Forestry Commission

Revised Forecasts of the Supply and Demand for Wood in the United Kingdom

Adrian Whiteman

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Front cover: Photographs courtesy of Forest Life Picture Library

A note on data sources

Figures on prices, consumption and production covering the period 1956–86 were obtained from the *Yearbook of forest products* (United Nations, 1988 and earlier). More recent volumes of this yearbook were used to compare the forecasts with outturns over the period 1987–92. The forecast of future wood supply comes from Forestry Commission sources supplemented by information from the Northern Ireland Forest Service. Due to different classification systems, and the difference between statistics applying to the United Kingdom and those for Great Britain only, some of the figures derived from United Nations sources do not match those presented in Forestry Commission publications (e.g. Forestry Commission *Facts and figures*).

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CONTENTS

Summary

This paper is a revision to an earlier paper on the same subject (Whiteman, 1991). It presents models of wood supply and wood product demand for the United Kingdom to the year 2050. The model of wood supply presented in the paper is based on the most recent production forecast for Great Britain (1996) and Northern Ireland. The models of wood product demand are based on an econometric study of consumption over the period 1956–86.

Most of the new material presented in the paper is concerned with the forecast of timber supply. This has been adjusted to take into account more recent information about trends in planting, felling and management practices, and the sensitivity of the forecast to a variety of economic and policy-related factors has also been examined. The models of wood product demand used in the paper have not been changed, but the forecasts have been updated to take into account new projections of explanatory variables and changes in the conversion factors used to get from product volumes to standing timber volumes. The paper also examines the effect of wood residues and paper recovered for recycling on the supply and demand balance.

The forecasts show that it is likely that wood supply will increase with demand up to 2025. After that, if no new planting is undertaken, supply will fall while demand will continue to rise, although the forecast of demand after 2025 is subject to a wide margin of uncertainty. In practice, both new planting and efforts to reschedule production may have the effect of reducing the peak in production. A continuous level of supply would be desirable for the development of the domestic wood processing industry, so the paper also examines the level of new planting that would be required to bring this about.

Chapter 1

Introduction

The first major study of the UK wood market was *The wood production outlook in Britain* (Forestry Commission, 1977). A later study of wood supply and demand in Europe published by the Economic Commission for Europe (United Nations, 1986) also included a section on UK supply and demand, but in only an abbreviated form (a revision to this publication is also currently being prepared). The most recent study of UK supply and demand was published in 1991 (Whiteman, 1991).

The 1991 study proved to be quite popular, and was quoted many times by the forest industry and forestry press. Much of the interest in the study centred around the supply forecast it contained and in particular, the policy implications of the peak in wood supply it showed occurring in about 30 years time. Since then, new data have become available with which the harvesting plans of the UK forestry sector can be predicted, so it was decided to revise the supply and demand forecasts, and this publication is the result of that exercise.

The remainder of the paper is in four sections. Chapter 2 describes the market for wood and outlines the main features of supply and demand in the UK. Chapter 3 summarises the demand models that were constructed previously and discusses the changes that have been made to the demand projections in this paper. The forecasts are then presented at the end of this chapter. Chapter 4 presents the revised supply forecast, and discusses the sensitivity of the forecast to a range of scenarios about future timber prices, forest growth, and harvesting policies. The final chapter compares future supply and demand in terms of wood raw material equivalents (WRME), taking into account the supply of wood residues from the sawmilling industry and the availability of paper recovered for recycling. This chapter also discusses some of the policy implications of the future supply and demand balance.

Chapter 2

The market for wood

Wood and wood products have played an important and varied role in human activity. An early example of industrial use was the production of charcoal for iron smelting, and the use of wood as fuel is still crucial in many parts of the world today. Nowadays, wood is needed for many industrial and domestic purposes in the UK where, on the basis of the revised information in this paper, every person consumes the equivalent of about 1.3 cubic metres of wood each year.

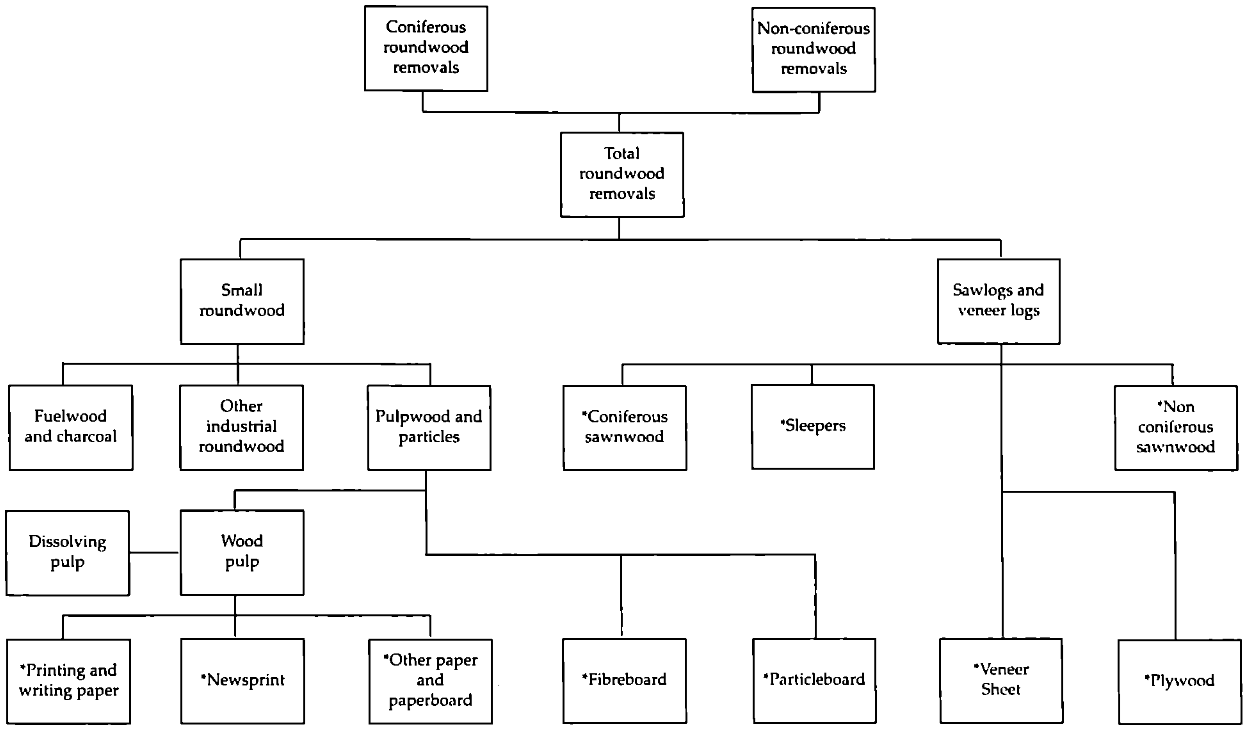
For some products such as fuelwood or fence posts, the conversion from standing tree to end product is simple. There are, however, many products – ranging from floor joists to high quality writing paper – that require a series of industrial processes, creating important markets for intermediate products. Consumer demand for finished products depends, among other things, on income, prices of the product and substitutes for it, and tastes. Even where the finished product is used by industry, ultimate demand for the roundwood from which it is derived depends upon the consumer because consumer demand determines the level of activity in that industry.

In order to model demand, it is useful to distinguish between raw materials and intermediate products which are sold to the wood processing industry; and finished products for use in other industries or household consumption. It is only necessary to construct demand models for finished products because demand for raw materials and intermediate products is a derived demand, i.e. it can be estimated from the demand for finished products by means of conversion factors. In this paper, 11 categories of finished wood product are analysed. These categories are based upon the FAO classification of forest products (see United Nations, 1988, for a more detailed description of what each category contains). Figure 1 shows the relationship between roundwood supply and each of these products; no distinction is made between home grown and imported timber in this diagram.

The market for wood products in the UK is characterised by a large import sector and, with the exception of some of the panel products, a large number of firms supplying the relatively small proportion of demand met by domestic production. Figure 2 shows the total supply and demand balance for wood and wood products in the UK, and shows that self-sufficiency in wood products (excluding material recovered for recycling) stood at about 10.5% in the years 1989–91.

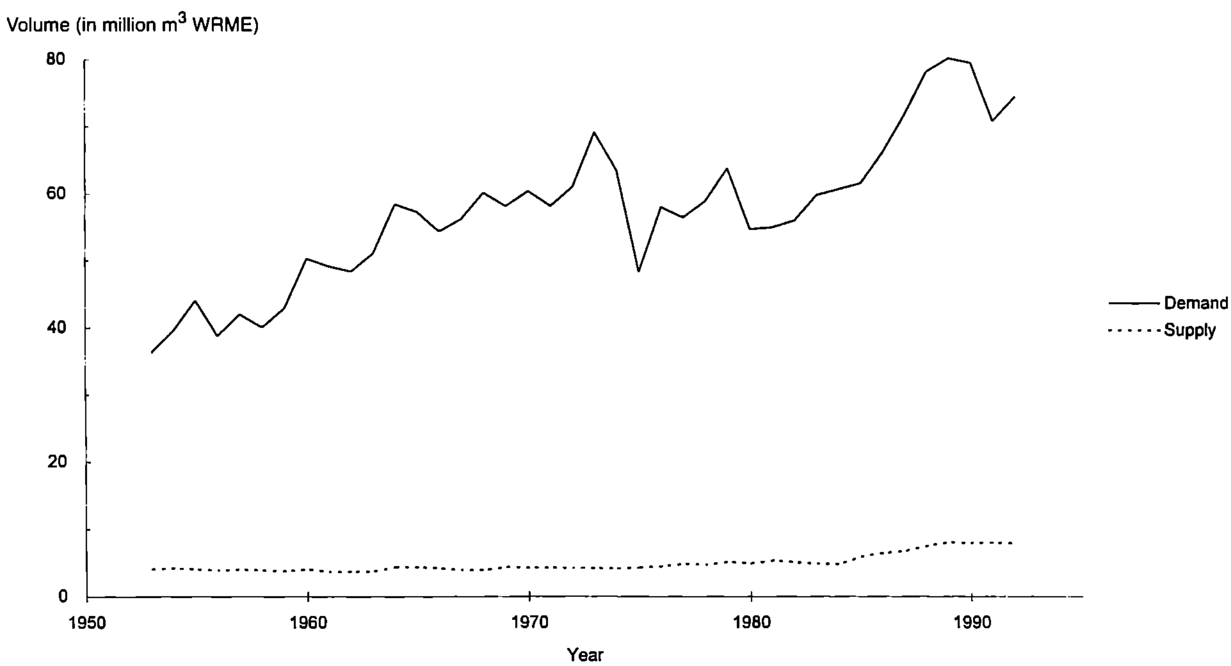
Such a high level of imports means that the domestic price of wood is effectively set by the world price (i.e. the UK is a price-taker on world markets). This, in turn, determines the level of domestic demand which then determines the amount of wood imported each year. Price may also affect domestic supply but, as Chapter 4 will demonstrate, the effect of price changes on domestic supply is only slight in comparison to the total demand for wood. Because domestic supply is very small compared to world supply, it also has little impact on world timber prices. This means that UK wood supply and demand can be modelled as separate systems, because one does not affect the other through the price mechanism.

Figure 1 The linkages between roundwood and wood products



Notes: * = final products
Recycling/residue interactions are not shown

Figure 2 UK roundwood supply and wood product demand 1953–1992 (expressed as wood raw material equivalent or WRME)



Note: The line for consumption shown above has been constructed using the latest WRME conversion figures which differ significantly from those which have been used before.

Table 1 shows the main countries supplying the UK wood market across a range of wood products. The majority of imported wood products made from coniferous timber (coniferous sawnwood, wood pulp, and fibreboard) comes from the countries of Northern Europe and North America having large forest resources. The exception to this is particleboard, most of the imports of which come from Western Europe. The proportion of imported products made from tropical timber (non-coniferous sawnwood and most plywood) has declined over the last 5 years to about one-third of current consumption. In contrast, the proportion of UK consumption met by domestic supplies has increased, although it still remains quite low in most product categories.

The table shows that a substantial proportion of UK paper consumption is met by domestic supplies. However, this figure must be treated with caution because the table also shows that a large proportion of the demand for wood pulp (the intermediate product derived from roundwood and used to make paper) is met by imports, so the proportion of UK paper demand met by paper produced from UK roundwood is quite small. Very little roundwood is imported, so most domestic production of wood products other than paper represents production from UK roundwood supplies. In 1993, the Forestry Commission accounted for 61% of these roundwood supplies in Great Britain.

Table 1. Major countries supplying the UK wood market in 1992 (in per cent)

Countries	Coniferous sawnwood	Non-coniferous sawnwood	Plywood	Particleboard	Fibreboard	Wood pulp	Paper and paperboard
United Kingdom	25	22	–	63	28	26	53
Temperate forests							
Canada	21	4	5	–	3	16	6
Russian Federation	7	–	4	–	2	1	–
Sweden	17	–	–	1	–	10	15
Finland	8	–	3	2	–	10	14
USA	1	14	24	–	6	17	3
Tropical forests							
Brazil	–	6	7	–	1	3	1
Malaysia	–	24	7	–	–	–	–
Indonesia	–	2	17	–	–	–	–
Others	21	28	33	34	60	17	8

Note: Individual trade flows vary from year to year (for example, imports of sawnwood from Canada fell significantly in 1993), but the above figures are broadly indicative of the countries supplying the United Kingdom with wood products.

Chapter 3

Future demand for wood products

A variety of techniques can be used to make forecasts. Most of them rely on collecting historical evidence, analysing it, and using the results to arrive at some sort of prediction of what will happen in the future. So, for example, a relatively simple technique is to calculate the past rate of growth in a variable, say demand for sawnwood, and project this forward (on the assumption that demand will grow at the same rate in the future as in the past). The main difference between alternative forecasting techniques is in the methods used to analyse past data and the complexity of that analysis. However, it must be remembered that, no matter how complicated the analysis is, there are always several areas where judgement has to be used to relate the results of the analysis to what might happen in the future, and this is often a major source of uncertainty in forecasts.

A technique called econometrics was used to arrive at the forecasts of UK wood product demand presented in Whiteman (1991). Econometrics is a process combining economic theory with statistical analysis (usually regression analysis) to build models that explain past levels of the variable or variables being studied (in this case wood product demand). Economic theory is first used to define the overall expected relationship between the variable of interest and a set of explanatory variables, then statistical analysis is used to estimate the details of the relationship. Once satisfactory models are constructed (i.e. models that concur with economic theory, are statistically valid, and explain a large amount of the historical variation in demand) these are then used with projections of the explanatory variables to make forecasts.

The strength of this approach is that the forecasts produced from such models are not only based on an analysis of the data but also make economic sense. There are, however, two weaknesses in this approach. The first is that it is assumed that the relationships defined within the models will be the same in the future as in the past (however, if this assumption was not valid there would be little point in looking at historical data at all and only judgement could be used to make forecasts). The second weakness is that projections of explanatory variables are still required to arrive at final forecasts. However, this is not so much of a weakness but an opportunity to explore the future, because the models enable forecasts to be generated for a wide range of possible future scenarios.

Data on demand over the period 1953–86 were used in the construction of demand models in the 1991 forecasting exercise. Data covering the period 1987–92 have become available since then, but it was felt that the addition of these new data would be unlikely to change the relationships identified within those models significantly, and would not justify the considerable effort required to re-estimate them. This revision therefore uses the models constructed earlier to generate updated forecasts of wood product demand. The forecasts presented here are different from those presented in 1991 however, because some of the projections of explanatory variables used to make the forecasts have been updated.

The rest of this chapter presents a very brief outline of the economic theory behind the modelling of wood product demand undertaken in 1991, and shows the main results of that modelling exercise. More detail about the models can be found in Appendix 1 of Whiteman (1991). It then goes on to discuss the changes that have been made to the projections of explanatory variables, and finishes by presenting the revised forecasts for future wood product demand.

The models of wood product demand constructed in 1991

Demand for a wood product is expected to change in response to changes in two types of variable. The first of these is the product price; economic theory demonstrates that if price rises demand is expected to fall and *vice versa*. This relationship is called the demand curve, and from it the sensitivity of demand to changes in price (the elasticity of demand) can be calculated.

The second type of variable affecting demand is the demand-shifter, so called because it shifts the whole of the demand curve one way or the other. A whole range of variables might be demand-shifters. So, for example national income could be one such variable if, when national income increases, demand for the product also increases. Another common demand-shifter is the price of a substitute product; if its price falls, demand for the first product is expected to fall (all other things being equal) because the substitute becomes relatively cheaper and therefore, more attractive to the consumer. Furthermore, demand can be affected by more than one demand-shifter at a time.

The aim of econometric modelling is to identify the set of variables that best explain past changes in demand. The estimated value of the coefficients on those variables (i.e. the exact amount by which, for example, demand changes if price were to rise by, say, 10%) should also be used to check that the results of the analysis are valid. Two types of validity can be examined: theoretical validity (i.e. that the coefficients are in accordance with economic theory), and convergent validity (i.e. that they are not radically different to what has been obtained in other studies in similar areas).

In order to model demand, therefore, data were collected on product demand, product price, and a range of possible demand-shifters over the period 1953–1986. This was taken from sources including the United Nations (1988) and UK Central Statistical Office (1988 and 1989). Multiple regression analysis was then used to construct demand models for each of the 11 major finished wood products shown in Figure 1. In these models, demand was estimated as a function of the following explanatory variables:

- the price of the product;
- the price of substitute products;
- macroeconomic variables such as national income, investment and population; and
- output indicators for any industry using the product.

Economic theory suggests that the coefficient on price in the models should be negative (i.e. indicating that in periods of high prices, demand is low – all other things held constant), and that the coefficients on all the other variables should be positive.

As was expected, only a few of the above variables were significant in each of the demand models. In several cases each of the macroeconomic variables or output indicators were significant in isolation, but not in combination. This is quite common and is due to the fact that these variables have displayed similar trends in the past such that, in combination, the influence of one masks the influence of the others. In such cases, the most significant or economically plausible variable was chosen for each of the final models. Thus, for example, construction industry output was chosen as a final explanatory variable for some of the models of sawnwood and wood panel demand but not the models of paper demand. The full results of the analysis can be found in Appendix 1 of Whiteman (1991), and a summary of the main results of the modelling exercise is presented in Table 2.

Table 2. Summary results of the 1991 UK wood product demand analysis

Product	Explanatory variables identified	Price elasticity	Correction for autocorrelation	Adjusted R^2 (%)	Type of model
Fuelwood and charcoal	Previous year's demand	–	yes	NA	Autoregressive
Other industrial roundwood	Deep mined coal production 1984/85 miners strike Concrete products price	–	no	85	Log-linear, aggregate
Coniferous sawnwood	Last year's price Construction industry output Wood based panels price Concrete products price Non-coniferous sawnwood price	-0.58	no	NA	Log-linear, aggregate
Non-coniferous sawnwood	Price Construction industry output Wood based panels price Concrete products price	-0.37	no	NA	Log-linear, aggregate
Plywood	Price Construction industry output Non-coniferous sawnwood price	-0.76	no	NA	Log-linear, aggregate
Fibreboard	Price Total UK investment	-0.91	yes	NA	Log-linear, aggregate
Veneer sheets	Construction industry output Non-coniferous sawnwood price	–	yes	NA	Aggregate
Particleboard	Price Total UK investment	-0.48	yes	NA	Log-linear, aggregate
Printing and writing paper	National income	–	yes	44	Aggregate
Newsprint	Price National income	-0.32	no	38	Log-linear, per capita
Other paper and paperboard	National income	–	yes	73	Per capita

Table 2 lists the explanatory variables which were significant in explaining past levels of demand for each of the products. Some of the models displayed serial or residual autocorrelation, and this was overcome by using the Cochrane-Orcutt technique to reduce bias in the estimation of coefficients.

The table also shows the types of model chosen for the forecasting exercise. Aggregate demand and per capita demand models were constructed for each product, using both the original data and the data converted to natural logarithms. The best model in each case was then chosen on the grounds of its explanatory power and whether it was considered appropriate given the nature of the product. (For example, since newsprint is mostly consumed by individuals it was felt that it would be sensible to model this in per capita terms, but less so in the case of say, other industrial roundwood, which has been used mainly in the mining industry.) In the case of fuelwood and charcoal, none of these specifications gave good results, and the best model turned out to be an autoregressive model with demand in any year specified as a function of average demand over the period plus a proportion of the previous years deviation from that average.

The adjusted R^2 statistics show how much of the historical variability in demand was explained by the price and demand shifting variables in the models. An unbiased estimate of R^2 could not be calculated in the models where the constant had been dropped (although before dropping the constant in the sawnwood and wood panel demand models it had been higher than 80% in all cases). The price elasticities show the percentage change in demand that would be expected with a one per cent change in price (these are of course negative because as price rises, demand would be expected to fall and *vice versa*). Price elasticity could not be calculated for some of the models where a significant relationship between price and demand could not be identified.

All the explanatory variables presented above had the correct sign (i.e. the sign predicted by economic theory) and the values of their coefficients were plausible. For example, the price elasticities calculated were of a similar order to those found in other wood product demand studies. It was disappointing however, that demand curves could not be identified for fuelwood and charcoal, other industrial roundwood, veneer sheets, printing and writing paper, and other paper and paperboard. In the case of the first three products it was suspected that this was due to unreliable price data (trade in these products tends to be very limited, so the prices recorded for these products must be treated with some caution). In the case of the two paper product categories, it was not known why demand curves could not be identified, unless this was an indication that demand really was extremely price inelastic.

Projections of the explanatory variables

As was noted above, in order to forecast future demand it is necessary to have forward projections of the explanatory variables identified in the demand models. Projections of future prices and the future levels of each of the demand-shifters were therefore required.

In the case of prices, examination of historical prices showed no overall trend upwards or downwards, so the assumption was made that these would be equal to the average of real import prices over the last 10 years of the study period (1977–86). Real price data over the more recent period 1987–92 was also examined, but this gave no reason to change this assumption. The wood product prices used in the demand forecasts are shown in Table 3. The same assumption was also made with respect to the other substitute product prices.

The Central Statistical Office (1988) publishes a projection of UK resident population at 5-yearly intervals to 2015 and a further projection for 2025. This was used with a straight line extrapolation to 2050 in forecasts using per capita demand models.

The above projections are all the same as the projections made in 1991. The main changes to the demand forecasts made in this revision arose as a result of changes made to the projections of future national income (Gross Domestic Product at market prices), investment (Gross Domestic Fixed Capital Formation) and construction industry output. The new projections of these variables are given in Table 4 along with projections of the other demand shifters.

Table 3. The long-run price of wood products used in the demand forecasts

Fibreboard	170	Printing and writing paper	540
Particleboard	130	Newsprint	380
Plywood	260	Other paper and paperboard	480
Veneer sheets	420	Coniferous sawnwood	120
All wood based panel products	190	Non-coniferous sawnwood	250

Note: All figures shown are in £/m^3 (or £/MT for paper products) at 1985 prices, rounded to the nearest £10.

Table 4. Projections of the explanatory variables used in the demand forecasts 1987–2050

Variable	Years					
	2000	2010	2020	2030	2040	2050
Resident population (in millions)	58.9	59.3	59.8	60.2	60.7	61.1
National income (GDP) (in £ billion at 1985 prices)						
High projection	534	684	875	1020	1434	1835
Low projection	461	509	562	621	686	758
Investment (GDFCF) (in £ billion at 1985 prices)						
High projection	85	109	140	179	229	294
Low projection	75	83	92	101	112	123
Index of construction industry output (1988=100)						
High projection	122	128	132	137	142	148
Low projection	110	111	112	113	113	114

Note: In all per capita demand models, GDP, GDFCF, and construction output were converted to per capita figures by dividing through by population, and can be derived from the table above.

Two projections of national income were made in Whiteman (1991). The first was that it would grow by 2.5% per annum (the high projection) every year over the forecast period. This was based on an examination of past growth rates made over a very long time period. The lower projection was that, with limits to growth coming into play, growth would reduce by 0.5 percentage points over each of the 10 year periods after 2001, until a position of zero real economic growth was reached in the period 2041–2050. After some consideration, it was decided to continue to use the high growth forecast, but change the low growth forecast to a much simpler one of 1% growth per annum to 2050. This also affected the forecast of future investment which, based on historical evidence, was assumed to account for 16% of national income.

The previous projection of future construction activity assumed that this would rise in line with changes in population. This was based on the apparent correlation between construction and population over the period 1953–86, and a hypothesis that construction activity is primarily driven by increases in population. Based on this, a projection of an 8% increase in construction activity over the period 1987–2050 as a whole was made.

On reflection, it was felt that this was perhaps somewhat on the low side. For instance, while year on year population growth had averaged 0.25% per annum in the past, year on year growth in construction activity had averaged 1.25% or five times this amount. However, it was also felt that it would be unrealistic to assume that construction activity would continue to grow at 1.25% per annum because by the end of the period this projection would result in almost a doubling of construction activity per capita. As a compromise therefore, construction was projected forward for the revised forecasts at five times the rate of population growth, resulting in a 48% increase in construction activity (compared to the level in 1986) by 2050. Because of the uncertainty surrounding this variable, this was taken as a high projection and the original projection was retained as a low projection. In reality, future construction activity will probably lie somewhere between these two projections.

The revised forecasts of wood product demand to the year 2050

The revised forecasts of wood product demand are given in Tables 5 and 6.

Table 5 Forecast of future annual UK wood product demand 1987–2050 **(high growth scenario)**

Wood product category	Actual 1989–91	2000	2010	2020	2030	2040	2050
				Years			
Fuelwood and charcoal	580	350	360	370	370	370	370
Other industrial roundwood	270	270	270	270	270	270	270
Printing and writing paper	3 020	3 040	3 880	4 970	6 360	6 400	6 450
Newsprint	1 920	1 610	1 680	1 750	1 820	1 890	1 970
Other paper and paperboard	4 450	5 320	6 100	7 090	8 350	9 960	12 010
All paper products	9 390	9 970	11 660	13 810	16 530	18 250	20 430
Veneer sheets	100	150	160	160	170	180	190
Plywood	1 430	1 390	1 480	1 550	1 630	1 710	1 790
Fibreboard	490	540	660	830	1 040	1 210	1 220
Particleboard	2 900	3 120	3 920	4 910	6 150	6 310	6 360
All wood based panels	4 920	5 200	6 220	7 450	8 990	9 410	9 560
Coniferous sawnwood	10 170	10 340	10 940	11 430	11 960	12 520	13 100
Non-coniferous sawnwood	1 180	1 450	1 500	1 530	1 580	1 620	1 660
All sawnwood	11 350	11 790	12 440	12 960	13 540	14 140	14 760

Note: Paper product figures are expressed in thousand metric tonnes, all other figures in thousand cubic metres product volume. All figures are rounded to the nearest ten thousand.

Table 6 Forecast of future annual UK wood product demand 1987–2050 **(low growth scenario)**

Wood product category	Actual 1989–91	2000	2010	2020	2030	2040	2050
				Years			
Fuelwood and charcoal	580	350	360	370	370	370	370
Other industrial roundwood	270	230	230	230	230	230	230
Printing and writing paper	3 020	2 620	2 890	3 190	3 530	3 890	4 300
Newsprint	1 920	1 580	1 610	1 640	1 680	1 710	1 740
Other paper and paperboard	4 450	4 950	5 220	5 510	5 830	6 170	6 560
All paper products	9 390	9 150	9 720	10 340	11 040	11 770	12 600
Veneer sheets	100	130	130	140	140	140	140
Plywood	1 430	1 060	1 070	1 080	1 090	1 100	1 110
Fibreboard	490	470	510	550	600	650	720
Particleboard	2 900	2 770	3 040	3 330	3 640	3 990	4 370
All wood based panels	4 920	4 430	4 750	5 100	5 470	5 880	6 700
Coniferous sawnwood	10 170	9 030	9 130	9 210	9 300	9 380	9 420
Non-coniferous sawnwood	1 180	1 340	1 340	1 350	1 360	1 370	1 370
All sawnwood	11 350	10 370	10 470	10 560	10 660	10 750	10 790

Note: Paper product figures are expressed in thousand metric tonnes, all other figures in thousand cubic metres product volume. All figures are rounded to the nearest ten thousand. Start date for model is 1987 – see text.

Because the econometric models of demand were constructed from data collected up until 1986, the revised demand forecasts presented above were started from the year 1987. Demand is quite variable in the short-run however, and this explains why some of the actual consumption figures for the period 1989–91 are significantly above or below the forecasts for future periods (i.e. consumption in those years was significantly above or below the underlying trend).

Demand for fuelwood and charcoal is not expected to rise or fall over the period, but to stay at an average level of around 370 000 m^3/year, the average level of consumption in the past. The original (1991) demand model for other industrial roundwood gave a forecast of consumption declining by about 90% to 20 000 m^3/year in 2050 (reflecting the expected decline in demand for mining timber). However, UK production of the other main constituent of this product category, roundwood fencing, already stands at about 230 000 m^3/year (200 000 m^3/year coniferous roundwood fencing (Forestry Commission, 1994) and a very rough estimate of 30 000 m^3/year non-coniferous fencing, so it was felt that this forecast was far too low. It was not possible to model the demand for mining timber and fencing separately because the historical consumption of these two products could not be identified. So, because very little of this product is traded, and the demand for mining timber already appears to have declined to a negligible amount (Forestry Commission, 1994), it was decided to present a low demand forecast of 230 000 m^3/year and a slightly higher forecast of 270 000 m^3/year for the period as a whole, based on the 1994 estimate of roundwood fencing production.

Demand for paper products is expected to increase by between 34% and 117% over the period, depending on future economic growth, most of this increase coming from increased demand for other paper and paperboard products. Demand for wood based panels is also expected to grow by a similar amount, mainly in the consumption of fibreboard and particleboard. As in the 1991 paper, some of the demand forecasts reached levels of per-capita consumption that were considered to be unrealistic in comparison to current levels of consumption in countries with extensive forest resources. Per-capita consumption limits were therefore forecast (see Appendix 3 of Whiteman (1991) for a fuller explanation of how this was done).

The models of sawnwood demand gave forecasts of consumption varying between a 30% rise and 5% fall (against 1989–91 actuals), depending on the assumed future rate of growth in construction activity. This very large difference reflected the uncertainty about by how much construction activity will grow in the future, and suggested that this should be investigated further.

As a final word of caution, it must be remembered that these forecasts are forecasts of trends in the level of demand. Demand in any particular year could vary quite significantly from the trend, especially in the most volatile wood product categories. So, for example, actual demand for coniferous sawnwood during the period 1989–91 was significantly higher than the trend for many years to come. The wood products which appeared to show the most volatility in demand were sawnwood and wood based panel products, possibly due to the very cyclical nature of construction. As a rough estimate, demand for these wood products could be as much as 25% higher or lower than the forecast in any particular year.

Chapter 4

The future supply of roundwood

The Forestry Commission has very recently produced revised conifer production forecasts for Forest Enterprise and the private sector over the period 1997–2016 (Rothnie, 1996). These were constructed in broadly the same way as the earlier production forecasts (Dewar, 1988; Kupiek and Phillip, 1988; Morris, 1991; Thompson, 1991). A long-run supply forecast was generated from the data sets used to produce these forecasts and was added to long-run supply information supplied by the Northern Ireland Forest Service and a separate forecast of non-coniferous roundwood supply, to give the forecast presented in Table 7 and Figure 3. The forecast for future non-coniferous roundwood production is based on a quite old forecast made by Oakley (1986). While this is now probably quite out of date, it was the only forecast available, and it was felt that it would not be worthwhile producing a new forecast until the Forestry Commission's current inventory of woodlands has been completed.

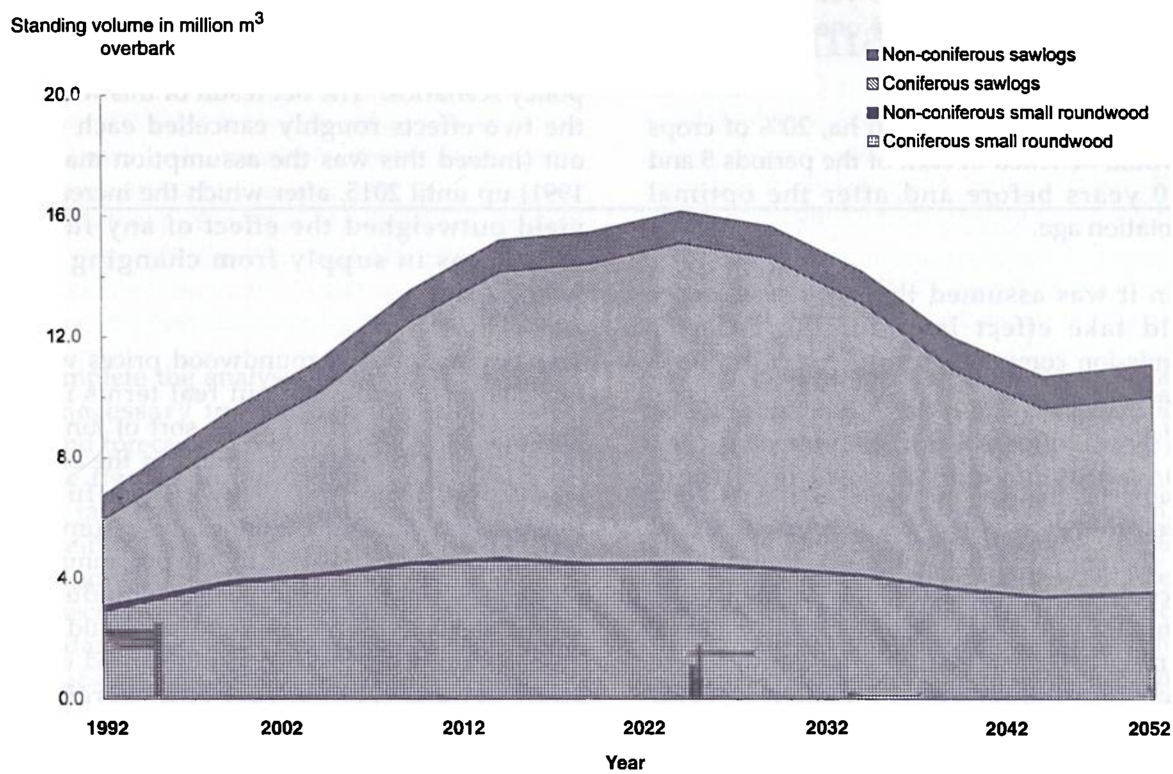
The new supply forecast differs from that produced in Forestry Commission Occasional Paper 29 in two ways. It is lower, peaking at 16 million m^3 rather than 19 million m^3, and the peak is much less pronounced. Part of the explanation for the lowering of the peak is that the Northern Ireland production figures were accidentally double-counted in Occasional Paper 29. Apart from this error, the main factors which have affected both the level and severity of the peak have been changes in the felling ages used in the private sector forecast, and the impact of an increased number of Forestry Commission design plans on their component of the forecast.

Table 7 Forecast of future UK average annual roundwood supply 1997–2051

Year	Coniferous small roundwood	Non-coniferous small roundwood	Coniferous sawlogs	Non-coniferous sawlogs	Total
1997–01	3.8	0.1	4.6	1.0	9.5
2002–06	4.1	0.1	6.0	1.0	11.2
2007–11	4.4	0.1	7.9	1.0	13.5
2012–16	4.6	0.1	9.5	1.1	15.2
2017–21	4.4	0.1	9.9	1.1	15.5
2022–26	4.5	0.1	10.6	1.1	16.2
2027–31	4.3	0.1	10.2	1.1	15.7
2032–36	4.1	0.1	9.0	1.1	14.2
2037–41	3.6	0.1	7.2	1.1	12.0
2042–46	3.4	0.1	6.2	1.1	10.7
2047–51	3.5	0.1	6.4	1.1	11.1

Note: Volumes presented are total standing volumes in million cubic metres down to a minimum top diameter of 7 cm overbark. Sawlog volumes have been calculated as volume to 18 cm diameter (20 cm in Northern Ireland) plus half the volume in the size category 14–18 cm top diameter (14–20 cm in Northern Ireland). Because of rounding, totals may not appear to sum.

Figure 3 Forecast of UK roundwood production to 2050



Note: The above forecast was constructed by taking 5-year moving averages of the figures presented in Table 7.

The sensitivity of the supply forecast to external factors

Several assumptions were made to produce the long-run supply forecast presented above. The first was that privately owned woodlands would be felled at the most profitable age to do so. This contrasted with the Forestry Commission component of the forecast, which took into account the effect of current design plans on future production (although these did not at the time cover all of the Forestry Commission estate). The second assumption was that crops would be replaced by identical crops after felling. For consistency with the demand forecast, it was also assumed that timber prices would not rise in the future.

To test the sensitivity of the forecast to changes in these assumptions, a range of future economic and policy scenarios were constructed, and their effect on future timber supplies were examined. Because of the lack of data, these changes were only made to the conifer production forecast (which anyway accounts for by far the greatest share of future production).

Starting with environmental improvements, a forecast incorporating a change in restocking practices was constructed. This included the effect of a 5% increase in open space on restocking (resulting in a 5% loss in subsequent thinning and felling volumes) and the effect of retaining 1% of crops to biological maturity (resulting in a 1% loss in felling volumes but additional thinning volumes from the retained crops). These effects were introduced from 2017 onwards for the Forestry Commission component of the forecast (to take into account the fact that design plans have already been incorporated into the 20-year forecast from which the long-run forecast was made), and from 1997 for the private sector component. The overall effect of these changes was negligible, resulting in differences of less than 100 000 m^3/year from the original forecast.

This scenario was then extended to show the effect of changing felling ages (to break-up the age structure of crops) on supply. Without comprehensive forest design plans for the whole forest estate, any attempt to do this had, of course, to be very simplified, so the following assumptions were made:

a. in forests of 50–500 ha, one-third of crops would be felled 5 years before the optimal rotation age and one-third 5 years after; and

b. in forests of over 500 ha, 20% of crops would be felled in each of the periods 5 and 10 years before and after the optimal rotation age.

Again it was assumed that these measures would take effect later for the Forestry Commission component of the forecast to take into account the effect of current forest design plans.

Considering that the above assumptions were applied to the whole of the conifer estate and were therefore, probably the maximum effect that could be expected to occur in the future, the impact of these changes was quite small. The new forecast resulted in a maximum reduction in production of 2 million m^3/year compared with the original forecast, and a total expected reduction of 20 million m^3 or about one year's production over the whole 50-year period.

To contrast with this, another forecast was constructed to examine the possible effect of improved silviculture on production. Increased future crop yields might arise as a result of many factors such as better plant handling, site preparation and protection, or the use of genetically improved stock. After discussion with researchers in these fields and a review of the site modelling literature (for example, Worrell, 1987; MacMillan, 1991; Bateman, 1994) a ⅓% per annum increase in yield seemed a reasonable assumption to make for an improved silviculture scenario. This was combined with the previous environmental policy scenarios. The net result of this was that the two effects roughly cancelled each other out (indeed this was the assumption made in 1991) up until 2015, after which the increase in yield outweighed the effect of any further reductions in supply from changing crop felling ages.

The assumption that roundwood prices would not change significantly in real terms in the future was based on the same sort of long-run historical evidence as was found in the case of wood product prices. However, a further forecast was constructed under the assumption that timber prices will rise by ½% per annum, to see what effect this might have on production. This showed that such an increase would have little effect on supply, because it turned out to affect optimal rotation ages only marginally. Another study on the stability of timber prices (Whiteman, 1995) was used to generate confidence limits for the forecast, and these also turned out to be remarkably small (roughly just under 1 million m^3 per annum).

It therefore seems that the supply forecast is fairly robust to both future uncertainties about timber prices and technical and environmental factors. It is also worth noting that these uncertainties are very small compared to the difference between the high and low demand growth forecasts, showing that changes in the factors affecting demand will probably have the largest impact on future self-sufficiency.

Chapter 5

The combined supply and demand forecast

To complete the analysis presented previously, it is necessary to combine the supply and demand forecasts. This was done by converting all the figures to the common numeraire of wood raw material equivalent (or WRME). To ascertain the net excess demand for wood over the supply from standing timber resources, it is also necessary to account for the availability of secondary wood and fibre resources from wood residues and materials that are recovered for recycling, so this is also discussed below.

Conversion factors

The conversion factors used to convert from wood product demand to demand in terms of standing roundwood are shown in Table 8. These figures differ from those presented in Whiteman (1991) in two ways. Firstly, they have been updated to take into account more recent information about product recovery in mills, from sources such as the regular sawmill surveys conducted by the Supply and Demand Sub-committee of the Home Grown Timber Advisory Committee (HGTAC). Secondly, they have been adjusted to take into account the volume difference after the removal of bark, and the waste that occurs during normal harvesting operations (forest conversion difference). The latter adjustment was not properly taken into account in Whiteman (1991), but is very important because about 10% of the measured standing volume is lost in the stump growth, in cutting logs into fixed lengths, tolerances, eliminating abnormalities in stem quality and occasional rot. So, because the production forecast is given in terms of standing volume rather than felled volume, this must also be taken into account.

Table 8 UK conversion factors (volume of standing roundwood or WRME required to produce one unit of final product)

Product and measurement unit	Conversion factor	Product and measurement unit	Conversion factor
Fuelwood and charcoal (m^3)[1]	1.25	Coniferous sawnwood (m^3)	2.13
Other industrial roundwood (m^3)	1.25	Non-coniferous sawnwood (m^3)	2.09
Newsprint (MT)	} 4.30	Plywood (m^3)	3.67
Printing and writing paper (MT)		Fibreboard (m^3)	2.35
Other paper and paperboard (MT)		Particleboard (m^3)[2]	1.61
		Veneer sheets (m^3)	3.67

Notes: 1 The charcoal component of the fuelwood and charcoal conversion factor is a volume to volume conversion factor. About 7.8 m^3 of wood is required to make one tonne of charcoal, but one tonne of charcoal is equal to about 6 m^3 in volume.

2 The conversion factor for OSB is higher than that for other types of particleboard, and this figure has been constructed assuming that 25% of future consumption will be consumption of OSB.

Residues and recycled material

The effect of residues and recycled material on the UK supply and demand balance were also not considered in Whiteman (1991). These secondary sources of supply are substantial and have a significant effect on the overall supply and demand balance. However, their inclusion raises three challenging methodological issues:

a. how much of each of these sources should properly be counted as supply from the United Kingdom;

b. how they should be calculated and projected into the future; and

c. whether they should be counted as a separate source of supply or be subtracted from the demand side of the overall balance.

Two alternative views could be taken in answer to the first question. If the original wood source was taken as the determinant of the source of residues and recycled material supply, then only residues recovered from the processing of UK sawlogs, and fibre recovered for recycling from paper produced from UK small roundwood would count as a source of UK supply. This, however, would give little credit to the UK for the recovery of paper for recycling, because most of the paper consumed in the UK is imported or made from imported pulp. This would therefore seem to underestimate the supply of recycled fibre from the UK.

At the other extreme, it could be argued that all of the consumption of wood products leads to the production of residues and recycled material. Thus, the consumption of paper in the UK leads to the recovery of paper for recycling in the UK, and UK consumption of sawnwood, plywood, and veneer sheets leads to the production of residues in the UK and in the countries supplying the UK with these products. Following this line, the UK could therefore, claim a supply credit for the recovery of residues outside the UK. (This recovery of residues could be netted out of the sawnwood, plywood and veneer sheet conversion factors as one way of accommodating this, if it were not for the fact that the residues are used in the pulp, fibreboard, and particleboard industries.) This would however, seem to overestimate the recovery of residues, by giving the UK a credit on the supply side for the recovery of residues in foreign supplier countries.

A compromise would be to take the point of recovery as the determinant of supply source. Thus, only residues recovered in UK sawmills would count as UK residue supply, but all fibre recovered for recycling within the UK would count as UK recycled fibre supply irrespective of where the fibre originally came from (i.e. it would treat UK paper consumers as the producers of recycled fibre). This would seem to be the sensible way to handle this, giving the UK credit for all the recovery of recycled fibre within the UK but only accounting for residues arising in UK sawmills, and was the approach chosen for this analysis.

The calculation of residues and recycled material supply is fairly straightforward, and the figures behind the conversion factors above give most of the technical co-efficients required to do this. For consistency with the other supply and demand figures, this supply has also to be converted to WRME.

The calculation of recycled material supply is relatively easy. Firstly, paper consumption is multiplied by the proportion recovered for recycling, currently about 30% (this makes the assumptions that paper consumed in any particular year becomes available for recovery in the same year, and that all paper recovered is used for further paper manufacturing). This is then multiplied by the fibre yield (the proportion of the fibre recovered which is utilisable), currently estimated to be 80%, and the resultant figure is multiplied by the paper conversion factor presented above, to arrive at a recycled material supply in WRME.

For the projection to 2050, it was assumed that the fibre yield will remain at 80%, and that paper recycling increases linearly from 30% in 1990 to 50% in 2010 and stays at 50% thereafter (in line with proposed EC directives on packaging and UK targets for recycling domestic waste). These figures were then applied to the paper consumption forecasts to arrive at a recycled material supply forecast.

There are two main uncertainties about the recycled material supply forecast. Firstly, the fibre yield may decline in the future as the proportion of paper made from virgin fibre entering the recycling system declines. Secondly, and more importantly, there is the question of how much paper recovered for recycling will be used for the production of energy. If this is found to be a more environmentally beneficial way of using recovered paper, and is promoted by the government, then future recycled material supply for the pulp and paper industry will obviously decline.

The calculation of residue supply is more complicated. As the sawnwood conversion factors above show, about half of the volume of wood used to make sawnwood is lost in the production process. Firstly, there are forest conversion losses which cannot generally be recovered. Then there is the removal of bark. This is not recovered from coniferous timber because it is not used in the pulp or panel industries. Bark from non-coniferous timber is used, however, in the particleboard industry, so this gives rise to the production of a certain amount of residues which must be taken into account. Other losses arise as a result of the removal of undesirable constituents of the timber (predominantly moisture, which is lost in the process of drying sawnwood), and these have to be excluded in the calculation of wood residues. The main stage at which residues are produced, however, is the sawmill conversion process during which logs (round) are converted into to sawn products (generally square or rectangular in cross section). This leaves a substantial quantity of small, odd shaped pieces of timber which can be used by the wood panel and pulp industry to produce other wood products.

The UK supply of residues was calculated from the supply of sawlogs given in the production forecast. This required the minor assumption that all UK sawlogs are processed in UK mills, and that UK mills use only UK sawlogs. The volume entering mills was first calculated by removing forest conversion losses (and bark in the case of coniferous sawlogs) from the production forecast figures to arrive at log input figures. Total residue production was then calculated by subtracting from these the volumes of sawnwood produced multiplied by 1.2 (to allow for 20% moisture loss during the sawnwood drying process). Only a proportion of total residue production is recovered for use elsewhere in the wood processing industry, so these figures were then multiplied by 0.9 in the case of coniferous sawlogs, and 0.6 in the case of non-coniferous sawlogs, to arrive at a figure for net residue recovery. (These figures were based on the destination of sawmill residues recorded in HGTAC sawmill surveys since 1977, shown in Table 9.) The net residue figures were then converted back into WRME by adding on forest conversion losses (and bark in the case of coniferous residues) to arrive at the equivalent volume of standing timber these residues represented.

Table 9 The use of UK sawmill residues reported in HGTAC sawmill surveys

Production category and destination of residues *(percentage of roundwood volume delivered)*	**1977**	**1983**	**1987**	**1990**	**1993**
Coniferous sawnwood					
Wood processing industry	75.6	75.8	82.7	90.2	93.5
Other uses	17.1	14.7	14.2	6.5	2.2
Burnt for heat	3.5	5.0	1.6	2.2	2.2
Waste	7.8	4.5	1.6	1.1	1.1
Non-coniferous sawnwood					
Wood processing industry	47.7	35.7	45.5	61.6	58.0
Other uses	24.3	31.9	33.1	28.3	20.0
Burnt for heat	17.4	22.7	18.0	7.1	17.0
Waste	10.9	9.7	3.4	3.0	3.0

For forecasting purposes, it was assumed that these figures for recovery to the wood processing industry (90% and 60%) would remain the same over the period of the forecast.

The overall supply and demand balance for wood in the UK is shown in Tables 10 and 11. Total demand expressed in terms of WRME is now expected to rise to about 140 million m^3/year under the high demand forecast or 90 million m^3/year under the low demand forecast. These forecasts are higher than those presented in 1991 because of the higher projection of consumption activity used in some of the product demand forecasts, and the raising of the conversion factors to take into account the 10% forest conversion difference in the calculation of WRME and other changes to the conversion factors (particularly for paper). Supply from forest resources peaks at 16 million m^3/year in 2025, at which point it will meet about 15% (high demand growth forecast) to 20% (low demand growth forecast) of estimated demand.

The question then remains as to whether the supply of residues and recycled material should be counted as an additional supply or be subtracted from the demand side of the equation in the calculation of self-sufficiency. Including residues as a further source of supply would be double counting because they come from the same original volume of timber quoted as the roundwood supply and have not been utilised in any intermediate product. Because the residue volume is not allowed for in the sawntimber: roundwood requirement conversion factor, the residues can be subtracted from the initial calculation of demand for WRME. However, the same argument cannot be applied to recycled fibre which has to be treated as a secondary source of supply: it is after all a matter of choice as to whether to produce recycled fibre while there is no way of avoiding the production of residues at sawmills. Two different expressions of self sufficiency are therefore given in Tables 10 and 11:

Self-sufficiency in roundwood (adjusted for residues)

Self-sufficiency in roundwood + recycled fibre

Recycled fibre has a major impact on the supply and demand balance. It amounts to 55% of total supply at the start of the forecast and 66% to 76% (depending on assumed demand growth) by the year 2050. The inclusion of recycled fibre in supply changes the expression self sufficiency at its peak from 16%–21% to 39%–44% and reduces the effect (in terms of self sufficiency) of the decline in roundwood production expected towards the end of the forecast.

Table 10 Forecast of UK wood supply and demand 1987–2050 **(high growth scenario)**

Wood product category	Actual 1989–91	Forecast years 2000	2010	2020	2030	2040	2050
Roundwood products	1 060	780	800	800	800	800	800
Paper products	40 410	42 870	50 160	59 380	70 190	78 530	87 890
Wood based panels	11 440	11 890	13 830	16 100	18 900	19 900	20 330
Sawnwood	24 100	25 010	26 390	27 500	28 730	30 000	31 320
TOTAL (a)	77 010	80 550	91 180	103 780	119 520	129 230	140 340
sawnwood residues (b)	*1 190*	*1 520*	*2 440*	*2 930*	*2 920*	*2 120*	*1 970*
NET TOTAL DEMAND (a-b)=(c)	75 820	79 030	88 740	100 850	116 600	127 110	138 370
ROUNDWOOD SUPPLY (d)	7 990	9 850	13 880	15 640	15 400	11 760	11 130
RECYCLED SUPPLY (e)	9 800	13 720	20 060	23 750	28 440	31 410	35 160
Self sufficiency in roundwood (d)/(c)	10.5%	12.5%	15.6%	15.5%	13.2%	9.3%	8.0%
Self sufficiency in roundwood + recycled fibre (d+e)/(c)	23.5%	29.8%	38.2%	39.0%	37.6%	34.0%	33.5%

Note: All figures in thousand cubic metres WRME rounded to the nearest ten thousand.

Table 11 Forecast of UK wood supply and demand 1987–2050 **(low growth scenario)**

Wood product category	Actual 1989–91	Forecast years 2000	2010	2020	2030	2040	2050
Roundwood products	1 060	730	750	750	750	750	750
Paper products	40 410	39 350	41 810	44 480	47 430	50 660	54 200
Wood based panels	11 440	10 330	10 900	11 510	12 180	12 900	13 700
Sawnwood	24 100	21 990	22 230	22 410	22 610	22 800	23 000
TOTAL (a)	77 010	72 400	75 690	79 150	82 970	87 110	91 650
sawnwood residues (b)	*1 190*	*1 520*	*2 440*	*2 930*	*2 920*	*2 120*	*1 970*
NET TOTAL DEMAND (a-b)=(c)	75 820	70 880	73 250	76 220	80 050	84 990	89 680
ROUNDWOOD SUPPLY (d)	7 990	9 850	13 880	15 640	15 400	11 760	11 130
RECYCLED SUPPLY (e)	9 800	12 590	16 720	17 790	18 970	20 260	21 680
Self sufficiency in roundwood (d)/(c)	10.5%	13.9%	18.9%	20.5%	19.2%	13.8%	12.4%
Self sufficiency in roundwood + recycled fibre (d+e)/(c)	23.5%	31.7%	41.8%	43.9%	42.9%	37.6%	36.6%

Note: All figures in thousand cubic metres WRME rounded to the nearest ten thousand.

Policy implications of theforecasts of future supply and demand

The above forecasts have several interesting policy implications. The first of these concerns the peak in roundwood production. It can be argued that for the secure development of the domestic roundwood processing industry it is desirable to have a smooth and non-declining level of future roundwood production. Already the impact of forest design plans on the Forestry Commission estate appear to have smoothed future production to some extent, and there may be scope for smoothing production further through the adjustment of rotation ages. An alternative to this, however, is to increase the area of woodland to provide further timber supplies to arrest any future decline in production.

The timing of the current forecast peak in production means that it will not be possible to plant now to sustain the level of production at about 16 million m^3. It is estimated, however, that only a slight dip in production, and a fairly rapid return to about this level could be achieved by increasing the forest estate by about 275 000 hectares (assuming a yield class of 12 m^3/ha/year) of mainly conifer forest over the next 25 years, with most of this new planting weighted towards the present.

Another interesting result can be found if the supply and demand forecast is split into the supply of sawlogs and demand for sawnwood, and the supply of small roundwood and demand for wood panel and paper products. In the case of the latter, self-sufficiency is expected to peak in 2025 and decline slightly thereafter. The fall in self-sufficiency is not very marked because the decline in small roundwood supply after 2025 is offset by large forecast increases in the availability of paper for recycling.

In the case of sawnwood, however, self-sufficiency is expected to peak at 45% (high demand growth) to 55% (low demand growth) in 2025, falling back to 35–45% in 2050. Considering that sawnwood produced from domestic logs can only currently meet certain sectors of sawnwood demand, this has interesting implications for the domestic sawmilling industry. At peak levels of sawlog production, the industry may have to consider improving the marketing of the domestic product if they are not to run up against limits to demand based on the quality of domestically produced sawnwood.

A final comment should be made about the future presence of a large potential supply of recycled fibre. The forecast for paper consumption implies at least a doubling of consumption by 2050. The UK paper industry currently uses recycled paper from home and abroad as a large proportion (about 50%) of its raw fibre. This, combined with the aim of 50% recovery for paper produced in UK, implies that the availability of wastepaper may increase to four times its current level. The industry should, therefore, bear this in mind in future development plans, as it would seem that the supply of wastepaper is set to rise significantly in the future.

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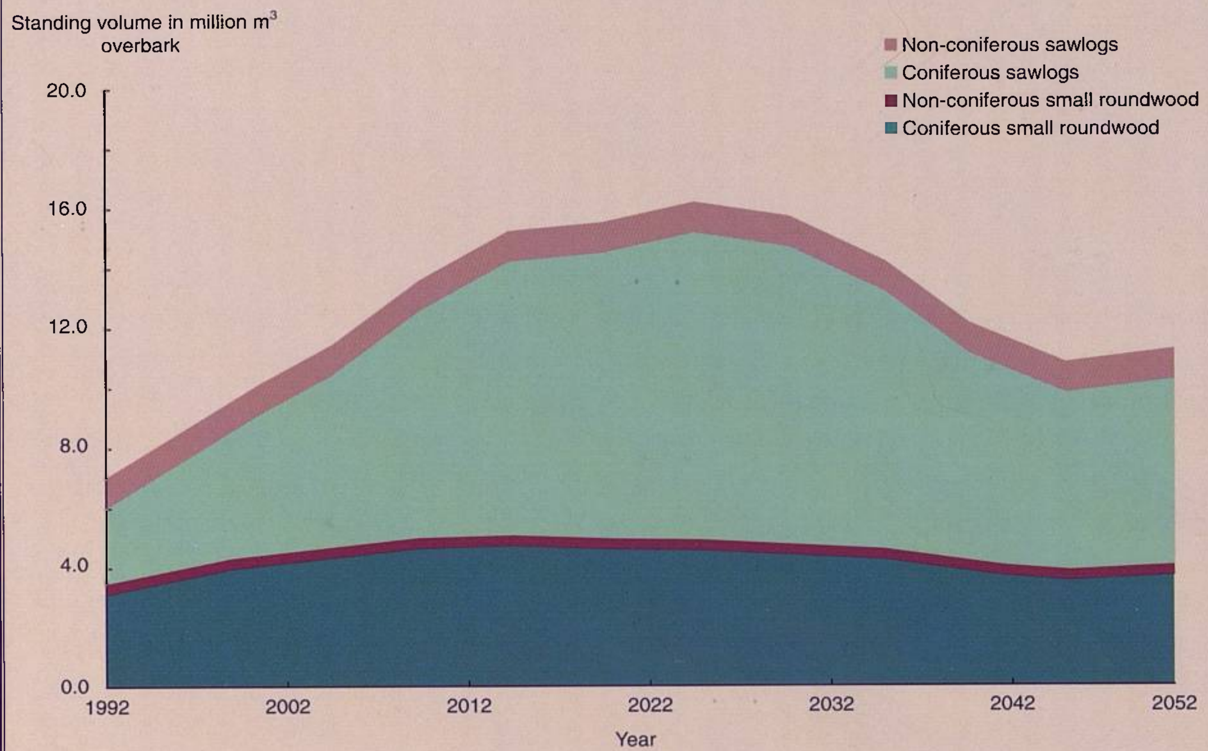
A projection of wood supply from existing UK forests



Forecasts show that wood supply will increase with demand up to 2025. After that, if no new planting is undertaken, supply will fall while demand will continue to rise, although the forecast of demand after 2025 is subject to a wide margin of uncertainty. In practice, both new planting and efforts to reschedule production may reduce the peak in production. A continuous level of supply would be desirable for the development of the domestic wood processing industry. An indication of the level of new planting that would be required to bring this about is given in this paper.

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