ARE THERE OPPORTUNITIES OF ADOPTING MORE CAPITAL-INTENSIVE TECHNOLOGY IN THE MALAYSIAN FURNITURE AND FIXTURES, AND WOOD PLANING AND JOINERY INDUSTRIES?

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MOHD. SHAHWAHID OTHMAN & MAISOM ABDULLAH 1991. Are there opportunities of adopting more capital-intensive technology in the Malaysian furniture and fixtures , and wood planing and joinery industries? A Constant Elasticity of Substitution (CES) production function is estimated for the furniture and fixtures and the wood planing and joinery industries for the period 1968 to 1986. Estimates of the elasticities of substitution for both industries are relatively low suggesting that there is a modest opportunity of adopting more capital-intensive technology with increasing wage to rental ratio.

Key words: Furniture - fixtures - planing - joinery - industries - capital-intensive technology - CES - wage to rental ratio

Introduction

The Industrial Master Plan (IMP) has identified the mouldings and furniture industries as strategic sectors on which Malaysia should concentrate during the plan period 1986 to 1995 (Ong 1986). The main objective of this recommendation is to reap the value-added accrued in downstream activities. Another social interest is employment creation. Malaysia, like many developing countries, pays lower wages than developed countries. The comparative advantage of developing countries in exporting goods with labour-intensive technologies is often debatable. Choice of technology between developed and developing countries is more influenced by the wage to capital rental ratio between the two groups of countries than by the abundance of labour. Most literature suggests that despite the scarcity of capital, developing countries tend to pay relatively higher wages when compared to rentals. Siggel (1986) attributed this trend to low capital prices caused by government policies to encourage investment. Thus the wage to rental ratio is high. As a result we have the paradox of capital-intensive technology in labour-abundant developing countries (Lim 1975, Maisom 1979, Hill 1983). However, there is evidence that labour-intensive technology is being employed in sawntimber and panel products manufacturing in a developing country (Stern 1977).

Labour absorption is enhanced if the technology adopted is flexible enough to permit substitution of labour for capital. Evidence for wood processing in tropical countries suggests that labour can be substituted for capital (Gregerson & Contreras 1975, Roemer 1975). One way to gauge such labour absorption potential is through the concept of elasticity of substitution between capital and labour.

The elasticity of substitution is a measure of the ease with which any two inputs such as capital and labour can be substituted for each other. If substitution between factors is relatively easy, as signified by an elasticity greater than one, then competitive firms will be induced to absorb increased employment by a relatively small reduction in wage-rental ratio. Conventional economic theory suggests that a labour-abundant country which has a relatively lower wage-rental ratio than capital-rich countries would use a labour-intensive production technique. Thus, knowledge of the values of the elasticity of substitution is useful for policy makers in diagnosing appropriate production techniques, in the direction of more capital intensivity or alternatively towards more labour intensivity, depending on existing relative factor prices in the manufacturing industries.

The objective of this paper is to estimate the Constant Elasticity of Substitution (CES) production function of two downstream wood-based industries namely, furniture and fixtures, and wood planing and joinery works. The grouping of these two industries was dictated by the Malaysian Industrial Classification's grouping of industries adopted by the Department of Statistics. From the CES production function it is possible to obtain estimates of the elasticity of substitution between capital and labour, as well as estimates of the rate of technical progress experienced in these industries. This study is an extension of an earlier study by Maisom (1987) on the agro-based industries.

Methodology and estimation

The theoretical model

The Constant Elasticity Substitution (CES) production function has been accepted and extensively analysed since its introduction in 1961 (Arrow *et al.* 1961), both theoretically and empirically. This paper represents a continuation of the empirical research applied to data from Malaysian wood-based industries.

The CES production function is given by

$$Y = \gamma\ [\delta K^{-\rho} + (1 - \delta) L^{-\rho}]^{-v/\rho} \qquad (1)$$

where Y is value output, K and L are capital and labour inputs, and γ, δ and ρ are constants denoting efficiency, distribution and substitution parameters respectively. v denotes the degree of homogeneity.

With assumptions of perfect commodity and factor markets and constant returns to scale, the CES production function is

$$Y = \gamma\ [\delta K^{-\rho} + (1 - \delta) L^{-\rho}]^{-1/\rho} \qquad (2)$$

The elasticity of substitution is derived from the values of marginal product of labour and capital respectively.

$$\frac{\delta Y}{\delta L} = \gamma (1 - \delta) L^{-\rho - 1} [\delta K^{-\rho} + (1 - \delta) L^{-\rho}]^{(-1/\rho) - 1} \qquad (3)$$

$$\frac{\delta Y}{\delta K} = \gamma (\delta) K^{-\rho - 1} [\delta K^{-\rho} + (1 - \delta) L^{-\rho}]^{(-1/\rho) - 1} \qquad (4)$$

In competitive equilibrium, the marginal rate of technical substitution, $MRTS_{K,L}$ (*i.e.*, the ratio of values of marginal product) equals the factor price ratio. Thus,

$$MRTS_{K,L} = \frac{(1-\delta)}{\delta} \frac{K}{L}^{1+\rho} = \frac{W}{R} \qquad (5)$$

where W is wages and salaries, and R is the rate of return to capital.

The elasticity of substitution is defined as

$$\sigma = \frac{\%\text{ change in } (K/L)}{\%\text{ change in } MRTS_{KL}}$$

$$= \frac{d\,\mathrm{Log}\,(K/L)}{d\,\mathrm{Log}\,MRTS_{KL}}$$

For $\sigma > 1$, an increase in the $MRTS_{KL}$ or W/R by 1% implies that the capital-labour ratio (K/L) will increase by more than 1%. This means a small increase in the wage-rental ratio will lead to a relatively large increase in demand for capital inputs resulting in greater employment of capital intensive technique.

From (5)

$$\mathrm{Log}\,MRTS_{KL} = \mathrm{Log}\left(\frac{1-\delta}{\delta}\right) + (1+\rho)\,\mathrm{Log}\,(K/L)$$

$$\mathrm{Log}\,(K/L) = \left(\frac{1}{1+\rho}\right)\mathrm{Log}\,MRTS_{KL} - \left(\frac{1}{1+\rho}\right)\mathrm{Log}\left(\frac{1-\delta}{\delta}\right)$$

$$\frac{d\,\mathrm{Log}\,(K/L)}{d\,\mathrm{Log}\,MRTS)_{KL}} = \left(\frac{1}{1+\rho}\right) = \sigma \qquad (6)$$

Statistical estimation of the elasticity of substitution cannot be derived directly from equation (2). An indirect method following Ferguson (1965) is used to derive the estimating equations without using capital stock data. Starting with the CES function:

$$Y = \gamma\ [\delta\ K^{-\rho} + (1 - \delta) L^{-\rho}]^{-1/\rho} \qquad (2)$$

Let $y = Y/L = \gamma\ (L^{\rho})^{-1/\rho}\ [\delta K^{-r} + (1 - \delta) L^{-\rho}]^{-1/\rho}$

Then, $y = \gamma \left[\delta \left(\frac{K}{L}\right)^{-\rho} + 1 - \delta \right]^{-1/\rho}$ (7)

Raising both sides of equation (7) to the ρ, we obtain

$$y^{\rho} = \gamma^{\rho}\left[\delta \left(\frac{K}{L}\right)^{-\rho} + (1-\delta)\right]^{-1} \quad (8)$$

$$\gamma^{-\rho} y^{\rho} = \left[\delta \left(\frac{K}{L}\right)^{-\rho} + (1-\delta)\right]^{-1} \quad (9)$$

Assuming competitive equilibrium, where the value of the marginal product of labour equals the wage rate, we have by reorganising equation (3):

$$\frac{\delta Y}{\delta L} = W = \gamma (1-\delta) \left[\delta \left(\frac{K}{L}\right)^{-\rho} + (1-\delta)\right]^{(-1/\rho)-1} \quad (10)$$

Substituting equation (7) into equation (10)

$$W = y (1-\delta) \left[\delta \left(\frac{K}{L}\right)^{-\rho} + (1-\delta)\right]^{-1} \quad (11)$$

Then, we substitute equation (9) into (11) and we get

$$W = y(1-\delta)\, y^{\rho} \gamma^{-\rho} \quad (12)$$

$$= (1-\delta)\, y^{1+\rho} \gamma^{-\rho} \quad (13)$$

Transforming,

$$y^{(1+\rho)} = W \gamma^{\rho} (1-\delta)^{-1} \quad (14)$$

Taking the logarithm of equation (14), dividing by (1+ρ), and transforming, we get

$$\text{Log } y = \left(\frac{1}{1+\rho}\right) \text{Log } [\gamma^{\rho}(1-\delta)^{-1}] + \left(\frac{1}{1+\rho}\right) \text{Log } W \quad (15)$$

$$\text{Log } y = \sigma \text{ Log } [\gamma^{\rho} (1-\delta)^{-1}] + \sigma \text{ Log } W \quad (16)$$

In equation 16, the efficiency parameter γ is considered a constant. However, if we assume that the technology becomes more efficient through time, then the production function will be shifted upwards in a neutral way.

To show this change in technology, the efficiency parameter can be written as

$$\gamma = e^{\lambda t} \quad (17)$$

where λ indicates the rate of neutral technical progress.

Replacing the value of λ in equation (14) we have

$$y^{(1+\rho)} = W (e^{\lambda t})^{\rho} (1 - \delta)^{-1} \qquad (18)$$

Proceeding the same way as before,

$$\text{Log } y = -\left(\frac{1}{1+\rho}\right)\text{Log } (1 - \delta) + \left(\frac{1}{1+\rho}\right)\text{Log } W + \left(\frac{\rho}{1+\rho}\right)\lambda t \qquad (19)$$

Equation 19 can now be written as

$$\text{Log } (Y/L) = a_1 + a_2 \text{ Log } W + a_3 t \qquad (20)$$

where $a_1 = -\left(\frac{1}{1+\rho}\right)\text{Log } (1- \delta)$;

a_2 = estimate of the elasticity of substitution, $\sigma = \left(\frac{1}{1+\rho}\right)$;

$a_3 = \lambda\left(\frac{\rho}{1+\rho}\right)$, which permits the estimation of λ once we have estimated σ

whereby $\rho = \frac{1}{\sigma} - 1$.

Thus $\lambda = \left(\frac{a_3}{1-\sigma}\right)$, which is the annual rate of technical progress.

Empirical model

Two regression equations were fitted to the 1968 to 1986 time-series data for the selected wood-based industries.

Model 1

$$\text{Log } (RY/L)_t = a_1 + a_2 \text{ Log } RW_t + a_3 T + U_t \qquad (21)$$

Model 2

$$\text{Log } (IY/L)_t = a_1 + a_2 \text{ Log } IW_t + a_3 T + U_t \qquad (22)$$

where RY = value of output deflated with Consumer Price Index (CPI); RW = wages and salaries deflated with CPI; IY = value of output deflated with Industrial Production Index (IPI); IW = wages and salaries deflated with IPI; L = labour employed; T = time; U_t = error term; a_1, a_2 and a_3 = parameter estimates synonymous to equation 20.

Using Time-Series Processing Package (TSP), the models are first estimated by Ordinary Least Squares (OLS). The initial results showed a number of problems including serial correlation and negative signs for the estimate of the elasticity of substitution (a_2). The models are then re-estimated using the maximum likelihood iterative technique assuming that the error term is first order serially correlated.

The two models vary only in the manner value of output and wages and salaries are deflated. In model 1 data on value of output and wages and salaries are deflated by the CPI to eliminate inflationary effects. However, in model 2 these data are now deflated by the IPI instead. Conceptually deflation by the IPI would eliminate the effect of the general growth trend of the economy, leaving behind growth trend attributed to the industry concern only.

Data

The data used for the estimation of the CES production functions were obtained from the census/surveys of Manufacturing Industries, West Malaysia for the period 1968 to 1976, and the Industrial Survey of Malaysia for the period 1978 to 1986. Consistency of time series data was achieved for furniture and fixtures and planing mills and joinery works by focussing only on West Malaysia. Since no statistics were published in 1977 and 1980, the missing observations were estimated using the linear interpolation method to find the average of the two intervening years. For each industry, the data required for estimation are: value of output in current Malaysian Ringgit, labour employed, wages and salaries (W), Consumer Price Index (CPI) and Industrial Production Index (IPI).

Results and policy implications

Model 2 was selected as the best fitting model based on statistical reasons - statistically significant t statistics at the 5% level of significance for the parameter estimated, high adjusted coefficient of multiple determination (R^2), and F statistic statistically significant at the 5% level of significance. This model selection suggests that production of furniture and fixtures, and wood planing and joinery works is influenced more by the general growth trend of the economy than by inflationary effects. Periods of bullish industrial production particularly in the building sector would require greater orders for wood planing and joinery products such as window and door frames, and wood joineries for manufacturing material and industrial inputs. Purchases of furniture components too would pick up as furniture factories raise their production levels. Thus the steady domestic business environment as evident particularly for the housing industry set during the period of the study, except in 1986, had encouraged the expansion and new set up of business operations, which expanded the orders on office furnitures and other wooden interior decorations. The steady growth in the economy also increased the per capita disposable income encouraging an increase in demand for new furnitures and home renovations.

The lesser influence of inflation on production of furniture and fixtures, and wood planing and joinery works is attributable to the fact that inflation rates in Malaysia have remained relatively stable at less than 10% throughout the period making the growth in production and domestic sales of furnitures and wooden joineries more or less steady. Furthermore consumption of locally made furnitures is relatively inelastic when compared to imported ones. The furniture and fixtures considered in the analysis include all types manufactured locally, whether of wood, steel, rattan, or other materials. The proportions of these different types were ascertained from a survey on domestic furniture consumption and it was found that 52% was made from wood, 25% of rattan, 3% of metal and the rest from combinations of the above (Mohd. Shahwahid & Zarina unpublished). There are practically no cheap substitutes for locally made furniture. Imported items are relatively more expensive and of higher quality. Consequently, producers are capable of paying for the increases in wages and salaries due to the mild inflationary pressures by raising furniture prices without very much affecting sales. The relatively inelastic demand for locally made furniture *vis-a-vis* imported ones, suggests that a bigger proportion of the increase in wages and salaries is passed on to the consumers.

The results of model 2 provided estimates of the elasticity of substitution between capital and labour at 0.55 and 0.39 for the furniture and fixture industry and the planing and joinery works, respectively. The elasticity estimates were relatively low when compared to an elasticity of substitution of 1.1 obtained by Roemer (1975) for sawmilling in Ghana. However, direct comparison cannot be made with furniture and fixtures, and planing and joinery works since their production technologies are more complex.

Table 1. Regression results of the CES production function

	Constant term (a_1)	Elasticity of substitution (a_2)	Coefficient log T (a_3)	R^2	F	First Order autoregression coefficient
Furniture and fixtures	-4.6988 (1.55)	0.5463 (2.10)*	-0.0062 (-0.04)	0.45	5.69*	0.81*
Wood planing and joinery	-3.0895 (-4.94)*	0.3653 (2.51)*	0.0010 (0.30)	0.80	35.35*	0.80*

* Suggests that the t and F statistics are significantly different from zero at the 5% level of significance

The elasticities of substitution estimated for furniture and fixtures, and planing and joinery industries were statistically different from zero. A zero elasticity of substitution between capital and labour indicates a fixed proportion production technology in which the capital to labour ratios remain constant as production scale is changed. Thus it can be concluded that both these downstream wood-based industries are not characterised by fixed proportions. Instead, the elasticity estimates obtained infer that there exist opportunities, albeit modest , for factor substitutions depending on the trends of the factor price ratio.

The wage-rental ratio in Malaysia is favouring the adoption of more capital-intensive technique in production. Wages of skilled workers are on an upward trend. Industrial sectors in Malaysia already face a tight labour market as witnessed by the great increase in legal and illegal Indonesian immigrants in recent years. Furthermore government policies have a hand in encouraging the adoption of more modern and capital-intensive technology. A wide variety of government policies have made capital artificially cheaper than its true value. Government subsidised loans, especially for small and medium scale industries, and over-valued exchange rates are particularly influential. According to the Strict Purchasing Power Parity Criteria, the Malaysian Ringgit effective exchange rate was over-valued by 5% in 1982, 9% in 1984 and 7% in 1985 (Gan 1987). The price of capital is also affected by low tariffs for imported capital goods, tax holidays and other investment incentives, accelerated depreciation allowances on capital goods, and investment tax credits offered by the government to investing firms in Malaysia. This low price of capital has encouraged businesses to make capital investment. From the Annual Report of the Malaysian Industrial Development Authority (MIDA) (1970 & 1981), the total paid up and loan capital investments of furnitures and fixtures companies which were granted pioneer status increased by more than five times to $8.7 million from 1970 to 1981. Together with relatively high urban and suburban wages, the low price of capital has led manufacturers to adopt more imported technology, although its factor proportion may not be optimum domestically. It is only recently that the government has offered several incentives to those mills which carry out research and development to offset the costs and risks of developing indigenous technologies (MIDA 1988).

Given the presence of opportunities for factors substitution, albeit a modest one, it is maybe an appropriate move for Malaysian downstream wood processors to absorb more capital-intensive technology, especially if Malaysia wants to go into the international trade arena as exhorted by the IMP. If developing countries such as Malaysia, are to make real inroads into the world markets, particularly of advanced countries, they have to produce goods with acceptable quality and taste for these markets. The exporting developing country also has to keep abreast with product and technology changes over time if it is to maintain its position in the export markets. Competition in other developing countries, where goods from developed countries like Europe and the newly industrialised countries like South Korea and Taiwan are available, makes it essential to keep up with advanced product developments. The best way of doing so seems to be to adopt the capital-intensive technology.

However, the appeal of the international market and the favourable government policies above do not necessarily lead to the adoption of capital-intensive technology. The scarcity of skills in downstream wood manufacturing discourages such occurrence. The few experienced managers, supervisors and technicians command relatively high wages and would strain production cost. The lack of skilled technicians and workers would lead to inefficient use of advanced techniques. As a result, the range of substitution between labour and capital tends to be reduced in the sense that both most advanced and most labour-intensive techniques may be excluded from the set of efficient production techniques.

Thus a more viable option for these downstream wood manufacturing industries is the adoption of an imported capital intensive technology with greater substitutability which is modified to meet local comparative advantages. Research and development to promote the adaptation of imported technology to local needs is imperative. Substitutability is enhanced if choice of production technology is not separated from the choice of output mix. For instance, in the furniture firm, the range of output should be narrowed down to produce specialised furnitures such as the less labour intensive institutional furnitures or to the production of component parts of more sophisticated household furnitures. The creation of an umbrella organisation that subcontracts orders of furniture component parts to be supplied to mass assemblers is encouraged.

The form of the CES function adopted in this study is amenable to an evaluation of technological progress. Technological progress implies efficiency whereby a given output is produced with less and less of inputs. However, since the coefficients of the time variable for both products were not statistically different from zero, the rate of technical progress (λ) corresponding to estimates of the elasticity of substitution in the furnitures and fixtures, and planing and joinery industries cannot be estimated. But it is believed that technical progress in these industries on average is very low. If we take the furniture industry, for instance, there are more than 2000 establishments and yet 95% of them are still operating on craftman production technology. Only about 100 establishments that can export their products appear to have included some form of serial production technology.

Conclusion

Low estimates of the elasticity of substitution for the furniture and fixtures, and wood planing and joinery industries suggest that there would be a modest opportunity for the adoption of more capital-intensive techniques in production if the wage to rental ratio escalated. Government policies and scarcity of skilled workers would be the contributing factors influencing the outcome. With the drive towards greater exporting of downstream products, the adoption of more capital-intensive technology is advantageous.

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