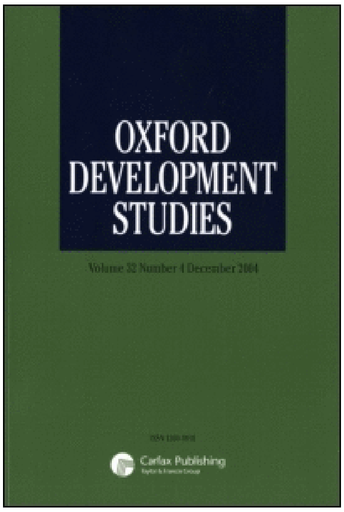

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The UK timber market: An econometric model

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The UK Timber Market: an Econometric Model

IAN BATEMAN & CHRIS MELLOR

ABSTRACT *Despite its importance in terms of volumes and value, little previous work has been undertaken to model quantitatively the UK timber market. This article sets out to provide a simple econometric analysis of this market, considering the influences of both home-grown and imported production, and in so doing to define an economic model which is robust to alterations in data period and which provides us with useful forecasting capabilities.*

1. Introduction

For UK farmers the introduction in 1987 of the Farm Woodlands Scheme (FWS) and the subsequent Woodlands Grant Scheme (WGS) may, as heralded, initiate a new phase in agricultural diversification. However, for the UK timber market these grants and subsidies represent simply a new facet in a long history of positive supply-side intervention by the government to promote the cause of home-produced timber.

Although the theoretical arguments for import substitution are weak, the UK's high consumption of timber and timber-related produce, at £4.9bn in 1986 the fourth highest value import item (see Figure 1), is based upon a domestic timber resource proportionately lower than almost all of its European partners. At the same time the physical and biological conditions of the UK are ideal for the production of high demand, lower grade

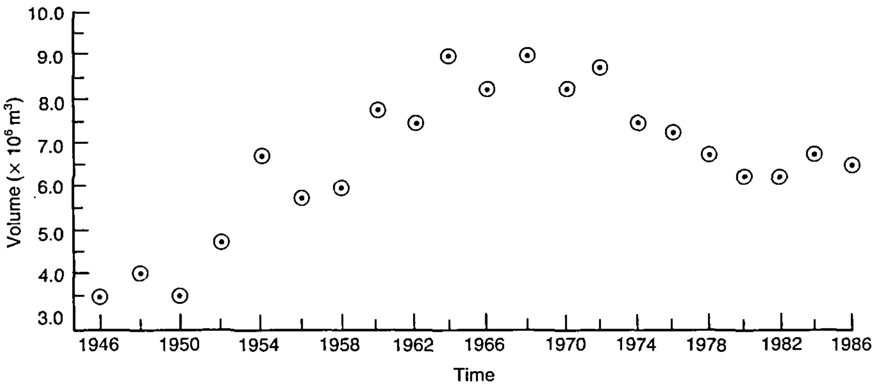

Figure 1. Imports of sawn softwood
(*source:* adapted from Forest Industry Commission of Great Britain, 1987).

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commercial softwood (current UK requirements are approximately 80% for softwoods: Leigh & Randall, 1981) with gestation periods almost half those of Scandinavian producers (Kula, 1986).

We can therefore justify consideration of the UK timber market as the study of a large, economically important, well-developed market in which the UK may exhibit some technical production advantages over competitors. Furthermore, because of the importance of output lags to production decisions, modelling is vital if we are to provide the best forecast for investment returns. This is particularly important in the face of the considerable recent debate concerning future real prices in the industry (Johnston *et al.*, 1967; Doran, 1979; Hart, 1987).

Government intervention in the supply-side production of domestic timber has a long history dating from the creation of the Forestry Commission in 1919. Initial objectives concerned strategic demands. However, timber production has been the beneficiary of non-timber policy goals such as employment generation during pre-war years, the more recent concerns over agricultural overproduction or, in the private sector, the capitalization of taxable income via generous government tax-relief provisions. Although Forestry Commission planting and production has grown considerably since the Second World War, accelerating awareness of individuals' tax relief possibilities (arising from the rise of specialized timber-oriented investment consultancies) has, from insigificant post-war beginnings, led to a consistently rapid growth in the private production of UK timber (with the necessary output lag), such that by 1987 an area of 1 145 000 ha was under private plantation (Phillip, 1976), being over 25% more than Forestry Commission holdings (Forestry Commission, 1987, 1988).[1] That we can attribute the growth of the private forestry sector to the introduction of tax-relief and grant incentives has been shown both by direct studies of this relationship (Kula & McKillop, 1988) and by analysis of the poor financial returns to forestry, compared with traditional agricultural activities (HM Treasury, 1972).

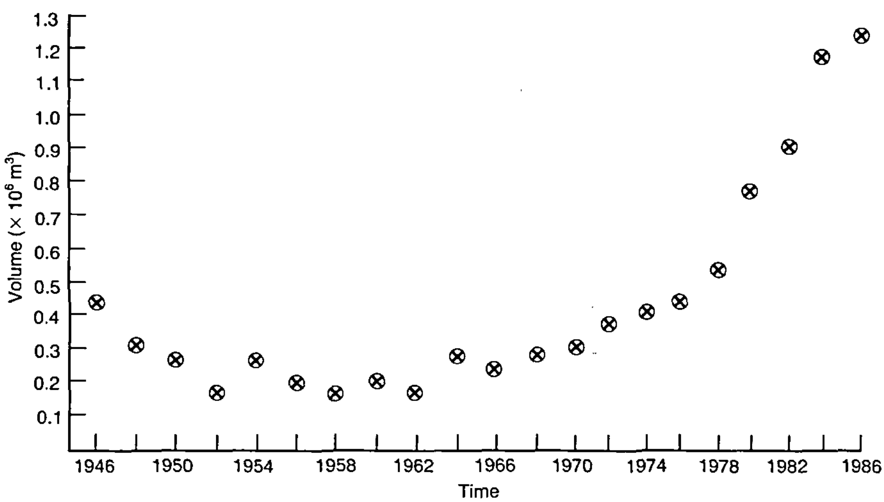

Figure 2. Home production (UK) sawn softwood (*source:* Timber Trade Federation, 1987).

Analysing softwood production, the cumulative effect of these planting decisions has been a lagged increase in domestic output (see Figure 2) from 440 000 m^3 in 1946 to 1235000 m³ in 1985 (Timber Trade Federation, 1973, 1987). Such a relatively rapid rate of output growth represents a marked increase in self-sufficiency from an initial 11% of total (home and imported) production figure to 16%, achieved during a period when market size has virtually doubled from 3890000 m³ in 1946 to 7676000 m³ annually in 1985 (Timber Trade Federation, 1973, 1987).

2. Modelling the UK Timber Market

2.1. Some Definitions

In our attempt to model the timber market in the UK we adopt the following notation and definitions.

(i) By timber we mean sawn softwood, since over 80% of total annual consumption falls into this category (Leigh & Randell, 1981). Home production (H_t) plus imports (I_t) plus net stock flows (ΔS_t) defines our supply of timber variable (Q_t) which, on the assumption of market clearing in each period, equals the market demand (figures from Timber Trade Federation, 1987).

(ii) We define the appropriate price variable as the deflated real price reflected in the real import price ($P_t = P_t^W = P_t^{UK}$) (see Figure 3). This would appear appropriate. The UK may be viewed as a price-taker, since imports account for 84–89% of total consumption during the data period (Leigh & Randell, 1981). Thus, if we see the UK viewed in a world context as a price-taker, the supply of imports is perfectly elastic at the world price. Following this the appropriate price series is taken as the Imported Sawn Softwood Real Price Index (Forestry Commission, 1982) (see Figure 4).

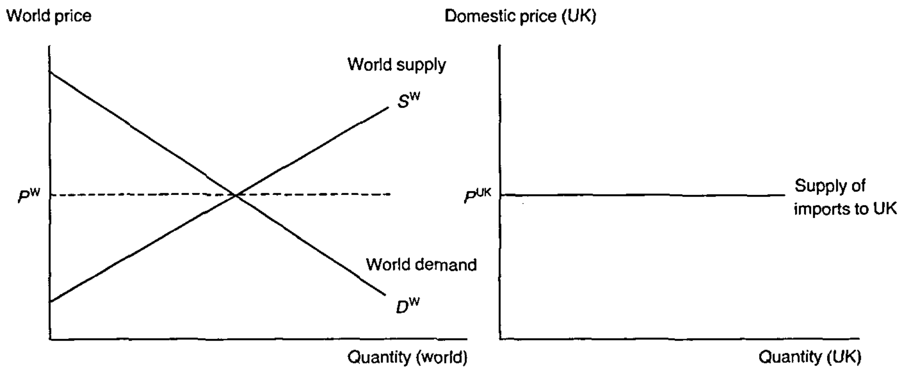

Figure 3. Domestic price determination (UK).

(iii) Income (Y_t) is real GNP at market prices in the UK (Central Statistical Office, 1989).

(iv) A time trend (t) to proxy output response to the uptake of grants and tax incentives discussed previously. We select our data period of 1958–85 inclusive to reflect this lagged output response. Pre-war plantation data are sparse and incomplete, but those available (Forestry Commission, 1923, 1933) support the contention that afforestation rose throughout the decades following the introduction of tax incentives. This increased plantation shows itself in domestic sawn softwood production in the selected data period (see Figure 2).

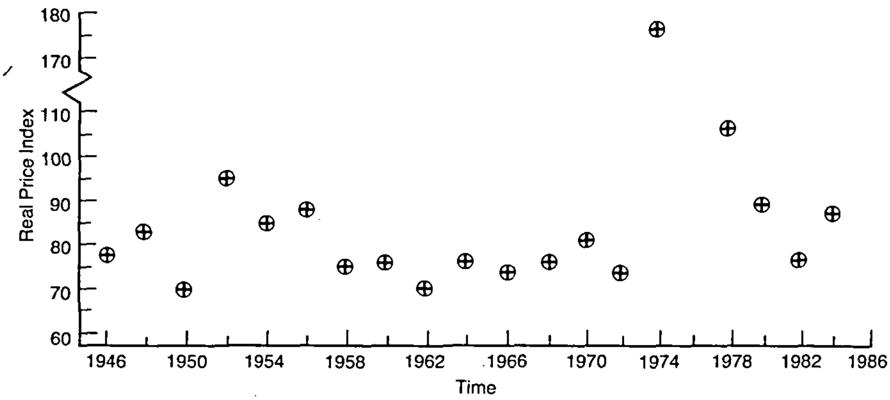

Figure 4. Imported Sawn Softwood Real Price Index (1975 = 100) (*source:* Forestry Commission, 1982, 1988).

2.2. The Model

Traditional econometric model-building is via either single equation models where variables can be categorized as either dependent or explanatory according to the underlying economic theory, or simultaneous equation models where variables are classed as endogenous or exogenous. Simple models of market behaviour incorporating demand and supply schedules are typically simultaneous in nature (see Kmenta, 1986, for example), since both price and quantity are determined together and require equations to be identified prior to their consistent estimation via techniques such as two-stage least squares (2SLS), or maximum likelihood methods (FIML or LIML). In this particular market the exogeneity of price (i.e. the fact that the UK faces the world price of timber) makes such an approach unnecessary and so instead we model the market via single equation methods.[2]

2.3. Demand

In examining UK timber demand, a simple relationship is proposed:

$$D_t = f(P_t, Y_t, t)$$

where D_t = total quantity demanded (home production plus imports plus stock flows) (Timber Trade Federation, 1973, 1987), P_t = real price (Forestry Commission, 1982), Y_t = real income (Central Statistical Office, 1989) and the true trend t here acts as a proxy for technical change. Indication of functional form and evidence of serial correlation led to the use of a Cochrane–Orcutt estimation procedure yielding the following results (t-ratios reported in parentheses).

$$\ln D_t = \underset{(-3.912)}{-19.801} \underset{(-7.417)}{-0.491} \ln P_t \underset{(5.884)}{+3.116} \ln Y_t \underset{(-4.631)}{-1.492} \ln t \qquad (1)$$

$$\underset{(8.826)}{\hat{\rho} = 0.858} \qquad R^2 = 0.81$$

$$\text{DW} = 2.00 \qquad n = 28 \qquad \text{df} = 24$$

The sample applied is 1958–85 (inclusive). A double log specification was selected in preference to alternative functional forms which yielded poor results. The further advantage of using this specification is that the coefficients are estimates of the (constant) price and income elasticities of demand.

The equation is well specified as is evidenced by the elasticities with respect to price and income having the theoretically 'correct' signs and being individually significantly different from zero at the 1% level. First-order serially correlated errors are handled by the Cochrane-Orcutt iterative estimation procedure, giving $\hat{\rho} = 0.858$ and a Durbin–Watson statistic of 2.00. The coefficient on $\ln t$ is significantly negative suggesting that, *ceteris paribus*, a reduction in demand (due to substitution of alternative products) is occurring over time. The fact that real income is increasing over the period more than offsets this downward trend, and we actually observe that the demand for sawn softwood has been increasing throughout our data period.

Finally, our equation when estimated over different subsets of the 1958–85 period demonstrated a commendable degree of parameter stability and appeared robust to the choice of data period (Chow tests confirmed this).

2.4. Home Production

Initial expectations of a home production function were for some relationship with price. However, upon testing, neither simple nor lagged functions gave any significant relationship (all estimations yielded insignificant results, some giving a negative coefficient on price). This led us to conclude that home production is not price sensitive but instead driven by other factors.

If we denote H_t^* as the desired level of home production in year t, then it is plausible to assume a multiplicative partial adjustment process of the form (see, for example, Johnston, 1984, p. 350; Gujarati, 1979, p. 271):

$$\left[\frac{H_t}{H_{t-1}}\right] = \left[\frac{H_t^*}{H_{t-1}}\right]^{\alpha} \qquad 0 < \alpha < 1$$

This equation simply states that a constant percentage of the discrepancy between the actual and desired level of H is eliminated within a single year.

Taking logs to the base e and rearranging gives:

$$\ln H_t^* = \frac{1}{\alpha} \ln H_t - \frac{(1-\alpha)}{\alpha} \ln H_{t-1}$$

In other words, the desired level of $\ln H_t^*$ is a weighted sum of the actual level of $\ln H$ in periods t and $t-1$.

Substituting this relationship into our home production function results in an equation which includes lagged $\ln H$ as an explanatory variable. This gives rise to the following estimated function:

$$\begin{aligned} \ln H_t = & -0.063 \; + 0.890 \ln H_{t-1} + 0.302 \ln t \qquad (2) \\ & (-1.679) \quad (12.737) \qquad (2.475) \\ & R^2 = 0.98 \\ & \text{Durbin } h = 0.55 \qquad n = 28 \qquad \text{df} = 24 \end{aligned}$$

The sample applied was 1958–85 (inclusive). The inclusion of a lagged dependent variable as a regressor biases the Durbin–Watson statistic towards 2 and so we report here the Durbin h statistic, which is asymptotically standard normal. A value of 0.55 gives no cause to suspect first-order serial correlation.

nant of current production. The coefficient of 0.89 indicates a sluggish adjustment process[3] as one might expect with habits and inertia playing an important role in current cropping decisions. The positive coefficient on $\ln t$ is consistent with the argument advanced previously concerning t proxying the uptake of grants which has increased over the years.

This analysis of demand and home production in the UK leads us to consider an appropriate import function, to which we now turn.

2.5. *Imports*

Consider Figure 5, which reproduces the world demand and supply schedules and the corresponding UK import supply offer curve (S^i_0). We have also sketched in the price inelastic home production curve and the demand curve for the UK.

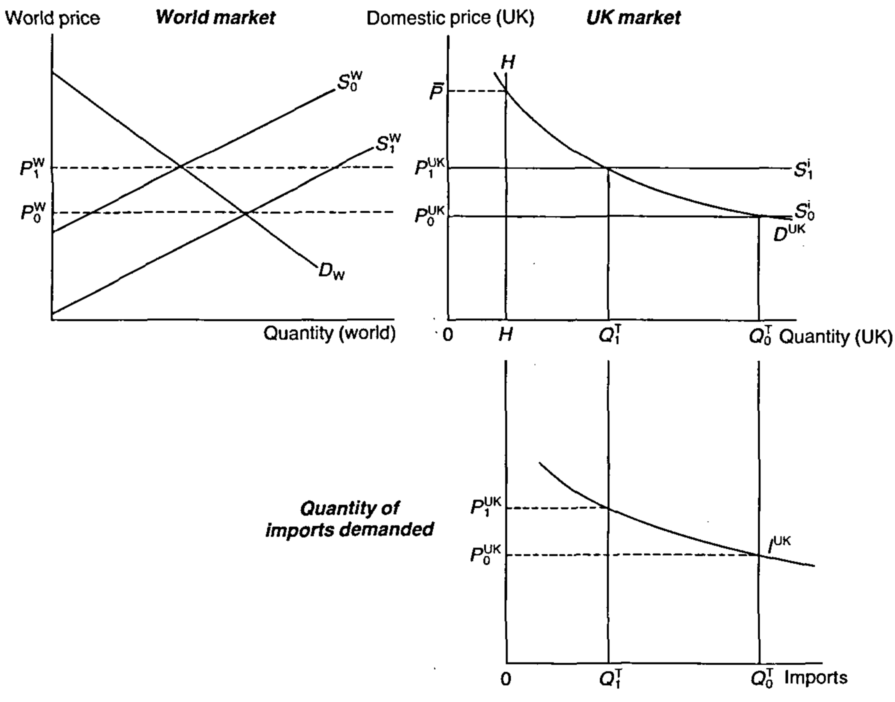

Figure 5. Price elasticity relationships.

We can see that a decrease in world supply has the effect of raising the world and hence the UK price from P^W_0 to P^W_1. An initial total consumption of OQ^T_0 (comprising OH of home production and HQ^T_0 of imported wood) falls to OQ^T_1 (which now comprises OH of home production and HQ^T_1 of imports). Clearly, home production is unaffected until price rises to $\bar{P}$, until which time imports alone are choked off by price increases. The response of imports to price changes is shown in the lower panel of Figure 5. The UK demand function defines the demand for imported wood curve as the identity:

$$I_t \equiv D_t - H_t$$

This identity implies that imports will have a negative coefficient relationship with $\ln t$

from the estimated demand function (equation (1)). Thus, we see a relationship between the uptake of tax-relief grants (proxied by time) leading to expansion of home production (see equation (2)) which, acting through the above identity, leads to a contraction of imports.

Figure 6 examines this relationship. Assuming, for simplicity, a stable world market, uptake of grant/tax incentives over time is represented by an expanding home production schedule (H_0 to H_1). This leads to a contraction of imports from $H_0Q_0^T$ to $H_1Q_0^T$. This prediction of the theory, backed up by our empirical evidence, appears wholly consistent with the UK experience in recent years.

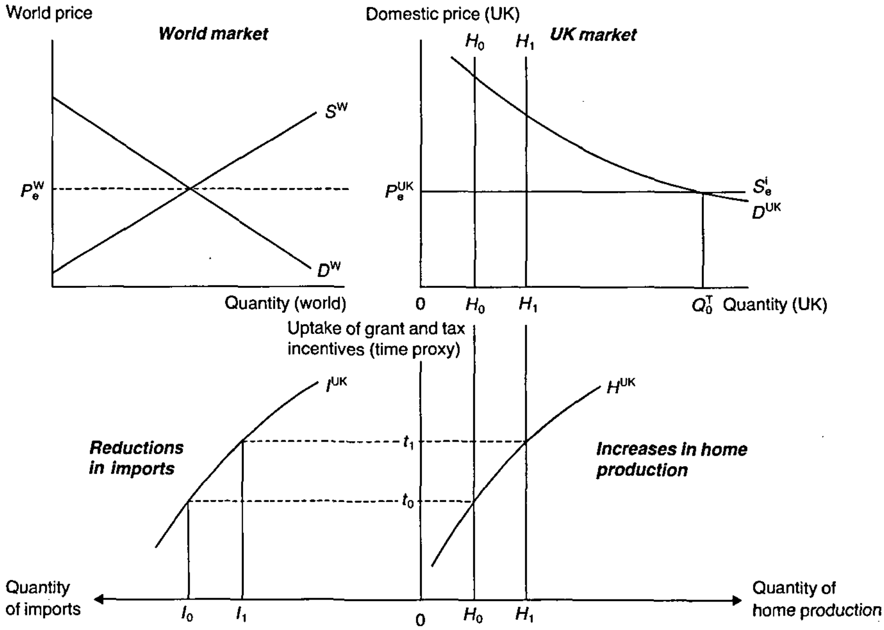

Figure 6. Long-term impact of grants/tax-relief incentives.

The lower panels of Figure 6 illustrate the effects of uptake of grant and tax-relief domestic production incentives upon home production and imports of wood. Here, the vertical axis shows the time proxy for uptake of these incentives, and we see that this does illustrate the relevant relationships with home production rising from H_0 to H_1 and imports contracting from I_0 to I_1.

3. Conclusion

We have presented and estimated a simple econometric moel of the UK timber market. Our results demonstrate our *a priori* beliefs concerning the relative magnitudes of elasticities, and tie in with a simple economic model of the market. We have captured the effects of price, income and the grant schemes which collectively provide a statistically sound explanation for the behaviour of economic agents in this market. The model helps us to understand and quantify relationships and (for example) enables us to consider future changes under different policy scenarios should we wish.

Remembering that the model is by nature autoregressive, any forecasts derived from it assume implicitly that producer/consumer response can validly be said to extend consistently out of the base time series into the future. Because of this, the model and its forecasts should not be used as a measuring rod to gauge the impact upon production of such recent market changes as the Farm Woodland Scheme, the Woodland Grant Scheme and the removal of major tax incentives to afforestation. However, whilst these schemes do entail a substantial shift in the nature of the UK domestic timber market, long production lags are likely to sustain the validity of the model for some time to come.

To obtain forecasts we need first to make some assumption conerning future real prices for sawn softwood. We constructed a simple time series which indicated that an assumption of constant real prices was highly defensible. This concurs with Doran (1979) and more recent unpublished work by Pearce and Markandya at University College, London.

Considering future levels of demand first, keeping real price constant in equation (1), we observe that future demand is an increasing function of real income levels, mitigated by the time trend proxy for substitutes. Rolling the model forward to the end of the century we find that a real income growth rate of approximately 1.5% per annum is necessary to maintain a constant level of total demand. This steady-state demand is typical of the last decade of the time series and, as average long-term rates of real income growth are likely to be of this order, we can defensibly predict a fairly stable or slowly growing total UK demand for sawn softwood up to the end of the century.

Given our forecast of total demand, what levels of home production and import penetration are likely? Here, the limitations of a time trend approach become apparent as production-lagged changes to planting trends within the home-grown sector filter through to the market. If the time trend of home production were to continue undisturbed we could expect domestic sawn softwood output to double its 1988 level by 1994. Considering Figure 2 this is clearly not an unreasonable forecast. However, it is unlikely that this growth would continue consistently unabated into the future. At some point a new factor will enter the system: the limitations imposed by the total area of previous UK planting. During the model's time series this has not been a problem as the rapid post-war planting expansion has facilitated the recent increase in domestic output. However, this planting expansion rate slowed (whilst still rising in absolute terms) during the late 1950s and 1960s (Forestry Commission, 1987, 1988). Whilst this still allows for a considerable increase in domestic production, it is likely to be a limiting factor to domestic output expansion as we approach and enter the next century. For this reason we do not extend our forecasts of home production beyond those given.

The model suggests a number of avenues for future research. Our recommendations concerning additional work in this area include the investigation of the limits at which home production might become demand-constrained and a detailed examination of both the uptake of grants and other production incentives, and the true economic value of this production.

Notes

1. This excludes land held by the Forestry Commission but considered unsuitable for production.
2. To confirm our assumption of price exogeneity, a simultaneous equation model was also considered and estimated, but with little success. This would appear to justify our view on price exogeneity.
3. A coefficient of 1.0 suggests a perfect inertia situation (cf. the Cobweb model, common in studies of agricultural supply), whereas a coefficient of 0.0 indicates a perfect adjustment.

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