Forestry Commission

Bulletin 68

Price-size Curves for Conifers

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1. Introduction

This Bulletin describes the development of the long-term price assumptions used by the Forestry Commission for estimating future timber revenues.

Over recent years timber prices have fluctuated greatly. Figure 1 illustrates the changes in the real price of standing coniferous timber which have taken place between 1957 and 1985. The graph illustrates that the price ruling at any one time is not necessarily a good indication of the final value of a crop which will be felled several or more years in the future. However, available information of past price movements can be used in helping to form a view about the likely level of future prices. In this study a detailed set of prices, those for the Commission's standing sales, has been statistically analysed. These results, together with some additional information, have formed the basis for the Forestry Commission's new price-size curves. 'Price-size curve' is a

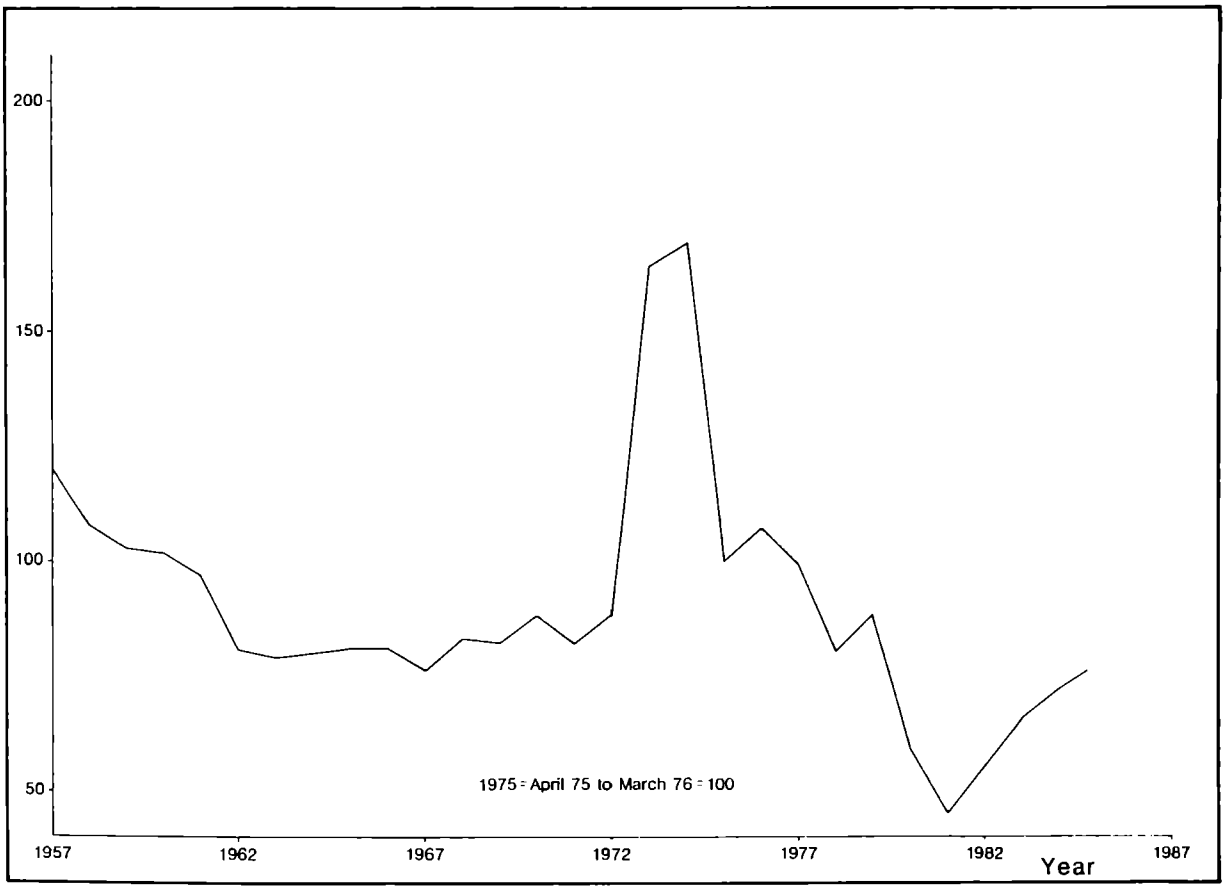

Figure 1. Forestry Commission standing sales index of conifers (all sizes).

summary term used to describe the functional relationship between a set of mean tree sizes and a set of real prices.

The data which have been used in the study and factors which may be important determinants of price are discussed in Section 2; the development of the statistical model and the results of the regression analysis are given in Section 3 and Appendix 2; and the further assumptions which have been made in order to move from the set of statistical results to the final set of timber prices are explained in Section 4. The conclusion is contained in Section 5 and the final price-size curves are illustrated in this Chapter and the values given in Appendix 1.

2. The Data

The standing sales data for conifers were chosen for this study because they are the most detailed figures available. Average tree sizes and prices have been recorded from 1957 to the present day. A new set of average prices is published every 6 months and these figures relate to the 12 preceding months. A typical entry is shown in Table 1. As can be seen, there are seven size categories in which the average price received is recorded for each country in Great Britain. The total volume sold in each size category is also noted.

Factors which may be important in determining price

There are several factors which may be important in determining price. The main ones are thought to be:

Size
Location
Year of sale
Species
Quality

The paragraphs below discuss these factors in more detail. The standing sales data include some information about the first three but not the remaining two.

Average tree size

The data used are broken down into six or seven general size categories. The size categories have changed over the period of the study and data from early years have had to be made compatible with data from later years by converting volume from imperial to metric units. Most of the timber sales in Great Britain fall within the range 0.063-0.258 m^3 and the average prices provide detailed information about these tree sizes. A lack of data for both the largest and smallest size categories means that there are estimation problems at either end of the curve. This problem is discussed at greater length in Section 4.

Location

Significant price differences may occur between different regions. Some of the causes for this, e.g. species and quality distribution, are discussed in detail below. Other causes include: the effect of terrain and mean coupe size on harvesting cost; the distance and transport cost to markets; the strength of local markets in relation to the availability of local supplies. The standing sales data record, for each size category, the average prices for England, Scotland and Wales. This provides information about the differences between each country's prices and the relative movements in these price levels which have taken place between 1957 and 1984.

Time

Movements in timber prices over time occur for many reasons. In Britain a large proportion of timber requirements are met from imports, and prices are strongly influenced by the price at which timber is imported. These, in turn, reflect changes in demand and supply across the world. Factors affecting world demand for timber include: economic growth rates; population growth rates; the availability of substitutes for wood and the scope for wood to substitute for other products; the development of new wood products; and the development of new technology which can be used in producing traditional timber products. Changes in the costs of primary and secondary processing are also relevant because they influence the final selling price. The available supply of wood also changes over time. In the long run it is influenced by the regeneration of existing forests and the extent of new plantation areas. In the short run it is affected by cutting regimes, costs of harvesting, extraction and transport, the need for foreign exchange in the case of the planned economies, import quotas and other restrictions on trade. The price series also moves broadly in line with prices of other raw materials and is subject to similar speculative movements. Prices are also influenced by movements in exchange rates between sterling and the currencies of our major trading partners. These factors change over time and timber prices adjust accordingly.

Species

Species is also a factor which may be significant in determining prices. The standing sales data are based on all conifer sales and do not discriminate between different conifer species so an investigation of this factor

Table 1. Sales contracts for standing coniferous timber from Forestry Commission areas: average price for each country

(a) 1 April 1982 to 31 March 1983 (b) 1 April 1983 to 31 March 1984

Average volume per tree (m^3)		England			Scotland			Wales			Great Britain		
		Volume m^3	Total price £	Average price £/m^3	Volume m^3	Total price £	Average price £/m^3	Volume m^3	Total price £	Average price £/m^3	Volume m^3	Total price £	Average price £/m^3
Up to 0.074	(a)	24 901	98,182	3.943	14 040	16,182	1.153	4 148	8,035	1.937	43 089	122,399	2.841
	(b)	16 984	62,156	3.660	6 474	9,825	1.518	3 126	9,635	3.082	26 584	81,616	3,070
Over 0.074	(a)	71 349	383,707	5.378	49 092	108,708	2.214	53 984	129,293	2.395	174 425	621,708	3.564
to 0.124	(b)	77 826	441,434	5.672	33 660	82,885	2.462	41 460	225,801	5.446	152 946	750,120	4.904
Over 0.124	(a)	46 663	304,852	6.533	37 016	151,071	4.081	36 612	130,667	3.569	120 291	586,590	4.876
to 0.174	(b)	45 160	321,925	7.129	54 947	211,395	3.847	39 641	213,708	5.391	139 748	747,028	5.346
Over 0.174	(a)	20 124	130,924	6.506	20 029	98,777	4.932	29 754	157,848	5.305	69 907	387,549	5.544
to 0.224	(b)	20 934	200,701	9.587	17 360	80,468	4.635	33 852	264,078	7.801	72 146	545,247	7.558
Over 0.224	(a)	11 102	83,632	7.533	27 535	140,908	5.117	20 538	120,127	5.849	59 175	344,667	5.825
to 0.274	(b)	14 025	142,585	10.166	26 197	168,001	6.413	29 438	343,702	11.675	69 660	654,288	9.393
Over 0.274	(a)	11 659	141,693	12.153	69 747	471,755	6.764	24 136	196,521	8.142	105 542	809,969	7.674
to 0.424	(b)	17 921	216,488	12.080	83 889	611,181	7.286	37 021	490,239	13.242	138 831	1,317,908	9.493
Over 0.424	(a)	56 577	900,354	15.914	88 807	769,036	8.659	81 195	1,102,263	13.575	226 579	2,771,653	12.232
	(b)	62 250	1,121,526	18.016	119 812	1,179,870	9.847	48 221	1,025,638	21.269	230 283	3,327,034	14.447
Total	(a)	242 375	2,043,344	8.431	306 266	1,756,437	5.735	250 367	1,844,754	7.368	799 008	5,644,535	7.064
	(b)	255 100	2,506,815	9.827	342 339	2,343,625	6.846	232 759	2,572,801	11.053	830 198	7,423,241	8.942

has not been possible. It should be noted that it is unlikely that any premium or penalty attached to a particular species will be a consistent figure throughout the full length of the curve.

Quality

Timber of a higher quality usually commands a premium price. This is more likely to be important for large logs than for small roundwood. Unfortunately there is no detailed analysis available on the importance of this factor over the long-term and the standing sales data do not record a quality classification. Some initial investigations of data from recent auction sales suggest that, once allowance has been made for location and size, this factor is not a significant determinant of price. However, this conclusion is only based on 2 years of data.

Conclusion

The data set chosen – standing sales prices – is detailed enough to allow the analysis to explore changes in price due to average tree size, country location and the period in which the timber has been sold. The importance of price differentials resulting from species or quality differences cannot be assessed.

3. The Statistical Analysis

This section describes the development of the econometric model which relates mean tree size to prices. It discusses the factors which have been considered in the analysis and how they have been included. A full description of the results is given in Appendix 2.

The basic functional form used in the analysis is an exponential function which is illustrated in Equation 1 below,

$$P = aS^f \quad \textit{Equation 1}$$

where P is the mean price per m^3 and S is the mean tree size.

The advantages of this formulation are that it allows simple equations to have a large explanatory power and is likely to require fewer coefficients to be estimated than an alternative functional form, e.g. a polynomial function.

An additional variable S^{kS} has been added to give greater flexibility to the model, as shown in Equation 2.

$$P = a\,S^f\,S^{kS} \quad \textit{Equation 2}$$

The data have been transformed using a natural logarithmic function to allow the equation to be estimated using multiple linear regression techniques, as in Equation 3.

$$LnP = a + fLnS + kSLnS \quad \textit{Equation 3}$$

Section 2 identifies several factors which may be important determinants of price. The analysis has attempted to consider these and the manner in which each has been incorporated is discussed below. Dummy variables have been used to help assess the relative importance of these factors. (For an explanation of the use of dummy variables see Chapter 9 in *Econometrics* by G.S. Maddala (1982), published by McGraw Hill.)

Time

The price index illustrated in Figure 1 shows that there is no clear trend evident in the data. Prices from year to year have been volatile, particularly so in the early 1970s. It was decided that the best way to model this would be to allow arbitrary variations from year to year by the use of a dummy variable on the constant term. Successive years could then be grouped together where the test statistics indicated that the coefficients on adjacent years were not significantly different.

Although a time trend is not immediately evident from a visual examination it was decided to investigate further the possible influence of this variable. Several amendments to the model have been made and these additions, illustrated in Equation 4, ensure that both the level and shape of the curve are able to change over time. ('t' represents the trend variable which is equal to year – 1900, e.g. for 1984, t = 1984 – 1900 = 84).

$$LnP = a + b_iD_i + \frac{d}{t} + fLnS + \frac{g(LnS)}{t} + \frac{h(LnS)}{t^2} + kS(LnS) \quad \textit{Equation 4}$$

Location

Price may be influenced by the location of sale. An indication of the country of origin has been incorporated into the model in a number of ways to allow a range of possible effects to be explored. The use of a dummy variable, D_j, on the constant term permits the significance of percentage price differences between countries to be investigated. The inclusion of a dummy variable on the trend term, 1/t, and on the term LnS, allows the country differentials to alter across time and within the range of different sizes.

The final model is give in Equation 5

$$LnP = a + b_iD_i + c_jD_j + \frac{d_jD_j}{t} + f_jD_j\ LnS + \frac{gLnS}{t} + \frac{hLnS}{t^2} + kSLnS \quad \textit{Equation 5}$$

where D_i represents the dummy variable for the year, such that

D_i = 1 for year = i
= 0 for year ≠ i

and D_j represent the dummy variable for the country, such that

D_j = 1 for country = j
= 0 for country ≠ j

Conclusion

The final model shown in Equation 5 is a result of testing down from a more general initial specification. All variables are significant apart from some of the yearly dummies and the SLnS term. In the case of the yearly dummies, this simply indicates that the influence of these years is similar to that of the base year, 1957/58, used in the country dummy variable analysis. The SLnS term has been retained because it has been shown to be significant when considering the first 20 years of the data set. When regressing the data using the model given in Equation 5, the resultant R^2 is equal to 0.891, indicating that almost 90 per cent of the variation in the data is explained.

4. Deriving a Price-size Curve

The regression analysis has drawn on all the available data. However, in drawing conclusions about the value of future prices, several remaining factors need to be taken into account. Three of these derive directly from the form of the equation itself. Two more result from shortcomings in the available data. This chapter identifies the questions that remain and describes the assumptions which have been used to derive the curves given in Appendix 1.

In using the model described in Equation 5 to estimate a set of price-size curves appropriate to any specific year, two values need to be input into the estimating equation: a value for b_i, the coefficient on the yearly dummy variable, and a value for 't', the time trend. When considering the future, assumptions about these values must be made.

The future price level

The coefficient b_i indicates the specific effect which any given year has on the constant term in the equation. In the price-size curves shown in Appendix 1 the long-term value of b_i has been estimated by calculating the average value of the set of yearly coefficient values from 1957 to 1984. Each coefficient value has been weighted by the volume in each volume category for each year. The long-term value for the coefficient is -0.6192. Using the average value of b_i over the period under analysis as the best possible approximation of the long-term value of b_i means that prices are expected to rise from their level in April 1983/84 – the last period used in the statistical analysis. The figures imply a rise of 1.1 per cent per annum if they are to return to their long-term average level in 25 years or 0.55 per cent per annum if this is not achieved until 50 years hence. The time-path is, of course, unlikely to be smooth, for example in 1985/86 prices in real terms were 5.5 per cent higher than 1983/84.

The assumption that the long-term value for b_i can best be represented by its average value between 1957 and 1984 has been made because there is no clear evidence for a trend of increasing or decreasing timber prices in Britain during the post war period. It must be recognised that this assumption of long-term constant prices is not universally accepted and reports made by some other organisations predict real price increases, see Table 2. However, in some cases these predictions have been based on the rapid rise in the price of timber products which occurred in the early 1970s but which was followed by a dramatic fall.

The 'year' of estimation

The value of 't' affects the value of the fourth, sixth and seventh components of Equation 5 and is important in determining the final shape of the curve. In the statistical analysis, the variable 't' takes the value of the year in which the price observation is made. As discussed above, changes in the shape of the curve (i.e. the relative price received for different sizes of tree), may result from factors which alter the demand or supply for a particular size of timber, e.g. harvesting or processing technology, new products, etc. Over the period considered the curve has become more linear, that is, less bowed, in shape. However, there appears to be no reason why this trend should continue, nor is it thought reasonable to predict any change in any particular direction. The shape of the long run curve has therefore been fixed at its current shape by entering a value appropriate to 1985 for 't' in the estimating equation.

Table 2. Estimated increases in real prices

Year	Source	Product	To 2000	To 2025+
1977	Forestry Commission	All wood products	Approximate balance of supply and demand	Moderate increase
1979	World Bank	Sawn softwood	+ 2½% per annum	
1980	Centre for Agricultural Strategy, Reading	Roundwood in general	+ 30% over 20 years	+ 100-150% over 50 years
1980	US Forest Service	Standing timber: Softwood Hardwood	+ 0.8 – 2.9% p.a. + 0 – 0.2% p.a.	+ 0.6 – 2.5% p.a. + 0 – 0.6% p.a.

The country price differential

The initial statistical analysis hypothesised that each country might have a different shape and level for the price-size relationship. The results indicate that there have been significant differences between countries over the period considered. However, it was thought unlikely that the differential between English and Welsh prices, evident early in the period, will continue in future years. In recent years price movements have indicated that merchants are increasingly aware of, and are reacting to, prices in other regions. In 1985, prices in English and Welsh markets have been nearly identical suggesting that they now form one market. It was therefore decided that future prices in these countries could best be represented by a single curve, with a second curve being used for Scotland where there is still evidence of a significant price differential. This aggregation reduces the value for R^2 from 0.891 to 0.873.

Estimating prices for small and large sizes of timber

The regression equation is based on data from trees with an average mean tree size of between 0.07 m^3 and 0.65 m^3. It would not be statistically sound, however, to form the lower and upper reaches of the curve by simple extrapolation. These problems are discussed below in more detail, looking first at the smaller size categories and second at the larger ones.

The statistical results are biased at the lower end of the curve because there are no negative price observations. The cost of harvesting some stands of small average volume exceeds the value of the timber either felled or thinned, and standing sale merchants would need to be paid to do these jobs. The price required would vary depending on such factors as tree size and location of the site. (In practice these stands are allowed to grow to a larger mean tree size when sale becomes profitable.) However, these cases cannot be recorded and in the smaller sizes the data set has a biased population as it contains only those stands which earn positive prices. The curve identified by the regression analysis is therefore biased upwards at the lower end. Dealing with this problem requires a judgement of the marginal tree size, i.e. the tree volume for which the price is zero, or the point where the curve crosses the X axis. This tree size has been estimated after considering past values. The values have been set at 0.07 m^3 for Scotland and 0.06 m^3 for England/Wales. This has enabled adjustments to be made to the lower end of each curve so that it is a better representation of average prices in the smallest size categories.

At the top end of the curve there is simply an absence of data. Sufficiently detailed standing sales information has not been recorded because the total volume sold in these categories has been too small to justify disaggregation. The bulk of sales are still below 0.6 m^3, although the increase in sales of larger trees has led recently to separate statistics being kept for a range of sizes between 0.5 m^3 and 1.0 m^3.

The shape and level of the curve at the top end has been formed by considering harvesting and processing costs. The harvesting cost curve is relatively flat from 0.7 m^3 onwards indicating that this factor can account for little additional value in larger trees. Processing costs, which also influence the value of the standing trees, are a more complicated story as unit costs for different tree sizes are related to the total volumes available of trees at given sizes. In general, recovery of sawnwood is greater in larger trees. Sawnwood of larger dimensions which is obtainable from larger trees is usually more valuable. However, some sawmills have invested in capital equipment which is designed to cope with smaller tree sizes and in these circumstances larger sized trees can be more expensive to process.

The price range which is found at the top end of the curve is much greater than that for small sizes. Timber

quality can be important. In some cases, high prices have been earned by supplying large logs to particular markets. However, where these markets have limited growth potential, it would be misleading to extrapolate from this evidence to the conclusion that a larger quantity of logs could achieve these prices if they were made available. In setting prices at the top end of the curve attention has been give to each of the above factors. The prices used are consistent with what is known about previous price differentials between smaller and larger trees and between the two broad regions used in the analysis.

Conclusion

This chapter has described the development of the final set of price-size curves. This process started with the statistical analysis of price movement over the last 27 years and went on to consider appropriate values for the long-term average level of prices and the trend term in the equation. Consideration has also been given to the validity of long-term country price differentials and an attempt has been made to adjust for a known bias in the data at either end of the curve.

5. Summary and Conclusions

The Forestry Commission's conifer price-size curves set out in Appendix 1 result from a detailed statistical analysis of standing sales data. Multiple regression analysis has been used to explore the relationship between price and three determinants: average tree size, country location and time of sale. Alternative methods of estimation have been used at the top and bottom of the curve in order to estimate the marginal tree size and prices for larger sized trees.

In calculating the final values for the long-term price-size curve it has been assumed that the value of the coefficient for the year dummy variable on the constant can best be determined by taking its average level over the last 27 years. The time trend, important in determining the final shape of the curve, has been held at its value for 1985; there being no available information to indicate the direction in which these influences will move. For the purposes of valuation Britain is divided into two regions, England and Wales forming one region, where higher prices prevail, and Scotland where prices are significantly lower *(Figure 2)*.

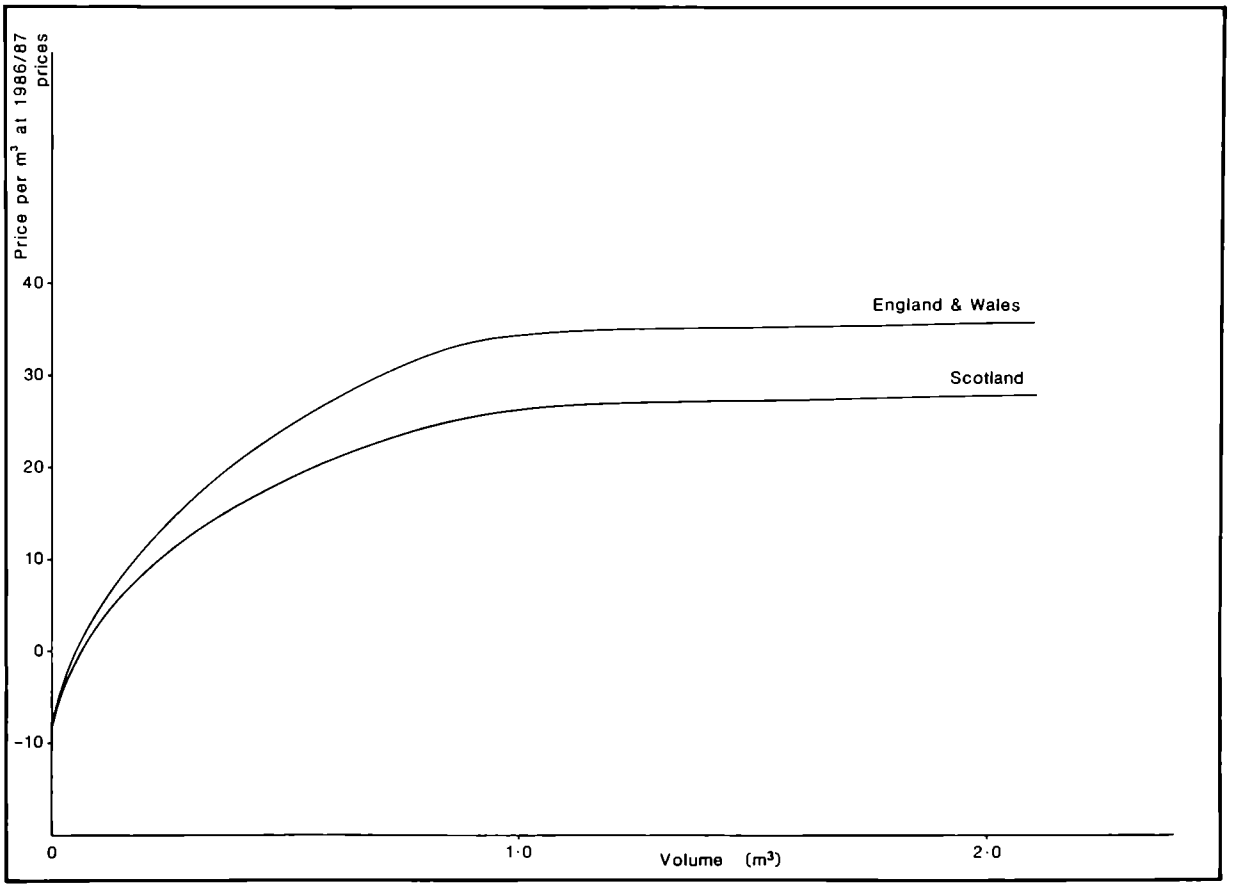

Figure 2. Price-size curves for the Forestry Commission's 1986/87 quinquennial review.

The price-size curves in Appendix 1 use the most detailed long-term information available. They have been designed for general long-term valuations and are not ideal for location specific or short-term valuations. In the future it is hoped to look in detail at some remaining factors, including species, quality, location (by district) and method of sale.

Appendix 1

Price-size Curve – England and Wales at 1986/87 Prices

Average volume per tree (m^3)	£/m^3	Average volume per tree (m^3)	£/m^3
0.01	– 8.33	0.35	19.26
0.02	– 5.72	0.40	21.03
0.03	– 4.06	0.45	22.59
0.04	– 2.50	0.50	24.25
0.05	– 1.04	0.60	27.27
0.06	0.00	0.70	29.87
0.07	1.56	0.80	32.27
0.08	2.81	0.90	33.30
0.09	3.96	1.00	34.04
0.10	4.89	1.10	34.45
0.11	5.78	1.20	34.76
0.12	6.66	1.30	34.97
0.13	7.49	1.40	35.18
0.14	8.33	1.50	35.29
0.15	8.95	1.60	35.39
0.16	9.78	1.70	35.49
0.18	18.93	1.80	35.60
0.20	12.18	1.90	35.70
0.22	13.11	2.00	35.81
0.24	14.36	2.20	35.81
0.26	15.09	2.40	35.81
0.28	16.24	2.60	35.81
0.30	17.17	2.80	35.81
		3.00+	35.81

Price-size Curve – Scotland at 1986/87 Prices

Average volume per tree (m^3)	£/m^3	Average volume per tree (m^3)	£/m^3
0.01	– 8.33	0.35	14.78
0.02	– 5.72	0.40	16.03
0.03	– 4.68	0.45	17.38
0.04	– 3.75	0.50	18.63
0.05	– 2.39	0.60	21.03
0.06	– 1.04	0.70	23.11
0.07	0.00	0.80	24.67
0.08	1.04	0.90	25.81
0.09	1.77	1.00	26.23
0.10	2.60	1.10	26.54
0.11	3.75	1.20	26.75
0.12	4.68	1.30	26.96
0.13	5.41	1.40	27.17
0.14	6.14	1.50	27.27
0.15	6.71	1.60	27.37
0.16	7.29	1.70	27.48
0.18	8.12	1.80	27.58
0.20	9.16	1.90	27.69
0.22	10.10	2.00	27.79
0.24	11.03	2.20	27.79
0.26	11.66	2.40	27.79
0.28	12.49	2.60	27.79
0.30	13.32	2.80	27.79
		3.00+	27.79

Appendix 2

The Statistical Analysis of the Price-size Relationship

This appendix gives some additional information on the statistical analysis of the price-size relationship.

The data

Prior to estimation the data were transformed to express all prices in common units, using 1980 prices as the price base, and adjusting for changes in measurement which had occured over the period.

The model

The model which has been used is described in Section 3. The regression results are given below; coefficient values and 't' ratios are reported. The first table, Table 3, contains the results from an early regression estimation where all three countries were considered individually. The second table, Table 4, contains the results with England and Wales treated as a single unit.

Weighting

Each observed price is derived from a varying number of individual sales. Ideally the number of sales, and the individual sale volumes, from which each observation is derived should form the basis for weighting the observations. However, these data are not available and the total volume used in calculating the average price has been used as a proxy. Each observation has therefore been weighted by the appropriate total volume sold in that size category.

The regression coefficients and test statistics

The regression coefficients and test statistics are given in Table 3 and Table 4. The second of these tables contains the results from a second regression estimation which combined England and Wales in the country dummy variable analysis. (See Section 4 for a discussion of this amendment). As is shown, adjacent years where the individual coefficients on the dummy variable attached to the constant are not significantly different from each other have been aggregated together. This has resulted in 17 final time periods. Prices in 1973 changed markedly and it was not possible to combine the two entries for that year, therefore each data set has been separately identified in the dummy variable analysis, 73A and 73B. The tables include the coefficients on time periods which are not significantly different from zero.

Table 3

	Variable	Coefficient value	t statistic
Constant		4.455	22.32
Year dummies	58	–	–
	59/61	−0.54	−7.17
	62	−0.79	−8.22
	63/66	−0.81	−7.65
	67/70	−0.76	−6.35
	71/72	−0.67	−5.19
	73A	−0.42	−3.06
	73B	0.01	0.65
	74	0.174	1.29
	75/76	−0.314	−2.30
	77	−0.345	−2.46
	78	−0.699	−4.94
	79	−0.749	−5.27
	80	−0.911	−6.35
	81	−1.453	−10.06
	82	−1.279	−8.80
	83/84	−1.075	−7.34
Country dummies	Eng	–	–
	Scot	−0.50	−12.32
	Wales	−0.53	−8.61
Time	Eng/t	−16.10	−6.25
	Scot/t	−10.41	−9.40
	Wales/t^2	−85.70	−6.63
Size	Eng LnS	1.1672	29.02
	Scot LnS	1.2274	30.73
	Wales LnS	1.2514	30.76
	S LnS	−0.081	−0.54
	LnS/t	−22.26	−16.52
	LnS/t^2	−104.61	−10.48
	$R^2 = 0.891$	N = 1171	

Table 4

	Variable	Coefficient value	t statistic
Constant		4.106	16.54
Year dummies	58	–	–
	59/61	−0.464	−5.61
	62	−0.687	−6.41
	63/66	−0.689	−5.65
	67/70	−0.616	−4.32
	71/72	−0.515	−3.31
	73A	−0.254	−1.55
	73B	0.166	1.01
	74	0.331	2.02
	75/76	−0.149	−0.89
	77	−0.178	−1.04
	78	−0.523	−3.01
	79	−0.582	−3.32
	80	−0.747	−4.21
	81	−1.284	−7.17
	82	−1.109	−6.13
	83/84	−0.900	−4.93
Country dummies	Eng and Wales	–	–
	Scot	−0.3759	−10.47
Time	(Eng/Wales)/t	−11.42	−5.16
	Scot/t	−7.97	−3.68
Size	(Eng/Wales) LnS	1.2318	28.83
	Scot LnS	1.1981	28.42
	S LnS	0.028	0.17
	(LnS)/t	−22.40	−15.60
	(LnS)/t^2	−108.6	10.26
	R^2 = 0.873	N = 1171	

This simply means that the price levels ruling in these time periods are similar to those in the base period 1957/58 and they have been left in the table for clarity.

The remaining coefficients are well determined except for the SLnS term. It was decided to retain this variable because it has been significant in determining prices in some earlier explorations of the data.

An example

The following equation illustrates how the statistical results can be used to estimate prices for a particular year and country. In this case the country is Scotland and the year is 1980. The coefficients are taken from Table 4. The first term is the constant and the second the value of the year dummy variable on the constant (the coefficient for 1980 has been used). The third value is the country dummy variable constant coefficient and the fourth component the country dummy variable as it alters with time. The fifth, sixth, seventh and eighth terms are all dependent on the size of the timber with the fourth term being the term which considers the relationship between Scotland and size. In order to calculate a set of prices, set 't' equal to 80 (1980-1900), and insert a series of values for S, the tree size.

$$\text{LnP}_i = 4.106 + -0.747 + -0.3759 + -7.97(1/t) + 1.1981\ \text{LnS}_i + -22.4\ (\text{LnS}_i/t) + -108.6\ (\text{LnS}_i/t^2) + 0.028\ S_i\text{LnS}_i$$

where S_i is the set of size categories and
P_i is the price for each size category.

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