(13)

$$S_5 = \partial \ln C / \partial \ln P_5 = \delta_5 + \delta_{51} \ln P_1 + \delta_{52} \ln P_2 + \delta_{53} \ln P_3 + \delta_{54} \ln P_4 + \delta_{55} \ln P_5$$
(14)

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:

a. $\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 = 1$
b. $\delta_{11} + \delta_{12} + \delta_{13} + \delta_{14} + \delta_{15} = 0$
c. $\delta_{ij} = \delta_{ji}$, (symmetry)

There are two standard approaches to econometrically estimate 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 four of the cost share equations simultaneously and then impose the constraints to solve for the fifth 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 ($\delta_{11} = - \delta_{12} - \delta_{13} - \delta_{14} - \delta_{15}$) into the first cost share equation:

$$S_1 = \delta_{11} + \delta_{121}(\ln P_2 - \ln P_1) + \delta_{131}(\ln P_3 - \ln P_1) + \delta_{141}(\ln P_4 - \ln P_1) + \delta_{151}(\ln P_5 - \ln P_1) \quad (15)$$

Likewise, substituting in the fact that ($\delta_{22} = - \delta_{12} - \delta_{23} - \delta_{24} - \delta_{25}$) into the second cost share equation:

$$S_2 = \delta_{21} + \delta_{121}(\ln P_1 - \ln P_2) + \delta_{231}(\ln P_3 - \ln P_2) + \delta_{241}(\ln P_4 - \ln P_2) + \delta_{251}(\ln P_5 - \ln P_2) \quad (16)$$

Likewise, substituting in the fact that ($\delta_{33} = - \delta_{13} - \delta_{23} - \delta_{34} - \delta_{35}$) into the third cost share equation:

$$S_3 = \delta_{31} + \delta_{131}(\ln P_1 - \ln P_3) + \delta_{231}(\ln P_2 - \ln P_3) + \delta_{341}(\ln P_4 - \ln P_3) + \delta_{351}(\ln P_5 - \ln P_3) \quad (17)$$

Likewise, substituting in the fact that ($\delta_{44} = - \delta_{14} - \delta_{24} - \delta_{34} - \delta_{45}$) into the fourth cost share equation:

$$S_4 = \delta_{41} + \delta_{141}(\ln P_1 - \ln P_4) + \delta_{241}(\ln P_2 - \ln P_4) + \delta_{341}(\ln P_3 - \ln P_4) + \delta_{451}(\ln P_5 - \ln P_4) \quad (18)$$

By estimating four of the five cost share equations using the seemingly unrelated regression technique and using the fact that ($S_5 = 1 - S_1 - S_2 - S_3 - S_4$), it is possible to solve for the fifth cost share.

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

$$\sigma_{ij} = (\delta_{ij} + S_i S_j) / S_i S_j \quad i \neq j \quad (19)$$

Where, $\sigma_{ij}$ 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

*Source of Data*

Five industries are chosen, namely, wood-based (MIC 33), paper products (MIC 34), chemical products (MIC 35), non-metallic mineral products (MIC 36) and basic metal products (MIC 37). For the purpose analysis, the workers are divided into four groups, namely, local semi skilled (including skilled), foreign semi skilled (including skilled), local unskilled and foreign unskilled workers. The skilled workers cannot stand by themselves because their number are quite small particularly the foreign. This study uses annual time series data for the above mentioned industries for the period 1985-1996. The data is obtained from the annual Manufacturing Survey conducted by the Malaysian Department of Statistics (DOS). Data of 1985-1996 used in this study are gathered from the raw data at DOS. A more recent data cannot be utilized due to two reasons; firstly, difficulties in obtaining raw data from DOS due to time and cooperation; the published data is too aggregated and doesn't classified the occupational level by industries; secondly, data after 1999 was not classified by skills, ie unskilled, semi skilled and skilled labour were lumped together under the production workers. Unlike data up to 1999 the production workers are categorized by unskilled, semi skilled and skilled workers. The information from the survey that used in this analysis is total wage pay to local and foreign workers, number of local and foreign workers. Data on price of capital (interest rate) is obtained from the Annual Statistical Bulletin published by the Bank Negara Malaysia. In this study the annual average base-lending rate is utilised.

## ANALYSIS OF THE RESULTS

Table 4 presents the results of the estimation of elasticity of substitution between foreign and local workers and capital in five selected industries. Among these industries there are two light industries, i.e. wood-based and paper products and three heavy industries, ie,

TABLE 4
Estimates of the elasticity of substitution in selected Malaysian manufacturing industries, 1985-96

| Industry | $\sigma_{12}$ | $\sigma_{13}$ | $\sigma_{23}$ |
|---|---|---|---|
| Wood-based (ISIC 33) | 1.0283 (3.7337)*** | 1.3613 (1.3164) | 0.3387 (2.8331)*** |
| Paper products (ISIC 34) | 1.0039 (0.3752) | 2.7984 (1.9102)** | 0.1516 (0.3132) |
| Chemical products (ISIC 35) | 1.0006 (0.2105) | 2.4849 (7.2659)*** | 0.9607 (0.0773) |
| Non-metallic mineral products (ISIC 36) | 0.9179 (1.7415)* | -2.7969 (-0.8053) | 2.4778 (0.5145) |
| Basic metal products (ISIC 37) | 1.0259 (0.8460) | 3.0709 (2.1599)** | 0.5086 (0.1905) |

Notes: '1' denotes local workers
　　　'2' denotes foreign workers
　　　'3' denotes capital
　　　'*' denotes significant at 10% level
　　　'**' denotes significant at 5% level
　　　'***' denotes significant at 1% level
　　　The figures in the parentheses below the estimated elasticity are their t-statistics

chemical, non-metallic and basic metal products. There are fifteen estimated elasticity of substitutions, in which six of them are significant, five are less than unity and ten greater than unity.

Elasticity of substitution between foreign and local workers is significant in the wood-based and non-metallic product industries. The result shows that foreign workers are higher substitutes in the wood-based industry as compared to the non-metallic mineral products industry. This result could be attributed to lower technological adoption in the light industry, i.e. wood-based and associated with a greater hiring of unskilled workers. Noticeably, the majority of foreign workers are unskilled. Further, the result shows that the elasticity of substitution between capital and foreign workers is only significant in the wood-based industry.

The results of estimation of elasticity of substitution by level of skills are presented in Table 5. Of the fifty estimated elasticity of substitution, thirty-five are greater than unity (in absolute value) and 15 are less than unity and twenty-three are statistically significant. The majority of elasticity of substitutions is higher in the paper products and basic metal products and most of them are statistically significant. In the wood-based industry, even though most of the elasticity of substitution is significant, they are less than unity. The results indicate that

elasticity of substitution between local and foreign workers does not depend on group of industry whether they are light or heavy. Instead the elasticity of substitution is very dependence on types of products and skills mix. This result could also be attributed to level of technological adoption and skill required by these industries. For example, technology is higher in the paper product industry as compared to the wood-based, and need more skilled workers. On the hand in the heavy industry, most of the elasticity of substitutions is not statistically significant. The elasticity of substitution is greater in the chemical and basic metal products as compared to non-metallic mineral products.

The elasticity of substitution between local and foreign semiskilled workers is statistically significant in the paper products, non-metallic mineral products and basic metal products. In the first two industries, they are complement and in the last industry they are substitute. In contrast, the local semiskilled and foreign unskilled workers are substitutes in most of the industries under study. The value of elasticity is significantly high especially in the paper products, chemical and basic metal products. This result indicates that any wage reduction for the unskilled foreign workers will result a decrease in demand for local semiskilled.

The foreign semiskilled workers are shown to be a substitution for local unskilled in the

TABLE 5

Estimates of the elasticity of substitution in selected Malaysian manufacturing industries, 1985-96

| Industry | $\sigma_{12}$ | $\sigma_{13}$ | $\sigma_{14}$ | $\sigma_{15}$ | $\sigma_{23}$ | $\sigma_{24}$ | $\sigma_{25}$ | $\sigma_{34}$ | $\sigma_{35}$ | $\sigma_{45}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Wood-based | 1.2740 | 0.9037 | 1.1542 | 0.9687 | 1.1128 | 0.8151 | 0.6805 | -0.7417 | 0.9726 | 0.9481 |
| (ISIC 33) | (1.2906) | (3.7325)** * | (3.6799)* ** | (0.4614) | (2.4457) *** | (2.4615) *** | (3.0107) *** | (-0.0823) | (-1.8738) * | (2.1874) ** |
| Paper products | -12.2870 | -0.6491 | 13.8672 | 1.0158 | 7.9826 | -11.6168 | 1.0992 | -13.1181 | 0.9243 | 1.9855 |
| (ISIC 34) | (-1.9870) ** | (-6.1695) *** | (1.9265) * | (0.9826) | (3.9065) *** | (-2.4452) ** | (0.1280) | (-0.7702) | (1.7054) * | (1.2268) |
| Chemical products | 6.0167 | -1.4868 | 9.8898 | 1.0744 | -2.1133 | -1.6434 | 1.1050 | -7.4556 | 0.9775 | 1.7781 |
| (ISIC 35) | (0.4302) | (-5.7243) *** | (0.9682) | (2.6109) *** | (-0.2516) | (-0.8052) | (0.1775) | (-0.0534) | (0.6659) | (1.5073) |
| Non-metallic mineral | -2.6223 | 0.8002 | 1.5242 | 1.0511 | -1.3217 | 7.0839 | 1.1811 | -9.2866 | 0.9834 | 0.9457 |
| Products (ISIC 36) | (-2.5904) *** | (2.0871) ** | (2.0824) ** | (1.5709) | (-0.7145) | (0.7117) | (0.9330) | (-4.4888) *** | (1.1671) | (-1.4494) |
| Basic metal products | 5.9429 | 0.5803 | 4.0245 | 1.0658 | 4.7686 | -1.9058 | 1.0712 | 8.7280 | 1.0079 | 0.8903 |
| (ISIC 37) | (1.8975) * | (4.5136) *** | (4.3564) *** | (1.3379) | (0.7902) | (-0.8138) | (1.4588) | (3.0569) *** | (0.4336) | (0.7988) |

*Notes:* '1' denotes local semiskilled workers

'2' denotes foreign semiskilled workers

'3' denotes local unskilled workers

'4' denotes foreign unskilled workers

'5' denotes capital

'*' denotes significant at 10% level

'**' denotes significant at 5% level

'***' denotes significant at 1% level

The figures in the parentheses below the estimated elasticity are their t-statistics

wood-based and paper product industries. Both values are greater than unity and in the paper products the value of elasticity is high. This result could be attributed to willingness of foreign workers to accept lower wage even though they are more skill. The foreign semiskilled and capital are substitutes in the wood-based industry, which implies that technological adoption in this industry is still low. Further, the result show that the local and foreign unskilled workers are complement in the non-metallic mineral products industry and substitute in the basic metal industry. The foreign unskilled and capital are substitute in the wood-based industry.

The results from this study can also be influenced by the availability of labor facing some industries. When there is labor shortage, foreign and local labor is more likely to be complement regardless of their skills. Therefore, even though wage increase for the particular skills, the demand for them increase because of shortages in their supply.

## SUMMARY AND CONCLUSION

The results from this study show that the foreign and local workers are more substitutes than complement. Of the fifteen significant elasticity of substitution, eleven are substitute and four are complement. This reflects that when the foreign wage rate decrease, firms would be willing to take foreign workers to cut cost of production. A high substitutability are found in heavy industry basic metal products

The results suggest that the influx of foreign labour may jeopardize the local in terms of job opportunity especially in heavy industry. The less complementarity between the local and foreign labours and the higher elasticity of substitution suggest that the government must undertake a correct policy to safeguard local workers especially in getting jobs. Any wage change that involved foreign labour will affect local job opportunity in certain industries. Although the wage policy suggest equal pay for equal job regardless of local or foreign, many employers do not obey this rule and continue to pay less wages to the foreign.

This study covers data from 1985 to 1996 which exclude the crisis period of 1997/98. This is because of problem in gathering the recent data, even though it is available until 1999 with the same data format. But given

longer time further research may include 1997, 1998 and 1999 data. However, we would expect that there will be not much different in the results because the 1997/98 crisis affect mostly on the output and export not the technology. The cost function estimated in this study concerning cost share that may change via technological change. Further research may be needed just to confirm this claim.

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