DEMAND FOR SAWNWOOD OF WELL KNOWN AND LESSER KNOWN SPECIES IN PENINSULAR MALAYSIA

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ISMARIAH AHMAD & VINCENT, J.R. 1992. Demand for sawnwood of well known and lesser known species in Peninsular Malaysia. Declining timber resources are forcing tropical timber producing countries to develop markets for "lesser known" species (LKS). This paper provides a quantitative analysis of the effects of relative prices, output of end-use industries (construction and mouldings) and technical change (residual trends) upon the domestic demand for sawnwood of well known species (WKS) and LKS in Peninsular Malaysia during 1979 through 1989. A two-output cost function is developed to analyze demand for sawnwood as derived from cost minimization by the end-use industries. Regression results indicate that the consumption of sawnwood by the construction and moulding industries was significantly influenced by relative prices, output of end-use industries and technical change. Future increases in domestic consumption of LKS depend on their continued price advantage offsetting underlying trends away from their use.

Key words: Sawnwood demand - Peninsular Malaysia - cost function - lesser known species

Introduction

Peninsular Malaysia is the largest tropical sawnwood exporter in the world. It has more than 600 sawmills, which consume about three-quarters of its log harvest. About half of the annual production of sawnwood is exported. Most exports are graded sawnwood. Low-grade and ungraded sawnwood are sold mainly in the domestic market.

Like wood-processing industries in many other tropical countries, Peninsular Malaysia's sawmilling industry is confronted by a declining forest inventory of the well known species (WKS) that have traditionally comprised the bulk of its log input. The industry's ability to maintain high levels of production during the next few decades will depend in part on its ability to increase its usage of so-called "lesser known" species (LKS). In turn, increased use of LKS will depend on the industry's ability to develop markets for sawnwood manufactured from these species.

Previous work (Vincent *et al.* 1990) indicates that the Japanese market has responded very slowly, if at all, to economic factors that would be expected to prompt increases in consumption of non-dipterocarps, which include many of the LKS from Southeast Asian rain forests. However, what are the prospects for increased consumption of LKS within tropical countries? In the long run, domestic markets might offer better opportunities than export markets. Consumption of tropical timber products (all species, not just LKS) within tropical countries has been rising faster than exports, due to rates of population growth and income growth that exceed those in more highly developed, tropical timber importing regions. Domestic consumption has received additional stimulus from resource-based development strategies that call for greater processing of raw materials within tropical countries.

Peninsular Malaysia provides an excellent case for examining the likelihood of enhanced domestic marketability of wood products, particularly sawnwood, made from LKS. Domestic demand for sawnwood and other wood products is expected to increase in coming decades for several reasons. Since the mid-1960s, Peninsular Malaysia's per capita income has risen at one of the most rapid rates in the developing world, and its population continues to increase at a rate of more than 2% per year. The Malaysian government's Industrial Master Plan has targeted downstream wood-processing industries (*e.g.*, furniture and mouldings) as a key growth sector (MIDA/UNIDO 1985). The federal government's special "Low-Cost Housing Programme" announced in 1986, is expected to increase domestic sawnwood demand substantially (Zainab 1989).

In addition, government agencies and industrial organizations in Malaysia have actively promoted fuller usage of LKS. The Malaysian National Forest Policy, formulated in 1980, encourages maximum forest usage by reducing logging residuals from felled trees, which include both LKS and WKS, and reducing the number of unfelled trees above the cutting limits, which comprise mainly LKS. The list of species covered by the Malaysian Grading Rules (MGR) has been expanded to facilitate the merchantability of LKS (Wong 1983, Tong 1983). Research conducted at the Forest Research Institute Malaysia on the technical properties of LKS aims at increasing the range of products made from them.

Perhaps most importantly, data on sawnwood consumption are available in Peninsular Malaysia at a more finely disaggregated level than was possible in the study of the Japanese market cited above. This makes it possible to define LKS more precisely than by the broad category of "non-dipterocarps." In Peninsular Malaysia, LKS include not only non-dipterocarps but dipterocarps as well. Using non-dipterocarps and dipterocarps as synonyms for LKS and WKS, respectively, can lead to misleading inferences since in reality each category contains both LKS and WKS. For example, the proportion of LKS consumed within both dipterocarp and non-dipterocarp categories could increase without affecting the consumption shares of non-dipterocarps and dipterocarps.

In this paper we analyse data on sawnwood consumption in Peninsular Malaysia during 1979 through 1989 to investigate whether fundamental economic forces are promoting an increase in domestic consumption of sawnwood of LKS. We test the hypothesis that end-use industries in Peninsular Malaysia are able to respond to market signals by substituting, in a cost-minimising manner, between sawnwood of LKS and WKS. The end-use industries we consider are construction and mouldings.

The first section of the paper briefly describes domestic sawnwood demand in Peninsular Malaysia. The second section presents a theoretical model of species-specific tropical sawnwood demand. The third section describes the data and econometric procedures used to estimate this model empirically. The fourth section presents and discusses regression results and demand elasticities. The final section summarises the findings and points out their policy implications.

Sawnwood consumption in Peninsular Malaysia

Figure 1 shows domestic consumption of sawnwood in Peninsular Malaysia during 1971 to 1989 [To calculate apparent consumption, we first needed to calculate apparent production by species category. This was done by multiplying data on log input by species (given in Forestry Department publications) times the aggregate recovery rate for the sawnwood industry. Then, we subtracted export volume by species].

Consumption rose during this period at a statistically significant (5% level) rate of 2.7% per year. Most of the increase occurred before the early 1980s. Consumption fell drastically during the recession of the mid-1980s but began recovering in 1988. In 1989, domestic consumption accounted for nearly half (44%) of domestic production.

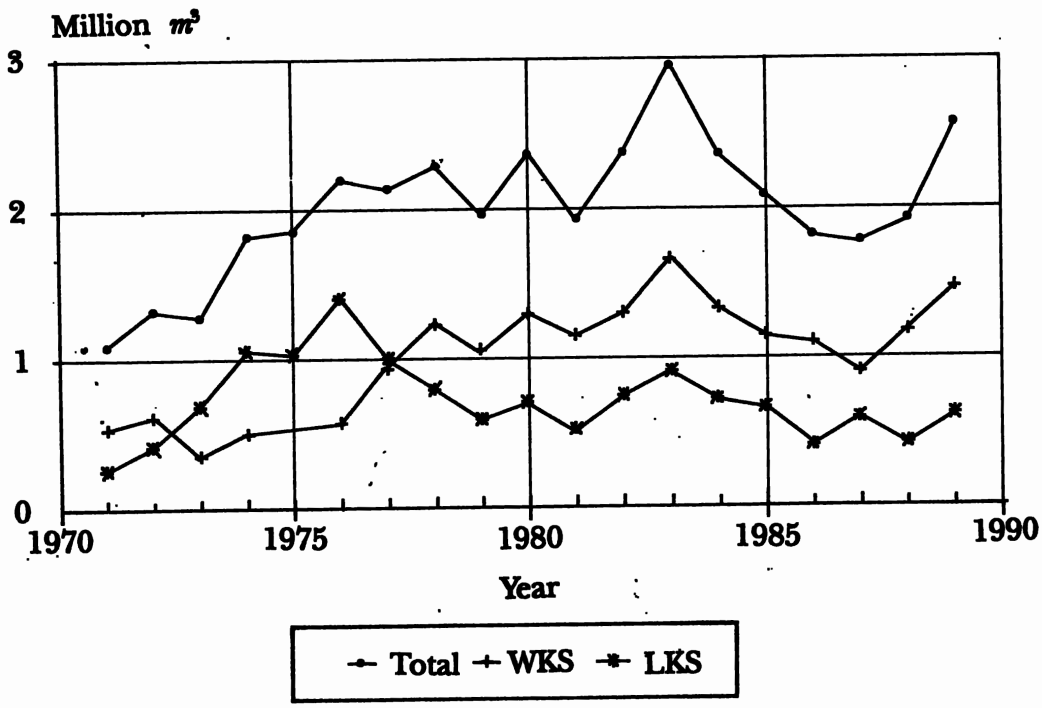

Figure 1. Domestic consumption of sawnwood ("Total" refers to consumption of all species, "WKS" and "LKS" refer to consumption of species in the light and medium density categories only)

Leading domestic end-uses in 1989 were construction (59% of consumption) and the manufacture of mouldings (21%). Figure 2 shows that the increase in domestic consumption into the early 1980s corresponded with an increase in output of the two principal end-use industries. End-use output is shown as an index, with 1974 = 1. Construction output is defined as real value of construction from the nation's GDP accounts, while moulding output is defined as volume of exports (about 70 % of total production of mouldings was exported in 1989). The indices for both industries declined in the early to mid-1980s, the construction index due to the domestic recession and the moulding index due to declining demand in key export markets (Thomas & Waggener 1987). Moulding output rebounded more quickly than did construction output, nearly doubling during 1986 to 1989.

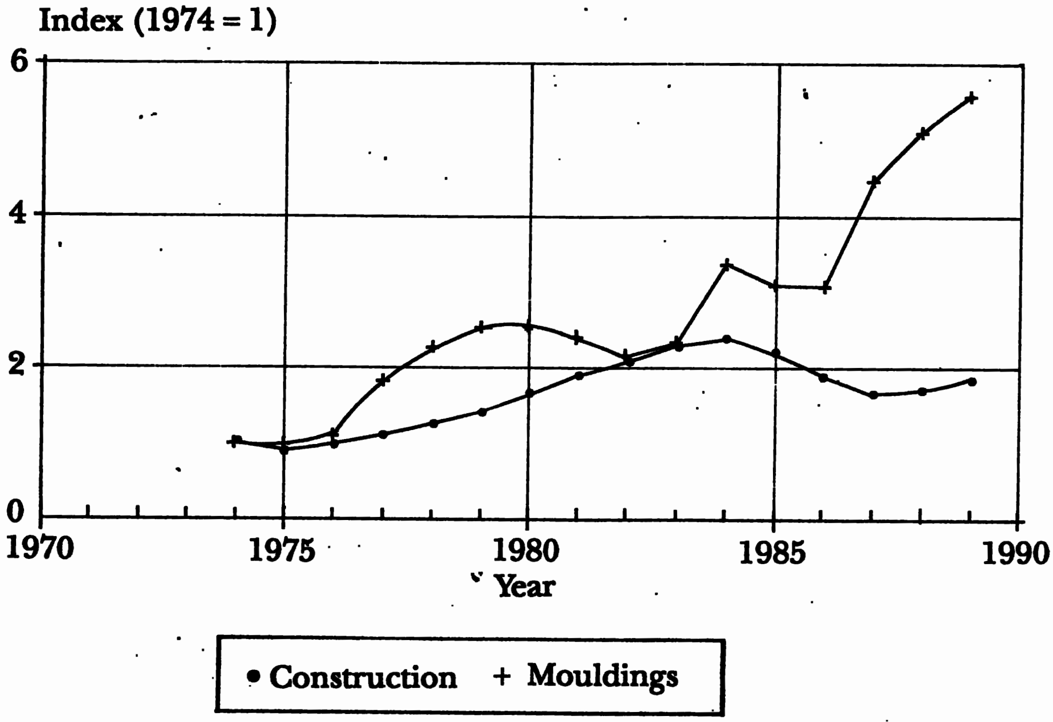

Figure 2. Output of end-use industries [Construction index is based on value of construction output from the GDP accounts, in real terms (1978 price levels); Moulding index is based on export volume of mouldings]

Most sawnwood consumed domestically is in the light density and medium density hardwood categories. In 1989, light hardwoods comprised 56% of domestic consumption and medium hardwoods comprised 26%. Heavy hardwoods, which have quite specialized uses, accounted for the remaining consumption. Light and medium hardwoods are consumed by both the construction and mouldings industries. An important difference between the two industries is that the construction industry tends to consume better quality and larger sizes of sawnwood, while the moulding industry consumes mainly offcuts and strips.

Domestic consumption of WKS and LKS within the aggregate light/medium hardwood category is shown in Figure 1. WKS were defined to be those species for which data by commercial trade names are reported in Forestry Department publications and in trade publications like Maskayu. These were jelutong, red meranti, yellow meranti, white meranti, mersawa, nyatoh and sepetir in the light hardwood category, and kapur, keruing, kempas and mengkulang in the medium category. All other species in the light and medium categories were considered to be LKS. This definition somewhat understates the consumption of WKS, since the aforementioned publications single out only the species that have historically been most significant. During 1971 through 1989, consumption of WKS was, on average, 20% larger than consumption of LKS. In 1989, WKS in the light/medium category accounted for 58 % of domestic consumption.

Figure 3 presents aggregate, ex-mill prices for sawnwood of WKS and LKS in the combined light/medium category sold in the domestic market. Prices are in nominal terms and are in ringgits per cubic meter. Prices were aggregated across species by using (M$) consumption quantities as weights. Data on prices during 1974 to1978 are suspect, as they are based simply on the average of minimum and maximum annual prices for a given species as reported in Ibu Pejabat Perhutanan Semenanjung Malaysia (1979). Data on prices during 1979 to 1989 reported in Ibu Pejabat Perhutanan Semenanjung Malaysia (1986, 1990) are more reliable, as they are based on a sample of prices for both graded and ungraded sawnwood of each

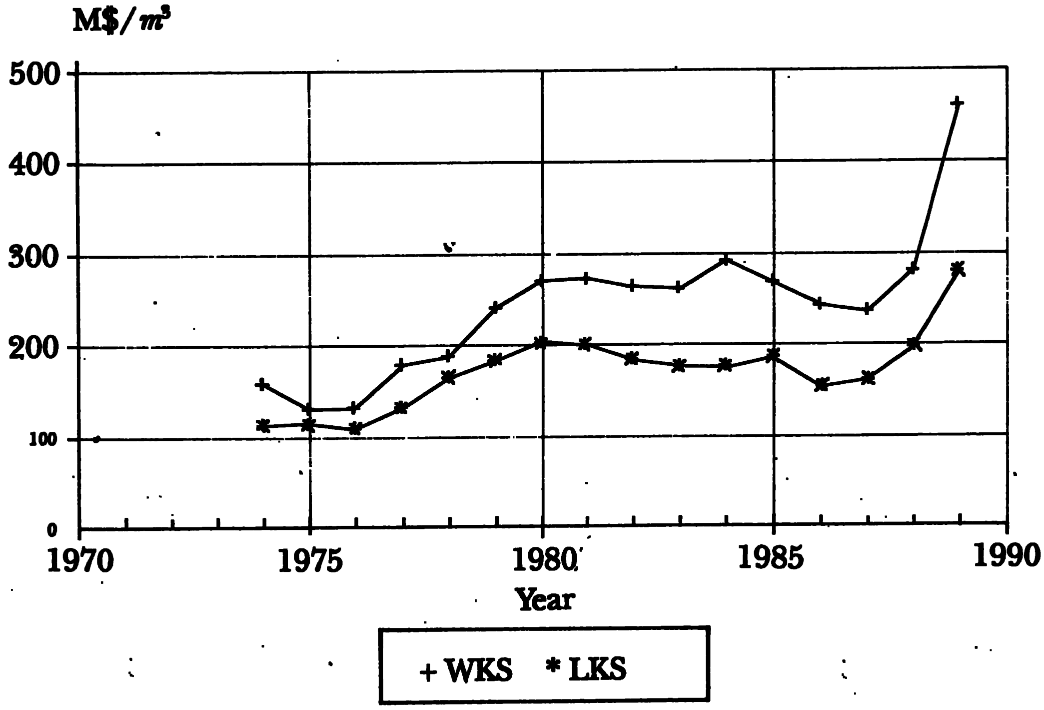

Figure 3. Domestic sawnwood prices ("WKS" and "LKS" refer to species in the light and medium density categories only)

species in three size classes (boards: 25 - 50 × 150 *mm* or wider; scantlings: 50 - 75 × 75 - 150 *mm*; strips: 12 - 19 × 50 - 125 *mm*) and in three regions of Peninsular Malaysia (East, West, Central). During 1974 through 1978, prices of WKS were greater than prices of LKS by an average of 44%; during 1979 through 1989, the average difference was slightly larger, 48%. During 1979 through 1989, the ratio of price of WKS to price of LKS increased at a statistically significant rate of 1.6% per year.

One would expect such a significant relative price increase to stimulate a relative decrease in consumption of WKS. During 1979 through 1989, the ratio of consumption of WKS to LKS did in fact decrease, at a rate of 0.5 % per year, but the rate was not statistically significant.

A model of sawnwood demand

An econometric model was formulated to investigate whether fluctuations in consumption of sawnwood of WKS and LKS were due to changes in relative prices, changes in output of end-use industries, technical change, or some combination of these factors. The model is very similar to the one employed by Vincent *et al.* (1990). Sawnwood demand was modeled as resulting from the minimisation of costs of sawnwood inputs for given levels of output in the construction and moulding industries.

A two-output cost function was employed instead of separate cost functions for the two end-use industries due to the lack of data on consumption of sawnwood of WKS and LKS by end-use. Given that the sizes and grades of sawnwood consumed by the two industries are fundamentally different, we might expect this theoretical model to encounter some problems when applied to Peninsular Malaysia. Indeed, we will see that this is the case.

To focus attention on substitution between WKS and LKS, sawnwood was assumed to be "weakly separable" (Chambers 1988) from other factors of production, such as labour, capital, energy, and non-wood materials. Technically, this assumption means that the elasticities of sawnwood demand with respect to prices of these other factors are assumed to be identical for WKS and LKS. Operationally, it allows us to exclude all non-sawnwood factors of production from the analysis. Of course, this convenience is achieved at the cost of not obtaining information about substitution between sawnwood and other factors.

The generalised Leontief function was chosen to represent the multi-output cost function (Fuss *et al.* 1978). As a "flexible form" (Chambers 1988), this function has desirable approximation properties and imposes few restrictions on the cost function. The two-output (construction, mouldings), two-input (WKS, LKS) generalized Leontief cost function is:

$$C = Y_C[\alpha_{cww}p_w + 2\alpha_{cwl}(p_wp_l)^{1/2} + \alpha_{cll}p_l + \tau_{cw}p_wt + \tau_{cl}p_l t] + Y_m[\alpha_{mww}p_w + 2\alpha_{mwl}(p_wp_l)^{1/2} + \alpha_{mll}p_l + \tau_{mw}p_wt + \tau_{ml}p_lt] \qquad (1)$$

C is domestic expenditure on sawnwood consumption in Peninsular Malaysia, Y_c and Y_m are output of the construction and moulding industries, p_w and p_l are prices of sawnwood of WKS and LKS, and t is an annual trend variable. τ_{kij} and τ_{ki} are parameters. C, p_w and p_l do not need to be deflated, since by construction Equation 1 is homogeneous of the first degree in prices.

The trend variable is a proxy for technical change - secular changes in demand that are independent of changes in prices or output. Examples of technical change include improvements in end-use technology leading to more efficient use of sawnwood and new timber treatment methods that allow the use of species with less desirable wood properties.

Demand equations for WKS and LKS are derived from Equation 1 by Shephard's lemma:

$$x_w = \frac{\partial c}{\partial p_w} = Y_c\,[\alpha_{cww} + \alpha_{cwl}\,(p_l/p_w)^{1/2} + \tau_{cw}t] + Y_m\,[\alpha_{mww} + \alpha_{mwl}\,(p_l\,/p_w)^{1/2} + \tau_{mw}t\,] \tag{2a}$$

$$x_w = \frac{\partial c}{\partial p_l} = Y_c\,[\alpha_{cll} + \alpha_{cwl}\,(p_w/p_l)^{1/2} + \tau_{cl}t] + Y_m\,[\alpha_{mll} + \alpha_{mwl}\,(p_w\,/p_l)^{1/2} + \tau_{ml}t\,] \tag{2b}$$

x_w and x_l are consumption of WKS and LKS. Demand depends on output of end use industries, relative prices, and technical change. Producer theory requires that the bracketed terms in Equations 2a and 2b be positive and that the parameters on the relative price ratios (α_{cwl}, α_{mwl}) be non-negative (because there are only two inputs). If α_{cwl} and α_{mwl} equal zero, then the model simplifies to a fixed-factors model. If α_{cwl} and α_{mwl} are greater than zero, then sawnwood of WKS and LKS are substitutes for each other. Technical change is biased toward using species category i in end-use k if τ_{ki} is positive, away if τ_{ki} is negative.

Elasticities provide a quantitative measure of how consumption responds to changes in key variables. They indicate the percentage change in consumption due to a 1% change in an explanatory variable. The end use elasticity is:

$$\varepsilon_{ik} = \frac{\partial x_i}{\partial Y_k}\,\frac{Y_k}{x_i} = [\,\alpha_{kii} + \alpha_{kij}\,(p_j\,/\,p_i)^{1/2} + \tau_{ki}t\,]Y_k\,/x_i \tag{3}$$

The own-price elasticity is:

$$\varepsilon_{kii} = \frac{\partial x_i}{\partial p_i}\,\frac{p_i}{x_i} = -1/2\;\alpha_{kij}\,(p_j\,/p_i)^{1/2}\,Y_k\,/x_i \tag{4}$$

Equations 2a and 2b are homogeneous of degree zero in prices, so the cross-price elasticity for each species category is just the negative of the own-price elasticity:

$$\varepsilon_{kij} = -\varepsilon_{kii} \tag{5}$$

The technical change elasticity is:

$$\varepsilon_{kit} = \frac{\partial x_i}{\partial t}\,\frac{1}{x_i} = \tau_{ki} Y_k / x_i \qquad (6)$$

This elasticity indicates that every year, consumption of species category *i* changes by 100* ε_{kit} %, in the absence of changes in other explanatory variables.

Estimation techniques

The two demand equations (Equations 2a and 2b) were estimated jointly due to their shared parameters [Vincent *et al.* (1990) estimated the cost function as well as the demand functions]. Estimation efficiency was increased by using a multivariate maximum-likelihood technique (essentially, nonlinear, iterative seemingly-unrelated regression) that allowed nonzero error covariances across equations (Judge *et al.* 1985). This is the error structure expected of demand equations derived from a common cost function. Simultaneous equations bias was ignored.

The unconstrained model in which all parameters were estimated was termed Model I. Three additional models were estimated with particular sets of parameters constrained to equal zero:

Model II: $\alpha_{mww} = \alpha_{mll} = \alpha_{mwl} = \tau_{mw} = \tau_{ml} = 0;$

Model III: $\tau_{cw} = \tau_{d} = \tau_{mw} = \tau_{ml} = 0;$

Model IV: $\alpha_{mww} = \alpha_{mll} = \alpha_{mwl} = \tau_{mw} = \tau_{ml} = \tau_{cw} = \tau_{d} = 0.$

Model II excludes the effects of changes in moulding output, Model III excludes technical change effects, and Model IV excludes the effects of both moulding output and technical change. Comparison of the likelihood functions for Models I-IV made it possible to test whether the constrained parameters were significantly different from zero. The likelihood ratio statistic is:

$$L = 2[\ln (L_u) - \ln (L_c)]$$

L_u and L_c are the likelihood values for unconstrained (Model I) and constrained (Models II-IV) models. Under the null hypothesis that the constrained parameters are equal to zero, L has a chi-squared distribution with degrees of freedom equal to the number of constrained parameters.

Data

The equations were estimated using annual data for the period 1979 through 1989. This relatively short period was chosen due to the suspect data on prices before 1979. The total number of observations was thus 22 (2 dependent variables times 11 data points).

The data used in estimation were the same as those plotted in Figures 1 to 3: domestic consumption and average prices of sawnwood of WKS and LKS for the combined light/medium hardwood categories, real construction value from the national income accounts (in million ringgits, 1978 price levels) and volume of moulding exports (in cubic meters). Data were drawn primarily from Ibu Pejabat Perhutanan Semenanjung Malaysia (1986, 1990) and Maskayu. The Bank Negara Quarterly Economic Bulletin and UNDP Statistical Yearbook were also consulted.

Results and discussion

Regression results are presented in Table 1. Likelihood ratio tests indicated that Model I was significantly different from Models II, III, and IV at the 5% level. Hence,

Table 1. Regression results

	Model[a]			
	I	II	III	IV
Parameter estimates[b]				
α_{cww}	-775.54	337.04	-829.31	668.96
	(2.6143)**	(2.174)**	(3.9620)***	(3.4013)***
α_{cll}	-1924.7	23.642	1712.6	372.28
	(5.6458)***	(0.1071)	(5.7841)***	(1.2835)
α_{cwl}	1949.7	259.34	1657.1	-58.804
	(7.0578)***	(1.3929)	(6.9423)***	(0.24805)
τ_w	-65.853	5.7328		-
	(2.7276)**	(0.4997)		
τ_l	-43.065	-7.4647		-
	(3.9916)***	-(1.7039)*		
α_{mww}	14.571	-	17.113	-
	(3.8223)***		(6.5024)**	
α_{mll}	23.308	-	23.739	-
	(6.2966)***		(6.3181)***	
α_{mwl}	-19.679	-	-19.525	-
	(6.6995)***		(6.4275)***	
τ_{mw}	0.54095	-	-	-
	(1.7885)*			
τ_{ml}	0.2661	-	-	-
	(2.0828)**			
R^2 [c]				
x_w	0.5243	0.1292	0.0356	0.1435
x_l	0.6095	0.3693	0.0989	0.3139
Durbin-Watson statistic [c,d]				
x_w	2.2586	1.1921	0.9162	1.1392
x_l	2.3327	1.5513	0.8001	2.4727
Log of likelihood function				
	-251.985	-264.738	-260.269	-267.419
Likelihood ratio statistic[e]				
	-	25.506	16.568	30.868

a. Model I: unconstrained model; Model II: moulding industry excluded; Model III: technical change excluded; Model IV: moulding industry and technical change excluded; b. t-statistics in parentheses. ***, **, and * indicate parameters significantly different from zero at the 1-, 5-, and 10 % levels; c. x_w denotes the demand equation for well-known species, and x_l denotes the demand equation for lesser known species; d. May be biased, due to the exclusion of a constant from the estimated equations; all equations have been corrected for first-order serial correlation; e. For test of null hypothesis that excluded parameters are equal to zero, 5 % critical values: for 4 degrees of freedom, 9.488; for 5 degrees of freedom, 11.070; for 7 degrees of freedom, 14.067. Degrees of freedom equal number of constrained parameters.

output of end-use industries, relative prices and technical change effects were all statistically significant, and Model I is the preferred model. Only in this model were all parameter estimates significantly different from zero, as measured by *t*-statistics. Because Model I contained the most parameters, the coefficients of determination (R^2) for the two demand equations were also the highest. The results in Table 1 are for equations corrected for first-order serial correlation. Only Model I showed no evidence of serial correlation after the correction was done.

Table 2 presents elasticities based on Model I estimates and Equations 3 to 6. All end-use elasticities are positive (as theory requires), their magnitudes for a given end-use are similar across species categories and the elasticities for the construction industry are about three times larger than those for the moulding industry. Together, these last two points suggest that consumption of sawnwood of both types by the construction industry is about three times as large as corresponding consumption by the moulding industry: a 1% change in output of the construction industry has three times as great an impact on consumption as does a 1% change in output of the moulding industry. This is consistent with the aggregate 1989 data cited earlier, which indicated a 59% share for construction and a 21% share for mouldings. The end-use elasticities for each species category sum to 1, due to the mathematical structure of the model.

Table 2. Demand elasticities

Elasticity	End-use: Construction	End-use: Mouldings
End-use		
WKS	0.76	0.25
LKS	0.71	0.30
Own-price[a]		
WKS	-1.30	1.10
LKS	-4.06	3.51
Technical change		
WKS	-0.11	0.07
LKS	-0.15	0.08

[a] The cross-price elasticities equal the negative of the own-price elasticities

Price elasticities show less consistency and less agreement with theory. Results are most consistent with theory for the construction industry. The negative own-price elasticities imply that cross-price elasticities are positive, which indicates that WKS and LKS are substitutes. Both elasticities are greater than 1 in absolute value, which indicates that sawnwood demand is elastic. A 1% increase in the WKS price causes the construction industry's consumption of WKS sawnwood to decrease by 1.3% and its consumption of LKS sawnwood to increase by 4.1%; a 1% increase in the LKS price causes consumption of WKS to increase by 1.3% and consumption of LKS to decrease by 4.1%. Hence, consumption of LKS sawnwood is much more sensitive to price. The construction industry increases its consumption of LKS sawnwood substantially if the price of WKS relative to LKS increases, but it decreases its consumption equally substantially if the relative price ratio decreases. Consumption of WKS fluctuates less with price changes, suggesting that inherent preferences for WKS are stronger.

In the moulding industry, own-price elasticities are positive, which violates producer theory. We suspect that this indicates that the price data do not provide an accurate measure of the sawnwood prices actually faced by moulding manufacturers. As mentioned earlier, the moulding industry consumes mainly sawnwood offcuts and strips. The domestic price data for Peninsular Malaysia, however, are based on averages across sizes, which exclude offcuts and are dominated by sizes larger than strips. Interviews with representatives of sawmilling and moulding industries revealed that prices of offcuts and strips typically move in opposite directions from prices of larger sizes of sawnwood. This is because sawnwood production is driven by demand for the larger sizes required not only by the construction industry but also by the sawnwood export market, with offcuts and strips being produced as byproducts.

Figure 4 illustrates the economic explanation for the inverse relationship between sawnwood prices in large and small size classes. The top half of the figure shows supply and demand for larger sizes of sawnwood, and the lower half shows supply and demand for smaller sizes (offcuts and strips). The supply curve for smaller sizes is vertical, indicating that it is simply proportional to the production of larger sizes, *i.e.* that smaller sizes are byproducts. The units of the horizontal (quantity) axis in the lower half are given by δ times the units in the upper half, where δ is a fraction much less than one ($0 < \delta < 1$). This indicates that smaller sizes account for a minor portion of sawnwood production.

When demand for larger sizes increases (the demand curve shifts from D to D', due, for example, to an increase in construction or export demand), the price of larger sizes rises from P to P', causing production of larger sizes to rise from Q to Q'. The increase in output of larger sizes causes output of the byproduct, offcuts and strips, to rise from δQ to $\delta Q'$. Since the demand curve for smaller sizes has not shifted, price drops from p to p'. So, P has increased, while p has decreased.

The incorrect signs on the price elasticities for the moulding industry are thus not surprising: the price data used to estimate the model move in opposite directions from the actual prices of sawnwood consumed by moulding manufacturers. If the correlation between prices of offcuts and strips and prices of larger sizes equals -1, then the magnitude of the estimated cross-price parameter α_{mwl} is unbiased; its sign is simply wrong. This would imply that the own price elasticities are not much different between the construction and moulding industries (for WKS, -1.30 versus -1.10, and for LKS, -4.1 versus -3.5) and that, as in the construction industry, demand for LKS sawnwood in the moulding industry is much more price sensitive. Unfortunately, the absence of data on prices of offcuts makes it impossible to calculate the correlation, so this suggestive similarity can support no more than speculation.

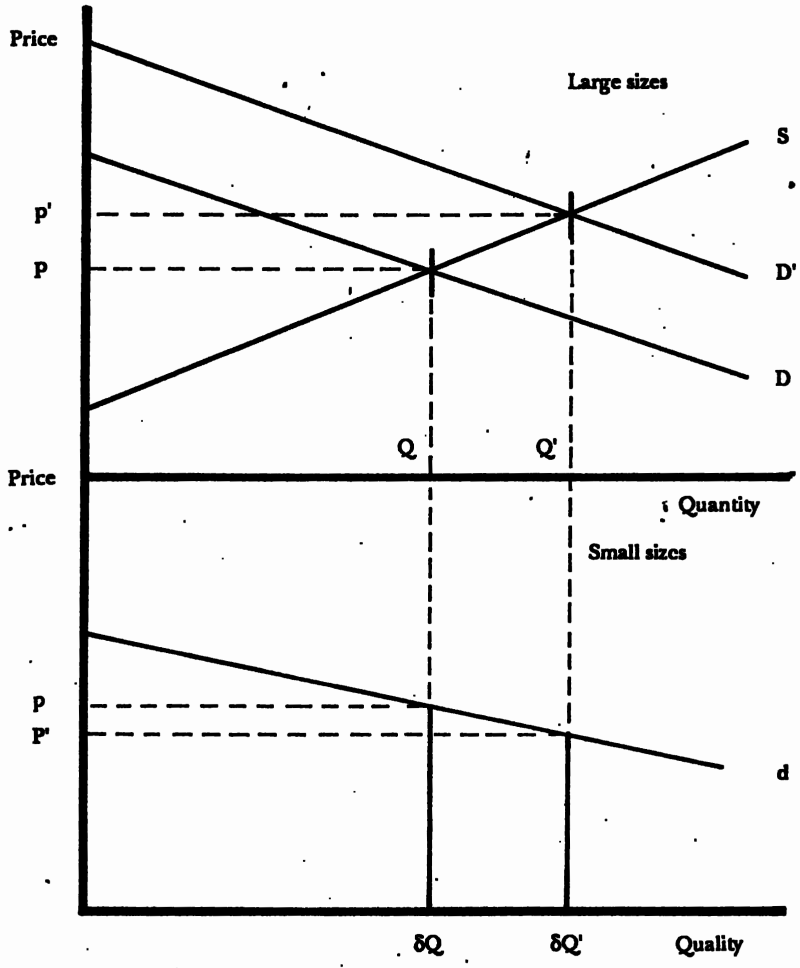

Figure 4. Joint production of sawnwood of large and small sizes

The technical change (residual trend) elasticities are negative for construction but positive for mouldings. This indicates that if levels of end-use output and prices remained constant, then consumption of sawnwood of both WKS and LKS would decline over time in the construction industry, but increase in the moulding industry. The positive elasticities for the moulding industry are probably picking up effects of expansion in consumption by other industries left out of the model, such as furniture. The negative elasticities for the construction industry are more important, given this industry's dominant share of sawnwood consumption. They appear to have two explanations. First, the construction industry is increasing the efficiency of its use of sawnwood and substituting other materials for sawnwood. Second, construction in Peninsular Malaysia is increasingly dominated by urban structures, which use very little sawnwood.

The technical change elasticities in the construction industry are more negative for LKS than WKS. Interviews with architects and representatives of the construction industry revealed that building regulations were more strictly enforced and adhered to during the 1980s. One regulation is that timber species that are not naturally durable be treated with preservatives before use. Treatment costs are not affected much by species type (at least within the light/medium hardwood category), but the costs relative to the sawnwood price are greater for LKS than for WKS, due to the lower price of the former. The increasingly stringent requirement to treat wood reduced the relative price advantage enjoyed by LKS sawnwood. This helps explain why the underlying trend away from LKS was greater than in the case of WKS.

Summary and conclusions

This analysis has demonstrated that demand for sawnwood in Peninsular Malaysia is significantly affected by three factors: output of end-use industries, relative prices and technical change. What do our findings related to these factors suggest about future consumption of sawnwood of WKS and LKS in Peninsular Malaysia?

Output is increasing in the two principal end-use industries, construction and mouldings, which causes demand curves for sawnwood of both WKS and LKS to shift outward. Holding all other factors constant, this will increase consumption of sawnwood of both categories.

Of course, all other factors are not constant. One of these factors is price. The price of WKS sawnwood relative to the price of LKS sawnwood is increasing. In the construction industry, our regression results indicate that this is causing substitution of LKS for WKS, that is a movement along the price/quantity demand curve. Results are less clear in the moulding industry, but what appears initially to be a perverse regression result (the sign is incorrect on the cross-price parameter) might in fact be consistent with price induced substitution of LKS for WKS once the characteristics of the price data used in the model are taken into account.

Results for the third factor, technical change, indicate that underlying trends are leading to increases in consumption of both types of sawnwood in the moulding industry but decreases, particularly for LKS, in the construction industry.

In sum, analysis of the 1979 through 1989 period suggests that consumption of sawnwood of both WKS and LKS by the moulding industry is likely to rise, while consumption of both by the construction industry could either increase or decrease, depending on the extent to which the negative trend effects offset the price and end-use effects. These forecasts assume that output of the construction and moulding industries will continue to increase, as will the price of WKS relative to LKS.

We conclude by noting an implication of our results for a major policy related to the sawnwood industry implemented recently. In 1990, the Ministry of Primary Industries announced export levies on sawnwood in 21 species groups, mainly WKS. The levies were imposed first on rubberwood in June 1990, then on strips of the other listed species in September 1990, and then on other sizes of sawnwood of the listed species in March 1991. If the levies reduce sawnwood exports (indeed, sawnwood exports fell sharply in 1991; the levies, not the anti-tropical timber campaign, might be to blame), which consist primarily of WKS, they will increase the supply of WKS sawnwood in the domestic market. This will cause the price of

WKS to decrease relative to the price of LKS, which in turn will cause consumption and production of LKS sawnwood to fall. The fall in consumption could be steep, due to the great price sensitivity of demand for LKS. The sawnwood export levies could therefore inhibit the fuller use of LKS (moreover, Figure 4 suggests that prices of offcuts and strips for the moulding industry might actually rise as a consequence of the export levies, since production of export sizes of sawnwood will decrease; a rise in the price of sawnwood for domestic downstream processors is the opposite of what the levies intend).

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