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FORECASTING SAWNTIMBER CONSUMPTION: THE APPLICATION OF AN END-USE MODEL*

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A multi-equation end-use model is used to analyse the consumption of sawntimber in Australia. The forecasting ability of the model is evaluated. Simulations of the model are reported and implications for policy are discussed.

Sawntimber consumption projections have been used extensively for purposes of forestry planning. The demand for timely market information by representatives of industry and government has led to the regular provision of short- and medium-term projections of sawntimber consumption by research bodies such as the Australian Bureau of Agricultural and Resource Economics (ABARE) (for example, Bureau of Agricultural Economics 1984, 1985; ABARE 1988). Long-term projections have been used in major public reports as a basis for examining the economic viability of growing and processing timber in Australia (Forestry and Forest Products Industry Council 1985*a*, *b*; Ferguson 1985).

These forecasts, however, leave much to be desired. There has recently been an increased awareness of the considerable disparity among published forecasts, even where similar approaches and data are used. Such disparities have been attributed to factors such as the use of statistical techniques that ignore known limitations of the data, a failure to divide consumption of sawntimber into separate end uses, the omission of one or more of the variables that influence consumption (such as price, income or household formation) and dependence on forecasts of variables such as gross domestic product or population which are known to be imprecise or conditional (Ferguson 1985). While it is difficult, if not impossible, to avoid conditionality in such forecasts, there is still considerable scope to refine the methods and data used in sawntimber projections.

In developing models of sawntimber consumption, the close association between the consumption and production of wood products and the level of housing activity has long been recognised (Ferguson 1973). However, the nature of the linkage between the consumption of sawntimber and the demand for housing is not well understood; neither is the relative importance of other market factors which influence the consumption of wood products in end uses other than housing. Accordingly, there is a need for research to identify and quantify the factors that influence the consumption of wood products.

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In this paper, the main factors influencing the consumption of sawntimber are analysed, with the aim of developing a forecasting model of sawntimber consumption. Particular attention is given to the influence of the dwelling and non-dwelling markets. To this end, a multi-equation end-use model has been investigated. It was anticipated that, by using a disaggregated framework to capture the effects of structural change in the market, as well as to allow for the derived nature of the demand for sawntimber, forecasting performance would be improved.

The measure of sawntimber consumption used in the analytical models is first defined. There follows a review of previous research findings. Alternative ways of incorporating dwelling and non-dwelling uses into a model are discussed. Results are presented from an annual model using a multi-equation approach. In addition, forecasts of sawntimber consumption are provided for the period 1986–87 to 1989–90. In conclusion, some comments are made on forecasting issues associated with the model specifications used, indicating areas for future research.

The Nature of Sawntimber Consumption

In developing forecasts of the consumption of sawntimber, it is desirable to measure both the demand and supply elasticities over a range of prices. However, there are no reliable sales-versus-price data or information on stocks held by timber merchants. Accordingly, it is necessary to use a measure of apparent consumption, defined as domestic production plus imports less exports. Because this consumption measure includes stock fluctuations, it is not identical to sawntimber utilisation in end markets.

The demand for sawntimber is essentially a derived demand, strongly related to the rate of new dwelling construction. Although there has been no regular data collection on sawntimber consumption by end use, estimates provided in a draft report prepared by the Australian Timber Producers' Council (1985) indicate that in 1983–84 approximately 60 per cent of sawntimber was used in dwelling construction. This includes detached houses, villa units, flats, and alterations and additions to dwellings. 'Non-dwelling' uses include industrial production (pallets and packaging), commercial, industrial or rural buildings, domestic fencing, garages, pergolas, furniture, landscaping and shop fittings. Although some of these uses (fences, garages and furniture) may be related to some extent to the level of new dwelling construction, it is also likely that factors affecting industrial markets in general, such as changes in the level of business activity and the cost and availability of finance, will affect the consumption of sawntimber for non-dwelling purposes.

Previous Studies

Most earlier attempts to estimate the demand for sawntimber have used single-equation models and have taken consumption as a measure of demand. Demand for sawntimber has been hypothesised to be a function of variables such as the price of sawntimber, the prices of substitutes and disposable income. Some authors have recognised the derived nature of the demand for sawntimber through the inclusion of variables associated with building activity, such as the number or value of buildings commenced and the nature of the buildings constructed (Ferguson 1973; Edquist 1982). Alternative methods of estimating the derived demand relationship have also been investigated. For example, Doran and Williams (1982) use a cost function method, deriving a system of equations relating the demand for sawntimber to the relative prices of other inputs used in residential construction. Such an approach reveals the nature and strengths of substitutions and complementarities.

Although Australian studies to date have typically sought to identify the market factors influencing the demand for sawntimber, they have suffered the conceptual weaknesses associated with the use of apparent consumption as a measure of demand. Theoretically, this measure does not indicate the level of demand at the associated levels of price, but only the level of consumption that resulted from supply–demand interaction. Consequently, apparent consumption represents both supply and demand, and any price elasticities computed are therefore some combination of both supply and demand elasticities. Similar difficulties have been encountered in demand models for forest products in other countries (Kumar 1985).

Byron (1981) has suggested a more general theoretical framework for the analysis of sawntimber consumption in the Australian context, but acknowledges that continuing data limitations, particularly with regard to the requirements for estimating the slopes of the demand and supply curves, inhibit the development of a general econometric model of the sawntimber market.

Although most earlier models have fitted historical trends well, marked structural changes in the market for sawntimber have meant that these models are no longer appropriate for forecasting. Factors that influence the level of housing activity, such as the growth in unemployment in the age group 18–25, the upward surge in mortgage interest rates since the mid-1970s, the introduction of the Commonwealth first home owner scheme and changes in other government policies, will exert a significant influence on the consumption of sawntimber. The role of financial factors in influencing the consumption of sawntimber has been highlighted by Benninghoff (1978), who showed that shifts in government monetary policies (including changes in interest rates and in the supply of mortgage money) are the main causes of fluctuations in housing activity and in the demand for sawntimber in the United States. Moreover, technical changes such as the growth in the use of concrete flooring and change in materials used for outside walls of dwellings have had a dramatic effect on the consumption of sawntimber.

One way of incorporating structural changes which have occurred in the market, as well as taking account of the derived nature of the demand for sawntimber, would be to respecify the one-equation consumption model to include variables which affect both the demand for housing and the consumption of sawntimber. However, this approach may not give satisfactory results, both because of the imperfect relationship between the demand for housing and the consumption of sawntimber and because of econometric problems that may arise when a large number of explanatory variables are included in a single equation.

In an alternative form of demand specification, which was used in an earlier study by the Australian Bureau of Agricultural and Resource Economics (Bureau of Agricultural Economics 1977), the derived nature of the demand is represented using a two-equation model. One equation models the demand for new housing as measured by the number of dwellings commenced. The second equation estimates the quantity of sawntimber per dwelling. The consumption of sawntimber is then derived by multiplying the number of dwellings commenced by the sawntimber consumption per dwelling. The main conceptual shortcoming of that two-equation treatment was its neglect of non-dwelling uses, which account for approximately 40 per cent of total sawntimber consumption. Accordingly, the use of aggregate sawntimber per dwelling as the dependent variable in the second equation could be expected to provide only limited explanatory power or predictive ability (unless sawntimber consumption for non-dwelling purposes moved in parallel with dwelling commencements). Moreover, the equation for dwelling commencements could also be expected to provide inaccurate forecasts of dwelling commencements, since no account could at that time be taken of factors such as changes in mortgage interest rates and government housing schemes which have had a major influence on dwelling commencement activity since the mid-1970s.

Since the early 1960s, a number of models have been developed to investigate the causal relationships underlying housing activity. A survey of housing demand models developed in the United States, the United Kingdom, Australia and New Zealand is provided by Burtt (1979), while Bromilow, Lesse, Anderson and Crawford (1980) and Brenac and Shepherd (1981) have reviewed housing demand models used in Australia alone. The specifications of these models have depended on the time span considered and on whether the model is part of a wider model system relating to the economy as a whole. In the latter case, both the choice and value of variables may be constrained, since they may be derived from other parts of the model system.[1] Longer term models (forecasting 10–20 years ahead) are generally based on demographic factors such as movements in the number of new households being formed, birth rates or internal and external migration (Burtt 1979).

Model Specification

In view of the nature of sawntimber consumption, the main choice in specifying the consumption equation would appear to be between a

[1]In the studies by Burtt (1979), Bromilow *et al.* (1980) and Brenac and Shepherd (1981), a number of alternative hypotheses were tested regarding economic and demographic determinants of the demand for housing. Variables found to be statistically significant in explaining the demand for housing included the percentage annual change in real disposable household income per person; the change in the ratio of average personal savings to new house price levels; an index of new house prices relative to prices of materials used in house building; the volume of money in circulation; the annual percentage change in the volume of money; the rate of interest on first mortgages; and the change in population aged 15 years or over. Other significant determinants of housing consumption in Australia have included a seasonal dummy variable for the March quarter, reflecting the annual decline in building activity over the Christmas holiday period, and lags in endogenous variables used as explanatory variables to allow for delays in adjusting to desired levels of new house numbers.

single-equation model incorporating factors affecting the consumption of sawntimber and/or the demand for housing, and a multi-equation model as discussed above. The latter method is to be preferred on conceptual grounds, though it is then necessary to overcome definitional and data problems associated with the specification of separate equations for dwelling construction activity and for end-use sawntimber consumption.

The single-equation alternative

An annual model of total sawntimber consumption was first investigated using a single-equation specification. It was anticipated that, consistent with the postulates of utility theory, total sawntimber consumption would vary negatively with the price (or relative price) of sawntimber and positively with income (as measured by real household disposable income per person or non-farm gross domestic product per person). In addition, because of the derived nature of the demand for sawntimber, it was hypothesised that consumption would be positively related to the level of building activity (as measured by total dwelling commencements, detached dwellings commenced, other building commenced and the value of loans for additions and alterations). The proportion of houses (or detached dwellings) to total dwelling commencements has varied markedly since the 1950s (Figure 2). Because a house requires far more timber than a non-detached dwelling such as a flat or home unit, it was expected that the consumption of sawntimber would be positively related to increases in the ratio of detached dwellings to total dwellings commenced.

It was also anticipated that factors influencing the demand for housing, such as home mortgage interest rates and the availability of housing finance, would affect the consumption of sawntimber. Where a single-equation specification is used, such variables could be used as substitutes for measures of building activity.

The single-equation annual model had relatively low explanatory power, with $\bar{R}^2=0{\cdot}56$ (Paul, Sar, Maxwell and Willey 1985). Total annual consumption of sawntimber was found to be positively related to the level of building activity as measured by dwelling commencement, detached dwellings commenced, other buildings commenced and the value of loans for additions and alterations. The model gave better results when quarterly data were used. However, there was some evidence that neither version of the single-equation model could adequately capture the long-term effects in the relationships being considered.

The multi-equation model

The multi-equation method consisted of deriving estimates of sawntimber consumption indirectly with three separate equations: new dwelling commencements, sawntimber used per dwelling commenced and sawntimber used for non-dwelling purposes. Total sawntimber consumption can be represented by the following identity:

(1) $C=P_dN_d+C_n$

where C is the total quantity of sawntimber consumed, P_d is the quantity of sawntimber used in new dwellings per dwelling commenced, C_n is the quantity of sawntimber used for non-dwelling purposes and N_d is the number of new dwellings commenced.

Forecasts of total sawntimber consumption can thus be derived from P_d, N_d and C_n estimated as three separate equations.

Since time series data are not available on the value of sawntimber consumed by end use, the practicability of this approach depends on devising a way to split the data series for total sawntimber consumption between dwelling construction and non-dwelling purposes. This was done by deriving a separate series for the amount of sawntimber used for non-dwelling purposes (as defined above).

First, the value of sawntimber used in non-dwelling construction was approximated by multiplying the value of non-dwelling construction commenced (Australian Bureau of Statistics 1987*b*) by the value weight of wood and wood products used in building other than house building.[2] Second, an implicit quantity index of sawntimber used in non-dwelling construction was obtained by dividing the estimated value of sawntimber used in such construction by the price index of wood and wood products used in building other than house building (Australian Bureau of Statistics 1987*d*).[3] A time series of the physical quantity of sawntimber used for non-dwelling purposes was then derived by applying this quantity index to the 1985–86 estimate of the amount of sawntimber used in non-dwelling construction supplied by the Australian Timber Producers' Council (1985). Finally, sawntimber used in dwelling construction was derived by subtracting sawntimber used for non-dwelling purposes from total consumption.

In Figure 1 the estimated series for sawntimber used in dwellings and for non-dwelling purposes are compared. The consumption of sawntimber by end use varied markedly over the period 1949–50 to 1984–85. In 1950–51, about 80 per cent of sawntimber was used in dwelling construction; by 1970–71 this proportion had fallen to around 40 per cent, due to both a rise in the amount of timber used for non-dwelling purposes and a declining trend in the quantity used in dwellings. The latter trend appears to be related to changes in the type of dwelling constructed (see Figure 2). After 1970–71 the end-use pattern changed again, and from 1974–75 dwelling construction accounted for about 60 per cent of sawntimber consumption. The determinants of these trends are examined in more detail below.

Since the model being developed will be used for forecasting purposes, only explanatory variables that can reliably be predicted into the future and that are statistically significant are included in the final model. Dwelling commencements were postulated to be negatively related to mortgage interest rates and positively related to income and

[2]The value weight was obtained from the price index of materials used in building other than house building (Australian Bureau of Statistics 1987*d*) and from Australian Timber Producers' Council (1985). The respective value weights were 0·119 in 1965–66, 0·0797 in 1975–76 and 0·072 in 1983–84. These weights were apportioned over time to enable the value of timber used in non-dwelling construction to be estimated.

[3]A more desirable procedure would have been to express the price index of timber used in house building as a ratio to the price index of total building materials used in house building excluding timber. However, this procedure could not readily be adopted, because prior to 1966 the price indexes for timber and total building materials were published separately. It was not practically possible to separate the timber data from those on other building materials.

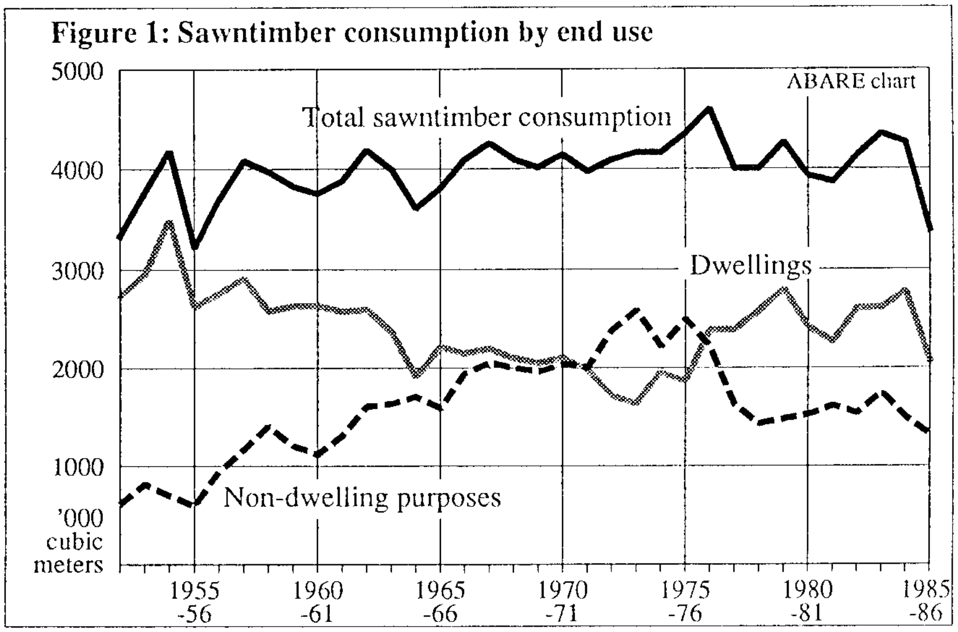

FIGURE 1—Sawntimber Consumption by End Use.

population size. In addition, Commonwealth Government housing activities were expected to have a positive impact on the demand for housing. (Such activities included capital expenditure on war service houses, defence houses built, advances to states for housing projects

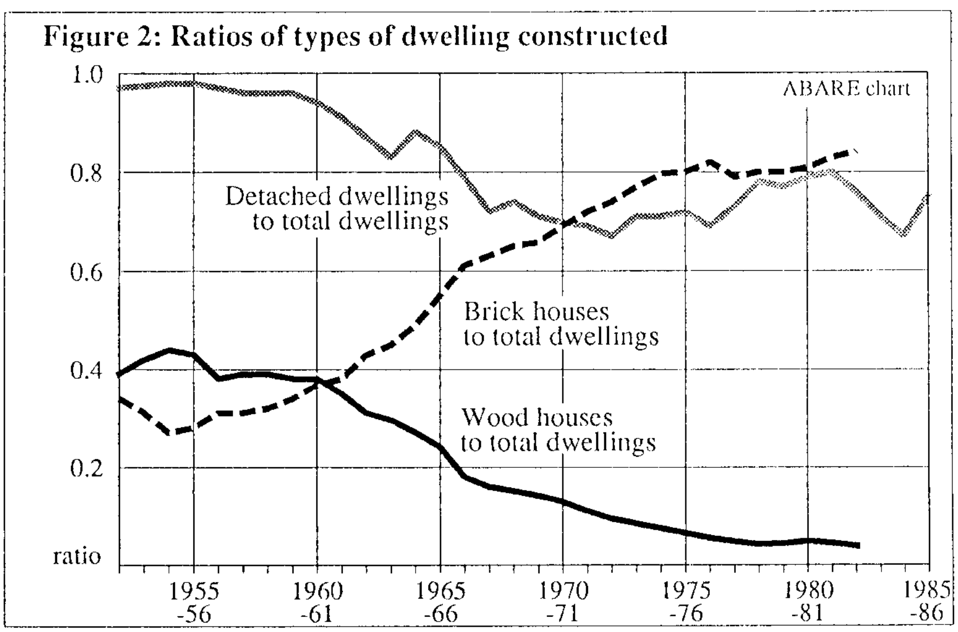

FIGURE 2—Ratios of Types of Dwelling Constructed.

and expenditure relating to the deposit assistance scheme and the earlier home savings grant schemes.)

The quantity of sawntimber used per dwelling was hypothesised to be a function of the relative price of sawntimber and the proportion of detached dwellings constructed in the previous year (allowing time for timber stock replacement). Conservatism in preferences for building materials was allowed for by including the lagged dependent variable.

The final component of total consumption (equation 1) requires an equation for the consumption of sawntimber used for non-dwelling purposes. First, sawntimber use for some non-dwelling purposes (such as fences, garages and furniture) is expected to be associated with new dwelling construction. Second, the use of timber in non-residential construction occurs mainly in the later stages of construction, and was therefore hypothesised to be related to the lagged ratio of the value of non-residential construction to the value of total building construction. It was anticipated also that an increase in the overdraft interest rate would discourage investment in non-residential construction and hence reduce the amount of sawntimber used for this purpose.

Estimation

Data for the variables of interest were collected for the period 1950–51 to 1985–86.

Data were obtained from the Australian National Accounts (Australian Bureau of Statistics 1987*a*) and other statistical publications published by the Australian Bureau of Statistics (1985; 1987*b*, *c*, *d*). The consumer price index was used as the deflator to convert value and price variables into real terms, except in the case of the value of building activity (of all kinds), which was deflated by the price index of materials used in house building (Australian Bureau of Statistics 1987*c*). Time series relating to interest rates were obtained from Norton and Garmston (1984) and Reserve Bank of Australia (1985).

Variables

Endogenous: N_d, dwelling commencements (thousands); P_d, quantity of sawntimber used in new dwellings per dwelling commenced (cubic metres); C_n, sawntimber used for non-dwelling purposes (thousand cubic metres); C, total annual sawntimber consumption (thousand cubic metres).

Exogenous: N_P, change in population aged 15 years and over (thousands); R_d, ratio of number of detached dwellings commenced to total dwellings commenced; R_b, ratio of value of new non-residential buildings commenced to value of total buildings commenced; Y, real household disposable income per person aged 15 years and over (dollars); I_l, maximum housing loan interest rate charged by savings banks; I_o, maximum overdraft rate charged by trading banks on loans less than \$100 000 at end of each June; D_s, dummy variable for years in which a Commonwealth home savings grant scheme or home deposit scheme was in operation; D_a, dummy variable for 1975–83 (depressed conditions in non-residential construction); D_b, dummy variable for 1973.

Estimated model

The three separate equations for new dwelling commencements, sawntimber used per dwelling commenced and sawntimber used for non-dwelling purposes were estimated. Given that estimation was conducted simultaneously the maximum likelihood method was used. The estimated coefficients are shown below together with their *t*-statistics (in parentheses), R^2 values and Ljung–Box (1978) *Q*-statistics.[4] Lags are shown, in years, in parentheses following the variables.

Dwelling commencements:

$$(2)\quad \underset{(1{\cdot}04)}{N_d=-19{\cdot}2} + \underset{(5{\cdot}45)}{0{\cdot}017Y} - \underset{(4{\cdot}02)}{8{\cdot}13I_l(-1)} + \underset{(2{\cdot}97)}{0{\cdot}15N_P} + \underset{(3{\cdot}23)}{21{\cdot}4D_s} + \underset{(2{\cdot}56)}{28{\cdot}9D_b}$$

$$R^2=0{\cdot}89;\ Q(12)=20{\cdot}40$$

Sawntimber used for dwellings:

$$(3)\quad \underset{(1{\cdot}63)}{P_d=-12{\cdot}3} + \underset{(1{\cdot}83)}{24{\cdot}4R_d(-1)} + \underset{(4{\cdot}22)}{0{\cdot}649P_d(-1)}$$

$$R^2=0{\cdot}90;\ Q(12)=8{\cdot}18$$

Sawntimber used for non-dwelling purposes:

$$(4)\quad \underset{(4{\cdot}59)}{C_n=-781} + \underset{(7{\cdot}21)}{3642R_b(-1)} - \underset{(2{\cdot}26)}{31{\cdot}5I_o(-1)} + \underset{(8{\cdot}24)}{10{\cdot}9N_d} - \underset{(3{\cdot}28)}{266D_a}$$

$$R^2=0{\cdot}87;\ Q(12)=18{\cdot}53$$

Dwelling commencements were found to be responsive to real disposable income per person aged 15 years or over, the change in this population, housing loan interest rates lagged one year, and the Commonwealth Government's home savings grant and/or deposit assistance scheme. After an inspection of the residuals in an initial estimation, a dummy variable was included to take into account an unusually large number of dwellings commenced in 1973 resulting from a generous assistance scheme introduced by the Labor government.

Housing loan interest rates lagged one year gave a better correlation than the current housing loan interest rates. This is likely to be because a loan for purchase of a dwelling is typically approved at an interest rate applying prior to the time when the dwelling is commenced. However, with the recent trend toward increasing volatility of mortgage interest rates, and the prospect of continuing government deregulation of the finance market, expected rather than current or past interest is likely to have an increasing influence on dwelling construction activity. Such matters warrant further investigation.

The amount of timber used in new dwellings was found to be positively related to the ratio of detached dwellings to total dwellings commenced, lagged one year, and to past preferences regarding the wood content of dwellings, represented by the lagged dependent variable.

The variables found to be significant in explaining sawntimber use for non-dwelling purposes included dwelling commencements and the overdraft rate of interest lagged one year. Each of these variables had the expected sign. In addition, sawntimber used for non-dwelling

[4]At the 5 per cent level of significance, the *Q*-statistic should be less than $\text{Chi}^2(12)=21{\cdot}03$ to confirm the hypothesis that the residuals are white noise.

purposes was found to be positively related to the ratio of the value of non-dwelling construction to the value of total building construction, also lagged one period. The importance of this relationship suggests that sawntimber usage for non-dwelling purposes such as fencing and furniture manufacture is linked closely to the level of new dwelling construction. However, some autocorrelation is present as indicated by the low Durbin-Watson value. Inspection of the residuals indicated that the autocorrelation was probably introduced by the low values of building other than dwelling for the years 1975–83. Accordingly, the equation was re-estimated with a dummy variable for those years.

Simulations

Two historical simulations were performed to evaluate the ability of the model to replicate the actual data. The first simulation (static) was for the whole sample period (1951–86) and the second (dynamic) from the years 1972–73 to 1985–86. The dynamic simulations employed the values of the endogenous variables obtained from the simulation of the preceding year. The results of these simulations are summarised in Table 1 and in Figure 3. For each simulation, root mean square errors (rms), root mean square percentage errors (rms%) and the Theil's U_2 statistic are shown for the four endogenous variables. The Theil's U_2 statistic of the total sawntimber equation in the dynamic simulation appears to indicate that the main source of error lies in the equation for sawntimber used per dwelling. A third run was therefore performed, using 'actual' (rather than simulated) wood per dwelling over the period 1972–73 to 1985–86. The model reproduces the general trend and is considered suitable for use in the projection of total sawntimber consumption and in policy analysis.

Figure 3: Actual and simulated sawntimber consumption

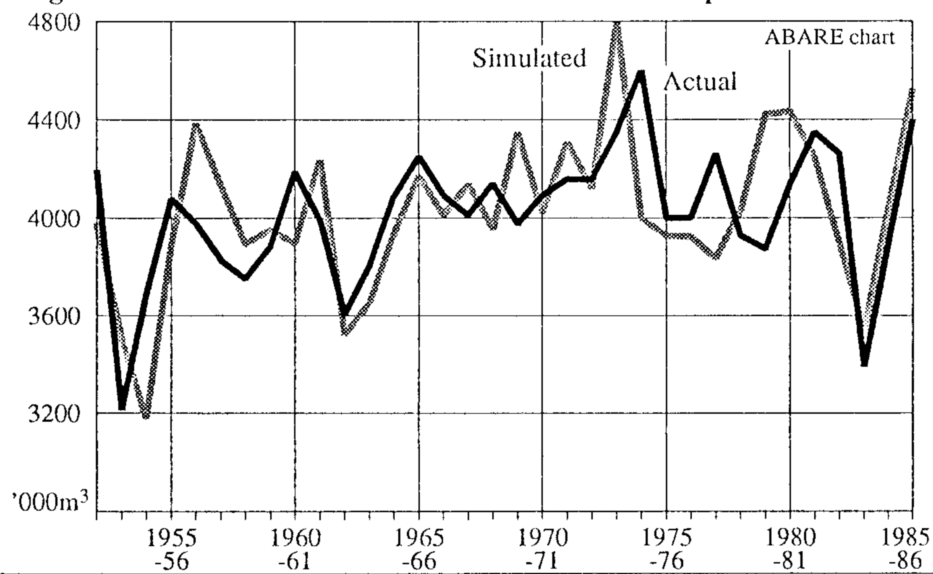

FIGURE 3—Actual and Simulated Sawntimber Consumption.

TABLE 1

Results of Historical Simulations

Variables	Static 1951–52 to 1985–86			Dynamic 1972–73 to 1985–86			Using actual wood per dwelling 1972–73 to 1985–86		
	rms	rms%	U_2	rms	rms%	U_2	rms	rms%	U_2
N_d	9·43	7·31	0·61	12·4	8·7	0·56	9·43	7·31	0·61
C_d/N_d	2·68	9·55	0·94	2·84	13·47	1·17	—	—	—
C_n	151·0	9·27	0·67	121·0	6·13	0·49	151·0	9·27	0·67
C	272·3	5·85	0·78	341·9	7·36	0·92	282·4	6·00	0·76

Forecasts of sawntimber consumption

Forecasts of sawntimber consumption by end use and dwelling commencements are included in Table 2. These forecasts employ values of the variables derived from Bureau of Agricultural Economics internal assessments and Australian Bureau of Statistics (1985).

Dwelling commencements are expected to rise between 1986–87 and 1989–90 due to a forecast drop in housing loan interest rates and increases in the growth rate of the population and in the real disposable income per person 15 years of age or over. The quantity of timber used per dwelling commenced seems likely to remain relatively constant. The increase in housing activity will therefore directly affect the consumption of sawntimber in dwelling construction. In addition, the upswing in dwelling commencements, together with expected lower overdraft rates toward the end of the period, are likely to increase the

TABLE 2

Consumption of Sawntimber, by End Use and Dwelling Commencements, Including Medium-Term Forecasts

Year	Dwelling commencements[a]	Sawntimber used per dwelling[b]	Sawntimber used for non-dwelling purposes[c]	Total sawntimber consumption[d]
	'000	m^3	'000 m^3	'000 m^3
1979–80	134	19·4	1535	4136
1980–81	149	17·5	1744	4351
1981–82	132	21·0	1492	4266
1982–83	105	19·7	1317	3390
1983–84	137	16·7	1596	3890
1984–85	153	16·6	1843	4386
1985–86	136	19·0	1645	4238
1986–87[e]	119	17·8	1703	3832
1987–88[e]	133	18·6	2080	4526
1988–89[e]	143	18·8	2317	5021
1989–90[e]	153	18·7	2605	5483

[a]From equation (2).
[b]From equation (3).
[c]From equation (4).
[d]Simulated values.
[e]Forecasts.

consumption of timber used for non-dwelling purposes. Hence, the consumption of sawntimber in 1989–90 is likely to be some 30 per cent higher than in 1985–86. It is probable, however, that this forecast is an overestimate, since no account has been taken of the potential dampening effect of tax reform measures such as capital gains tax and the treatment of negative gearing on rented property.

Sensitivity analysis

The effect of a 1 per cent change in each independent variable on the consumption of sawntimber in the medium term was investigated using the model. Sawntimber consumption proved most sensitive to mortgage interest rate changes. For example, a 1 per cent decline in mortgage interest rate is associated with a 4 per cent increase in sawntimber consumption. The effect of changes in the overdraft interest rate was less marked; a 1 per cent change in the overdraft rate produced less than 1 per cent change in total sawntimber consumption. Change in other variables, such as real household disposable income per person aged 15 years or more, type of dwelling constructed and level of housing demand, are all likely to have a significant influence on the level of sawntimber consumption. The removal of Commonwealth Government home assistance would initially reduce the annual consumption of sawntimber by about 20 per cent, with a subsequent partial recovery.

Conclusion

An attempt has been made to develop a model which can be used to forecast the consumption of sawntimber. A particular challenge has been the development of estimation techniques which can adequately account for the derived nature of the consumption of sawntimber as well as capture the effects of structural change in the market. To this end, the paper has focused on the development of a multi-equation end-use model, with the objective of capturing the influence of the dwelling and non-dwelling markets on the consumption of sawntimber.

For this purpose, data on the consumption of sawntimber by end use are required. Although such time series are not available, series for dwelling and non-dwelling use of sawntimber can be derived provided that certain assumptions are made regarding timber utilisation in non-dwelling construction. Although the resulting figures may be sensitive to the underlying assumptions, there would seem to be little scope for improvement until data on sawntimber consumption by end use are collected regularly.

A multi-equation end-use model has several advantages. For example, the use of separate equations for different facets of the market systems allows for the incorporation of market factors that influence demand for particular end uses, as well as allowing longer term structural changes affecting the dwelling and non-dwelling markets for sawntimber to be captured. By estimating three separate equations for dwelling commencements, sawntimber used per dwelling and sawntimber used for non-dwelling purposes, it was found that changes in total sawntimber consumption were influenced, by different mechanisms, by changes in factors such as the nature of building activity, real average household disposable income, interest rates, population and Commonwealth Government involvement in housing schemes.

Although comprehensive models can thus be developed to predict consumption levels of sawntimber, there is still a pressing need to collect data that will enable researchers to learn more about the behaviour of the supply and demand relationships for forest products. Without such information, the forecasting models used in forestry remain empirically inadequate.

Future research could profitably be directed to developing an import demand model for Australian wood products, including sawntimber. Such a model would facilitate understanding of how major components of sawntimber consumption are likely to change in the future.

There is also a need to examine the influence of new technologies on the demand for sawntimber and other wood products. For example, it has been suggested that the introduction of new types of wood-based panel with improved physical qualities, or technological developments involving some non-wood building materials, could erode some of the prefabricated component of the market for sawntimber (Edquist and Wallace 1985).

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