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Valuation of European forests — Results of IEEAF test applications

2

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CONTENTS

List of figures

List of Tables

Preface

This publication summarises the numerical results and methodological findings of test exercises focusing on the valuation of forests in Germany, France, Austria and Finland. These valuation test exercises were specifically designed to explore the range of valuation methods available, their data needs and applicability in practice and the effect the choice of method has on the numerical results. The publication contributes to the work on the implementation of the *European Framework for integrated Environmental and Economic Accounting for Forests* (IEEAF). It follows the publication of the IEEAF (Commission of the European Communities 2000a). and the results of the first round of pilot exercises (Commission of the European Communities 1999).

This publication is one of the outputs of Eurostat's Environmental Accounting work. It contributes to various EU-wide and international activities in the context of national accounts and environmental accounting, including the implementation of the European System of Accounts (ESA 1995) and the revision of the United Nations' System of Integrated Environmental and Economic Accounting (SEEA). The publication was prepared by Mr Gerard Gie of Planistat Europe and Mr Anton Steurer of Eurostat B1.

Special thanks are to the members of the Eurostat Task Force on Forest Accounting:

- L. Ritter, C. Grobecker and L. Frankford (German Federal Statistical Office),
- V. Bergen, H. Schröder and S. Gutow (University of Göttingen - Germany),
- C. Thoroe and P. Elsasser (Federal Research Centre for Forestry and Forest Products - Germany),
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Both the pilot exercises and the development of the IEEAF benefited from substantial financial support provided by the European Commission's Directorate General for Environment and Directorate General for Regional Policy and Cohesion, in the context of the *Communication from the Commission to the Council and the European Parliament on "Directions for the EU on Environmental Indicators and Green National Accounting - The Integration of Environmental and Economic Information Systems"* (COM(94) 670).

The work on forest accounting is continuing at Eurostat together with the Task Force on Forest Accounting. Work is now focusing on the physical description and monetary valuation of non-market environmental and protection services provided by forests and on collecting IEEAF data more regularly from more Member States.

Brian Newson
Head of Unit B1
National accounts methodology,
statistics of own resources

Introduction

The European Framework for Integrated Environmental and Economic Accounting for Forests - IEEAF

As an integrated part of the development of Natural Resource Accounting, the 'European Framework for Integrated Environmental and Economic Accounting for Forests' (IEEAF)[1] was developed and tested by the Eurostat Task Force on Forest Accounting. Objective of the IEEAF is to consistently link forest balance sheets and flow accounts, forest-related economic activities and the supply and use of wood within the economy, in physical and monetary terms. Moreover, the forest accounting framework contributes to the classification and valuation of forest-related assets within the European System of Accounts (ESA)[2], the System of National Accounts (SNA)[3] and to the revision of the System for Integrated Environmental and Economic Accounting (SEEA)[4].

In order to implement the IEEAF a set of 20 main tables was developed covering balance sheets for land and standing timber, economic accounts for forestry and supply-use tables. These tables have been the basis for pilot accounts completed by Sweden, Finland, Germany and France. The results of this first set of pilot accounts have been published as “The European Framework for integrated environmental and economic accounting for forests: results of pilot applications”.[5]

Compilation of asset accounts: valuation of assets and flows

An important issue for the compilation of forest accounts is the valuation of forest assets and related flows. Within the IEEAF, countries are free to choose the methods best suited for valuing their forest assets, as long as the method complies with ESA principles and land and timber values are separated.

The first set of pilot exercises showed that several approaches and methods may be used for the valuation of forest assets and flows including market valuation for land and forest real estates, hedonic valuation, stumpage and consumption valuation for standing timber, present value for standing timber and land, etc. All these approaches follow more or less closely the ESA principles and/or forest economics prescriptions. However, the resulting values for the forest assets in test countries appeared to differ quite substantially. In order to isolate the effect of the valuation methods chosen from other factors (climate, species composition, age distribution, main uses of timber, etc.) it was decided to analyse in detail the differences and the similarities between these methods. Austria, France and Germany agreed to undertake specific studies comparing the results of different valuation methods. This publication presents the results of these comparisons. Finland made a specific work as concerns the value of protected forest areas which may also be useful for the treatment of protected areas in national accounts.

Limitation of valuation in ESA

Forests fulfil numerous functions: supply of wood as well as recreational, protection and ecological functions. After an analysis of these functions, the Task Force concluded that some of these functions are “ESA-type”, whereas others are not. The non-ESA functions were studied during a specific meeting of the Task Force. It was concluded that their valuation and consistent integration in a national accounts-type framework was not possible for the moment and that more experience with the physical and monetary description of these functions is needed before they can be fully included in the IEEAF.

ESA-type functions were defined as those functions of forest assets that result in economic benefits as defined by national accounts. According to the ESA (§ 7.11), economic benefits consist of:

- primary incomes (operating surplus by using, property income by letting others use) derived from the use of the asset,
- the value, including possible holding gains/losses, that could be realised by disposing of the asset or terminating it.

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[1] Commission of the European Communities (2000a).

[2] Commission of the European Communities (1996).

[3] Commission of the European Communities et al (1993).

[4] United Nations (1993), currently under revision by the London Group.

[5] Commission of the European Communities (1999).

For ESA/SNA, primary incomes are payable out of the value added created by production. In national accounts, a production process is defined as an activity carried out under the control and responsibility of an institutional unit that uses inputs of labour, capital and goods and services to produce output of goods and services. Whereas activities that result in the production of goods are always included in the national accounts production boundary, the production of services is confined to activities that are capable of being carried out by one unit for the benefits of another. Many functions of the forest do not match this condition.

The Task Force therefore excluded from the valuation process all functions that do not give rise to flows that may be qualified as primary incomes in ESA, and the corresponding assets, unless their value is recognised by a transaction or a formal appraisal. For example, the sequestration of carbon by forests or the provision of free recreational services are not considered as production processes and are therefore not valued as flows. However, certain transactions may integrate some of these functions, e.g., when a forest real estate is bought for biodiversity conservation purposes or when carbon bound in forests can be internationally traded.

Contents

Starting with the classification of the various types of forests and forest assets, the **first chapter** of this publication describes the valuation of forest assets in ESA and forest economics. It points out that the “theoretically” sound method is the present value method, recommended by ESA. Consequences as concerns the valuation of the different flows that affect forest assets are presented.

In the **second chapter**, practical valuation methods are presented. Methods are classified in market valuation, including stumpage and consumption value methods and present value methods. Their application to forest real estates, land and standing timber as well as to forest-related flows is reviewed.

In **chapter 3,** forests and forestry in the five countries involved in the pilot applications are briefly described in order to identify the factors that may influence the choice and results of valuation methods, including: volume, density (m^3/ha), rate of growth and rate of exploitation of forest resources, structure of removals and prices of forest products.

The results of the valuation test exercises are presented in **chapter 4**. Differences between the results of the various valuation methods are shown and as far as possible explained. Tables comparing the results for the countries involved are drawn.

Finally, **conclusions** are drawn. The main result is that it is not possible to recommend a single method for all countries. The main methods have advantages and disadvantages, the basic trade-off being between “theoretical soundness” and “data needs”. In principle, it seems that the present value method (or some of its variants, such as the age constant method) should be preferred. However, the need for basic data is higher and, above all, results have to be calibrated with actual data, from e.g. Eurostat “Economic Accounts for Forestry (Commission of the European Communities 1997). In this respect, two axis are considered important: a functional disaggregation of the EAF between forestry and logging, and a joint analysis of current physical and monetary statistics.

In the **annexes**, tables from the test exercises are presented.

Summary and conclusions

Modern forest economics provide a sound theoretical basis for the valuation of forest land and standing timber based on the principles for net present value calculations laid down in Faustmann's seminal article of 1849. Faustmann’s formulae are an application to forest assets of what later became known as the theory of capital and investment and give the correct theoretical values of land and standing timber. They can be applied to different types of forests, cultivated or non-cultivated.

However, the net present value method has limitations, which mainly follow from the discrepancies between theoretical assumptions and actual forest management. One of the assumption is the succession of identical rotations of even-aged stands and therefore the existence of a final harvest which liberates the land for a new rotation. This assumption is not verified by reality: harvest is spread over a long period of time and the timber sometimes remains standing well after its "optimal" felling age. Adaptations of the basic formulae are necessary to account for the particular circumstances of actual forests. Practical difficulties, such as data needs and availability, also hamper the application of the net present value method.

The European System of Accounts (ESA 1995) privileges in principle the valuation by market prices, but recommends the net present value method for the valuation of standing timber (and in general for assets the proceeds of which are delayed). ESA (§ 7.38) states that ‘..standing timber is valued by discounting the future proceeds of selling the timber at current prices after deducting the expenses of bringing the timber to maturity, felling, etc.’ ESA recommends to separate the value of land and the value of standing timber. The best solution for the valuation of forest assets would thus be to value the forest land through market prices and the standing timber through the net present value method. The combination of these two methods allows to calculate the internal rate of return of forestry and to go beyond the need to fix, more or less arbitrarily, a rate of discount for the net present value method.

In practice, few countries (e.g., France) have already implemented national accounts balance sheets for forest assets. Those that have, did so far privilege valuation based on market prices of forest real estates, giving the combined value of land and standing timber. The starting point for such calculations are the transactions in forest real estates. Average prices per hectare are calculated and applied to the whole forest area. This method does not allow separating the value of land and standing timber. In order to go further, some practical rules have been applied such as the estimation of a ratio between the land value and the forest real estate value.

More sophisticated methods are possible, such as the Lancaster approach (hedonic pricing). In this approach, through a statistical analysis, the value of forest real estates is explained by the characteristics of the transacted assets: area, volume of standing timber, species, age distribution etc. The results allow to separately value forest land and standing timber, with the value of timber being influenced by the stand characteristics.

Alternatively, methods based on transactions in timber or wood products are applied. The value per cubic metre of timber is calculated and applied to the stock. Several variants exist and several steps may be necessary according to the availability of data.

Data availability is an important aspect. In some countries prices of timber while standing are directly available as the timber is sold while standing (these prices are called *stumpage prices*). In other countries, only the prices of the harvested timber (wood in the rough) are available. In this case, it is necessary to establish the value of the timber while standing. This is generally done by deducting from the value of the price of the wood in the rough (or *roadside pick-up price*) the costs of logging the timber, transporting it to the road side and stacking it. In a second step the volume of felled timber is then transformed into volume of standing timber. These steps require assumptions and additional data (e.g., on costs), and the use of specific forestry algorithms.

Two main variants may be distinguished. In the *stumpage value method*, the average value per cubic metre is assessed on the basis of removals. In its simplest form, one may start from the overall value of the removed timber (generally already collected and published, see e.g. Eurostat Economic Accounts for Forestry), deducts estimated felling costs and divides by the volume of removals (available from forestry statistics). Variants of the stumpage value method distinguish between main species, according to the availability of data.

In the *consumption value method*, the average price per cubic metre is calculated by main age classes and then applied to the respective stocks (available from national forest inventories). When stumpage prices are not available (or known only for few categories), it is necessary for each age class to transform the volume of standing timber into assortments of wood in the rough, and to apply the prices of these assortments.

The basic difference between the stumpage value method and the consumption value method is that the first method uses the structure of the fellings for weighting the stumpage prices, whereas the second method uses the structure of the stock. These two structures may differ considerably and may also change over time. The two methods can be seen as special forms of the net present value method (with implicit discounting due to future natural growth) and it can be argued that they are in line with ESA principles. However, it is difficult to analytically compare their results with the results of the net present value method. Which of the two methods gives more accurate results has to be judged on the basis of the characteristics of the forest to be valued, including its exploitation conditions. The choice depends upon the current structure of the stock and the fellings and their assumed evolution in the future.

Although the forests of the five countries that participated in the pilot exercises are all in expansion, either in terms of area or timber stocks, they present rather different characteristics. Density, rate of growth, species and conditions of exploitation differ markedly. Due to soils and climatic factors, the density (expressed in cubic metre by hectare) is rather low in Swedish and Finnish forests. While the stocks grow, the ratios of removals to stocks are high, showing a high rate of exploitation and forest productivity. Prices are rather low, the structure of removals being influenced by the importance of coniferous pulpwood. The Austrian and German forests are characterised by high densities. As a consequence the ratio of removals and net annual increment to the stocks is low, although the net annual increment per hectare is high. The structure of the removals is marked by the importance of logs of conifers. The French forest shows an intermediate situation as concerns density and growth. The importance of broadleaves in the stock and the removals is a specific feature of French forest. However, there is uncertainty as concerns the importance of fuel wood in the harvest. Moreover, heterogeneity is high, between species and regions.

For Austria, five methods were tested for the valuation of standing timber stocks. Two of these methods pertain to the family of "net present value" methods. In the "age constant" method the value given to the standing timber of a certain age class is a proxy of the net present value, based on standard curves, taking into account the establishment and cultivation costs, an implicit rate of return and the final harvest receipts. A simplified net present value method showed very volatile results that are sensitive to the assumptions made as concerns the management costs. The structure of the stock and the removals being rather similar in Austria, the consumption value method and the stumpage value method give almost identical results, 30% lower than the "age constant" method.

For Germany, the results of three methods were compared. The hedonic and stumpage value methods give rather similar results, although the comparison is made difficult by different reference periods, the changes in prices for 1991 being important, due to severe wind throws. The consumption value is much lower than the stumpage value. The reason for this difference is a different assortment structure of the harvested timber as compared to the assortment structure of the standing timber. Comparisons between prices suggest that the average age of the harvested wood is more or less 130 years, whereas the average age of the stock is 75 years. According to available statistics the German harvest is characterised by a high percentage of logs and a low percentage of fuel wood; as a consequence the average stumpage price is high.

France tested three main methods. The stumpage value is the lowest: due to the importance of fuel wood for own final consumption in the harvest, the assumed average diameter of the harvest is well below the average diameter of the stock. As with the "age constant" method for Austria, the net present value gives the highest value. Interesting results are obtained comparing the values for the main species, ownership categories and regions. For softwood the range of values is small, whereas it is important for hardwood (fuel wood for own final consumption is mainly hardwood). The French ‘Landes’ region, where private forest dominates and maritime pine is the main species, is intensively exploited for commercial purposes and the three methods give very similar values. These values are also similar to the value that can be derived from the market value of forest real estates. For the Mediterranean region (much less exploited but with more non-wood uses) the market value of forest real estates is higher than the values generated by the other methods, whilst it is the contrary in all other regions, where in general hardwood dominates. The French regionalised results show the high diversity across French forest regions and underline the need to adapt valuation methods to the concrete conditions of forests in a European context.

As a general conclusion it seems that, for purposes of international comparisons, the stumpage value method offers the best solution.

First it may be related with other existing statistics, including Eurostat Forestry statistics (physical quantities of wood removed from the forest by assortments, stocks etc.) and Economic Accounts for Forestry (monetary values of wood assortments removed from the forest). Calculations are rather straightforward. Making existing basic data consistent and integrating them for valuation of forest assets is a relevant principle for European statisticians and national accountants.

The only supplementary data needed is an estimate of the logging costs. Within IEEAF, it has been advocated that the economic accounts for forestry should be separated between forestry and logging activity, on the basis of a functional analysis. Pilot exercises have shown that the forest sector has specific and rather different characteristics within European countries. This separation would be useful to better analyse the forests and the contribution they give to the European economy, including when institutional sectors are distinguished.

Other methods are more demanding in terms of data and assumptions: it is necessary either to transform standing timber to assortments (consumption value method), or to make assumptions as concerns the intermediate costs and receipts.

Would a second method be recommended, the age constant method is a good candidate; it is rather standardised in some countries, standard factors could be calculated once and then rather simply actualised (with plantation costs, wood or timber prices).

However, for national purposes other methods (detailed net present value or consumption value methods) may appear more appropriate, due for example to the structure of removals in relation to the structure of the stock, i.e. a specific age structure of the national forest. These methods can also give interesting insights on specific issues.

As concerns land, data are much more scarce than for standing timber. Estimated values vary considerably between countries. Whereas it seems that in some countries the value of forest land is almost exclusively determined by the wood production function, and hence is rather low, it appears that in other countries functions of forests other than wood supply play an important role, related to, e.g., population density. For those countries were the value of land is important it would certainly be useful to collect data on the prices of forest land. This could be important in the context of the abandonment of agricultural land as well.

Main numerical findings

Tables 1 and 2 show the overall results of the valuation test exercises. An estimate of the total value of EU-15 and European Economic Area (EEA) forests is also presented, referring to the mid-90s.

Table 1: Land value in test countries and EU-15 (forest available for wood supply)

	Forest available for wood supply (1000 ha)	Average value (ECU/ha)	Total value (million ECU)
Germany	10 142	3 200	32 454
Austria	3 352	4 500	15 084
Sweden	21 236	55	1 168
France	14 470	800	11 576
Finland	20 675	375	7 753
Total 5	**69 875**	**974**	**68 036**
Other EU countries	25 650	:	*24 975**
EU-15	**95 525**	**:**	***93 010****

*…Eurostat estimates

Sources: Eurostat Forestry Statistics 1995-1998 (area data, various years between 1990 and 1998), IEEAF pilot exercises (average values)

Table 2: Timber value in test countries and EU-15 (forest available for wood supply)

	Growing stocks (million m^3)	Average prices (ECU/m^3)	Total values (million ECU)
Germany	2 820	31	87 420
Austria	1 037	22	22 814
France	2 836	24	68 064
Sweden	2 567	16	41 072
Finland	1 867	20	37 340
Total 5	**11 127**	**23**	**256 710**
Other EU countries	2 292	:	*52 879**
EU-15	**13 419**	**:**	***309 589****

*…..Eurostat estimates

Sources: Eurostat Forestry Statistics 1995-1998 (stock data, various years between 1990 and 1998), IEEAF pilot exercises (average values)

The value of forest assets for the EU countries not covered by the IEEAF pilot exercises were estimated using the average prices for the 5 participating countries. This grossing–up results in a total value of forest assets for the EU-15 of 403 billion ECU, adding 24% to the value for the 5 participating countries. A sensitivity analysis was made using the prices for the French Mediterranean forest region for estimating Spanish, Italian and Greek forest asset values. The results of this estimate are slightly lower with a total of 384 billions ECU. Overall, these estimates suggest that the value of EU forest assets is about 400 billion ECU, about 25% of which is the value of the forest land and 75% the value of the standing timber.

The inclusion of Switzerland, Norway, Liechtenstein and Iceland in the estimate adds about 26 billion euro to the EU using the average of Swedish and Finnish forest values to estimate Norwegian forests, and Austrian data to estimate the value of forest in Switzerland and Liechtenstein. For the European Economic Area (EEA) as a whole, the value of forests may be estimated at about 430 billion ECU.

The total value of EEA forest resources is in the same order of magnitude as the value of EEA oil and gas reserves. At the end of 1996, the value of oil and gas reserves of Norway, the United Kingdom and the Netherlands was about 320 billion ECU, with these 3 countries representing 94% of oil and 89% of gas reserves in the EEA (see Commission of the European Communities 2000d, forthcoming). In the mid-90s, the value of EU-15 standing timber alone (about 300 billion ECU) is twice the value of EU-15 oil and gas reserves (about 170 billion ECU). If compared to the total value of the EU-15 capital stock, however, forest assets only represent 2.4 %, as Table 3 shows.

Table 3: Value of forest assets in test countries and EU-15 compared to net capital stock, billion ECU

	Total value (1)	Net capital stock (2)	% (1)/(2)
Germany	120	5 582	2.1%
France	80	2 441	3.3%
Austria	38	510	7.4%
Finland	45	277	15.2%
Sweden	42	404	11.2%
Total 5	325	9 214	3.5%
Other EU countries	78	7 307	1.1%
EU-15	403	16 521	2.4%

Sources: Eurostat Capital Stock in the European Union, January 1998 (net capital stock data, year 1994), Tables 1 and 2 above (total value of forests)

1. Valuation principles in forest economics and in ESA

1.1 Forest classification and consequences for valuation

For economic accounting purposes, the IEEAF, following the UN-ECE/FAO TBRFA 2000 definitions, proposes to distinguish:
- forest not available for wood supply
- forest available for wood supply

Forests not available for wood supply include forest for which the exploitation of timber is not economic for various reasons (low productivity, access conditions, etc.) and protected forests. Timber located in forest not available for wood supply has a zero value. In particular, when forest are protected, the timber and the land values cannot be realised, i.e. do not provide economic benefits. Nevertheless, these forests could receive a value, within the balance sheets of the unit that has acquired them via a transaction. They could be classified in a new category as “natural remarkable assets”, in the same way as “historic monuments” are recorded in balance sheets when their significance has been recognised by someone other than the owner, as evidenced by a sale or a formal appraisal (SNA § 13.41). For the valuation of protected forest see section 4.3 below.

Forest available for wood supply may be cultivated or non-cultivated.

Non-cultivated forests

Natural/old growth forests

By definition these forests are non-renewable assets. Furthermore, as they are at their “climax” the net natural growth may be considered nil. The theory of non-renewable natural resources applies, with the only difference that the exploitation of these forests clears the former forest land for other uses, if any. Although not important in European Union countries, clearance of natural forests for reclaiming the land is one of the main cause of the disappearance of the world’s old growth forests.

It has to be noted that in ESA “clearance of forests, to enable land to be used in production for the first time” is classified as major improvement to land (cf. ESA § 3.106).

Second growth and other non-cultivated forests

These correspond to the cases when the original natural forest has been exploited (harvested) and the land left without or with insignificant forestry intervention. Natural regeneration of the forests takes place and there is a natural growth but there are no costs. The owner only has to wait for harvesting the forest at its maturity age. The timber is classified as non-produced and the natural growth is not considered output by ESA.

Planted/cultivated forests

For these forests, there are costs: either both initial (plantation) and intermediate (cultivation) costs, or only intermediate costs, in the case of natural regeneration. The value of these forests may be assessed by different methods: by the sum of past costs, including a mark-up for the net operating surplus/mixed income or by the present value of future net receipts. The timber is classified as produced and natural growth is considered as an output.

1.2 Valuation in forest economics

In forest economics, valuation of forests is based on the present value method. The value of the forest is divided between the value of the forest land and the value of the timber. The main results of forest economics are summarised below, distinguishing between cultivated and non-cultivated forests.

Modern forest economics was developed mainly by M. Faustmann, a German forest economist, whose founding text was published in 1849. In this text, he stated that "one must not calculate the value of standing timber starting from the value of the volume of timber the forest actually bears, but from the value corresponding to the uses of this timber when arrived at maturity". Faustmann's views are an application of the general theory of capital and investment, that was established much later. Although some refinements occurred, Faustmann's formulae continue to form the basis of forest economics.

1.2.1 Cultivated forests

Let there be a hectare of land used for the production of timber during successive and identical rotations. At time 0 (beginning of year 1) the plantation cost is C_0. R_τ and C_τ are the intermediate receipts and cost for the year τ (τ = 1 to T), the value of the final harvest, supposed to be at the end of T, is p_TQ_T, T being the age of the timber at the time of the final harvest, these parameters depending upon the species, category of land and type of management.

From Faustmann, the value of the land (L) is given by the following general expression, where r is the discount rate:

$L = [p_TQ_T – C_0(1+r)^T + \Sigma(R_\tau – C_\tau)(1+r)^{T-\tau}]/[(1+r)^T – 1] - A$, where A is the "administration cost capital"[6], the summation being for τ = 1 to T.

Neglecting the "administration cost capital", the value of the timber stock at the end of year t (0<t<T), S_t, is given by two expressions.

- the *cost formula*, where the value of the standing timber at the end of year t is based on past costs and receipts:

  $S_t = [(1+r)^t – 1]L + C_0(1+r)^t + \Sigma(C_\tau - R_\tau)(1+r)^{t-\tau}$, the summation being for τ = 1 to t.

  In this formula, the value of the timber is the sum of:
  - the capitalised value of the rent on land: $L[(1+r)^t – 1]$,
  - the capitalised cost of initial plantation: $C_0(1+r)^t$,
  - the capitalised value of past net intermediate costs: $\Sigma(C_\tau - R_\tau)(1+r)^{t-\tau}$ over the years 1 to t.

- the *expectation formula*, where the value of the standing timber at the end of the year t is based on the future receipts and costs:

  $S_t = [p_TQ_T – L[(1+r)^{T-t} – 1] - \Sigma(C_\tau-R_\tau)(1+r)^{T-\tau}]/(1+r)^{T-t}$, the summation being for τ = t+1 to T.

  In this formula the value of timber is given by:
  - the present value of the final receipt: $p_TQ_T /(1+r)^{T-t}$, less
  - the present value of the future rent on land: $L[(1+r)^{T-t} – 1]/(1+r)^{T-t}$, less
  - the present value of future net intermediate costs: $\Sigma(C_\tau-R_\tau)(1+r)^{T-\tau}]/(1+r)^{T-t}$ over the years t+1 to T.

The two expressions are equivalent when the rate of discount is chosen equal to the internal rate of return.

Consequences of Faustmann's formulae are that:
- the value of the timber does not depend upon the present stock of timber but only on the future (or past) receipts (i.e. quantities harvested times the prices at harvest time) and costs.
- the change in value of the timber during the year t (the rate of discount and the prices being constant) is given by $rS_{t-1} + C_t – R_t + rL$,
- the increase in value, $rS_{t-1} + C_t + rL$, corresponds to the value of the timber at the beginning of the year plus the value of the land (S_t+ L) times the rate of discount plus the costs of the period (C_t).
- the decrease in value corresponds to the receipts of the period (R_t).

[6]The "administration cost capital" is a value introduced by forest economists to represent the capital corresponding to the fixed annual costs and receipts (taxes, non-wood receipts, etc.) of the forest land. Its value is given by v/r, where v are the fixed annual costs and receipts. When regular non-wood receipts (hunting rights, etc.) exceed the current fixed costs, the "administration cost capital " becomes negative and adds to the "timber" value of the land, which explains that in some cases the value of land may be high in spite of low net returns on forestry activities.

1.2.2 Non-cultivated forests

For non-cultivated forests, there are neither initial nor intermediate costs. The value of the standing timber at the end of year t simplifies to:

$S_t = p_T Q_T[(1+r)^t-1]/[(1+r)^T -1]$

The change in the value of the stock of standing timber during year t is given by:

$\Delta S_t = rp_T Q_T(1+r)^{t-1}/[(1+r)^T - 1]$

Based on Faustmann's "optimal rotation" condition[7], Vincent (1999) proposes an equivalent formula where the value of the change in the value of the standing timber during one year is given by $\Delta S_t = p_T g(T)/(1+r)^{T-t}$, g(T) being the growth rate at the harvesting age.

In this case, the discount rate being given, the optimal age T* for harvesting is the age such that:

$$r(1+r)^{T^*}/[(1+r)^{T^*}-1] = g(T^*)$$

One should notice that in this case (non-cultivated forest), an implicit value is given to the forest land as:

$L = p_T Q_T/[(1+r)^T - 1]$,

and the value of the standing timber at the end of year t may be reformulated as:

$S_t =[(1+r)^t - 1]L$, which means that the value of the standing timber is the capitalised rent on land over the period 1 to t.

A problem may appear when the market value of the bare forest land is zero, or near zero, i.e. for example when there is no alternative use for land. According to the formula that gives the value of land, this is only possible with a very high rate of discount. Assuming a "normal" rate of return would produce a discrepancy between the market value of bare land and the "calculated" (i.e. "theoretical") value. As an example, the calculated value of land in Finland (265 ECU/ha) is five times higher than the "assessed" value of land in Sweden (57 ECU/ha), see Commission of the European Communities (1999), page 20.

For non-cultivated forests, the change in the value of the standing timber during year t is:

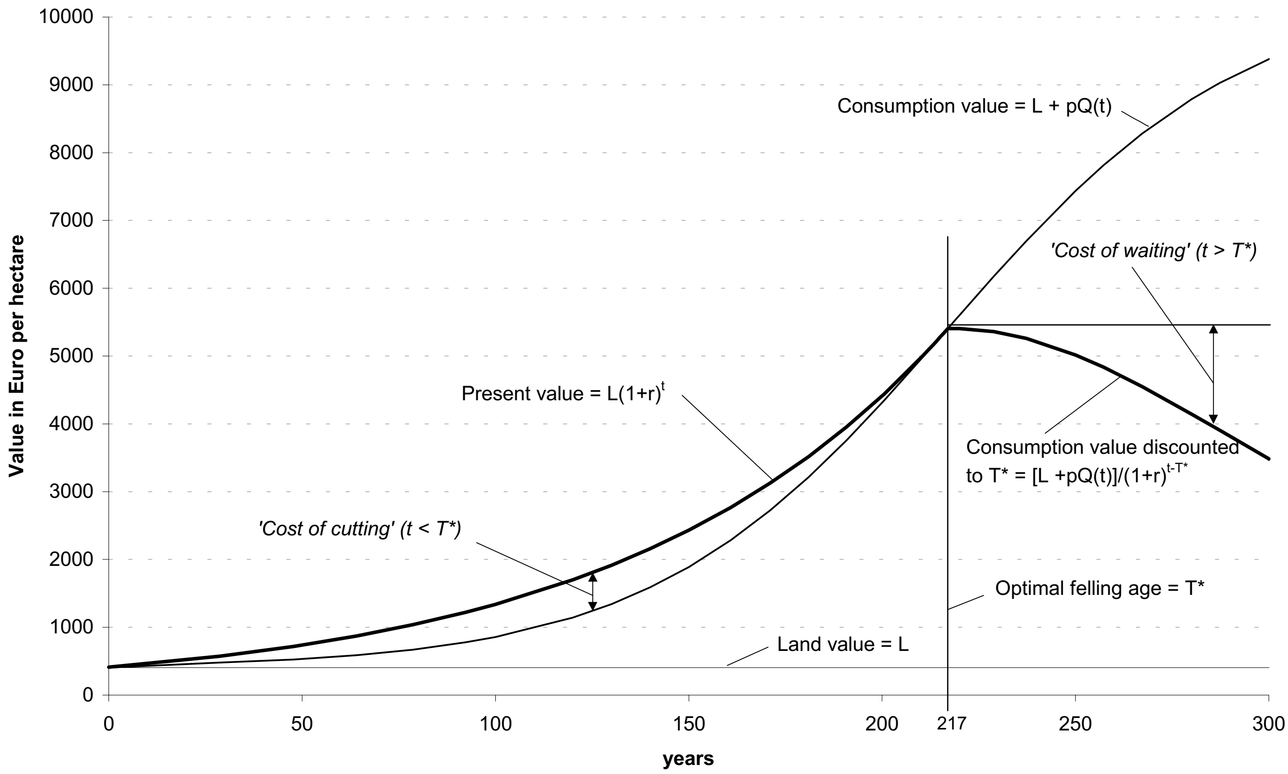
$\Delta S_t = r(S_{t-1} +L)$, i.e. the value of the standing timber at the beginning of the year plus the (implicit) value of land times the rate of discount.

The problem is thus how this change in value should be interpreted, and how natural growth should be defined and valued.

Figure 1 below shows the sum of the land and standing timber value of a hectare of beech according to the net present value method and the consumption value method. In this figure, the consumption value is obtained multiplying the standing volume by the stumpage price. The volume is supposed to follow a logistic function and the stumpage price is supposed to be the same for all age classes, which is not correct but does not change the conclusions. The present value is obtained under Faustmann's or Vincent's optimal rotation condition, the rate of discount being fixed to 1.2%. The "optimal" harvesting age is 217 years. At this age, the consumption value is equal to the net present value. Before this age, the net present value is higher than the consumption value, i.e. the costs of postponing the harvest are lower than the increase in the consumption value under the assumptions made. If the harvest is made after the optimal age, while the consumption value continues to increase, the costs of postponing the harvest are higher than the increase in the consumption value.

[7] Faustmann's optimal rotation condition states that timber is cut when the rate of growth of the timber value equals the costs of postponing the harvest. The rate of growth of the timber value is $p_T g(T)$ and the cost of postponing the harvest is $rp_T Q_T(1+r)^T/[(1+r)^T-1]$, i.e. the total value of land and standing timber times the rate of discount, see Vincent (1999).

Figure 1: Consumption and net present value of forest real estates (land plus standing timber)



In SNA, natural growth corresponds to the fact for timber to grow taller. In some sense this seems to imply a link between the increase in volume (and quality) of the timber and natural growth. However, there is no direct link as the value of natural growth is defined independently of the increase in volume and quality and <u>the increase in the consumption value of timber as it grows is not the value of natural growth</u>.

The consumption value method ideally consists in valuing each tree of the stock by the net receipt the owner would benefit from if the tree were felled at the time the valuation refers to, given its characteristics. By definition, when the timber is felled before (or after) its optimal age, the consumption value (i.e. the value that is realised harvesting the tree) is less than the value that would be realised harvesting at the optimal age. There is a loss of expectation value.

Under optimal management, the timber has to be left growing as long as the rate of growth times the rate of price increase is higher than the cost of immobilising the capital constituted by the standing timber and the land (Faustmann's condition).

Forest economics give the theoretical reference frame for the valuation of forest land and standing timber. However, assumptions made are very critical. In particular, it has to be assumed that the standing timber is harvested at its optimal age. This condition is not fulfilled in real forestry. As shown by the age distribution of European forests (see Figures 6-9 in Annex for the age distributions of Austrian, French and German forests) not all standing timber is cut at the same (optimal) age, disregarding species and other conditions. Other assumptions made by Faustmann need to be examined, including:

- the role of non-wood receipts, which seem to have increased in relation to the 19th century,
- the existence of a competitive market,
- the presumed repetition of identical rotations,
- the choice of an appropriate rate of discount which is sometimes considered a severe constraint for the application of Faustmann's formulae,
- integration of uncertainty as concerns the future, which is certainly a major challenge.

Solutions exist as concerns all these aspects and Faustmann's basic principles remain valid. However, properly taking account of these deviations from the simplifying assumptions requires very detailed data. For all these reasons forest economists have developed alternative methods (see chapter 2 - Valuation of forest assets in practice and chapter 4 - Valuation in the test countries).

1.3 Forest assets and related flows in ESA

1.3.1 Classification of forest assets

The classification of forest assets adopted by the IEEAF closely follows the ESA classification of assets. It distinguishes land, timber and other forest-related assets. Land is always a non-produced asset. Timber is produced when the forest is cultivated and non-produced when the forest is non-cultivated. Other forest-related assets may be tangible produced fixed assets (buildings, roads, equipment used in forestry) or tangible non-produced assets (game, birds and other biological assets living in forests). Unless separately recognised by market transactions or formal appraisal, the (asset) value corresponding, e.g., to hunting rights giving rise to monetary payments is supposed to be embedded in the value of land.

1.3.2 Separation of land and standing timber

Land and timber have a very different nature, which is fully recognised in the national accounts classification of assets. Although land may suffer from degradation (due for example to erosion or pollution), i.e. a decrease in its capacity to produce plants (and trees) and in general to offer space for economic activities, the land is not really consumed in the production process, which explains that there is no consumption of fixed capital for land. In many cases deforestation occurs in order to clear forest land for other uses.

The nature of timber is clearly different. Timber is felled and used either for final consumption (e.g. fuel wood) or for intermediate consumption (e.g. to produce paper pulp). In such a case, the timber value becomes embedded in the value of the product, and disappears as timber value.

Table 4: ESA balance sheets and accumulation accounts for land

Opening balance sheets: Value of the land at the beginning of the period (AN.211)	
Capital account	
Acquisitions less disposals of land (K.21)	only affects balance sheets for institutional sectors: for the economy as a whole the value of acquisitions less disposals of land is zero
Additions to the value of land (P.513)	the value of improvements to land and the costs of ownership transfers on land
Consumption of fixed capital (K1)	the consumption of fixed capital for fixed assets that add to the value of land
Other changes in the volume of assets account	
Economic appearance of land (K.3)	covers mainly additions to the value of land due to changes in economic uses (e.g. from forest to built-up land)
Other economic disappearance of land (K.62)	covers reductions in the value of land (degradation due to economic activities) and changes in economic uses (e.g. from agricultural to communal use)
Catastrophic losses (K.7)	reduction of the value of land due to natural disasters and major toxic spills
Uncompensated seizures (K.8)	covers the seizure of land without full compensation
Other volume changes in land (K.9)	covers all other volume changes of land
Changes in sector classification and structure (K.12.1)	only applies to sector balance sheets and covers changes in the sector classification of the land owner
Other changes in classification of assets (K.12.22)	only applies to changes in land classification: covers the changes in land use with the same absolute value being recorded for both entries
Revaluation account	
Nominal holding gains/ losses (K11)	the value of the benefit accruing to the owner of the land as a result of a change in its price, or more generally, its monetary value over time
Closing balance sheets: value of land at the end of the period (AN.211**)**	

1.3.3 Produced and non-produced standing timber

When produced, standing timber yielding once-only products on destruction is classified as inventories. More precisely, until the time it is harvested or sold while standing for being harvested, cultivated standing timber is classified under a specific item: “work in progress on cultivated assets”. Natural growth, which is output, accrues to the value of standing timber as “additions to work in progress”. At the time of harvesting or sale for felling, the value of standing timber decreases with “transfer to inventories of finished goods”.

Table 5: ESA balance sheets and accumulation accounts for produced timber

Opening balance sheets: value of inventories of standing timber at the beginning of the period (AN.1221**)**	
Capital account transactions	
Changes in inventories (P.52)	Changes in inventories result from natural growth, harvest or sales
Additions to work in progress	Natural growth as output of the forestry activity
Withdrawals from inventories of work in progress	Transfer to inventories of finished goods (AN.123): when harvested or sold for being harvested
Other changes in the volume of assets account	
Catastrophic losses (K.7)	covers the decrease of the value of timber due to natural disasters, etc.
Uncompensated seizures (K.8)	covers the seizure of timber without full compensation
Other volume changes in produced timber (K.9)	covers all other volume changes of timber
Changes in sector classification and structure (K.12.1)	only applies to sector balance sheets and covers changes in the sector classification of the owner of the produced timber
Other changes in classification of assets (K.12.22)	changes in classification of timber (e.g. from economic to non-economic, the same absolute value being recorded for both entries)
Revaluation account	
Nominal holding gains/losses (K.11)	the value of the benefit accruing to the owner of the timber as a result of a change in its price, or more generally, its monetary value over time
Closing balance sheets: value of inventories of standing timber at the end of the period (AN.1221**)**	

When non-produced, timber falls under a specific category of assets (non-produced assets: non-cultivated biological resources AN.213), which is neither inventory nor fixed asset. Natural growth, which is not output, but other changes in volume, accrues to the value of the stock of timber. At the time of harvesting or sale for felling, the decrease in the value of the stock of timber is recorded as depletion.

Table 6: ESA balance sheets and accumulation accounts for non-produced timber

Opening balance sheets: value of the stock of non-produced timber at the beginning of the period (AN.213)	
Capital account transactions	
acquisitions less disposals of non-produced timber (K.21)	
Other changes in the volume of assets account	
Economic appearance of non-produced timber (K.3)	covers the increase in the value of non-produced timber when it becomes exploitable
Natural growth of non-produced timber (K.5)	corresponds to the increase in the value of the stock of non-produced timber due to natural growth
Depletion of non-produced timber (K.61)	corresponds to the decrease in the value of the stock of non-produced timber due to harvesting
Other economic disappearance of non-produced timber (K.62)	covers the decrease of the value of non-produced timber when it becomes non-exploitable, or when its quality is degraded by pollution, etc.
Catastrophic losses (K.7)	covers the decrease of the value of non-produced timber due to natural disasters, etc.
Uncompensated seizures (K.8)	covers the seizure of non-produced timber without full compensation
Other volume changes in non-produced timber (K.9)	covers all other volume changes of non-produced timber
Changes in sector classification and structure (K.12.1)	only applies to sector balance sheets and covers changes in the sector classification of the owner of the non-produced timber
Other changes in classification of assets (K.12.22)	changes in classification of non-produced timber (e.g. from economic to non-economic, the same absolute value being recorded for both entries)
Revaluation account	
Nominal holding gains/losses (K.11)	the value of the benefit accruing to the owner of the non-produced timber as a result of a change in its price, or more generally, its monetary value over time
Closing balance sheets: value of the stock of non-produced timber at the end of the period (AN.213)	

1.4 Valuation of forest assets and related flows in ESA

1.4.1 Valuation principles

In ESA, the value of an asset is derived from the value of the economic benefits derived from using or holding this asset. In the latter case the value is given by the price that is, or will presumably be, received when disposing (selling) the asset, now or latter. In general, ESA privileges market valuation: "The System does not attempt to determine the utility of flows and stocks. Instead, flows and stocks are measured according to their exchange value, i.e. the value at which flows and stocks are in fact, or could be, exchanged for cash. Market prices are thus ESA's basic reference for valuation" (ESA § 1.51).

ESA (§ 1.52) makes clear that: "In the case of monetary transactions and cash holdings and liabilities, the values required are directly available. In most other cases, the preferred method of valuation is by reference to market prices for analogous goods, services and assets. This method is used for e.g. barter and the services of owner-occupied dwellings. When no market prices for analogous products are available, for instance in the case of non-market services produced by government, valuation should be made according to production costs. If neither of these two methods are feasible, flows and stocks may be valued at the discounted present value of expected future returns. However, due to the great uncertainty involved, this last method is only recommended as a last resort".

In § 7.25, ESA specifies that: "Assets and liabilities are to be valued using current market prices on the date to which the balance sheets relates. This means that assets should be valued on the basis of:
(a) purchaser's prices if they are bought,
(b) basic prices if they are own-account produced and on the basis of basic prices of similar goods or of the sum of its costs if no basic prices are available."

ESA (§ 7.26) states, that: "Ideally these prices should be prices observable on the market. When there are no observable prices – as may be the case if no purchases/sales of the items in question have been observed in the recent past – an attempt has to be made to estimate what the prices would be if the assets were acquired on the market on the date to which the balance sheets relates"..

ESA § 7.27 clarifies that: "In addition to prices observed on market or estimated from observed prices or cost incurred, current prices may be approximated for balance sheets valuation by:
(a) revaluating and accumulating acquisitions less disposals or
(b) the present, or discounted, value of future returns."

For certain categories of assets, ESA states (e.g. § 7.30) that "…in the case of assets for which the returns are (…) delayed (as with timber) (…), a rate of discount must be used to compute the present value of the expected future returns. The rate of discount should be derived from information based on transactions in the particular type of assets under consideration (….) rather than using a general rate of interest".

Finally, ESA § 7.38 states that "..standing timber is valued by discounting the future proceeds of selling the timber at current prices after deducting the expenses of bringing the timber to maturity, felling, etc.".

1.4.2 Valuation of forest-related flows in ESA

Non-cultivated forests: natural growth and depletion

When forests are not cultivated the value of standing timber may change under the effects of natural growth, depletion, natural losses, holding gain and losses, etc. (see table 5 above).

<u>Old growth forests</u>

Although not important in Europe, the case is worth investigating as some natural old-growth forests are protected. In the case that protection is achieved via the purchase of the forests by general government or environmental protection private institutions, or via a formal appraisal that involves another unit than the owner, a value has to be put on them.

As shown in the Finnish report, the transaction value is based on the sum of the stumpage value of the timber plus the value of the (bare) land according to the alternative use it could receive (including for building second (summer) houses or other recreational infrastructures).

Such a transaction has to be recorded as 1) acquisition of non-produced assets, 2) disappearance of non-produced assets and 3) changes in classification and structure.

Non-cultivated forests: valuation of natural growth

Second growth non-cultivated forests involve no other costs than the cost of the land. When immature, the value of the timber is given by the accumulated rent on land. The value of natural growth is reduced to the opportunity cost of the capital represented by the land and standing timber.

Cultivated forests: natural growth and removals

When forests are cultivated the timber is classified as "inventories of work-in-progress". The value of inventories of work-in-progress changes under the effect of additions to inventories (natural growth), withdrawals from inventories (removals or transfers to finished products) and other flows. Additions to work-in-progress are valued in proportion to the estimated current basic prices of the finished product. Reduction in work-in progress as withdrawn from inventories when production is finished are valued at current basic prices of the finished products.

Natural growth

SNA § 6.77 states that “assuming the basic price of the finished product remains unchanged over the period during which it is being produced, the value of the addition to work-in-progress in a given period is obtained multiplying the basic price by the share of the total production costs incurred during that period. In other words, the value of the final output is distributed over the various periods during which production takes place in proportion to the costs incurred.”

On the condition that “total production costs” include a return to the asset, this valuation is consistent with the net present value method, as soon as the internal rate of return is chosen as the rate of discount.

It means that the change of value of the timber stock due to natural growth is given by $rV_{t 1} + C_t$, where V_{t-1} is the value of the combined asset (land and standing timber) at the beginning of the period, i.e. at the end of the previous period, and C_t the current costs. It supposes that “all things are equal” between the beginning and the end of the period, and in particular the price and the rate of discount used, as well as that the felled quantities are the – expected - quantities used for the valuation of the opening stock of timber.

V_{t-1} is equal to the net present value of future net receipts.

$V_{t-1} = \Sigma(R_\tau - C_\tau)/(1+r)^{T-\tau}$ for $\tau = t$ to T;
$V_{t-1} = (R_t - C_t)/(1+r) + \Sigma(R_\tau - C_\tau)/(1+r)^{T-\tau}$ for $\tau = t+1$ to T;

$\Sigma(R_\tau - C_\tau)/(1+r)^{T-\tau}$ (for $\tau = t+1$ to T) $= V_f/(1+r)$.

$V_{t-1} = (R_t - C_t)/(1+r) + V_f/(1+r)$.

The ESA identity for inventories is $S_t = S_{t-1}$ + additions to inventories – withdrawals from inventories. Let NG_t be the value of the natural growth during the period, that accrues to the value of inventories, whereas R_t is the value of the withdrawals from inventories, from the two expressions it comes that $NG_t = rV_{t-1} + C_t$, where C_t is the value of forestry costs during year t.

It should be noted that C_t should not include the value of plantations during the year, as plantations do not refer to the existing stock of growing timber but contribute to the creation of a new stock, value of which was not included in the initial value of the stock. But C_t includes all costs related to the growth of the initial stock of growing timber, including the consumption of fixed capital and opportunity cost of the fixed assets involved in the growing of stock.

Removals

The value of removals is the stumpage value of the timber that has been removed from the forest. Although conceptually simple, the value of removals may be rather complicated to assess, as the stumpage value (i.e. the value while standing) is not always available. In many cases it has to be calculated as the value of the wood in the rough (output of the logging activity) less harvesting costs. However, as it should cover all costs, including capital costs, i.e. consumption of the fixed capital used by the logging industry and the corresponding net operating surplus/mixed income, the assessment of logging costs may be difficult. In any case the logging costs and the forestry costs (necessary for the valuation of the natural growth) have to be determined at the same time, as they are generally known as a total, e.g. through Economic Accounts for Forestry.

Other flows

Beside natural growth and removals, various other flows affect the value of the initial stock of timber (see table 4 above).

Catastrophic losses

The value of catastrophic losses is given by the difference between the present value of the stock of timber before the catastrophic event and its value immediately after. Such calculation depends upon the way the present value is practically implemented.

When the catastrophic event does not destroy the wood, it is necessary to take into account the value of the wood that will be salvaged. This value is a consumption value, although due to problems of quality and excess supply the prices to be used may be lower than “normal” prices. There may also be supplementary costs for the recuperation and the storage of the felled timber, the clearance of the forest, etc. The stumpage value of the salvaged timber has to be accounted for in the value of the stock, as long as it is not removed from the forest, which, in some cases, may take some years.

There may be a second effect of these catastrophic events: the decrease in the prices of the wood, due to the excess supply. As illustrated by the prices of wood in Germany after the 1990-91 tempests, there may be a sharp decrease in the prices of wood, followed by a slow recovery (see Figure 21 in Annex). As the prices used in the present value method are current prices, a tempest may result in a sharp decrease in the value of the standing timber. However, as the net present value is a “long term expectation” value, it is not sure that the full price effects of tempests have to be taken into account. Using averaged prices would smooth the changes in value.

Other flows: changes in use, status and classification

Other changes that affect the value of stocks of standing timber as a resource for the logging industry may be changes in use or status, e.g. when forest is protected and logging is prohibited. In this case the value of the standing timber is reduced to zero. One could however consider that the value passes to a new type of asset, similar to historic monuments (see above under ‘old-growth forests’).

Holding gains and losses

The value of holding gains and losses results from the change in the prices of timber, forestry costs and rate of discount between opening and closing balance sheets. When the net present value method is used, the value of the stock of standing timber also depends upon the assumptions made as concerns the pattern of removals. These assumption may differ from actual removals. In this case, the impact of these differences on the value of the stock has to be analysed and classified as other change in volume (K.9).

2. Valuation of forest assets in practice

Practical valuation methods may be divided into two main categories, each with several variants:

- Transaction value methods which apply a price derived from transactions observed during the period to value the whole stock of an asset.
- Net present value methods which calculate the value of an asset by the present value of future net returns.

These methods may be applied to value the stock (i.e. the asset itself) or the flows that change the volume or/and value of the assets.

2.1 Transaction value methods

Transaction value methods apply a price per unit as derived from observed transactions to the whole stock. The stock is described in physical terms. For example, a price per hectare is applied to the total forest area, or a price per cubic metre is applied to the total stock of standing timber expressed in m^3.

The method may be applied to forest real estates, to bare forest land or to standing timber. In the first case, the value of the combined asset has, then, to be divided between land and standing timber in order to establish separate balance sheets for land and standing timber. In the second case, when the value of land and timber are separately assessed, it is worth comparing the sum of these values with the transaction value of forest real estates.

2.1.1 Transaction value method applied to forest real estates

The simplest method for valuing forest real estates (i.e. the combined asset formed by the land, the standing timber and any other forest-related asset) is to calculate the average price of one hectare of forest and to apply it to the whole forest area. Average prices may be calculated from a register of transactions or a fiscal database. This is a rough method, which does no take into account the various characteristics of forest real estates: productivity of land, age and species of the timber stock, actual conditions of the timber exploitation, existence of other assets that may influence the value of the real estate, etc. The only necessary data are the areas of the transacted forests, in order to calculate a price per hectare.

Data on transactions exist in many countries. However, experts are often rather reluctant to use these data. Main reasons are that:

- transactions are very few. For example, in France less than 100 000 ha are exchanged annually, i.e. 0.7% of the total forest area; in Austria the respective percentage is 0.1%.
- transactions may not be representative of pure forestry motivations (e.g. biased by hunting motivations). For example, the Austrian report states that: “many transactions with forests are dominated by public authorities, in connection, e.g., with the construction of major public roads. A considerable amount of the other transactions are motivated by inheritance or swaps, so that also in these cases there is no real market situation involving supply and demand and revealing market prices. Finally there is often a significant discrepancy between the market prices of forests and the capitalised value, indicating non-monetary motives of the investors…”. For French experts, two other factors may result in non-representative prices: transacted forests do not include state forests or other publicly owned forests and they possibly concern the less well managed or maintained forests. Sweden indicates that “sellers of forest land have probably exploited their asset as much as possible before they sell it, which means that there is a bias in the statistics of transactions towards lower values”.
- Finally, when data on transactions come from fiscal database, the reported price may suffer from systematic underreporting of prices.

As forests are not homogeneous, it is preferable, following SNA recommendations (see SNA § 13.57), to classify forests according to their characteristics, to calculate a price for each category of forests and to apply this price to the corresponding stock. However, often the characteristics of the transacted forest real estates are not available in the databases so that average prices for the various categories of the stock cannot be calculated.

An application of SNA recommendations is the Lancaster approach (hedonic pricing). Starting from a sample of recorded transactions and collecting the characteristics of the corresponding forest real estates, the factors that determine the observed transaction values are identified through a regression analysis. The resulting equation is then applied to the whole stock, which is described according to the same characteristics. This method was applied to the German forests (see Bergen et al 1998). On the basis of a sample of 70 transactions, the transaction value of forest real estates were explained as a function of area, volume of the stock of standing timber and timber species. As the area was found to be one of the explanatory variables, the method allowed separating directly the value of land from the value of timber. Other characteristics were excluded by the statistical analysis: stocking degree, age of timber, yield class, etc.

Shortcomings of the Lancaster approach are that the size of the sample may grow considerably when one wants to test the impact of several characteristics, e.g. the reason of the transactions (pure forestry purpose or other purpose), volume of standing timber by age, species, conditions of exploitation (slope, distance to the nearest sawmill, etc.), but also local conditions determining the pressure on land, etc.

When applied to forest real estates, the transaction value method cannot be used to value those flows that only affect standing timber, except when it has been possible, using the Lancaster approach, to separate the value of the forest real estate between the value of land and the value of timber.

2.1.2 Transaction value method applied to bare land

When the Lancaster approach cannot be applied (e.g. because the characteristics of the transacted real estates are not available) or give no significant results one has to assess the value of bare land and the value of timber separately. In some countries (e.g. France) the price of transacted bare forest land is available. The price of bare forest land may also be approximated by the price of comparable land, e.g. starting from prices of marginal agricultural land. Finally the price of land may be estimated as a ratio of the price of real estates (as was done e.g. in Sweden, Austria) or based on recommended (calculated administrative) values (Finland). However, in this last case, it cannot be said that the price of land is actually based on a transaction value method.

It is important to collect the price of bare forest land if one wants to apply the full net present value method; as can be seen from the Faustmann formulae (see chapter 1) it is equivalent to have the rate of discount or the value of land - when the value of bare land is available, the rate of discount may be calculated as the internal rate of return of the forestry.

Shortcomings are more or less similar to those reported for the transaction prices applied to forest real estates.

2.1.3 Transaction value methods applied to standing timber

The price per cubic metre of timber is generally observed, although it may be at different stages. There exist two main price concepts for timber: the “stumpage price” i.e. the price of timber while standing and the “roadside pick-up price” (or wood in the rough or raw wood price), which applies when timber is already felled, transported to the roadside and stacked. The stumpage price is the price that should be used for the valuation of standing timber. When stumpage prices are not available, it is necessary to derive them from the roadside pick-up prices by deducting the logging, transporting and stacking costs. This may be a rather complex operation, in particular if one wants to calculate costs according to different conditions of the logging activity such as slope, species, use of timber, etc. In general an average cost is estimated, which allows assessing the stumpage prices from the roadside pick-up prices. A further complication is that prices do not refer to the same products: stumpage prices generally refer to species and classes of diameter, whereas roadside pick-up prices refer to “wood assortments”, i.e. potential uses and quality of wood: logs, by diameter and species, pulp wood, fuel wood. A transformation has therefore to be made between the timber while standing and the assortments.

This stumpage price is then applied to the stocks or flows. There are two main variants, called the “stumpage value” method and the “consumption value” method.

The "stumpage value" method

In the simplest variant, an average stumpage price is calculated and applied to the whole stock. The stumpage value of the wood removed from the forest is obtained, e.g. deducting from the value of the wood in the rough, as given by industrial statistics, the logging costs. The average stumpage price is then calculated dividing the stumpage value by the volume of the harvest, expressed in cubic metre of standing timber. The stumpage value method is sometimes called the "net price" method (see Statistics Canada 1995).

Physical data are generally available from forestry statistics and national forest inventories and the main difficulty is the calculation of the stumpage price.

More detailed variants apply several average stumpage prices per species to the volume of standing timber per species. It is worth noting that the stumpage value method is dependant on the structure of the removals. When the structure of the removals changes over time, it may introduce changes in the valuation. However it seems that for European countries the structure of removals is fairly stable, except in exceptional circumstances.

A positive feature of the stumpage value is that it is the correct and most straightforward method to value the harvest, i.e. the withdrawals from inventories of standing timber. This allows to simplify the establishment of monetary balance sheets on the basis of physical accounts, including when balance sheets distinguish species. However, it does not give the right value to natural growth.

When the stumpage value method is used, various precautions are necessary.

As concerns physical data the volumes are to be accurately measured with the correct units. In general coefficients are used for the conversion between a cubic metre of standing timber (measured following the prescriptions of, e.g., the TBFRA 2000) and a cubic metre of wood in the rough. These coefficients depend upon the type of wood in the rough (logs, pulp wood, fuel wood) and the way it is measured (with or without bark).

Physical and monetary data should be consistent. The main problem is the fuel wood. Generally, fuel wood for own final use is not included in the output of logging, whereas it may be included in forestry statistics. In most cases estimation of the consumption of fuel wood is made by experts, comparing two successive forests inventories, as a balancing item.

The "consumption value" method

In this method different stumpage prices are used for the various categories of timber in terms of both species (as in the stumpage value method) and age or diameter classes. These prices are applied to the stock of timber, generally known by species and age/diameter classes through forest inventories.

When stumpage prices by species, diameter, etc. are available they are directly applied.

When stumpage prices are not available, the standing timber stock, described by species, diameter or age classes, etc., has to be converted into assortments of wood in the rough, using specialised forests algorithms. A potential total production of wood in the rough is calculated by assortments and wood in the rough prices are applied. Then the logging costs are deducted in order to arrive at a stumpage value. In the most detailed methods, logging costs are calculated by wood assortments and/or logging conditions (slope, access, etc.). In general, however, an average logging cost by m^3 of wood is used.

The consumption value method may be applied to flows. When applied to removals, it gives the same value as the stumpage value method, provided that removals are described accurately. When applied to natural growth, it gives the increase in the consumption value due to the natural growth. This increase in the consumption value is not the correct value of natural growth.

A variant of the "consumption value" method: the sample trunk grading

In this method, stems are converted into wood in the rough, according to their characteristics (species, diameter, height, etc.) using algorithms similar to those used in the consumption value method, although more detailed. This conversion is made for a sample of trees and the results are extrapolated to the whole forest. The next steps are the same as in the "consumption value" method, including the use of logging costs differentiated by type of terrain accessibility.

Transaction value methods: conclusions

The difference between the "stumpage value" and "consumption value" methods is that in the stumpage value method, the average stumpage price is applied to the stock and the flows, irrespective of the age/diameter structure and related characteristics of the stock and flows (except removals), whereas in the consumption value method the age/diameter structure of the stock and flows are taken into account. For the valuation of the stock of a given species the difference between the results of the two methods varies with the difference between the average structure of the removals and the average structure of the stock. When the structure (by diameter/age) of the removals is the same than the structure of the stock, the two variants give the same result for the stock.

Both the stumpage value and the consumption value methods can be seen as special forms of the net present value method (with implicit discounting). It is however difficult to analytically compare their results with the results of the net present value method. Which of the two methods gives more accurate results has to be judged on the basis of the characteristics of the concerned forest, including its exploitation conditions. it depends upon the current structure of the stock and the fellings and the assumptions on their evolution in the future.

2.2 Present value methods

These methods are in line with ESA prescriptions and forest economics. They calculate the value of the forest assets as the present value of future net economic benefits. However, the application of the present value method to a stock of timber raises some complex problems.

First, it is rather difficult to determine the part of the future receipts that corresponds to the present stock. In effect, the timber will continue to grow, and the future receipts will therefore correspond to the present stock plus the natural growth between the current time and the time of harvest.

The only way to value the present stock is to calculate the present value of the future receipts (including the receipts corresponding to the future natural growth) and to deduct the present value of the natural growth over the rest of the life of the stock of standing timber.

This results into the formula $S = [\Sigma R_\tau(1+r)^{T-\tau} - \Sigma C_\tau(1+r)^{T-\tau}]/(1+r)^{T-t} - L[(1+r)^{T-t} - 1]/(1+r)^{T-t}$, the summation being over the years t+1 to T, i.e.:

- the present value of future receipts: $\Sigma R_\tau(1+r)^{T-\tau} /(1+r)^{T-t}$;
- the present value of the future natural growth: $\Sigma C_\tau(1+r)^{T-\tau} /(1+r)^{T-t} + L[(1+r)^{T-t} - 1]/(1+r)^{T-t}$, i.e. the present value of future forestry costs plus the capitalised value of the future rent on land.

One may verify that this value is identical to the Faustmann formula presented above. However, as the formula includes the capitalised value of the rent on the land occupied by the stock of standing timber, it implies that the land is fully occupied by the stock of standing timber all over the life of the stock, and that the final harvest liberates the land in totality. This last assumption is generally not verified.

Foresters distinguish two periods. During the first period the area is fully occupied, and the only harvest consists in thinning in order to allow the growth of timber. During the second period, the mature timber is felled and a part of the area is cleared for new plantations.

As no age for the final harvest can be fixed and the land cannot be considered fully occupied all over the life of the stock, this complicates significantly the calculations. A solution is to calculate from the observation of forests the probabilities for stems to be cut over the life of the stand (see e.g. the French test exercise).

2.2.1 Application of the present value method to standing timber

According to the complexity of the modelling and the way the rate of discount is fixed, there are several variants of the net present value method.

In the simplest variants, the rate of discount is fixed exogenously (e.g. from consultation of forest experts). It is generally agreed that an admissible range for the rate of discount for calculating the present value of forest assets in Europe is between 0.5 and 3,5%. However, the information as such is not so relevant: given the duration of life of a forest (e.g. 80 years) the discount factor varies from 0.8 for a 0.5% rate of discount to 0.3 for a 3.5% rate of discount. Note that it has also been argued that even a zero rate of discount is admissible – see Sekot (1999).

On the basis of the forest inventory, the forest stock is distributed by age classes (e.g. twenty years classes). A harvesting age and a final volume of standing timber by hectare at the harvesting age are fixed. Intermediate receipts are neglected. Future receipt is only the final receipt, calculated multiplying the present stumpage price of mature timber by the volume that will be harvested. Costs and rent on land are neglected. The present value is calculated discounting future receipts.

Let T be the harvesting age, Q_T the volume per hectare at the harvesting age, p_T the stumpage price of mature timber (i.e. the price at the harvesting age), A_t the area of the forest of age t, the net present value of the standing timber is given by:

$$S_t = \Sigma A_t p_T Q_T/(1+r)^{T-t}$$

As far as yields, price and harvesting age are not the same by species, this method has to be applied separately to the main species. As it neglects intermediate costs and receipts, as well as the rent on land, the method introduces a bias in relation with the theoretical value. However, the bias is difficult to assess; in particular the actual rent on land may be nil.

In a more realistic variant, an average management cost is introduced. It may be calculated, e.g., dividing actual forestry costs by the forest area, or assessed from the consultation of forest experts, or analysis of the accounts of forest firms. Let $\mathbf{C}_t$ be the value in year T of the total capitalised management cost, between t and T, for one hectare of timber of age t (when the management cost per hectare and per year is the same all over the life of the forests, $\mathbf{C}_t = c[(1+r)^{T-t} - 1]/r$) and the net present value of the standing timber is given by:

$$V = \Sigma A_t(p_T Q_T - \mathbf{C}_t)/(1+r)^{T-t}$$

Finally, it is possible to model all receipts, including receipts from thinning, and costs. Modelling of receipts is in general rather complex as soon as the assumption of clearcutting at a given harvesting age is not made. Two types of receipts corresponding to the different periods have to be distinguished: from plantations to maturity receipts are those from thinning. These may be modelled on the basis of the national forestry inventory data, through the decrease of the number of stems by hectare during the growth period. The description of “final” receipts, once the stems have reached the maturity age, needs to take into account the probability of trees to be harvested according to their age. Normally, this can only be done comparing two successive forestry inventories.

In the general method, the rate of discount is not fixed but derived as the internal rate of return that equalises receipts and costs (including plantation costs and rent on land) all over the life of the forest, the price of land being given.

2.2.2 Methods derived from the present value method

In the "age constant method" the forest is distributed by age classes; for each age class the value of the respective timber is obtained multiplying the "expected felling value" (the same as above in the net present value method) by an "age factor" or "age constant". For younger stands the "age constant" value does not take into account the volume of standing timber but the cost of establishment of the stands. For the intermediate age stands, the expected felling value is discounted. In the Austrian application of this method the implicit rate of discount embodied in the age constant method is around 1%.

When the forest is considered non-cultivated and managed in a sustainable way, the present value method may be simplified calculating the present value of an infinite stream of net receipts: stumpage value less forest management expenditure, see Statistics Canada (1995). A similar approach is to calculate the present value of the net "forestry" income over an infinite period.

The consumption value method and the stumpage value method could be interpreted as variants of the net present value. The rationale would be that the future increase in the volume of standing timber offsets the need for discounting future returns. For the consumption value method, this 'implicit discounting' may be higher due to both the natural growth and an increase in quality (higher diameter classes receiving higher prices per cubic metre).

Let Q_t be the volume of standing timber of age t, the consumption value method gives to this timber the value $Q_t p_t$ where p_t is the stumpage price of the timber of age t. The stumpage price method gives this timber the value $Q_t p$, where p is the average stumpage price of the harvest.

In T-t years the volume of this timber will be $Q_T = Q_t(1+g)^{T-t}$ (where g is the average growth rate of the timber over the period t+1 to T. The receipts will be $Q_T p_T$, therefore, neglecting the forestry costs and rent on land, which means neglecting the value of the future natural growth, the present value is $(Q_T p_T)/(1+r)^{T-t}$.

- A condition for the consumption value to be a good proxy of the (simplified) present value is that the rate of discount r be such that $1+r = (1+g)(p_T/p_t)^{T-t}$
- A condition for the stumpage value to be a good proxy of the (simplified) present value is that the rate of discount r be such that $1+r = (1+g)(p_T/p)^{T-t}$,

which means that in general the implicit rate of discount associated with the consumption value method will be higher than the implicit rate of discount associated with the stumpage value method.

These conditions do not have do be valid for each age class, but on average for the whole stock, general formulae being:

- $p_T \Sigma A_\tau/(1+r)^{T-\tau} = \Sigma A_\tau p_\tau/(1+g_\tau)^{T-\tau}$
- $p_T \Sigma A_\tau/(1+r)^{T-\tau} = p \Sigma A_\tau/(1+g_\tau)^{T-\tau}$

Whether these conditions are valid or not depends upon the structure of the forest (A_τ), the final rates of growth of the various age classes (g_τ) and the prices for the various categories of timber.

2.2.3 Application of the present value method to land

In forests economics the present value method is applied simultaneously to the land and the standing timber. The value of the land which is consistent with the value of standing timber is given by:

$$L = \Sigma A_\tau[p_T Q_T - \mathbf{C}_T - C_0(1+r)^T]/\{(1+r)^T - 1]$$

where $\mathbf{C}_T$ is the capitalised forestry cost over the rotation of the timber, C_0 is the plantation cost and $p_T Q_T$ is the receipt from harvesting the timber at maturity. For non-cultivated forests this simplifies to $Ap_T Q_T/[(1+r)^T - 1]$, with $A = \Sigma A_\tau$. However, the resulting value has to be compared with information derived from actual transactions on bare forest land. When the rate of discount is taken equal to the internal rate of return, the theoretical value of land is implicitly set equal to the market value.

2.2.4 Valuation of flows for cultivated forests

The value of the stock of timber varies with natural growth and harvest.

Harvest

As has been seen the value of the harvest is given by the stumpage value of the timber removed from the forest. When the stumpage prices are known, one has to transform the harvest (described as assortments of wood in the rough) into the corresponding volumes of standing timber (described by age/diameter) and to value these volumes by the stumpage prices. When the stumpage prices are not available, one has to take the value of the wood in the rough and deduct the harvesting costs.

Natural growth

Natural growth may be valued either on the basis of physical quantities or on the basis of costs. When valued on the basis of physical quantities either the stumpage value method or the consumption value method may be used. In the first case the average stumpage price (either calculated or directly available) is applied to the volume of natural growth, disregarding the structure, by age/diameter, of the natural growth. In the second case the structure by age/diameter of the natural growth is taken into account and specific stumpage prices are applied to each age/diameter category.

When the natural growth is valued on the basis of costs, which is more in line with ESA prescriptions, a proxy is given by forestry costs plus the opportunity cost of the value of the forest at the beginning of the year.

3. Forests in the test countries

As has been shown in chapter 2, the valuation of forests should take account of the characteristics of the forests, their exploitation etc. In this chapter a characterisation of the forests of the five countries that participated in the pilot and test exercises is presented. Together, the five countries represent about 70% of EU-15 forest area, 73% of forest area available for wood supply, 80 % of total net annual increment (NAI) and 83% of standing timber on forests available for wood supply in the EU.

3.1 Importance of forests

Data from Eurostat forestry statistics for the year 1998 show the importance of the wooded area for the five countries that participated to the pilot exercises.

Table 7: Forest and other wooded land in test countries and EU-15, in 1000 hectares

	Wooded area	% of total area	Forest	Other wooded land	Forest available for wood supply	As a % of forests
Germany	10 740	31	10 740	-	10 142	94
France	16 989	31	15 156	1 833	14 470	95
Austria	3 924	48	3 840	84	3 352	87
Finland	22 768	75	21 883	2 995	20 675	94
Sweden	30 259	74	27 264	2 995	21 236	78
Total 5	**84 680**	**48**	**78 883**	**7 907**	**69 875**	**89**
Other EU	51 514	35	34 684	14 730	25 650	74
EU-15	**136 204**	**44**	**113 567**	**22 637**	**95 525**	**84**

Source: Eurostat Forestry Statistics 1995-1998

The total of the five countries under report is 62.2 % of EU-15 wooded land but 69.5 % of EU-15 forests and 73.1% of exploitable forests. High forest is highly predominant in the five countries, except in France where coppice is important.

3.2 Characteristics of forests

3.2.1 Standing timber

Whereas the five countries under report account for 73.1% of EU-15 forest available for wood supply, they represent 82.9% of the growing stock of standing timber on these forests, which indicates a density (m^3/ha) that is higher than the EU average. The density varies widely across the five countries, from 310 m^3/ha for Austria to 90 m^3/ha for Finland.

Table 8: Growing stock in test countries and EU-15, in million m^3

	Growing stock on forest available for wood supply	In % of EU-15 growing stock	Density in m^3/ha
Germany	2 820	21.0%	278
France	2 836	21.1%	196
Austria	1 037	7.7%	310
Finland	1 867	13.9%	90
Sweden	2 567	19.1%	121
Total 5	**11 127**	**82.9%**	**159**
Other EU	2 292	17.1%	89
EU-15	**13 419**	**100.0%**	**140**

Source: Eurostat Forestry Statistics 1995-1998

3.2.2 Species distribution

Table 9: Growing stock by species in test countries and EU-15, in million m^3

	Softwood	Hardwood	Total stock[8]	Softwood in % of total
Germany	2 001	910	2 911	68.7
France	757	1 202	1 959	38.6
Austria	849	181	1 030	82.4
Finland	1 601	353	1 954	81.9
Sweden	2 491	454	2 945	84.6
Total 5	**7 699**	**3 100**	**10 799**	**71.3**
Other EU	1 330	1 199	2 529	52.6
EU-15	**9 029**	**4 299**	**13 328**	**67.7**

Source: Eurostat Forestry Statistics 1992-1996

The five countries represent 81% of EU-15 total stock of standing timber on forest and other wooded land; 85.3 % of EU-15 softwood and 72% of hardwood. Four of the five countries are predominantly stocked with softwood, mainly spruce; only in France hardwood dominates.

3.2.3 Age distribution and density of standing timber

For Austria, France and Germany, the age distributions by main species are known through the test exercises. As may be seen from Figures 6 to 9 in Annex, the Austrian and French distributions, although not similar, are rather regular for softwood and hardwood. The German distributions show deficits, for the age classes 40-60 years (softwood) and 60-80 years (hardwood). The average ages of the volumes of standing timber by main species are rather different for the three countries. Whereas in France and Germany the average age of hardwood is higher than the average age of softwood, this is the contrary in Austria.

Table 10: Average age of standing timber in Germany, Austria and France, in years

Species	Germany 1991	Austria 86/90	France 1991
Softwood	69	90	
Spruce	67		63
Pine	72		
Hardwood	90	79	
Oak	99		109
Beech	88		

Source: Eurostat calculations based on IEEAF test exercises

Densities are also rather different as well. For the two main groups of species, the density is much higher in Germany and Austria than in France. Density for mature stands (i.e. stands that reached the harvest age) reflects the same differences between Germany and Austria on the one side and France on the other. For the age class 61-80 years, the density is 295 m^3/ha for German hardwood, 385 m^3/ha for Austrian hardwood and only 92 m^3/ha for French oak.

[8] As can be seen comparing Tables 8 and 9, there are noticeable differences between Eurostat Forestry Statistics 1992-1996 and Eurostat Forestry Statistics 1996-1998 due to the changes in the definition of the growing stock following TBFRA 2000.

Table 11: Density of standing timber in Germany, Austria and France, m^3/ha

Species	Average density			Density for age class 121-140 yrs		
	Germany 1991	Austria 86/90	France 1991	Germany 1991	Austria 86/90	France 1991
Softwood	275	343		377	585	
Spruce	325		212	523		472
Pine	217			310		
Hardwood	244	246		380	489	
Oak	241		112	314		164
Beech	245			415		

Source: Eurostat calculations based on IEEAF pilot exercises

The general picture is thus different for Austria and Germany on the one side and France on the other, which corresponds to the importance of high forests (with higher density and natural growth) in Germany and Austria, and the important proportion of coppices and coppices with standards in France.

3.2.4 Productivity

According to Eurostat Forestry Statistics, the five countries that participated in the pilot exercises represent 79.8 % of the EU 15 total net annual increment (NAI) on forests available for wood supply. The net annual increment as a % of growing stock is lower for Austria (2.6%) and higher for Finland (3.9%). Due to the high density the NAI per hectare is much higher in Germany and Austria: around 8 m^3/ha, to be compared to 6.4 m^3/ha in France, 4 m^3/ha in Sweden, 3.5 m^3/ha in Finland and an average of 3.6 m^3/ha in other EU countries.

Table 12: Net annual increment (NAI) in test countries and EU-15 (forest available for wood supply)

	NAI (1000 m^3 o.b.)	In % of the growing stock	NAI per hectare (m^3/ha)
Germany	88 998	3.2	8.8
France	92 299	3.3	6.4
Austria	27 337	2.6	8.2
Finland	72 470	3.9	3.5
Sweden	85 431	3.3	4.0
Total 5	**366 535**	**3.3**	**5.2**
Other EU	92 971	4.1	3.6
EU-15	**459 506**	**3.4**	**4.8**

Source: Eurostat forestry statistics 1995-1998, tables 1.3 and 1.4

3.3 Exploitation of forests

3.3.1 Rate of exploitation

The rate of exploitation is an important parameter for the valuation of forest assets and the assessment of their sustainability. In the five pilot countries fellings are substantially lower than the NAI.

Table 13: Ratio of fellings to net annual increment in test countries
(forests available for wood supply)

	Fellings/NAI
Germany	0.55
France	0.65
Austria	0.65
Finland	0.75
Sweden	0.77
Average	**0.68**

Source: Eurostat Forestry statistics 1995-1998, table 1.4

Removals are systematically lower than fellings in the five countries, representing between 80 and 93% of fellings (fellings and removals are measured overbark and relate to forests available for wood supply). The difference is mainly the wood left in the forest. Differences between Sweden and Finland on the one side and Germany, France and Austria on the other may be explained by the uses of wood (Sweden and Finland mainly produce pulpwood). It is also possible that removals are not uniformly measured.

Table 14: Fellings and removals in test countries, in 1000 m^3

	Fellings (overbark)	Removals (overbark)	Removals in % of fellings
Germany	48 584	38 867	80.0
France	60 174	47 611	79.1
Austria	19 521	16 921	86.7
Finland	54 300	49 500	91.2
Sweden	66 115	61 266	92.6
Total	**248 694**	**214 165**	**86.1**

Source: Eurostat Forestry statistics 1995-1998, table 1.4

In general, the coverage of fuel wood is a problem. For example, in the Eurostat Forestry statistics 1992-1996, three different estimates are given for French removals: Table 1.4 (34.5 million m^3 overbark) states that removals exclude fuel wood for own consumption. Table 4.1 (41.6 million m^3) includes 9.8 million m^3 for fuel wood and Table 4.2 (52.1 million m^3) includes an estimate of fuel wood for own consumption. The full inclusion of fuel wood would increase the ratio removals/NAI.

Other interesting ratios are the ratio of removals to the total stock and the removals per hectare. Together with the ratio of fellings to net annual increment, they give an indication of the intensity of exploitation.

Table 15: Removals in test countries, in % of total stock and per hectare
(forests available for wood supply)

	Removals in % of stock	Removals per hectare
Germany	1.18	3.3
France	1.84	3.6
Austria	1.28	4.0
Finland	2.42	2.2
Sweden	2.20	2.7

Source: Eurostat Forestry statistics 1995-1998, tables 1.4 and 4.1

3.3.2 Products removed from the forests

The types of products removed from the forests differ across countries. There are two types of differences: the proportion of softwood and hardwood and the importance of logs. Germany has the highest proportion of logs (63%) and Finland the lowest (45%), Sweden has the highest proportion of softwood (90%) and France the lowest (47%). Austria and France have the highest, and rather similar (23%) production of fuel wood. However, would fuel wood for own consumption be included the proportion of fuel wood in the French removals would increase significantly.

Table 16: Removals by type of product, average 1992-1996, in % of total removals in test countries

	Germany	France	Austria	Finland	Sweden
Logs	**62.6**	**50.1**	**57.9**	**45.3**	**51.1**
softwood	52.6	30.3	53.6	43.1	50.4
hardwood	10.0	19.8	4.3	2.2	0.7
Pulpwood	**30.7**	**26.3**	**18.8**	**46.1**	**42.2**
softwood	21.2	13.8	16.9	37.0	36.1
hardwood	9.5	12.5	1.9	9.1	6.1
Fuel wood	**6.6**	**23.6**	**23.4**	**8.6**	**6.7**
softwood	3.7	3.1	13.8	2.9	3.4
hardwood	2.9	20.5	9.6	5.7	3.4
Total removals	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
softwood	**77.6**	**47.2**	**84.2**	**83.0**	**89.7**
hardwood	**22.4**	**52.8**	**15.8**	**17.0**	**10.2**

Source: Eurostat Forestry Statistics 1992-96, Table 4.1

3.4 Relating Economic Accounts for Forestry to forestry statistics

An attempt has been made to compare forestry output from EAF and removals from forestry statistics and to derive average prices that can later be compared with the results of the valuation test exercises.

For Austria, the economic accounts are based on the removals by round wood assortments (as they appear in Eurostat Forestry statistics 1992-1996, table 4.1), corrected by a coefficient for underestimation, inclusion of wood from other sources than forests, whilst the consumption within the forestry is deducted. Overall, the result is an increase of the volume recorded by Eurostat Forestry statistics by ± 7,5%. This volume is then multiplied by the assortment prices; a mark-up of 3% is finally added to take into account non-timber products.

Table 17: Comparing EAF and removals for Austria

	1991	1992	1993	1994	1995
Value EAF (in 1 000 ATS)	11 841	12 127	10 186	13 008	13 134
of which: wood products	11 496	11 774	9 889	12 629	12 751
Volume (in 1 000 m^3)	12 360	13 184	13 197	15 488	14 840
Price (ATS/$m^{3)}$	930	893	749	815	859
Price (ECU/$m^{3)}$	**64.4**	**62.3**	**55.0**	**60.2**	**65.2**

Sources: Eurostat Forestry Statistics 1992-96 (volumes), Eurostat Economic Accounts for Forestry 1991-1996 (values), Sekot (1999)

For France, the Eurostat Economic Accounts for Forestry data are more detailed, giving the output by assortment. These prices are comparable with the prices that result from the French Ministry of Agriculture statistics, although slightly higher.

Table 18: France: prices by assortments derived from EAF and Forestry statistics, ECU/m^3

	1992	1993	1994	1995	1996
Logs softwood	52.8	47.5	62.7	61.7	60.6
Pulp softwood	22.5	19.5	27.5	26.4	28.2
Logs hardwood	79.5	76.6	88.7	98.5	102.1
Pulp hardwood	25.8	24.3	32.3	34.1	38.8
Fuel wood	36.6	35.7	42.9	44.5	47.2
Total	**45.3**	**42.5**	**52.0**	**54.0**	**56.1**

Sources: Eurostat Forestry Statistics 1992-96 (volumes), Eurostat Economic Accounts for Forestry 1991-1996 (values)

Table 19: Germany: average prices of removals derived from EAF and Forestry statistics

	1993	1994	1995	1996
Output (million ECU)	2 324	2 966	3 531	3 220
Volume (1000 m^3)	27 958	34 618	39 344	37 013
Price (ECU/m^3)	**42.8**	**44.6**	**48.0**	**45.5**

Sources: Eurostat Forestry Statistics 1992-96 (volumes), Eurostat Economic Accounts for Forestry 1991-1996 (values)

Table 20: Finland: average price of removals derived from EAF and Forestry statistics

	1992	1993	1994	1995	1996
Output (million ECU)	1 579	1 328	1 845	2 249	2 079
Volume (1000 m^3)	39 682	41 920	48 420	49 894	46 272
Price (ECU/m^3)	**39.8**	**31.7**	**38.1**	**45.1**	**44.9**

Sources: Eurostat Forestry Statistics 1992-96 (volumes), Eurostat Economic Accounts for Forestry 1991-1996 (values)

3.5 Consequences for valuation

The table below recapitulates the main characteristics of the forests in the countries that participated in the pilot exercises.

Table 21: Recapitulative of main forest characteristics in test countries

	Germany	France	Austria	Finland	Sweden
Density (m^3/ha)	278	196	310	90	121
Rate of growth					
NAI/stock (%)	2.7	3.9	3.1	3.8	3.3
NAI/hectare (m^3/ha)	7.3	5.1	8.1	3.7	4.0
Rate of exploitation					
Fellings/NAI (%)	47	47	63	78	70
Removals/stock (%)	1.2	1.8	1.3	2.4	2.2
Removals/ha (m^3/ha)	3.3	2.2	4.0	3.3	2.7
Price index (1)	72	85	100	70	n.a.

(1) Austria = 100, average 1995-1996

Source: Eurostat calculations based on IEEAF pilot exercises

The valuation methods based on the stock (stumpage or consumption value) would result in higher per hectare values for Austria, Germany and France, in relation to Sweden and Finland, due to the higher density and prices (i.e. the more highly priced structure of roundwood assortments removed from the forests).

The results of present value type methods are more difficult to predict. The rate of exploitation (removals/stock) as well as the rate of growth (NAI/stock) being higher in Sweden and Finland than in Austria and Germany, the present value method should result in higher values per unit of the stock of timber.

However, this effect would be offset by a likely higher rate of return for Swedish and Finnish forests which seem to be more intensively – economically – managed. They probably do not accumulate large quantities of overmature timber. They should have a lower value, per hectare, but the rate of return should be higher. German and Austrian forests are characterised by very important stocks per hectare and thus have a high per hectare value. However, due to the lower intensity of exploitation in relation to the stock (removals represent less that 1.5 % of the stock), the rate of return should be lower.

Capitalisation in French forests is less than in Austrian and German forests, when measured by the density. Taking the removal/stock or the NAI/stock ratios as a proxy for "productivity", French forests would occupy an intermediate position between Swedish and Finnish forests on the one side and Austrian and German forests on the other. However, the uncertainties linked to removal of fuel wood should be kept in mind. Also, French forests appear to be very heterogeneous across regions (see section 4.4.5 for details).

4. Valuation in the test countries

4.1 Availability of data

4.1.1 Prices

In Austria and Germany, the stumpage prices are not available; only the prices of the wood in the rough by wood assortments are known from official statistics. Therefore, stumpage prices have to be calculated on the basis of harvesting costs

Harvesting costs

Austria: harvesting costs of the Österreichische Bundesforste (Öbf) are taken as the basis; they are comparable with the costs of large-scale private forests and are an average over all types of terrain. Harvesting costs are fairly constant, which amplifies the variation of stumpage prices in relation to prices of wood in the rough. The average value for the period is 26 ECU/m3 of harvested timber measured under bark.

Germany: harvesting costs are estimated from official reports of the Ministry of Agriculture. Felling costs were figured up according to a standard wage schedule. Skidding costs were derived from practical knowledge of Länder forest administrations. As for Austria, costs fluctuate relatively little. The average value for the period is 20 ECU/m3 of harvested timber measured overbark.

France: in so far as stumpage prices are directly available from the Office National des Forêts (ONF) and are considered representative for all ownership categories, felling costs are not necessary. However, it was judged interesting to estimate these costs, comparing the value of timber while standing (stumpage price) for different species and classes of diameter and the value of the corresponding wood in the rough (logs, pulp wood and fuel wood) by species. The average margin is around 18,2 ECU/m3 of standing timber. Interesting result is that this margin is very different according to type of wood and uses.

4.1.2 National forest inventories

In all three countries data from National Forest Inventories (NFI) are available which allow to calculate the distribution of the stock of standing timber by species and age/diameter classes. In general, NFI data are not directly used: some calibration is necessary in order to put the data in a form useable for the calculations; in particular in the three countries as NFIs do not give figures on measured areas broken down by species and age classes, it was necessary to calculate these areas based on yield tables and growth models. Remarkable are the differences between France and Germany as concern the age/diameter relationship (see Figures 6 and 7 in Annex).

4.2 Austria

4.2.1 Price of forest real estates and forest land

General considerations

The Austrian report (Sekot 1999) notes that the statistics of the Austrian Central Statistical Office on land transactions do not distinguish between agricultural and forest land, therefore there is no comprehensive documentation of transactions concerning forests. However, the real market transactions with forests have been collected for several provinces for the period 1981-1995. These data show that a market exists although only some 0.1% to 0.15% or the forest area is traded annually.

Many transactions are dominated by public authorities, e.g. in connection with the construction of roads. A considerable amount of the remaining transactions are motivated by inheritance or swaps, so that also in these cases there is no real market situation involving supply and demand and revealing market prices. Moreover, some authors estimate that the reported prices might suffer from systematic underestimation in the range of 5 to 10% due to tax considerations. Finally, there is often a significant discrepancy between the market prices of forests and the capitalised value as calculated on the basis of receipts, indicating non-monetary motives of the investors.

One forest property is never entirely comparable to another and at best one could compare cleared forest land. However, even in this case there are subjective aspects which often play a decisive role. The owner of a small area of wood land will tend to undervalue cleared land because it will be unable to generate revenue for decades. Reasons relating to land consolidation, hunting rights and other considerations also tend to push forestry aspects into the background.

Results

Two studies analysed 7 100 and 4 400 transactions, respectively. Results may be summarised as follows: the data indicate a nominal rise in prices, whereas there is no clear indication as to a rise in constant prices, i.e. deflated by the general CPI. The per hectare value of forest real estates is between 125 000 and 135 000 ATS/ha; i.e. more or less 9 600 ECU. A price ratio can be deduced between categories of real estate, which – with all due reservation – may be set approximately at 2:1 for agricultural land versus forest land.

A generally accepted view is that the ratio between the land value and the standing timber value is around 1:1. Tax authorities would be ready to accept a general share of 65% of the value of forest properties as pertaining to the land, the remaining 35% representing the value of the timber as well as the hunting rights.

The value of forest land would therefore be around 70 000 ATS/ha, i.e. more or less 5 000 ECU/ha.

This value was used in order to calculate the internal rate of return on the basis of the “theoretical” formula. Data used were the value of land, the harvest age, the value of the final receipt, the value of plantations costs and the value of annual management costs.

The theoretical formula for the land value is $L = [pQ – Co(1+r)^T – c((1+r)^T – 1)/r]/[(1+r)^T-1]$, which is a variant of the formula presented in section 1.2.1, assuming the ‘Administration cost capital’ is zero, no intermediate receipts exist and cultivation costs are constant. The value of r that equalises the theoretical value of land with the market value is 0.03% for softwood. For hardwood, the internal rate of return is negative: the value of the final receipt does not compensate costs.

Comparing separate and combined valuation for forest real estates

The value of standing timber resulting from direct valuation of standing timber is, depending on the valuation method chosen, between 90 000 and 120 000 ATS per hectare for the 1993-1997 period. Taking 70 000 ATS/ha as the value of land, the sum of the land and standing timber would be about 170 000 ATS/ha. On average the value of forest real estate given by the market price would therefore be only 75% of the sum of the standing timber and land values.

This result is also found in the studies for Finland and France (see below). One interpretation would be that the transacted forests are on average younger than the total stock. For example, the average present value of softwood forest in the age categories ‘less than 61 years’ is 65 000 ATS/ha and their average age is 53 years, whereas the average age of the stock is 89 years.

4.2.2 Timber value: transaction based valuation methods

Five methods were tested as concerns the value of timber. Three of these methods basically use a transaction based valuation with different degrees of sophistication.

In the first method (consumption value method), starting with NFI data, the stock is first classified by age classes (8 classes, corresponding to 20 year intervals) and species (2 categories: softwood and hardwood). Then these categories are transformed into assortments of wood in the rough depending upon quality, use and species. Agricultural price statistics allow to put a (roadside pick-up) price on each assortment; harvesting costs are deducted and the value of the stock is calculated for each age class and species category, and then summed up. The transition from the inventory data (age class and species) and the assortments is rather complex.

In the second method (stumpage value method), the whole stock is valued by a sole price, which is the average stumpage price of the harvest. Need of data is lower than in the first method: the only data necessary are the total volume of the stock and the average stumpage price. The average stumpage price is derived from the product structure of annual felling. This structure is available from the Ministry of Agriculture and Forestry, which gives the felling broken down by species (hardwood and softwood) and categories (logs, pulp wood and fuel wood). Prices are then allocated to these categories of products. The calculated average stumpage price is then applied to the total stock.

The third method (sample trunk grading) is based on a sample of trees. Each sample tree is converted into products, using either a stem form factor or a product range table. Agricultural price statistics are used to value the products. However as price statistics are less detailed than the results of the sample trunk grading, some aggregation is needed. In parallel, each sample trunk is allocated to a felling cost class (according to the difficulty of harvest operations). Stumpage prices are calculated and multiplied by the corresponding quantity in the stock.

Table 22: Austria: transaction value methods applied to standing timber

	1/1/1993	1/1/1994	1/1/1995	1/1/1996	1/1/1997	Average
	Values on 1 January in ATS/m3					
Consumption value	326	206	240	283	240	259
Stumpage value	341	219	269	310	262	280
Sample grading	325	211	256	293	245	266
Average	331	213	255	295	249	

	1993	1994	1995	1996	average
	Average values in ECU/m3				
Consumption value	19.5	16.5	19.8	19.5	18.8
Stumpage value	20.6	18.0	22.0	21.3	20.5
Sample grading	19.7	17.2	20.8	20.0	19.4
Average	20.0	17.3	20.9	20.3	19.6

Source: Eurostat calculations based on Sekot (1999)

The results of the three methods are very similar. However, the stumpage value is systematically above the consumption and the sample trunk grading values. From 1987 to 1993 the stumpage value is 5% higher than the consumption value. From 1994 to 1997 it is 11% higher. The reason is that the structure of the harvest is slightly more favourable, in terms of quality (i.e. prices) than the structure of the stock when transformed into assortments for the calculation of the consumption value. Moreover the grade structure of the stock is less favourable for the end of the period.

Table 23: Austria: comparison of the structure of the stock and annual fellings

Grades	% in fellings (10 year average)	% of assortments in stock (1988)
Logs softwood	53.6	49.8
Logs hardwood	4.5	1.9
Pulp softwood	17.9	33.7
Fuel softwood	12.4	
Pulp hardwood	2.0	14.6
Fuel hardwood	9.6	

Source: Eurostat calculations based on Sekot (1999)

4.2.3 Present value methods

Presentation of the simplified present value method

In the Austrian application of the present value method, the following assumptions were made: the rate of discount is fixed to zero, the final harvest age (T) is 100 years for softwood and hardwood.

From forest inventory data the distribution of the forest area (A_t) as well as the stocking degree (δ_t) by age class are calculated.

The average harvest at the maturity age (Q_T) is 646 m^3/ha for softwood and 477 m^3/ha for hardwood over the whole period 1992-1997. The stumpage price at the maturity age (p_T) is calculated for each year. For 1995 the respective values are 571 ATS/m^3 for softwood and 334 ATS/m^3 for hardwood.

Harvesting losses are estimated to be 20%. The receipts of the final harvest are $R = 0.8p_TQ_T\delta_t$. No intermediate receipts are considered, the assumption being that the stumpage value of these intermediate fellings is negligible.

A management cost per hectare and per year (c) is assessed from two forestry test operation networks. These costs are only average values without any breakdown (e.g. by species, age class or other criteria). Moreover, costs are averaged over a five year period. For the period under review, the per hectare management cost is between 2460 ATS/ha/year and 2225 ATS/ha/year.

- for stands such that $t<T$, the total management cost per hectare until harvest is $C_t = c(T-t)$, the rate of discount being set to zero.
- for stands the age of which is higher that the maturity age, the management cost per hectare is c.

The present value of one hectare aged $t <T$ is given by $0.8p_TQ_T\delta_t - c(T-t)$. The present value of one hectare aged $t>T$ is given by $0.8p_TQ_T\delta_t - c$. These values are then multiplied by the respective areas A_t. The calculation is made for softwood and hardwood.

When the final receipt, $0.8p_TQ_T\delta_t$, is less than the management cost times the time to maturity, $c(T-t)$, the stand receive a negative value. Over the period under review (1992-1997), this is the case in all years for up-to-40-years hardwood stands and up-to-20-years softwood stands, except for softwood stands in year 1992, 1995 and 1997. It means that even with a zero rate of discount, no explicit plantation costs and a zero value for the rent on land, it is not profitable to grow timber. Of course this situation depends upon the stumpage price of the timber.

For the 1992-1997 period, values obtained through the net present value method are the most fluctuating. Over the period under review, the present value gives the highest and the lowest values. The reason is that receipts follow the price for standing timber times the final harvest, whereas management costs are deducted. As the structural parameters (distribution of the area by age class) and volumes (quantities and stocking degree) are kept more or less constant, the value only depends on the stumpage price of standing timber and management costs.

The age distribution of the forest and stocking degrees being given, the present value may be expressed as $ap_T – b$, where a and b are two constant parameters.

In these conditions, the valuation amplifies the effect of changes in prices:

$$\Delta V/V = a\Delta p_T/(ap_T - b) > \Delta p_T/p_T$$

Discussion

The assumption as concerns the rate of discount seems plausible. Given the high level of forest land prices, the return to forestry is marginal. However, the level of management costs per hectare seem very high. Their level is 2 380 ATS/ha (177 ECU). These costs “cover all costs recorded in the forestry cost accounts under "silviculture", "maintenance of facilities" and "administration". In these costs "silviculture" costs represent only 14% of the management costs”. It would mean that silvicultural costs are only 24.5 ECU/ha, which is more or less the level of management cost per hectare retained for private forests in the French study. At this stage, the problem would be to determine if a part of these management costs is covered by general administration units.

As an indication that these costs are very high, it may be observed that for the 1991-1997 period, the value of fellings, priced at stumpage price is inferior to the total of management costs, obtained multiplying the average management cost per hectare by the total area of productive forests. Total management costs are 29% higher than the stumpage value of fellings. However reintegrating natural growth in the forestry output, would compensate the excess of management costs over the stumpage value.

Table 24: Austria: comparison of management costs with the stumpage value of standing timber

	Value of fellings (stumpage value) million ATS	Management cost ATS/ha	Area of productive forest 1000 ha	Total management costs million ATS
1991	5 689	2 408	2 947	7 096
1992	5 821	2 459	2 947	7 247
1993	3 748	2 452	2 947	7 226
1994	5 386	2 422	2 947	7 138
1995	5 983	2 368	2 947	6 978
1996	5 482	2 281	2 947	6 722
1997	5 971	2 224	2 991	6 652

Source: Eurostat calculations based on Sekot (1999)

Moreover, it seems that, in Austria, the logging activity appropriates the main part of the economic benefits of the forest. According to available data the logging margin (i.e. the difference between the value of the harvest at roadside pick-up prices and its value at stumpage price) is higher than the logging costs.

Table 25: Austria: comparison of logging costs with logging margin

	Value of fellings (roadside prices) million ATS	Stumpage value million ATS	Quantity of timber 1000 m^3	Logging margin ATS/m^3	Logging cost ATS/m^3
1992	11 774	5 821	12 360	482	373
1993	9 889	3 748	13 184	466	374
1994	12 644	5 386	13 197	550	371
1995	12 751	5 983	15 488	437	365

Source: Eurostat calculations based on Sekot (1999)

Given these characteristics one may wonder whether the separation of forestry and logging, which is entirely based on the estimation of harvesting costs, gives a realistic picture of the forest economy.

The age constant (or age factor) method

The forest is distributed in age classes; for each age class the value of the respective timber is obtained multiplying the “expected felling value” by an "age factor". Age factors, or age constants, are tabulated ratios giving the relation between the value of any age class to the one of the final harvest. The lowest value is set equal to the costs of establishing the stand and the highest one is given by the final yield at maturity. For intermediate age classes, the values are derived by functions balancing out the values for younger and older stands. The age constant method thus involves implicit discounting the used rate of discount being the internal rate of return, which varies according to tree species, yield classes, harvest age, costs and receipts.

Implicit rates of return embodied in the age constant are around 1.2% for spruce and 0.8% for beech.

As it takes into account the costs and receipts, and uses the internal rate of return as rate of discount, the age value factors method is the method that is the closest of ESA prescriptions (and forest economics). In this sense it has certainly to be recommended.

The age constant varies with all parameters (price of the final harvest, implicit rate of discount, etc.); from the Austrian study, it is possible to derive the age constant as a ratio of the value of the stand to the value of the final harvest.

Table 26: Austria: age constant as a % of the value of final harvest (year 1992)

age	%
0-20	11.6
21-40	27.4
41-60	47.1
61-80	67.5
81-100	85.5
101-120	98.1
121+	99.2

For the period under review, the age value factors method bears a rather stable ratio with the consumption or stumpage values; on average it is 30% higher. One may notice that it is more or less the same ratio that the present value bears to the consumption value in the French test.

Table 27: Austria: net present value methods applied to standing timber

	1/1/1993	1/1/1994	1/1/1995	1/1/1996	1/1/1997	Average
	Values on 1 January in ATS/m^3					
Net present value	447	192	305	394	297	327
Age constant value	427	290	348	391	333	358

	1993	1994	1995	1996	Average
	Average values in ECU/m^3				
Net present value	23.5	18.4	26.5	25.7	23.5
Age constant value	26.3	23.6	28.0	27.0	26.2

Source: Eurostat calculations based on Sekot (1999)

4.2.4 Conclusions on the valuation of Austrian forests

According to all indicators, the price of forest land is rather high in Austria: 5 200 ECU/ha, which is by far the highest price for the countries under report. One of the reasons may be the integration within the value of forest land of significant non-timber values such as hunting, tourism, etc. Moreover, it seems that the value of forest land does not translate in rent on land, which is compatible with what may be inferred from the Austrian pilot exercise. However, as the basis for the estimation is rather weak, one should consider this value with caution.

The standing timber valuation methods result in very similar values when transactions based methods are applied. This is due to the rather similar structure of harvest and stock, the average grade of the harvest being however slightly superior, in terms of quality and prices.

Felling costs and management costs are somehow uncertain; as they determine the value of standing timber they should be checked against current statistics (forestry statistics and economic accounts for forestry).

In the context of Austria, the age constant valuation method seems preferable: it embodies a small but not zero rate of return, its application is rather simple once the age factors have been calculated, which is necessary for forests economics purposes and has not to be done specifically for the valuation exercise. The results may be actualised in a rather simple way using the value of the final harvest and the costs.

4.3 Finland

Finland made a specific study on the prices paid for forests bought by the State under specific protection programmes and the price of forest real estates mainly used for forestry and logging.

4.3.1 Valuation methods

The Finnish report (Muukkonen 1999)[9] focuses first on the relationship between the prices of forest real estates and the combined value of land and standing timber.

The summation method

The most widely used method in the sales of forest properties in Finland is the summation method. In the summation method, the value for each component of the real estate is estimated separately. The component values are then summed up and a correction to this sum is made on the basis of various characteristics of the real estate.

The value of land is estimated on the basis of calculated values for each forest soil productivity type. Expectation values for standing timber are estimated for seedlings, expectation and cutting values for young stands, and cutting value for mature stands. Regional model tables for both land and timber values are provided by the Finnish Forest Research Institute and the National Board of Survey.

Main factors taken into account in the calculation of the model table values are:

- volume and timing of forest renewal,
- forestry and logging measures according to forestry recommendations,
- products assortments: saw logs, pulp wood by tree species,
- unit prices for timber (stumpage prices) and forestry and logging measures,
- and interest rate. Interest rates used are usually 2,5-5 percent. For bare land value the internal interest rate is very dependent on soil productivity, and the variation is thus from 2,2 to 5,2 percent. Stumpage prices used are averages of 10 year period, which is quite close to the length of average business cycles.

In practice the correction to the summed value of land and timber of each forest stand is made as a subtraction from this sum. Factors increasing the subtraction are:

- delayed forestry measures,
- low quality of timber,
- factors lowering the soil productivity,
- high proportion of timber value defined by expectation values,
- high proportion of scrub and waste land,
- large size of the real estate,
- and mortgages and restrictions of use rights.

Factors that decrease the subtraction are:

- high proportion of mature forest stands,
- special values such as shore line,
- rights to leisure or house building,
- sand, gravel and peat extraction possibilities,
- special right e.g. for water areas,
- and forest road network etc.

Special values are defined on the basis of timber production or on the basis of alternative use, but not by both of them.

Several studies show that the range of the subtraction factor has been 25 - 52 percent of the sum of bare land plus timber values, depending e.g. on location and size of the traded forest estates. In most of the sales the subtraction factor has been 30-50 percent, and 40 percent as an average has been used.

[9] See also Muukkonen, J (1998).

Market price method

In the market price method the price is derived from prices in other similar sales in the same region and same time period. Data on prices is available from the register of real estate prices, but several comparable sales only seldom take place in the same area or region and time period. Therefore the market price method gives information on general price levels, but it is rarely used as the only method for single trades.

Expected incomes method

The method based on expected incomes from timber is used mainly for large forest areas. In this method current and future incomes and costs are estimated and discounted to the present time. Expected incomes are thus discounted incomes less discounted costs. Logging volumes, timing of logging, and forestry measures are estimated from predicted timber production of the real estate. Other factors taken into account are annual governmental costs, unit prices of timber and interest rate.

In practice the use of expected incomes method requires logging and forestry plans, which are based on steady stumpage price incomes over the accounting period. Results of this method are so dependent on interest rate used, that the method is applicable only for special combination of age and timber structure in the forest real estate concerned. The method gives the most reliable results in forest real estates, where proportions of different age structures of forest stands are approximately of the same size, and no high variation exist in annual incomes and costs.

Valuation methods and final prices of forest real estates

The final price of forest real estate is an agreement between the buyer and the seller, and thus not necessarily the recommended price obtained by the valuation method or methods used. Factors characteristic for forest real estate supply and demand and final prices include:

- changes or expected changes of land use (from forestry to e.g. building site or nature conservation),
- small number of buyers, sellers and annual trades,
- state as an only buyer of areas to be protected,
- current and expected prices of timber,
- interest rates of bank loans.

The differences between final prices agreed and prices obtained by valuation methods may thus be high. Still, it has been shown in several studies, that prices determined by summation value method and stumpage prices are main factors for market prices of forest real estates traded mainly for forestry and logging purposes. Prices of forest real estates follow the trends of stumpage prices with short delay.

4.3.2 Results 1995-1998

Forest available for wood supply

Calculating the monetary value of forests simply as a sum of land and timber over-estimates forest values with respect to actual market prices. The median actual market price per forest hectare is 59 % and the average actual price per hectare is 72 % of the summed price of land and timber. When the average subtraction factor in forest real estate sales valued by the summation method (40 percent of the sum of land and expectation and cutting values of standing timber) is taken into account, the imputed value per hectare comes very close to the median price obtained from forest real estate sales, and comparatively close to the average price. This can be seen in both the time series for 1995-1998 and in averages for 1995-1998.

It seems that the median and average market prices per hectare of traded real estates are quite well usable for estimating the value of forests available for wood production. For most of the forest area available for wood production in Finland forestry and logging is the main use, and no other clearly identifiable or significant market values can be found. Potential use of forests as building sites (leisure or regular use) and sand, gravel and peat extraction possibilities are connected to only small proportions of the area. Recreational values exist and may have some influence on total market price in some of the sales, but this influence is already reflected in the median and average prices of real estates.

Separate values for land and standing timber can be estimated, but this separation is not very relevant, since both values are based on the value of timber. The value of land related to forestry and logging uses is often based on soil type, standing timber and market prices of timber, and the value of land and value of timber are closely linked. Potential alternative uses of forest land may effect the value heavily, but in those cases timber values do not necessarily give very much information about the value of forest land in uses alternative to forestry. The value of forest land for alternative purposes is, in addition to timber stocks, strongly dependent on location, soil type, availability and supply and demand of land for uses other than forestry.

The exception would be cases, where losses of forestry-related economic benefits are the main factor determining the price of forest land concerned. When forest land is taken to other purposes than forestry, the timber and forestry-related values lost represent the minimum value of forest land.

Table 28: Finland: value of forests (FIM/ha)

	1995	1996	1997	1998	95-98 Average
Summation value method					
Value of forest land	1 634	1 651	1 806	1 855	1 737
Value of timber as stock	10 871	11 041	11 646	11 961	11 380
Value of land and timber	12 505	12 692	13 453	13 816	13 117
Average subtraction from summed value (40%)	-5 002	-5 077	-5 381	-5 526	-5 247
Summation method: value of land and timber	7 503	7 615	8 072	8 290	7 870
Market price of forest real estates					
Number of transactions	2 194	2 133	2 531	2 600	2365
Transacted area (ha)	39 711	37 967	50 873	53 300	45463
Transacted area in percent of total forest land	0,17	0,17	0,22	0,23	0,20
Average size of traded properties (ha)	18	18	20	21	19
Median price of traded properties	7 900	7 400	7 900	7 900	7775
Average price of traded properties	9 500	9 100	9 600	9 600	9450

Source: Muukkonen (1999)

Protected areas

The average price per hectare of land areas bought to state ownership for protection was 60 percent higher than the price of forests for mainly forestry and logging use. The difference was 80 %, when protected peat land and land connected to water-fowls were excluded from the price and area bought for protection. Results support the expert opinions, according to which approximately 50 percent of prices and compensations paid for protected forest areas consisted of value of standing timber and value of forest land (forest land as the soils capability to provide timber). The other 50 % consisted of prices and compensations paid for the losses of rights to build summer cottages or houses. Losses of fishery outputs in connected water areas and e.g. losses of sand and gravel outputs played a minor role in total prices and compensations paid.

The main reasons for higher prices in protected forests were compensations paid for losses of shore lines or building rights, or building rights near the shore line. Protected forests were also often old growth forests with relatively high timber stock and consumption values.

Sand, gravel and peat extraction losses were less important, as in many cases this extraction is restricted anyway by the land act without any compensations paid. Clearly, the highest average prices per hectare were paid for shore land, and old-growth forests, and lowest prices for peat land.

Average prices of forest to be protected, and average and mean prices for traded forest real estates were lower in Northern Finland than in Southern Finland. This was due to lower timber volumes and prices in Northern Finland, and it is also probable that compensation for building rights were lower in northern parts of the country, since population density in Northern Finland is very low. Average price of national parks, herb-rich forests and old-growth forests in the north was 56 % of the price in the south. For traded forest properties the average price in the north was 52 % and median price 48 % of the averages in the south.

Two main sources of uncertainty were identified in comparison of prices paid for forests to be protected and non-protected forests. The first one is that the average structure of soil and timber stock is not alike in forests protected and non-protected. The other one is that the state concentrates on different types of areas and protection programmes in different years. This concentration also has a connection to the annual state budget, and it is possible that under budget constraints the state buys more areas were the price per hectare is relatively low. High variations in prices per hectare were found especially for protected shore land.

Table 29: Finland: price of areas bought for protection

	1995	1996	1997	1998	95-98 Average
Areas bought for protection (ha)	10 715	13 802	21 494	24 285	17574
Average price (FIM/ha)	17 079	13 331	14 934	14 906	15 063
Average price by protection programme	(FIM/ha)				
1. National parks	9 701	14 374	16 469	11 133	12 659
2. Shore land	8 353	7 140	23 104	25 203	14 843
3. Peat land	1 992	1 622	3 726	3 103	2 981
4. Herb-rich forests	21 068	4 173	24 748	15 525	18 890
5. Old-growth forests	24 145	21 002	28 309	24 318	24 743
6. Woodpecker protection	32 494	31 908	32 286	34 236	32 423
1+4+5+6 as forest land	15 173	17 197	21 951	14 911	17 253

Source: Muukkonen (1999)

4.4 France

In the French reports (Tessier and Peyron 1998 and 1999) five methods have been tested and their results compared.

- the market value method
- the consumption value method
- the stumpage value method
- the present value method
- a simplified present value method.

4.4.1 Valuation of forest real estates and forest land

For the compilation of balance sheets for forest real estates, French national accountants (INSEE) use the market value. Data come from a fiscal data base: local tax offices report on the value of actual transactions on forest real estates; average, maximum and minimum value are collected. The value is the combined value of land and standing timber.

For recent years this method results in a price between 15 000 and 17 000 FF/ha (2 400 ECU). Over the period 1980-1996, current prices per hectare remained more or less at the same level, which means a strong decrease in constant prices.

This value is considered as biased for various reasons:

- only private forests are exchanged, whereas some experts think that from a forestry point of view the value of private forests is lower than that of public forests (volume per hectare is lower),
- reasons for the transactions are not always pure forestry ones: rounding-up of property, liquidation of inheritance play an important role,
- well maintained and managed forests are less exchanged than others.

A complementary survey was conducted on the price for bare forest land, i.e. forest land without trees or agricultural land intended for afforestation. For 1996, the resulting price was 5 240 FF/ha (810 ECU).

Other sources of data exist, in particular the data collected by the “Société Forestière”, results of which are more or less in line with the fiscal data results.

4.4.2 Valuation of standing timber: transaction value methods

The main difference between France and Austria or Germany is that stumpage prices are available. They are collected by the Office National des Forêts (ONF) which manages the public forests. Twice a year ONF makes auction sales of standing timber. The prices are considered by experts as representative of all standing timber, whatever the type of ownership.

Prices vary with species and diameter; in general only 2 or 3 diameter classes are distinguished. The table below gives examples of the structure of price for some species, according to diameter classes.

Table 30: France: examples of stumpage prices (FF/m^3)

		1981	1989	1996
Oak	50 cm+	655	867	752
	30-45 cm	218	261	223
	25 cm-	25	54	62
Spruce	25cm+	306	317	260
	20 cm-	64	58	44

Sources: Tessier and Peyron (1998, 1999)

Harvesting costs

For France, given the methods used, harvesting costs were not calculated. However, a comparison has been made between the price of the wood in the rough, for some assortments and the stumpage price for some diameter classes and species. These ratio show large differences in the logging margin (i.e., the difference between stumpage price and roadside pick-up prices) between species or assortments. For logs of softwood the logging margin (from standing timber to logs) would be 9.3 ECU/m^3. For logs of hardwood the logging margin is 46.6 ECU/m^3. For the two species together, the margin is 20 ECU/m^3. For pulp wood the margin is 12.5 ECU/m^3, and 17 ECU/m^3 for commercial fuel wood.

On average, logging margins are lower in France (about 18 ECU/ m^3) than for example in Austria (26 ECU/m^3) or Germany (20 ECU/m^3). This may be due to the lack of representativeness of either stumpage or wood in the rough prices.

The consumption value method

This method was applied in the first French pilot exercise: “Application of Eurostat Forest Accounts to French Forests".

The forests are described by species and diameter (NFI data). The corresponding volume are valued applying the stumpage prices for the different categories of standing timber.

As the national forest inventory distinguishes the ownership of the forest, the consumption values were calculated by species and ownership categories

Table 31: France: consumption value of standing timber by species, FF/m^3

	1981	1986	1991	1996
Hardwood	180,7	210,8	251.1	261.3
Softwood	177,3	161,1	178,9	178,7
Average	179,5	191,9	223,4	229,3

Sources: Tessier and Peyron (1998, 1999)

The table below gives an indication of the range of variation between species and ownership categories. As the same stumpage prices are used, the results only depend upon the age/diameter structure of the forest. In state and other public forests, the standing timber is on average older and the average consumption value is higher than in private forests.

Table 32: France: consumption value of standing timber by species and ownership, FF/m^3, 1991

	State	Other public	Private
Oak	452	445	302
Beech	267	276	218
Poplar			223
Other hardwood	180	180	180
Spruce/fir	264	268	234
Scotch pine	150	151	133
Maritime pine	136	144	145
Other softwood	137	138	125

Sources: Tessier and Peyron (1998, 1999)

The stumpage value method

In this method the same price is applied to the whole stock, without taking into account its age (diameter) distribution. Main species may however be distinguished. The price only depends upon the structure of the harvest. The structure of the harvest expressed in assortments of wood in the rough (logs softwood, pulp wood, etc.) has to be transformed into the categories of the NFI (diameter categories of standing timber) and the corresponding stumpage prices for these categories applied. For France, this method gives a value much lower than the consumption value.

Table 33: France: stumpage value, FF/m^3, fuel wood included

	1981	1986	1991	1996
Stumpage value				
- without distinguishing species	122,4	114,4	145,3	146,5
- distinguishing species	125,5	129,6	145,5	146,4
Hardwood	98,5	116,5	133,9	141,2
Softwood	170,0	151,0	164,2	154,7

Sources: Tessier and Peyron (1998, 1999)

The difference mainly lies in hardwood. The reason is that for this category, the average price of the harvest includes an important component of fuel wood (30 % of the total harvest), value of which is rather low. When this fuel wood is excluded, the average price of the fellings is rather close, although inferior, to the average consumption price.

Table 34: France: stumpage value, FF/m^3, fuel wood excluded

	1981	1986	1991
- without distinguishing species	169.9	168.2	186.5
- hardwood	169.8	186.9	211.5

Sources: Tessier and Peyron (1998, 1999)

Structure of the growing stock and structure of the harvest

In order to investigate these differences, the structure of the harvest was characterised, and compared with the structure of the stock. The following table shows that for hardwood (oak) the structures are totally different: whereas in the stock 31% of the volume is in trees less than 25 cm in diameter, 78% of the harvest comes from this category. The same phenomenon also occurs for softwood, except for spruce and fir. Moreover, the proportion of hardwood, which are more valuable species, is higher in the stock (61%) than in the harvest (55%).

Table 35: France: structure of the stock and the harvest, 1991

	Diameter classes	% Harvest	% Stock
Oak	50 &+	12,7%	29,0%
	30/45	9,6%	40,0%
	25 &-	77,7%	31,0%
	Total	100,0%	100,0%
Beech	40 &+	19,8%	48,5%
	30/35	4,6%	20,4%
	25 &-	75,6%	31,0%
	Total	100,0%	100,0%

Sources: Tessier and Peyron (1998, 1999)

4.4.3 Valuation of standing timber: present value methods

In contract to market valuation methods, the present value method calculates the value of the forest from a “theoretical” point of view. Calculations are made for three categories of ownership (state, other public and private) and seven species or groups of species.

For each of these 21 categories, the point of departure is the national forest inventory which gives the number of trees, volume of standing timber and growth by diameter classes. Due to the characteristics of the French forest, where the proportion of coppice and coppice with standards is important, the forest inventory does not provide the area for the various classes of diameter. The first step is thus to calculate the area corresponding to the various categories of diameter. The area occupied by trees of a given diameter is first calculated and calibrated with the actual area of forest by ownership categories. In this way, the forest is distributed in “standardised” even aged stands. Using the growth parameters a relationship is then established between the diameter and the age of the trees in order to arrive at the volume and area distribution of the various species by ownership and diameter/age. Many assumptions are however necessary for the various steps of the calculation.

Calculation of the receipts and costs

Intermediate and final fellings by hectare are calculated in physical quantities. Intermediate fellings occur before the maturity age. Intermediate fellings between ages t and t + n are given by the decrease of the number of trees by hectare between t and t + n, times the average volume of the trees. No fixed age for the final harvest is assumed, but rather the probability for a tree having reached the maturity age to be felled is calculated on the basis of the age distribution.

Intermediate and final fellings are translated in receipts using stumpage prices by cubic metre for the various age/diameter classes. Similar calculation is made for the eight species and the three types of ownership.

Initial (establishment) and intermediate (management) costs are introduced, and the internal rate of return (which equalises costs – including rent on land - and receipts all over the life of the stand) is calculated. This rate of return is then introduced in the standard forest economics formula for the valuation of standing timber. At this stage the value of an hectare of age t is available and the total value of the stock is calculated.

Table 36: France: costs used, 1991

	Establishment (plantation) costs (FF/ha)		Management costs (FF/ha/year)
Ownership/species	Hardwood	Softwood	
Public	10 200	9 600	350
Private	5 100	4 800 (maritime pine: 9 600)	175

Sources: Tessier and Peyron (1998, 1999)

Table 37: France: calculated rates of return by species and ownership, 1991

	Ownership		
Species	State	Other public	Private
Oak	1,27%	0,94%	1,71%
Beech	1,41%	1,16%	1,56%
Poplar			3,55%
Other hardwood	0,86%	0,86%	1,86%
Spruce/Fir	3,01%	2,62%	4,01%
Scotch pine	0,65%	0,29%	1,02%
Maritime pine	1,61%	2,13%	2,35%
Other softwood	0,90%	0,68%	2,00%

Sources: Tessier and Peyron (1998, 1999)

The table below presents the main results. The value is higher in public forests than in private forests. Softwood stands have less value than hardwood stands.

Table 38: France: present value by species and ownership, 1991, FF/m3

	Ownership		
Species	State	Other public	Private
Oak	613	780	431
Beech	370	406	323
Poplar			225
Other hardwood	189	187	157
Spruce/Fir	264	268	234
Scotch pine	179	169	171
Maritime pine	148	127	170
Other softwood	150	129	179

Sources: Tessier and Peyron (1998, 1999)

The present value method allows to calculate implicit age factors (i.e. the ratio between the value of a stand of age t and the value of the final harvest). For spruce, the age factors were calculated and compared to the Austrian age factors.

Table 39: France and Austria: comparison of age factors for spruce

Age class	France	Austria
10	n.a.	0.11
30	0.25	0.28
50	0.56	0.58
70	0.66	0.83
90	0.79	0.96
110	0.88	1.00
142	1.00	0.92

Source: Eurostat calculations based on IEEAF test exercises

For the young stands age factors are similar; for older stands, the age factors of Austria are higher, which could result either from the difference between the rates of return (France 4.0%, Austria 1.3%) or growth rates, or both.

The simplified present value method

A variant of the present value method has also been tested, where an age for the final harvest is fixed. As it assumes that all trees are cut at their maturity age, the valuation is more optimistic than the full present value method, and the resulting values are 25% higher.

4.4.4 Recapitulative of the value of the French forests: main methods

Table 40: France: value of standing timber by ownership category, FF/ha, 1991

	State		Other public		Private	
Consumption value	52 973	*100.0*	48 500	*100.0*	27 761	*100.0*
Present value	64 784	*122.3*	64 460	*132.9*	33 200	*119.6*
Stumpage value	27 924	*52.7*	25 764	*53.1*	19 972	*71.9*

Source: Eurostat calculations based on Tessier and Peyron (1998, 1999)

Table 41: France: value of one hectare of standing timber by species, FF/ha, 1991

	softwood		Hardwood		Average	
Consumption value	26 883	*100.0*	34 202	*100.0*	31 974	*100.0*
Present value	27 521	*102.4*	47 263	*138.2*	41 580	*130.0*
Stumpage value	24 675	*91.8*	18 238	*53.3*	20 788	*65.0*
Market value					11 000*	*34.4*

* value obtained deducting from the average market price for forest real estate the value of bare forest land

Source: Eurostat calculations based on Tessier and Peyron (1998, 1999)

Comments

The conclusion of the French study is that market and stumpage value methods should not be applied because they suffer from fundamental drawbacks. The present value method is the best founded, but is rather demanding in terms of calculation, although the necessary data are generally available in all European countries through National Forest Inventories. The consumption value method underestimates the value of French forests but seems to provide a satisfying approximation of their value. The situation is quite different between species. For softwood the three main methods give very similar results, with a price per hectare around 26 360 FF ± 5% (3 800 ECU). For hardwood, differences are important, the range being 18 240 FF to 47 260 FF/ha.

As concerns the difference between stumpage and consumption values, the reason lies in the proportion of fuel wood in the harvest, compared to the proportion of small trees in the stock. However the differences are so huge that estimations of fuel wood consumption should be checked. Preliminary calculations tend to demonstrate that e.g. for oak, the harvest in the small diameters would be above net annual increment.

Table 42: France: oak harvest, stock and NAI, 1000 m^3

Diameter classes	Harvest	Stock	Rate of growth	NAI
50 &+	1 769	143 050	1.63	2 330
30/45	1 340	197 309	2.51	4 950
25 &-	10 715	152 915	5.23*	8 000
Total	13 824	493 273	3.10	15 280

* including recruitment

Source: Eurostat calculations based on Tessier and Peyron (1998, 1999)

The present value is always higher than the consumption value, the only exceptions being spruce/fir (in all categories of property), poplar and other hardwood (private forests). There are two opposite effects. First effect is the integration of costs. The present value incorporates the costs (land costs, plantations costs and management costs). Therefore, it values young stem much higher than their consumption value.

However there is a partial compensation for mature and old stands. For these stands the present value method takes into account their probability of being felled later, and thus discounts the respective receipts and costs, whereas the consumption value takes their full value, without discounting and netting.

In general, the second phenomenon (discounting and netting future receipts) has a lower impact than the first one (integrating costs). In the case of spruce however, the consumption value is higher than the present value. For this species the rate of discount is high (3 to 4%) and the accumulation in old trees is important therefore the impact of discounting the receipts is higher than the impact of integrating the costs.

The main problem of the French valuation exercises is how far the actual structure of the harvest is taken into account in the present value method.

Although well founded and applied with a high level of detail (intermediate receipts and all costs are taken into account, the final harvest is spread over several years, the rate of discount is calculated and not fixed), the main drawback of the present value method is that the receipts are not calibrated with actual harvest. In particular, the importance of fuel wood (which has a lower price) in the harvest does not seem to be taken in due account when calculating the intermediate receipts.

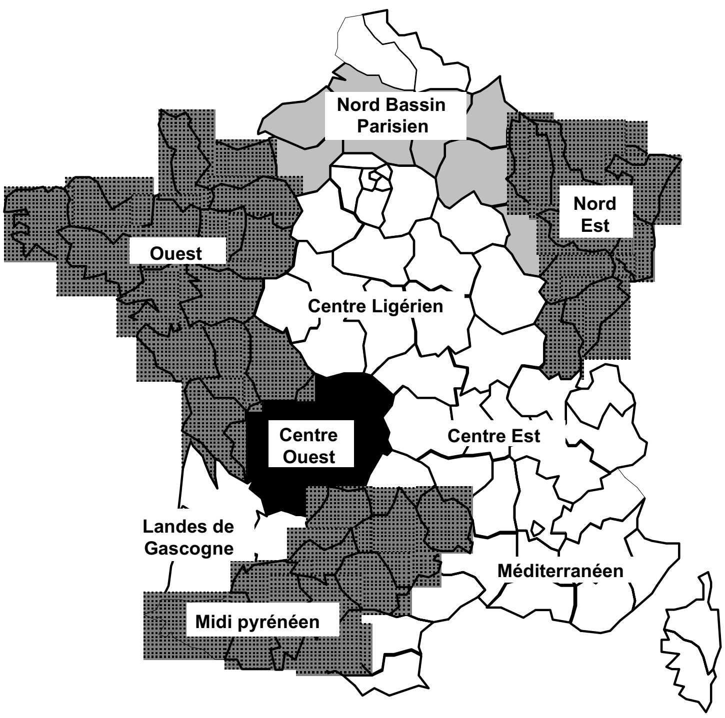
It seems that the only way to go beyond these limitations is to link the harvest to the stock comparing two successive inventories: the comparison of the age (diameter) distributions between two inventories would give a good proxy of the harvest, the natural growth being taken into account.

4.4.5 Regional breakdown of French forests

French forests are very heterogeneous: there are numerous species, without a single predominant one, high forests are not the rule and several bio-climatic zones exist, from the north-east to the Atlantic and Mediterranean regions. France has thus experimented with the application of the IEEAF at a regional level. Main objective was to identify homogeneous forest regions on the basis of their characteristics as regards the wood supply function.

French forests have been divided into nine regions (see map).

Figure 2: French forest regions



The nine regions present very different characteristics as concerns the wood supply function - see table below. The volume of standing timber per hectare ranges from 221 m3/ha (North East region) to 85 (Mediterranean). Total removals represent 85% of the increment in the Paris basin and 39 % in the Mediterranean region. However, in most regions (except the 'Landes' region) the commercial part of the removals is much lower than total removals.

Table 43: France: standing volume, increment and removals, 1996

Region	Standing volume (m3/ha)	Increment (m3/ha/yr)	Commercial harvest in % of increment	Total removals in % of increment	Dominant species and degree of exploitation
Paris Basin	168,4	7,5	48,1%	**86,6%**	Hardwood ; intensive exploitation
West	136,3	7,0	46,4%	68,2%	Hardwood; medium exploitation
Centre	144,9	6,7	34,5%	58,0%	Hardwood; low exploitation
North East	**221,2**	**8,8**	48,2%	**79,4%**	Hardwood, intensive exploitation
Landes	164,9	**8,5**	**68,0%**	74,8%	Maritime pine; intensive exploitation
Centre West	146,7	7,3	46,8%	58,6%	Hardwood; medium exploitation
Centre East	201,8	**8,6**	27,7%	57,2%	Softwood: mountains; low exploitation
Pyrenean	127,9	5,2	29,9%	55,6%	Hardwood; low exploitation
Mediterranean	**85,5**	**3,4**	**22,4%**	**39,2%**	Various; low exploitation
France	154,0	**7,0**	41,4%	**65,4%**	

Source: Tessier, personal communication

The different valuation methods have been applied to the nine regions. The results are still preliminary and all the relationships between the characteristics of the forests in the nine regions and the obtained values have not yet been explored. In particular the age structure was not systematically analysed. Commercial removals are available at a detailed level but the distribution of fuel wood for own final use between the various regions necessitated various assumptions.

In general, the heterogeneity of the French forest is well reflected in the values: in four regions the value per cubic metre (calculated either through the present value or consumption value method) is superior to 250 FF (35 to 40 ECU), in four it is between 100 and 200 FF, whereas in the Mediterranean region the present value is below 100 FF.

Table 44: France: comparison of values, FF/m^3, 1991

Region	Market value	Present value	Consumption value	Stumpage value inc. fuel wood	Stumpage value exc. fuel wood
North East	**76**	**326**	278	**193**	**251**
Centre East	66	165	167	152	183
Centre West	4	106	100	72	77
Landes	**138**	**138**	**155**	**131**	**131**
Pyrenean	46	197	175	107	144
Mediterranean	**144**	**70**	106	100	102
West	84	**282**	**271**	145	190
Centre	38	360	265	152	229
Paris Basin	48	**263**	**268**	**143**	**199**
France	70	**233**	210	**142**	**182**

Source: Tessier, personal communication

For four regions the present value is very close to the consumption value: Centre East (spruce, mountainous, relatively low intensity of commercial exploitation, high fuel wood for own final consumption), Centre West and West (hardwood, relatively high rate of commercial exploitation, low fuel wood for own final use) and the north of the Paris Basin (high proportion of hardwood, rather intensive exploitation).

The Landes region is a very specific case: all values, including the market value and the stumpage value are very similar. In the Landes region maritime pine is highly dominant, the exploitation is commercial and intensive, the productivity is high and there is almost no own final use of fuel wood.

The Mediterranean region is the sole region where the market value is higher than the present value, whereas the consumption and stumpage values are rather similar: there are numerous species, intensity of exploitation is low, as is the productivity of forest.

Finally for North East and Centre, the present value is much higher than the consumption value. It would be necessary to study in detail the age structure and species composition of these regions in order to explain this situation.

On average, the two stumpage values (including or excluding fuel wood for own final consumption) are well below the consumption and present values. The impact of the inclusion of fuel wood is high (between 20 and 40%) in six regions, which are those with the highest consumption and present values (more than 150 FF/m3).

Despite uncertainties the results are rather consistent with what could be expected. However, results do not allow recommending a particular method for France. An outstanding issue is the lack of a confrontation between the implicit harvesting model of the net present value method and the actual harvest, taking into account the importance of fuel wood.

4.5 Germany

4.5.1 Value of forest land and forest real estates

There are no official statistics available that would present sales of forest land for Germany as a whole. Therefore sometimes transaction prices for marginal agricultural land are used as orientation for forest land values (Englert, Küppers and Thoroe 1999). Official statistics by the Statistisches Bundesamt for marginal agricultural land (i.e. with a yield class index below 30 – see Table 81 in Annex) have been collected. They show that the prices of this category of land were rather stable during the period 1980-1998, with a slightly decreasing trend in current prices. The differences between Länder are rather high.

Bergen, Gutow and Schröder (1997)[10] used the Lancaster (hedonic pricing) approach to derive the price of forest land from a sample of actual transactions. The resulting price was 6 390 DM/ha.

Köhler (1994) used two different approaches. One approach is based on the method applied by the Hessian forest administration. It leads to an average forest land value of 23 918 DM/ha. The other approach is based on a method applied by the North Rhine-Westphalia forest administration and results in an average forest land value of 10 568 DM/ha.

The table below summarises these various results and estimations.

Table 45: Germany: prices of land, DM/ha

Länder	Forest land			Marginal agricultural land (1990)
	Köhler (a) (1990)	Köhler (b) (1990)	Bergen (1991)	
Hesse				17 066
North Rhine Westphalia				42 056
Lower Saxony			6 390	21.669
Bavaria				31 698
Former Länder average	10 568	23 918		22 613

(a) Based on North Rhine Westphalia forest administration method.
(b) Based on Hessian forest administration method.

[10] See also Bergen, Gutow and Schröder (1999).

As can be seen data are not very conclusive, neither as concerns the relationship between the prices of marginal agricultural land and forest land, nor as concerns the absolute level of forest land prices.

Table 46: Germany: prices of land, ECU/ha

	Forest land		Marginal
Länder	Köhler	Bergen	agricultural land
Lower Saxony		3 250	11 000
Former Länder averages	5 364 - 12 141		11 479

An attempt to calculate the internal rate of return, using a 3 000 ECU/ha price of land and plantation and cultivation costs based on French and Austrian data resulted in a slightly negative internal rate of return in 1991 (prices of wood were very low due to the tempest) and a slightly positive rate of 0.5% in 1995 (with higher prices for wood). This suggests that for Germany, as for Austria, the internal rate of return of forestry is low. This also supports, from a pure forestry perspective (i.e. ignoring non-wood uses of the land), the calculations of Bergen, Gutow and Schröder (1997).

4.5.2 Value of timber

In Germany, timber is usually sold after felling free on truck road, therefore stumpage prices are not directly available. Englert, Küppers and Thoroe (1999) calculated stumpage prices as a balance between revenues and harvesting and skidding costs. The distribution by age classes was calculated by a simulation model, based on yield tables, calibrated to the physical forest balances.

Stumpage value method

For the year 1991, an average stumpage price of 61.3 DM/m^3 u.b. was calculated using prices for wood and costs, which corresponds to 46 DM/m^3 o.b. for standing timber. The conversion between wood in the rough u.b. and standing timber o.b. is 1.33. Felling costs are approximately 42.5 DM per m^3 (wood u.b.).

For the year 1995, the average stumpage price is 77.6 DM/m^3 u.b. which corresponds to 58.2 DM/m^3 o.b. for standing timber. Felling costs are 40 DM/m^3 u.b.

Comparison with EAF and Forestry statistics data and prices of raw wood assortments

For the year 1995, the resulting average roadside pick-up price (117.6 DM/m^3 u.b.) is higher than the price resulting from the value of the wood in the rough (± 3.4 billion DM from EAF) and the harvested volume (± 39 million m^3 from Eurostat Forestry statistics). It is also higher than the average price obtained valuing the structure of the removals by assortments (from Eurostat Forestry Statistics) by indicative assortment prices (see Table 19). For the year 1991 discrepancies are higher, due to the wind throws.

Table 47: Germany: prices of wood assortments

Assortments	Removals %	Prices 1991 DM/m^3 u.b.	Prices 1995 DM/m^3 u.b.	Categories
Logs softwood	53	82	130	softwood logs category L3b
Logs hardwood	10	120	159	hardwood logs category L3b
Pulp wood softwood	21	55	58	softwood wood category IL
Pulp wood hardwood	10	53	52	hardwood wood category IL
Fuel wood softwood	4	39	37	softwood wood category IS
Fuel wood hardwood	3	34	31	hardwood wood category IS
Total	**100**	**75**	**104**	

Source: Englert, Küppers and Thoroe (1999)

Consumption value method

The stock of standing timber is distributed by age and assortment classes. Each assortment class is valued by price, harvesting and skidding costs for 1991 and 1995 respectively. Table 80 in Annex gives the values by twenty years classes.

Table 48: Germany: consumption values by species, DM/m³

	1991	1995
Oak	60.6	70.3
Beech	28.7	35.8
Spruce	18.1	39.6
Fir	18.7	22.4
Total	24.1	36.8

Source: Englert, Küppers and Thoroe (1999)

The average consumption value per cubic metre increased by 53% between 1991 and 1995, which is higher than the increase in the average stumpage price (26%). This increase is due to spruce, its consumption value more than doubling. Raw wood prices for spruce logs increased by more than 60% during the period, from 80 DM/m3 to 130 DM/m^3; as the costs are more or less constant (40 DM/m^3), this results in a sharp increase in the consumption values per cubic metre.

The average consumption values (24.1 DM/m^3 o.b. in 1991 and 36.8 DM/m^3 o.b. in 1995), are much lower than the stumpage prices. The reason for this difference is a different assortment structure of the harvested timber as compared to the assortment structure of the standing timber.

Whereas in 1995 the average stumpage price resulting from the stumpage value method corresponds to the consumption value of the age class 121-140 years (which represents only 6% of the stock) the average consumption value of the stock resulting from the consumption value method corresponds to the consumption value of the age class 61-80 years. It would mean that the average age of the harvested wood is more or less 130 years, whereas the average age of the stock is 75 years.

Unlike Austrian and French harvests, the German harvest is characterised by a high percentage of logs and a low percentage of fuel wood. As a consequence, the average stumpage price is higher.

Comparison with previous estimates

Hedonic pricing

The first German pilot exercise, see Bergen et al (1997), already proposed a valuation of standing timber, based on the Lancaster approach: a set of 70 transactions in forest real estates was analysed and prices were explained by three variables: the area of the forest transacted, the volume of standing timber and the species.

The resulting hedonic price function for one hectare of forest was P = 6 390 +2 590F +46.5V, where F is a dummy variable, the value of which is 1 when the species is spruce and 0 for other species, V is the volume of timber. Prices are in DM and correspond to average for the year 1991.

Interpretation is that the existence of spruce as stand building tree species increases the hectare price for forest areas by about 2 590 DM. Each cubic metre standing timber per hectare increases the price by 46.5 DM. The constant term is used for evaluating forest land. The forest land can be integrated into the forest asset balances with a hedonic price of about 6 390 DM.

It is worth noting that whereas in the hedonic approach the existence of spruce increases the value of the forest, the consumption value for spruce is much lower than the consumption value for hardwood species.

Comparisons between the timber stock values of different valuation exercises are complicated by the fact that different prices are used The value resulting from the hedonic approach is 46.5 DM/m^3 in 1991, but refers to 1 January. Taking into account the dummy variable for spruce increases the average price of timber stocks from 46.5 DM/m^3 to 50 DM/m^3. This last value is rather close to the 1991 stumpage value of 46 DM/m^3, but this value is an average value of the year 1991, therefore it takes into account the sharp decrease in prices resulting from the 1991 wind throws. In order to be made comparable with the stumpage value, the hedonic value should certainly be lowered by 15 – 20 %. In which case it would result in a value lower than the stumpage value.

For the year 1995, the original hedonic pricing function is P = 6 378 + 2 585F + 46.5V, i.e. almost identical to the function for the year 1991. The standing timber price resulting from the hedonic approach is thus almost at the same level than in 1991, whereas the stumpage price is 58 DM/m3. As for 1995 the hedonic value is slightly lower than the stumpage price.

As a whole, when the hedonic value method is corrected for the price effects of the wind throws, the two methods give rather similar values for the stock of standing timber.

Of course this is not the case when comparing the hedonic and consumption value methods with the consumption value method.

Table 49: Germany: comparison of standing timber values, billion DM

	1991	1995
Hedonic (1)	114	141
stumpage	120	165
consumption	63	104

(1)…1991 value adjusted to average year value

Source: Englert, Küppers and Thoroe (1999)

Other valuations

Köhler (1994) presented a pilot study on the feasibility of evaluation of forest assets in the framework of national accounting for the Federal Republic of Germany in its frontiers before 1990. Two valuation approaches, the consumption value method and a net present value method based on age constant factors were discussed.

The results are difficult to compare with the results presented above, mainly due to the use of long term prices (thus not taking into account the impacts of the German reunification and severe wind throws in 1991). Due to the changes in prices, values are more comparable with the 1995 results (prices in 1995 are more representative of long term prices than 1991). The table below extrapolate the results of the Köhler study to Germany using the ratio of standing timber (1.257).

Table 50: Germany: alternative valuations of standing timber stocks
former Länder (billion DM)

	Former Länder	Extrapolated to Germany
Consumption value	120	150
age constant value	224	281

Source: Eurostat calculations based on IEEAF test applications

The resulting consumption value lies between the stumpage and the consumption values presented above, and close to the hedonic pricing. The age constant value is much higher. Compared with the French and Austrian results, the ratio of the net present value approach (age constant value) to the average of consumption and stumpage values is 2.1 instead of 1.6 and 1.45 respectively.

5. Synthesis of results and conclusions

5.1 Market valuation of forest real estates and land

5.1.1 Market valuation of forest real estates

As said, ESA and SNA privilege market valuation. As concerns forest assets several markets exist: markets for bare forest land (i.e. land intended for forestry but without timber), for forests real estates (i.e. land with growing stocks of timber) and for standing timber.

In general, transactions in forest real estates are more frequent than transactions in bare forest land, but they do not separate the value of land and the value of standing timber. Furthermore, these transactions integrate values outside of forestry (e.g. hunting values).

Data on transactions exist in almost all countries that have participated in the pilot exercises. However, experts are often rather reluctant to use them due to a number of biases in these data.

Austria

Data for Austria show that the price of forests fluctuated considerably: during the 1981-1996 period five annual changes were over 10 to 20%, although in the long run the increase in current prices was slight: from 100 000-110 000 ATS/ha in 1982 to 130 000 ATS/ha in 1994. The prices would thus have decreased in constant prices (general inflation being deducted).

There are no direct data for the value of bare forest land. A 1:1 rule of thumb is generally admitted. The value of land would therefore represent 4 500 ECU/ha.

In Austria, whatever the method used for the valuation of standing timber, the market value of forest real estates (9 000 to 10 000 ECU/ha) seems to be only slightly inferior to the value resulting from the sum of land (4 500 ECU/ha) and standing timber (about 6 000 ECU/ha).

France

In France, several organisms follow the price of forests. After a large increase in the seventies, the current price of forests is decreasing since 1990. In recent years it more or less stabilised at the level of 15-18 000 FF/ha (2 700 ECU/ha). In the long run, this evolution is similar to the evolution of the price of standing timber.

A specific inquiry allowed to determine an average price of (bare) forest land: about 5 200 FF/ha in 1996 i.e. 800 ECU/ha for bare forest land and land for afforestation, i.e. 1/3 of the total market value.

For France, the discrepancy between the market value of forest real estates and the sum of land and standing timber is rather high: for private forests the 16 000 FF/ha (2 400 ECU/ha) market derived value has to be compared with 25 000 FF/ha stumpage value (3 750 ECU/ha) to 39 000 FF/ha net present value (5 850 ECU/ha).

Germany

The average price of forest real estates (1990-1996), derived from a sample of 70 transactions in Lower Saxony, is 14 800 DM/ha, i.e. 7 400 ECU/ha. A regression analysis showed that the price of forest real estates significantly follows the price of raw wood in the short run. The separation of land and standing timber made through a hedonic analysis resulted in an average land value of 6 400 DM/ha (3 200 ECU/ha), i.e. more or less 45% of the real estates value. The market value of forest real estates is only slightly inferior to the sum of the value of land and standing timber, when the standing timber is valued by the stumpage price method. Other estimates (Köhler 1994) give higher values for land.

Sweden

The value of land is based on the value of the (fiscal) general assessment. The value of forest real estates in 1993 is 7 143 SEK/ha (785 ECU/ha). The value of land is estimated as only 7% of this value. In 1973, as reported by the 1975 general assessment, the share was 9.1%; assumption is that due to the increase of the timber volume per hectare the share has decreased.

Table 51: Sweden: price of forest real estates and land per hectare

	1988-1990		1993		1993-1995	
	SEK	ECU	SEK	ECU	SEK	ECU
forest real estates	6 357	895	7 143	785	7 500	820
of which land	445	63	500	55	525	57

Source: Eriksson and Wolf (1998)

The market value of forest real estates is much lower than the value that results from combined valuation, i.e. summing the value of land and the value of standing timber (stumpage price). For the year 1993, the combined valuation gives 17 000 SEK/ha (1 865 ECU/ha), 2.4 times higher than the market value (the ratio is similar for other years).

Finland

Transactions in forest real estates are observed. For the period 1989 to 1995, the resulting market price fluctuates between 11 200 FIM/ha in 1990 (2 310 ECU/ha) and 8 400 FIM/ha in 1993 (1 255 ECU/ha).

The value of forest land is not observed but calculated on the basis of various elements (productivity of land, etc.). It is called "recommended" value and fluctuates heavily with the type of land and districts. The average value (calculated as the non-weighted average of the recommended value for four forest land types x 23 districts) is 1 781 FIM/ha in 1990 (367 ECU/ha) and 1 336 FIM/ha in 1993 (199 ECU).

Table 52: Finland: comparison of market value with separate valuation

	1990		1993		1995	
	FIM/ha	ECU/ha	FIM/ha	ECU/ha	FIM/ha	ECU/ha
forest real estates	11 200	2310	8 400	1 255	9 500	1 665
of which land	1 781	367	1 336	199	1 511	265

Source: Muukkonen (1998)

In general the market value of forest real estates is slightly lower than the sum of land and standing timber values: 85% in 1990 and 75% in 1994.

5.1.2 Synthesis

The following table recapitulates the values obtained by the market valuation.

Table 53: Comparison of forest real estates prices per hectare in test countries

	year	National currency	ECU	Basis
Germany	1996	15 485	8 100	market transactions
Austria	1996	136 000	10 125	market transactions
France	1998	18 500	2 800	market transactions
Finland	1995	9 500	1 665	recommended (administrative) value
Sweden	1994	7 500	815	market transactions

Source: Eurostat calculations based on IEEAF test applications

The market value of forest real estates is generally below the value resulting from a separate valuation of land and standing timber. Several factors may explain this. The first factor would be that the recorded value of transactions is biased for tax reasons (the database is generally a fiscal one). The second factor would be that transactions concern forests less wooded than the average forests (mature forests would be exploited before being sold).

However, the difference varies a lot across countries: for Austria, Germany and Finland the underestimation is rather low (more or less 20% of the separate valuation), for Sweden and France the difference is much higher (more than 50% of the separate valuation).

The market value of forest real estates generally fluctuates considerably, including in the short term. Fluctuations are generally linked with the prices of raw wood. The value of land, obtained through different methods, varies considerably across countries.

Table 54: Comparison of forest land prices in test countries

		ECU/ha	as a % of the market value of forest real estates
Germany	Statistical analysis of a sample of transactions	3 200	45%
France	Direct inquiry (tax authorities)	800	30%
Austria	As a “rule of thumb” ratio of observed transactions	4 500	50%
Finland	Calculated (forestry) value	375	16%
Sweden	As a ratio of forests market value (tax authorities)	55	7%

Source: Eurostat calculations based on IEEAF test applications

For Austria, France and Germany the ratio that the land value bears to the market value of forest real estates is higher, although the absolute values are extremely different. It is certainly influenced by the population density, the competition with agriculture, historic or cultural factors, hunting practices, etc.

For Nordic countries there exist almost no economically significant alternative uses of the land and the value of land is lower. Comparison between Sweden and Finland suggests that the difference in method explains the difference in value: the value of land in Finland is calculated whereas the value for Sweden is ‘assessed’. When comparing observed values for forest real estates, the difference is much less. The ratio between the market value of forest real estates in Sweden (780 ECU/ha) and in Finland (1 250 ECU/ha) is 0.62 (year 1993), whereas the ratio for forest land is less than 0.15.

5.2 Valuation of standing timber

5.2.1 Stumpage value method

The stumpage value method uses the value of removals for calculating an average price for removals (i.e. an average price of the wood in the rough, as the output of forestry). It then deducts an average felling cost, in order to arrive at a stumpage price. This average stumpage price is applied to the whole stock of standing timber.

The main advantage of this method is its simplicity, the value and structure of the removals being known, e.g. through the Eurostat Forestry Statistics and the Economic Accounts for Forestry.

In a less simplified approach, calculations can be done by main species (softwood and hardwood); if one wants to make explicit the impact of the structure of removals in order to explain changes in the average value, this structure, described in Forestry statistics, can be used. In this case prices for the main qualities of assortments are necessary. Normally the value of the removals has to be presented by assortments in the Economic Accounts for Forestry.

Tables 64-66 in Annex give the structure of removals for Germany, Austria and France for 1992-1996. The Tables show that the structures of removals are rather stable over time.

Table 55: Comparison of stumpage values of standing timber, ECU/m^3

Germany (1995)	31.1
Austria (1995)	22.0
France (1994) including fuel wood for own consumption	23.8
France (1994) without fuel wood for own consumption	29.7

Source: Eurostat calculations based on IEEAF test applications

5.2.2 Consumption value method

In the case of Austria and Germany the method for the consumption value is: the stock described by species and age/dendrometric characteristics is transformed into assortments (i.e. categories of products of a certain grade/quality) corresponding to potential uses. These assortments are valued by the corresponding prices (available from Ministry for agriculture statistics). The harvesting costs are deducted in order to arrive at the stumpage value.

The table below gives an example of the transformation in question for standing timber of the category softwood aged more than 140 year (example is for the year 1991).

Table 56: Austria: from standing timber to assortments

	ATS/m^3	ECU/m^3 u.b.	% of products
topping (pulp wood/pulp material-mixed price)	587	40.7	1%
other commercial timber (pulp wood/pulp material-mixed price)	587	40.7	12%
category 1b (log product 921)	928	64.3	7 %
category 2a (log product 921/922)	1 012	70.1	19 %
category 2b (log product 922)	1 097	76.0	22 %
category 3a (log product 923)	1 143	79.2	19 %
category 3b log products 923+)	1 189	82.4	15 %
category 4+ (logs)	1 189	82.4	5%
Total	1.030	71.4	100%

Source: Sekot (1999)

A cubic metre of this category of timber receives an average price of 1030 ATS/m^3 u.b. (71.4 ECU). After deduction of the felling costs (373 ATS/m^3) and conversion to cubic metres o.b., the "stumpage charge" for this category of wood results in (1030-373)*0.8 = 525.6 ATS/m^3 o.b., i.e. 36.4 ECU.

Tables 57 and 58 below gives the consumption value by species and age classes for Austria and Germany. They illustrate that the differences between consumption values are not only due to the different age structures of forests in the two countries (see Figures 8 and 9 in Annex) but also to the differences in the values attributed to each age class after the transformation, i.e. to the differences in presumed uses.

Table 57: Austria and Germany: consumption values, ECU/m^3, 1991

	Austria		Germany	
Age class	Softwood	Hardwood	Softwood	Hardwood
1-20	8.5	6.3	0.0	0.0
21-40	8.8	6.6	0.0	0.3
41-60	15.3	6.8	4,6	4.5
61-80	24.2	8.4	10.6	10.2
81-100	28.5	11.1	13.5	17.6
101-120	32.4	12.9	16.1	23.6
121-140	32.8	14.8	18.5	30.0
141+	36.4	16.6	22.0	39.2
Average	**26.0**	**10.0**	**8.9**	**17.9**

Source: Eurostat calculations based on IEEAF test applications

Table 58: Austria and Germany: consumption values, ECU/m^3, 1995

	Austria		Germany	
Age class	Softwood	Hardwood	Softwood	Hardwood
1-20	5.0	4.2	0.0	0.0
21-40	5.0	4.2	0.0	1.0
41-60	10.4	4.2	9.7	4.6
61-80	20.9	7.4	23.5	12.9
81-100	24.8	11.4	27.8	23.0
101-120	29.5	14.2	28.9	33.8
121-140	29.5	14.6	30.2	43.7
141+	29.2	16.4	32.2	58.0
Average	**21.9**	**9.2**	**17.8**	**23.7**

Source: Eurostat calculations based on IEEAF test applications

For France, stumpage prices are directly available; the table below gives some examples of the stumpage prices for various species and age classes.

Table 59: France: stumpage prices

Species	Diameter (cm)	Indicative age	Price ECU/m^3	
			1991	1995
Oak				
	50+	161+	109.8	123.6
	30-45	91-160	33.4	37.8
	25-	90-	7.2	11.2
	Average (private)		**43.2**	
Beech				
	40+	131+	59.1	84.7
	30-35	91-130	21.1	28.3
	25-	90-	8.2	11.0
	Average (private)		**31.3**	
Spruce				
	25+	51+	41.8	42.4
	20-	50-	7.3	8.4
	Average (private)		**33.6**	
Fir				
	25+	51+	43.6	44.0
	20-	50-	8.6	5.5
	Average (private)		**33.6**	

Source: Eurostat calculations based on Tessier and Peyron (1998, 1999)

When compared with Austrian and German stumpage prices, stumpage prices for France seem very high. It is possible that these stumpage prices only refer to the "best part" of the tree and that they are not representative of the average value of the products obtained from the trees.

Table 60: Germany, Austria and France: consumption value, ECU/m^3

	All species	Softwood	Hardwood
Germany (1995)	19.7	17.8	23.7
Austria (1995)	19.8	21.9	9.2
France (1996)	35.3	27.5	40.3

Source: Eurostat calculations based on IEEAF test applications

5.2.3 Present value method

Two countries tested the present value method: Austria and France.

Austria tested a simplified variant, where the rate of discount is set to zero, the only receipt is the final cut, management costs are introduced as a constant annual cost per hectare and plantations costs are not taken into account.

It appears that the method is very sensitive to the level of management costs. The application of this method to the Austrian softwood forests with the French management cost/ha (675 ATS/ha versus 2460 ATS/ha) was tested: the resulting value is 40% higher. The method was also applied to French oak forests: with the Austrian management costs, it gives a value that is one third of the consumption value, whereas with the French costs it gives a value which is twice the consumption value. One issue is to determine whether all management costs are really private and/or forestry costs or if they integrate some public or "collective" costs (forest roads, general administration, etc.), as well as costs for other functions of the forests, and in particular recreational functions (including hunting).

In another variant (the age constant method), Austria introduced an implicit rate of discount as well as plantations costs. Results are less volatile than those of the present value method. They are on average 30% higher than the transaction methods values.

France also tested the net present value method. Plantation costs as well as intermediate costs and receipts were taken into account. The final harvest is spread over several age classes using the actual distribution of forests. The internal rate of return is calculated on the basis of the price of forest land.

The method strictly conforms to forest economics, moreover it includes an interesting approach on the way to take into account that not all trees are cut at their optimal age. However, the amount of data and assumptions that are necessary constitutes a limitation. In particular, assumptions as concerns the intermediate and final receipts are not calibrated with actual removals.

Table 61: Austria and France: net present value of standing timber, ECU/m^3

	Pure NPV	Age constant
Austria (1995)	26.5 (simplified)	28.1
France (1991)	39.5	

Source: Eurostat calculations based on IEEAF test applications

5.3 Valuation of forest assets: conclusions

5.3.1 Standing timber

The tables below recapitulate the value of standing timber according to the main methods.

Table 62: Germany, Austria and France: recapitulative of standing timber values, ECU/m^3

	Germany 1995	Austria 1995	France 1991	France 1996
Consumption	19.7	19.8	32.1	35.3
Stumpage	31.1	22.0	20.8 – 26.8	23.8 – 29.7 b)
Net present value	(53.0) a)	26.5 –28.1	39.5	

a) calculated on the basis of Köhler (1994), as a benchmark indication; b) year 1994
Source: Eurostat calculations based on IEEAF test applications

Table 63: Germany, Austria and France: recapitulative of standing timber values, ECU/ha

	Germany 1995	Austria 1995	France 1991
Consumption	5 658	6 797	4 587
Stumpage	8 926	7 540	2 983
Net present value		9 179 – 9 608	5 966

Source: Eurostat calculations based on IEEAF test applications

The values per hectare are mainly influenced by the densities, which are 40 to 80% higher in Germany and Austria. More interesting are the difference in values per cubic metre.

As they incorporate expectation values, net present values are higher than other ones. A rather good ratio would be 1.3 between net present values and stumpage/consumption values.

The relative position of stumpage and consumption values is problematic. For Austrian forests the two values are almost identical (the stumpage value is slightly higher). For Germany the stumpage value is much higher than the consumption value, whereas for France this is the contrary. This is due to the structure of removals compared to the structure of the stock. In Germany, the structure of removals seems to be more favourable, in terms of species, density and prices than the structure of the stock, whereas the inverse is true for France. For France the importance of fuel wood for own consumption which is fully reflected in the stumpage value is a source of a great uncertainty and possible deviation.

All in all it seems that the stumpage value method offers the best solution, for international comparisons.

First it may be related with other existing statistics, including Eurostat Forestry statistics (physical quantities of wood removed from the forest by assortments) and economic accounts for forestry (monetary values of wood assortments removed from the forest). Calculations are rather straightforward. The only supplementary data that is needed is an estimate of the logging costs.

Within IEEAF, it has been advocated that the economic accounts for forestry should be separated between forestry and logging activity, on the basis of a functional analysis. Pilot exercises have shown that the forest sector has specific and rather different characteristics within European countries, and therefore that this separation would be useful to better analyse the forests and the contribution they give to the European economy, including when institutional sectors are distinguished.

On the condition that basic data are carefully analysed and made consistent, it seems that the close linking of these data with the valuation of forests is a relevant principle for European statisticians and national accountants.

Other methods are more demanding in terms of data and assumptions: it is necessary either to transform standing timber to assortments (consumption value method), or to make assumptions as concerns the intermediate costs and receipts.

Would a second method be recommended, the age constant method would be a good candidate; it is rather standardised in some countries, standard factors could be calculated once and then rather simply actualised (with plantation costs, and final harvest receipt …).

It is however possible due to specific considerations for some countries that other methods (detailed net present value or consumption value methods) appear more appropriate, due for example to the structure of removals in relation to the structure of the stock, i.e. a specific age structure of the national forest. However, the age structure and the structure of removals for European forests are not so different, except in the case of catastrophic events.

5.3.2 Land

The situation is less clear as concerns land: values vary considerably between countries. Whereas it seems that in some countries the value of forest land is mainly determined by the wood production function, it is probable that in other countries the other functions of forests play an important role. However, data are much more scarce than for standing timber. For those countries were the value of land is an important component of the value, and e.g. in order to answer to the question of the abandonment of agricultural land, it would certainly be useful to collect data on the prices of forest land.

Annex 1: Comparative tables and figures

Figure 3: Austria, France and Germany: consumption value for hardwood

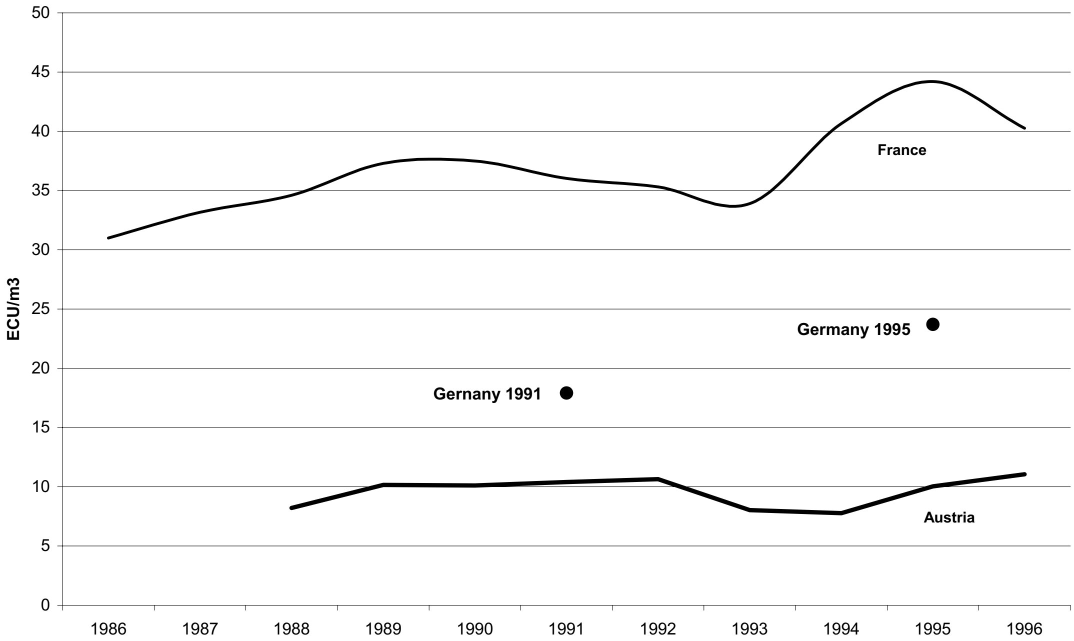


Figure 4: Austria, France and Germany: consumption value for coniferous

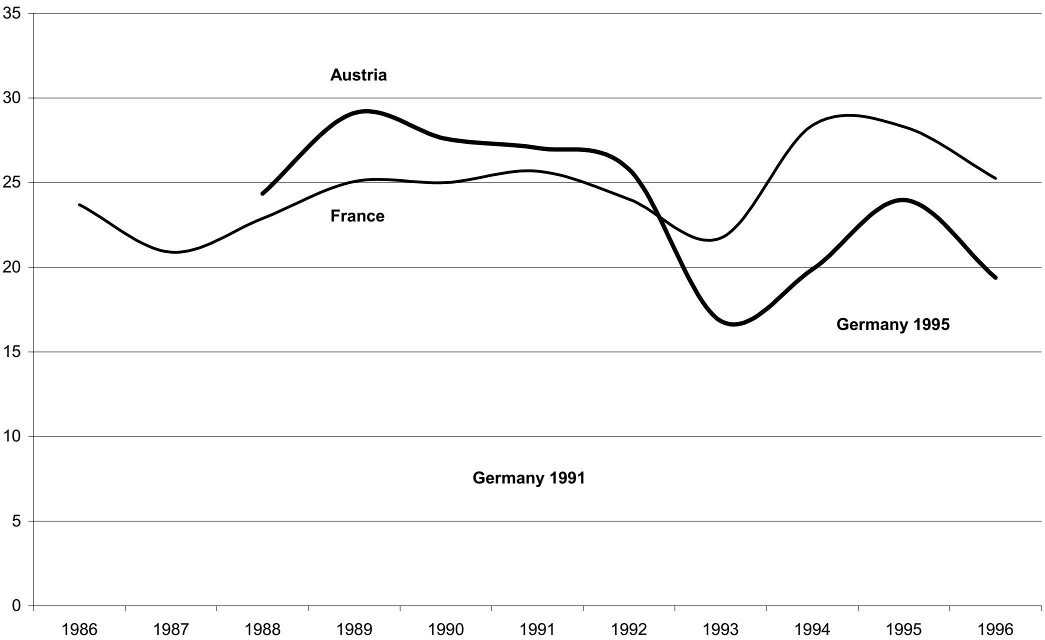


Figure 5: Austria, France and Germany: comparison of stumpage prices

Figure 6: France and Germany: distribution of spruce stocks by age classes

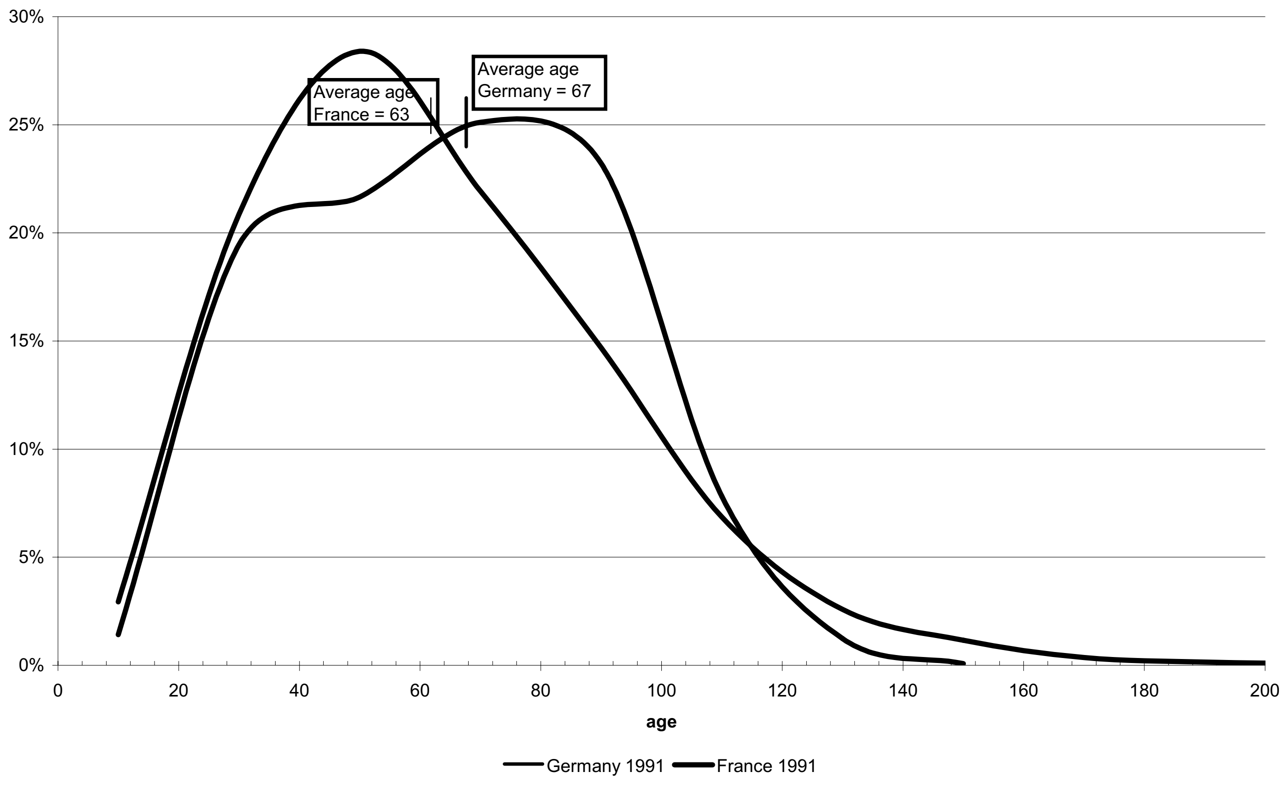


Figure 7: France and Germany: distribution of oak stocks by age classes

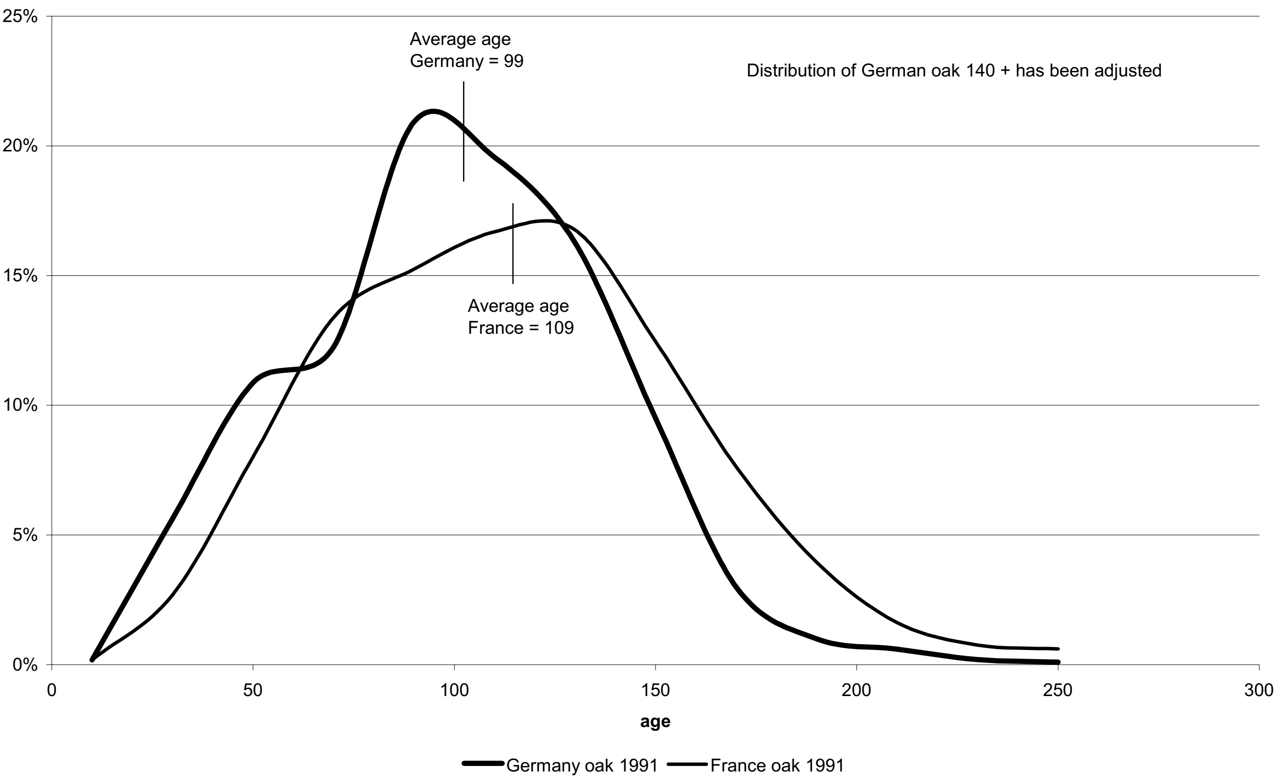


Figure 8: Austria and Germany: distribution of hardwood stocks by age classes

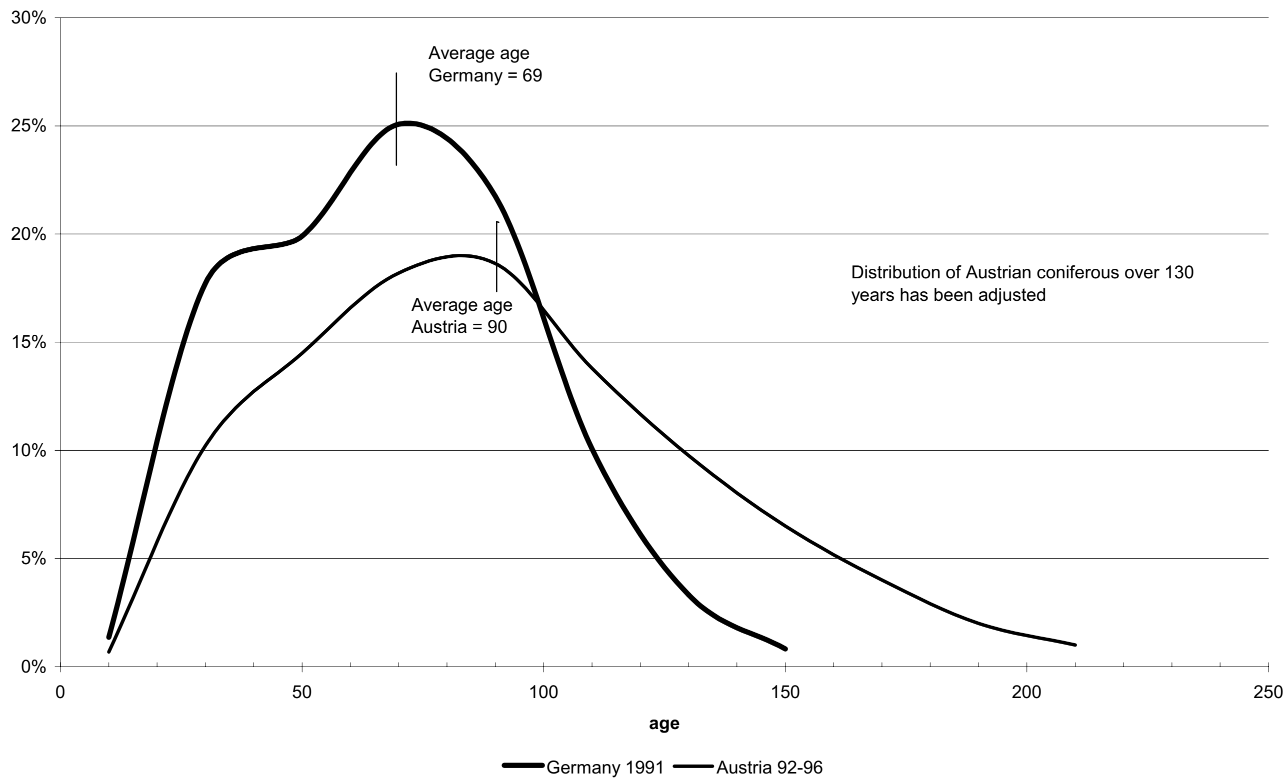


Figure 9: Austria and Germany: distribution of coniferous stocks by age classes

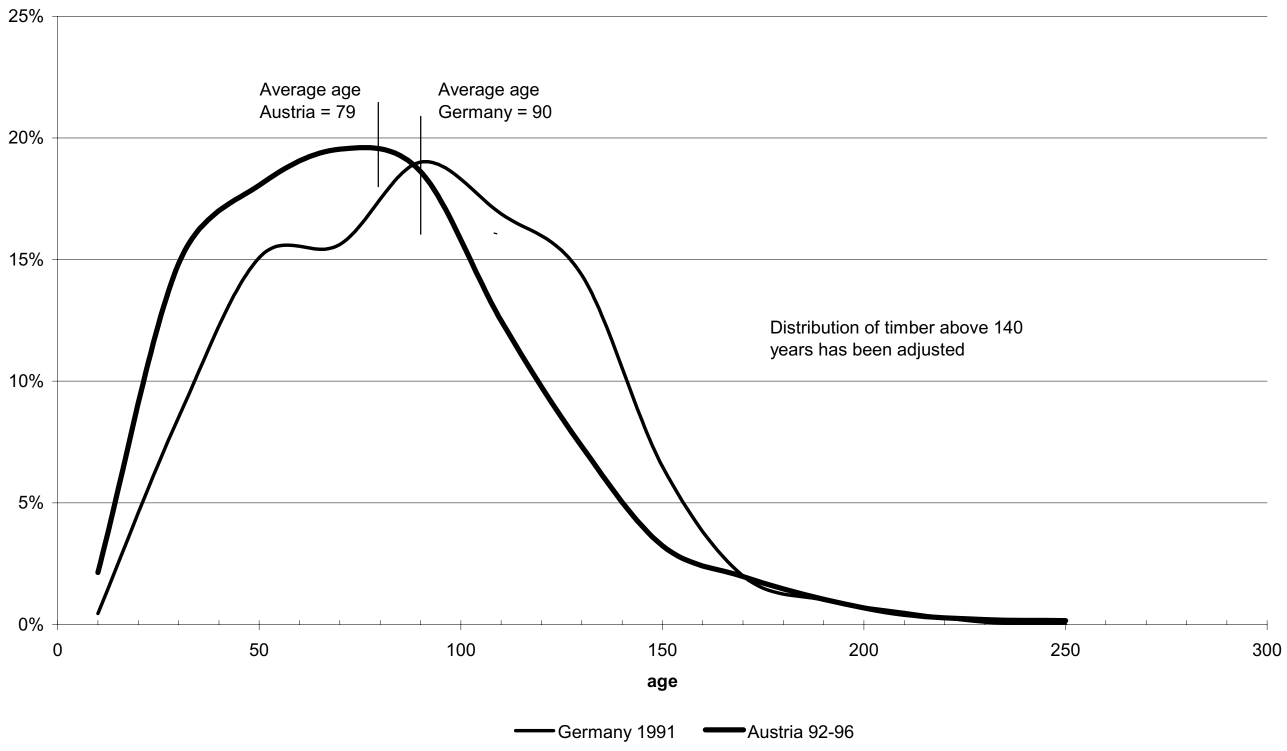
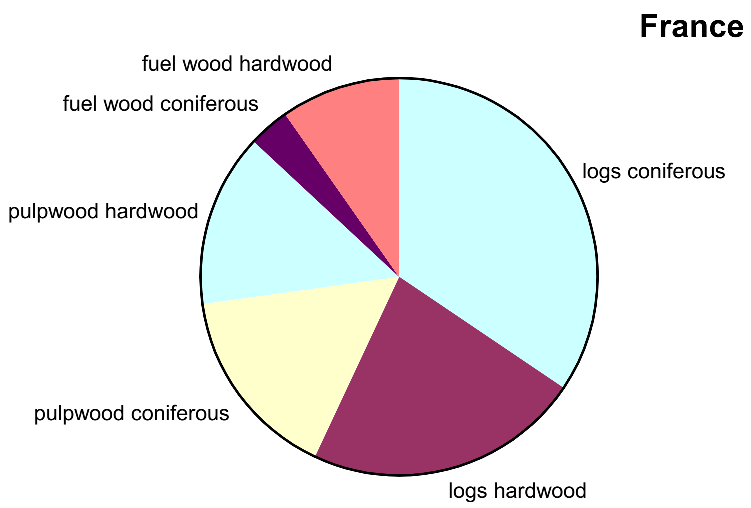
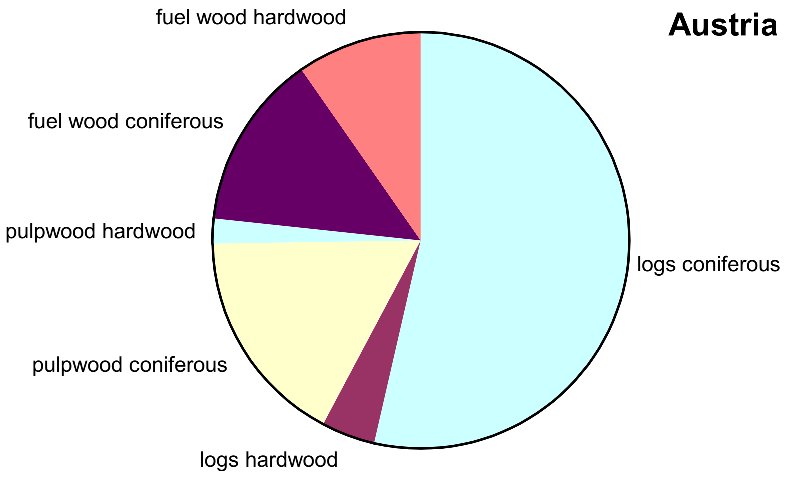


Figure 10: Austria, France and Germany: structure of removals





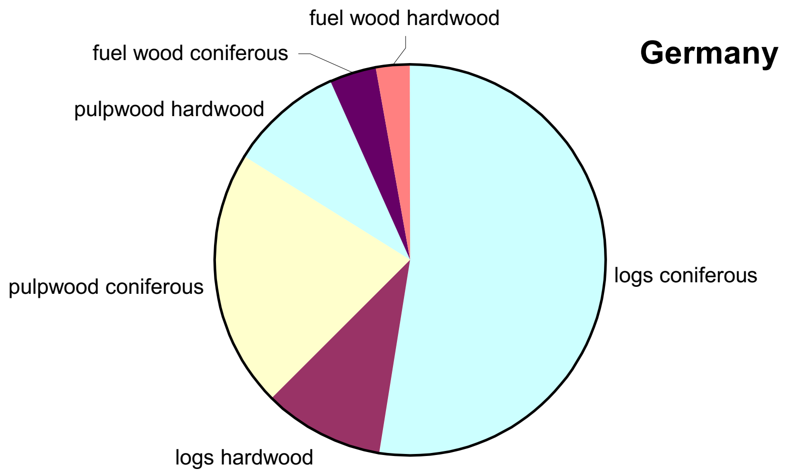


Table 64: Germany: removals by round wood assortments, 1000 m^3

		1992	1993	1994	1995	1996	average
logs	coniferous	13 565	14 754	19 741	20 314	19 362	17 547
	hardwood	2 835	2 769	3 194	3 978	3 813	3 318
	total	16 400	17 523	22 935	24 292	23 175	20 865
pulpwood	coniferous	6 716	5 911	6 569	8 652	7 544	7 078
	hardwood	2 700	2 520	2 864	3 970	3 819	3 175
	total	9 416	8 431	9 433	12 622	11 363	10 253
total (inc. other)	coniferous	20 281	20 665	26 310	28 966	26 906	24 626
	hardwood	5 535	5 289	6 058	7 948	7 632	6 492
	total	25 816	25 954	32 368	36 914	34 538	31 118
fuel wood	coniferous	1 025	1 045	1 283	1 476	1 420	1 250
	hardwood	918	959	967	953	1 056	971
	total	1 943	2 004	2 250	2 429	2 476	2 220
total	coniferous	21 306	21 710	27 593	30 442	28 326	25 875
	hardwood	6 453	6 248	7 025	8 901	8 688	7 463
	total	27 759	27 958	34 618	39 343	37 014	33 338

Source: Eurostat Forestry statistics 1992-1996

%

	1992	1993	1994	1995	1996	average
logs coniferous	0,489	0,528	0,570	0,516	0,523	0,526
logs hardwood	0,102	0,099	0,092	0,101	0,103	0,100
pulp coniferous	0,242	0,211	0,190	0,220	0,204	0,212
pulp hardwood	0,097	0,090	0,083	0,101	0,103	0,095
fuel coniferous	0,037	0,037	0,037	0,038	0,038	0,037
fuel hardwood	0,033	0,034	0,028	0,024	0,029	0,029
Total	1,000	1,000	1,000	1,000	1,000	1,000

Table 65: Austria: removals by round wood assortments, 1000 m^3

		1992	1993	1994	1995	1996	average
logs	coniferous	6 265	6 363	7 953	7 513	7 513	7 121
	hardwood	548	546	596	568	568	565
	total	6 813	6 909	8 549	8 081	8 081	7 687
pulpwood	coniferous	2 182	1 961	2 302	2 403	2 403	2 250
	hardwood	260	237	250	262	262	254
	total	2 442	2 198	2 552	2 665	2 665	2 504
total (inc. other)	coniferous	8 447	8 324	10 255	9 916	9 916	9 372
	hardwood	808	783	846	830	830	819
	total	9 255	9 107	11 101	10 746	10 746	10 191
fuel wood	coniferous	1 609	1 831	1 963	1 870	1 870	1 829
	hardwood	1 385	1 318	1 296	1 189	1 189	1 275
	total	2 994	3 149	3 259	3 059	3 059	3 104
total	coniferous	10 056	10 155	12 218	11 786	11 786	11 200
	hardwood	2 193	2 101	2 142	2 019	2 019	2 095
	total	12 249	12 256	14 360	13 805	13 805	13 295

Source: Eurostat Forestry statistics 1992-1996

%

	1992	1993	1994	1995	1996	average
logs coniferous	0,511	0,519	0,554	0,544	0,544	0,536
logs hardwood	0,045	0,045	0,042	0,041	0,041	0,043
other coniferous	0,178	0,160	0,160	0,174	0,174	0,169
other hardwood	0,021	0,019	0,017	0,019	0,019	0,019
fuel coniferous	0,131	0,149	0,137	0,135	0,135	0,138
fuel hardwood	0,113	0,108	0,090	0,086	0,086	0,096
Total	1,000	1,000	1,000	1,000	1,000	1,000

Table 66: France: removals by round wood assortments, 1000 m³

		1992	1993	1994	1995	1996	Average (a)	Average (b)
logs	coniferous	12 451	11 662	12 815	13 407	12 798	12 627	12 627
	hardwood	9 043	8 031	8 130	8 290	7 793	8 257	8 257
	total	21 494	19 693	20 945	21 697	20 591	20 884	20 884
pulpwood	coniferous	5 665	5 138	6 016	6 351	5 566	5 747	5 747
	hardwood	5 459	4 732	5 479	5 521	4 826	5 203	5 203
	total	11 124	9 870	11 495	11 872	10 392	10 951	10 951
total (inc. other)	coniferous	18 116	16 800	18 831	19 758	18 364	18 374	18 374
	hardwood	14 502	12 763	13 609	13 811	12 619	13 461	13 461
	total	32 618	29 563	32 440	33 569	30 983	31 835	31 835
fuel wood	coniferous	1 274	1 274	1 274	1 274	1 274	1 274	1 274
	hardwood	8 526	8 526	8 526	8 526	8 526	8 526	3 526
	total	9 800	9 800	9 800	9 800	9 800	9 800	4 800
total	coniferous	19 390	18 074	20 105	21 032	19 638	19 648	19 648
	hardwood	23 028	21 289	22 135	22 337	21 145	21 987	16 987
	total	42 418	39 363	42 240	43 369	40 783	41 635	36 635

Source: Eurostat Forestry statistics 1992-1996
(a) original data: include a part of fuel wood for own final consumption
(b) fuel wood for own final consumption excluded (estimated 5 million m³ hardwood)

%

	1992	1993	1994	1995	1996	Average (a)	Average (b)
logs coniferous	0,294	0,296	0,303	0,309	0,314	0,303	0,345
logs hardwood	0,213	0,204	0,192	0,191	0,191	0,198	0,225
pulpwood coniferous	0,134	0,131	0,142	0,146	0,136	0,138	0,157
pulpwood hardwood	0,129	0,120	0,130	0,127	0,118	0,125	0,142
fuel wood coniferous	0,030	0,032	0,030	0,029	0,031	0,031	0,035
fuel wood hardwood	0,201	0,217	0,202	0,197	0,209	0,205	0,096
	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Table 67: Austria, Germany and France: reconstitution of stumpage prices

	Structure of removals (average 92-96)				Prices used, ECU/m³ (u.b.)			
	Austria	Germany	France		Austria	Germany	France	
			exc. fuel wood	inc. fuel wood			exc. fuel wood	inc. fuel wood
logs coniferous	0,54	0,53	0,34	0,24	75	70	57	
logs hardwood	0,04	0,10	0,23	0,16	70	45	89	
pulpwood coniferous	0,17	0,21	0,16	0,11	40	25	25	
pulpwood hardwood	0,02	0,10	0,14	0,10	35	25	31	
fuel wood coniferous	0,14	0,04	0,03	0,02	26	17	41	
fuel wood hardwood	0,10	0,03	0,10	0,36	40	16	41	
Total	1,00	1,00	1,00	1,00	**58,0**	**50,1**	**53,4**	**49,8**
harvesting costs					**25**	**20**	**20**	20
net stumpage charge in m3 u.b.					**33,0**	**30,1**	**33,4**	29,8
from u.b. to o.b.					1,25	1,33	1,20	1,20
net stumpage charge in m3 o.b.					**26,4**	**22,6**	**27,8**	**24,8**
stumpage prices 1991					**24,9**	**22,4**	**26,8**	**20,8**

Source: Eurostat calculations based on IEEAF test applications

Note: The structure of removals for France is based on table 4.1 of Eurostat Forestry statistics 1992-1996. It underestimates fuel wool for own final consumption (hardwood). In Germany and Austria coniferous removals are mainly spruce and firs, whereas in France it is mainly pine (less valued). In France oak is important in hardwood, whereas in Germany beech is predominant.

Annex 2: Austria – Tables and Figures

Table 68: Austria: value of standing timber - net present value method

1992

Age class	2	3	4	5	6	7	8	Total
Age	10	30	50	70	90	110	142	63
Softwood								
Area in 1000 hectares	431	496	317	307	269	195	326	2341
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0,80	0,90	1,10	1,00	0,90	0,90	0,74	0,90
Quality rating (ATS/m^3 at maturity)	630	630	630	630	630	630	630	630
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,459	2,459	2,459	2,459	2,459	2,459	2,459	2,459
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	16.9	60.0	74.6	77.3	72.2	56.7	77.7	435.3
Hardwood								
Area in 1000 hectares	145	137	92	81	62	42	47	606
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.90	1.10	1.10	1.10	1.10	1.00	0.98
Quality rating (ATS/m^3 at maturity)	321	321	321	321	321	321	321	321
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2,459	2,459	2,459	2,459	2,459	2,459	2,459	2,459
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-17.9	-8.5	1.1	4.9	6.8	5.6	5.6	-2.3
Total ATS billion	**-1.0**	**51.5**	**75.6**	**82.2**	**79.0**	**62.2**	**83.4**	**433.0**

1993

Softwood								
Area in 1000 hectares	431	496	317	307	269	195	326	2341
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0.80	0.90	1.10	1.00	0.90	0.90	0.74	0.90
Quality rating (ATS/m^3 at maturity)	414	414	414	414	414	414	414	414
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-21.3	10.4	35.7	43.1	45.2	37.1	50.8	201.0
Hardwood								
Area in 1000 hectares	145	137	92	81	62	42	47	606
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.90	1.10	1.10	1.10	1.10	1.00	0.98
Quality rating (ATS/m^3 at maturity)	255	255	255	255	255	255	255	255
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-20.7	-11.5	-1.4	2.7	5.1	4.4	4.5	-17.0
Total ATS billion	**-42.1**	**-1.1**	**34.3**	**45.8**	**50.3**	**41.5**	**55.3**	**184.0**

1994

Softwood								
Area in 1000 hectares	431	496	317	307	269	195	326	2341
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0.80	0.90	1.10	1.00	0.90	0.90	0.74	0.90
Quality rating (ATS/m^3 at maturity)	505	505	505	505	505	505	505	505
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,422	2,422	2,422	2,422	2,422	2,422	2,422	2,422
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-4.0	32.4	52.6	57.8	56.7	45.3	62.2	303.1
Hardwood								
Area in 1000 hectares	145	137	92	81	62	42	47	606
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.90	1.10	1.10	1.10	1.10	1.00	0.98
Quality rating (ATS/m^3 at maturity)	289	289	289	289	289	289	289	289
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2,422	2,422	2,422	2,422	2,422	2,422	2,422	2,422
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-18.8	-9.6	0.0	3.9	6.0	5.0	5.1	-8.4
Total ATS billion	**-22.8**	**22.8**	**52.6**	**61.8**	**62.7**	**50.3**	**67.2**	**294.6**

1995

Softwood								
Area in 1000 hectares	431	496	317	307	269	195	326	2341
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0.80	0.90	1.10	1.00	0.90	0.90	0.74	0.90
Quality rating (ATS/m^3 at maturity)	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,368	2,368	2,368	2,368	2,368	2,368	2,368	2,368
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	9.9	49.5	65.4	68.8	65.1	51.3	70.4	380.4
Hardwood								
Area in 1000 hectares	145	137	92	81	62	42	47	606
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.90	1.10	1.10	1.10	1.10	1.00	0.98
Quality rating (ATS/m^3 at maturity)	334	334	334	334	334	334	334	334
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-16.1	-7.0	2.0	5.6	7.2	5.8	5.9	3.4
Total ATS billion	**-6.2**	**42.5**	**67.4**	**74.4**	**72.3**	**57.1**	**76.3**	**383.8**

1996

Softwood								
Area in 1000 hectares	431	496	317	307	269	195	326	2341
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0.80	0.90	1.10	1.00	0.90	0.90	0.74	0.90
Quality rating (ATS/m^3 at maturity)	469	469	469	469	469	469	469	469
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,281	2,281	2,281	2,281	2,281	2,281	2,281	2,281
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-4.9	29.0	48.4	53.4	52.5	42.1	57.7	278.2
Hardwood								
Area in 1000 hectares	145	137	92	81	62	42	47	606
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.90	1.10	1.10	1.10	1.10	1.00	0.98
Quality rating (ATS/m^3 at maturity)	351	351	351	351	351	351	351	351
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2,281	2,281	2,281	2,281	2,281	2,281	2,281	2,281
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-14.2	-5.4	3.1	6.4	7.7	6.1	6.2	9.9
Total ATS billion	**-19.1**	**23.6**	**51.4**	**59.8**	**60.3**	**48.2**	**63.9**	**288.1**

1997

Softwood								
Area in 1000 hectares	370	558	321	295	264	186	325	2319
Yield class	9	9	9	9	9	9	9	9
Stocking degree	0,80	1,00	1,10	1,00	0,90	0,90	0,80	0,93
Quality rating (ATS/m^3 at maturity)	588	588	588	588	588	588	588	588
Stock per hectare at maturity (U)	646	646	646	646	646	646	646	646
Real management costs per hectare	2,224	2,224	2,224	2,224	2,224	2,224	2,224	2,224
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	15.9	82.7	71.6	70.0	66.3	50.5	78.3	435.2
Hardwood								
Area in 1000 hectares	171	166	98	84	64	40	49	672
Yield class	6	6	6	6	6	6	6	6
Stocking degree	0.80	0.80	1.10	1.10	1.20	1.10	0.95	0.95
Quality rating (ATS/m^3 at maturity)	342	342	342	342	342	342	342	342
Stock per hectare at maturity (U)	477	477	477	477	477	477	477	477
Real management costs per hectare	2,224	2,224	2,224	2,224	2,224	2,224	2,224	2,224
Years to maturity (U-t)	90	70	50	30	10	1	1	
Value in ATS billion	-16.4	-8.5	3.2	6.5	8.6	5.7	6.0	5.0
Total ATS billion	**-0.5**	**74.2**	**74.8**	**76.4**	**74.9**	**56.1**	**84.3**	**440.2**

Source: Sekot (1999)

Table 69: Austria: comparison of transaction value methods

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Total value (billion ATS)										
Stumpage value	305,8	370,4	335,7	327,7	327,6	210,7	258,7	298,8	251,6	308,2
Consumption value	288,2	345,0	325,0	319,5	313,6	198,3	229,3	270,5	229,1	275,2
Sample trunk value	288,4	350,3	323,5	318,8	312,1	202,9	245,4	281,6	235,2	297,1
Standing quantities (1000 m^3)										
Softwood	760 659	760 659	760 659	760 659	790 746	790 746	790 746	790 746	790 746	796 226
Hardwood	150 371	150 371	150 371	150 371	156 513	156 513	156 513	156 513	156 513	165 513
Total	***911 030***	***911 030***	***911 030***	***911 030***	***947 259***	***947 259***	***947 259***	***947 259***	***947 259***	***961 739***

Sample trunk grading

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Value (billion ATS)										
Softwood	260,7	319,2	292,3	288,5	280,5	175,5	215,8	249,0	200,9	258,0
Hardwood	27,7	31,1	31,2	30,3	31,6	27,4	29,6	32,6	34,3	39,1
Total	***288,4***	***350,3***	***323,5***	***318,8***	***312,1***	***202,9***	***245,4***	***281,6***	***235,2***	***297,1***
Prices (ATS/m^3)										
Softwood	342,7	419,6	384,3	379,3	354,7	221,9	272,9	314,9	254,1	324,0
Hardwood	184,2	206,8	207,5	201,5	201,9	175,1	189,1	208,3	219,2	236,2
Total	***316,6***	***384,5***	***355,1***	***349,9***	***329,5***	***214,2***	***259,1***	***297,3***	***248,3***	***308,9***

Consumption value

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Value (billion ATS)										
Softwood	270,2	322,7	303,1	296,9	289,9	181,2	212,8	249,8	205,8	252,3
Hardwood	18,0	22,3	21,9	22,6	23,7	17,1	16,5	20,7	23,3	22,9
Total	***288,2***	***345,0***	***325,0***	***319,5***	***313,6***	***198,3***	***229,3***	***270,5***	***229,1***	***275,2***
Prices (ATS/m^3)										
Softwood	355,2	424,2	398,5	390,3	366,6	229,2	269,1	315,9	260,3	316,9
Hardwood	119,7	148,3	145,6	150,3	151,4	109,3	105,4	132,3	148,9	138,4
Total	***316,3***	***378,7***	***356,7***	***350,7***	***331,1***	***209,3***	***242,1***	***285,6***	***241,9***	***286,1***

Stumpage price method

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Roadside price ATS/m^3	794	877	828	823	805	652	712	759	687	
Felling costs ATS/m^3	374	369	367	373	373	374	371	365	355	
Net price ATS/m^3 harvested	420	508	461	450	432	278	341	394	332	401
Net price ATS/m^3 standing	336	406	369	360	346	222	273	315	266	321
Total value (billion ATS)	**306,1**	**370,2**	**336,0**	**328,0**	**327,4**	**210,7**	**258,4**	**298,6**	**251,6**	**308,5**

Source: Eurostat calculations based on Sekot (1999)

Table 70: Austria: calculation of consumption value (example of softwood 1988)

	Grades %							Total
	pulp wood	logs categories						
Age class		1b	2a	2b	3a	3b	4+	
2	100							100
3	100							100
4	74	25	1					100
5	44	20	25	11				100
6	33	16	25	21	5			100
7	21	11	23	23	18	4		100
8	21	11	23	23	18	4		100
9	15	8	20	22	19	15	1	100
Price (ATS/m^3)	581	836	946	1055	1094	1133	1133	

Age class	**Standing stock 1000 m^3**	**Quantities by grade**							
2	4 061	4 061							4 061
3	54 484	54 484							54 484
4	105 269	77 899	26 317	1 053					105 269
5	146 882	64 628	29 376	36 721	16 157				146 882
6	148 351	48 956	23 736	37 088	31 154	7 418			148 351
7	110 647	23 236	12 171	25 449	25 449	19 916	4 426		110 647
8	78 692	16 525	8 656	18 099	18 099	14 165	3 148		78 692
9	112 273	16 841	8 982	22 455	24 700	21 332	16 841	1 123	112 273
Total	760 659	306 630	109 239	140 864	115 559	62 830	24 415	1 123	760 659

Age class	**Average price ATS/m^3 harvested**	**Felling costs**	**Stumpage charge**	**Consumption value**
2	581,0	374,0	207,0	**673**
3	581,0	374,0	207,0	**9 023**
4	648,4	374,0	274,4	**23 109**
5	775,4	374,0	401,4	**47 166**
6	838,2	374,0	464,2	**55 096**
7	916,4	374,0	542,4	**48 015**
8	916,4	374,0	542,4	**34 149**
9	964,5	374,0	590,5	**53 035**
Total	729,3	374,0	355,3	**270 265**

Source: Eurostat calculations based on Sekot (1999)

Table 71: Austria: calculation of the consumption value (example of hardwood 1988)

	1981/85 structure of the stock by age class						
	up to 60	61-80	81-100	101-120	121-140	141+	Total
Assortments/grades %							
Pulp wood	100	94	86	76	73	68	88
Logs 3+		6	14	24	27	32	12
Quantities 1000 m^3	48 802	29 847	28 715	19 657	12 083	11 267	150 371
Pulp wood	48 802	28 056	24 695	14 939	8 821	7 662	132 975
Logs 3+	-	1 791	4 020	4 718	3 262	3 605	17 396
Roadside value	18 350	11 887	12 289	9 142	5 754	5 575	62 997
Felling costs	14 602	8 930	8 592	5 881	3 615	3 371	
Stumpage value	3 748	2 957	3 698	3 261	2 139	2 204	18 006
Average price standing ATS/m^3	77	99	129	166	177	196	120

Source: Eurostat calculations based on Sekot (1999)

Figure 11: Austria: evolution of prices for softwood

Figure 12: Austria: roadside pick-up price and stumpage price for softwood, 1988-1997

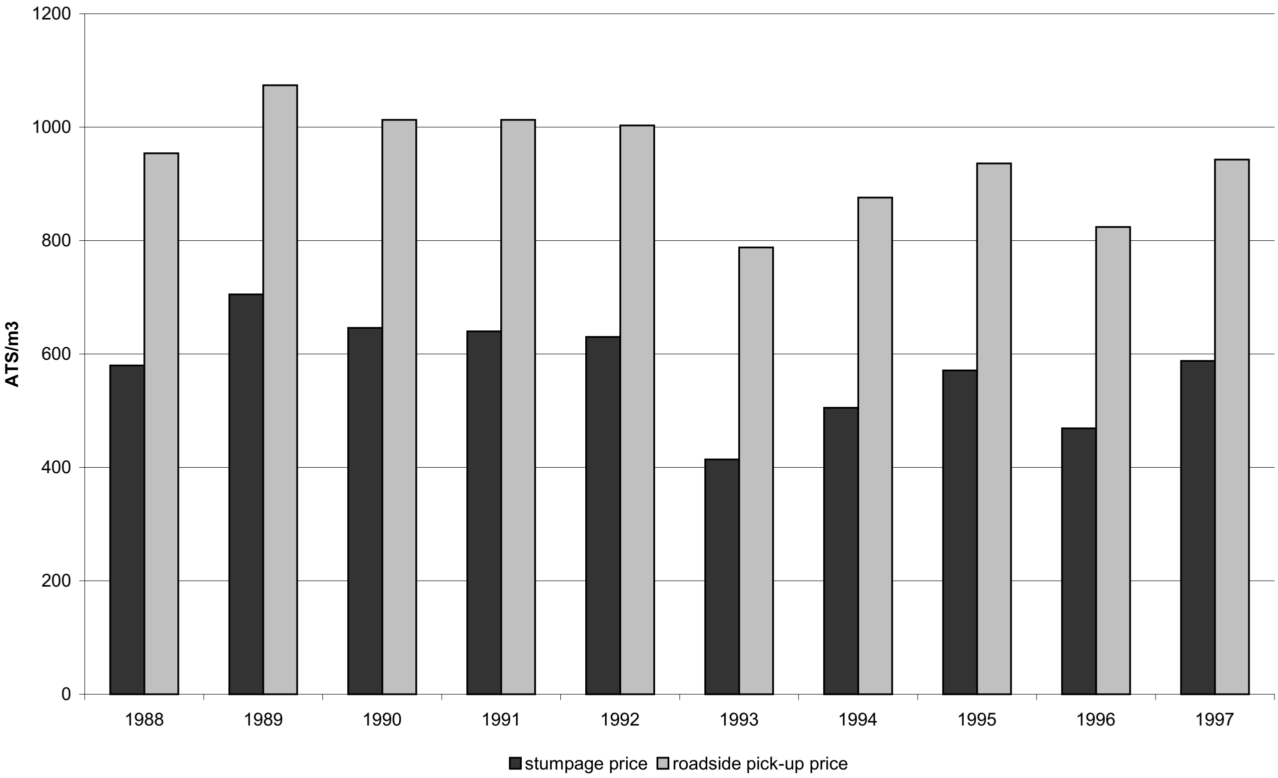


Figure 13: Austria: comparison of age constant and transaction value methods

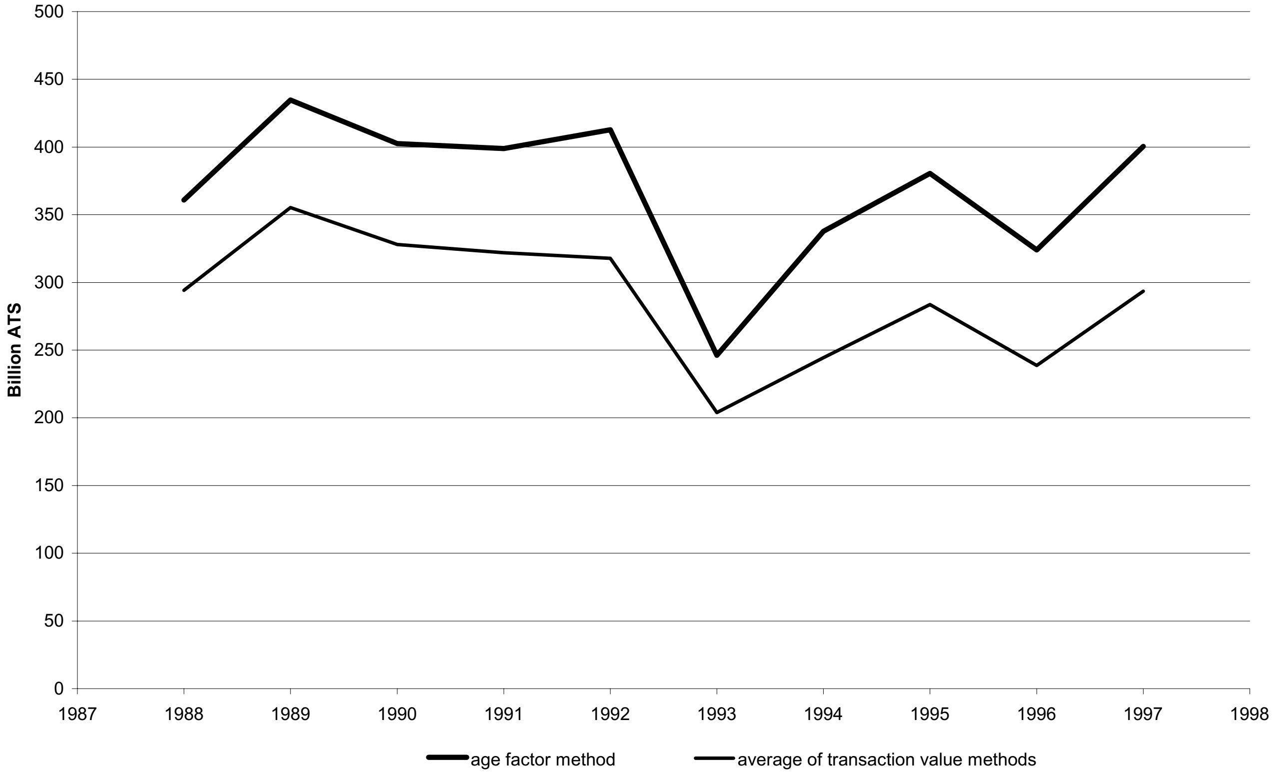
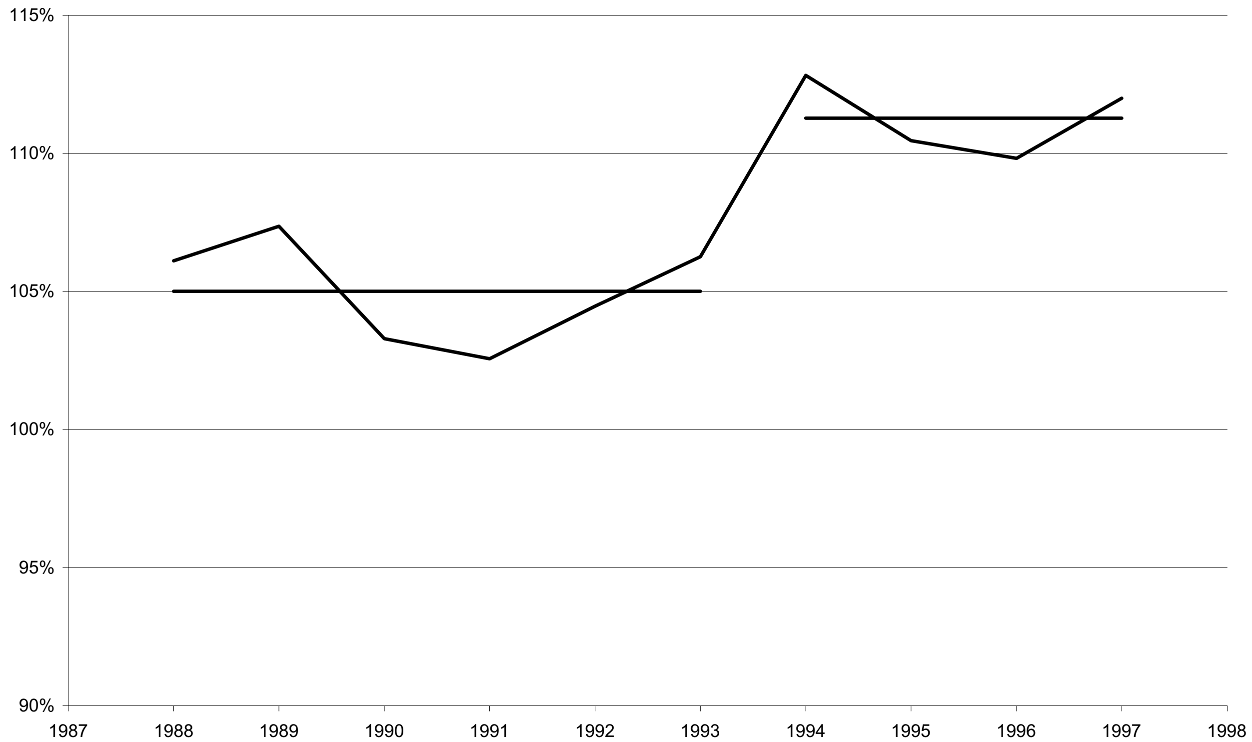


Figure 14: Austria: comparison of stumpage and consumption value methods



Annex 3: France – Tables and Figures

Table 72: France: distribution of area and stock by age class: oak and spruce/fir by ownership

Oak — Public

Age class	Area	Stock	% stock	m³/ha
1-20	22.2	7419	0.1	3.3
21-40	31.8	1 415.9	2.0	44.4
41-60	39.7	3 328.9	4.6	83.9
61-80	40.0	5 109.3	7.0	127.7
81-100	45.1	7 216.4	9.9	160.0
101-120	52.1	9 590.4	13.2	184.1
121-140	53.8	11 122.4	15.3	206.3
141 160	52.0	11 436.3	15.8	219.9
161-180	40.0	9 394.7	12.9	234.9
181 200	27.7	6 749.9	9.3	243.6
201-220	14.6	3 678.9	6.1	251.9
221-+	13.1	3 451.1	4.9	248.5
Total	432.1	72 568.4	100.0	167.9
Average age	111.2	133.7		

Oak — Private

Age class	Area	Stock	%	m³/ha
1-20	233.3	666.7	0.2	2.9
21-40	295.3	9 557.1	2.9	32.4
41-60	446.1	29 292.6	8.7	65.7
61-80	552.9	49 444.1	14.8	89.4
81-100	462.2	54 918.2	16.4	118.9
101-120	419.7	58 428.6	17.4	139.2
121-140	362.9	57 187.2	17.1	157.6
141 160	230.7	39 348.9	11.7	171.1
161-180	120.7	21 690.4	6.5	180.7
181 200	50.6	9 373.0	2.8	185.2
201-220	16.5	2 933.8	0.9	177.8
221-+	14.0	2 132.4	0.6	152.3
Total	3 204.8	334 972.8	100.0	104.5
Average age	87.0	109.0		

Spruce — public

Age class	Area	Stock	% stock	m³/ha
1-20	28.3	1 022.6	2.2	36
21-40	43.0	5 822.8	12.5	136
41-60	39.9	9 478.3	20.3	238
61-80	29.9	10 030.1	21.5	335
81-100	21.7	8 693.6	18.6	401
101-120	13.1	5 928.3	12.7	452
121-140	6.2	3 070.6	6.6	494
141 160	3.1	1 692.2	3.6	541
161-180	1.1	643.8	1.4	583
181 +	0.6	375.8	0.7	674
Total	186.8	46 757.9	100.0	
Average age	56.9	77.7		

Spruce — private

Age class	Area	Stock	%	m³/ha
1-20	119.9	5 174.1	3.1	43.2
21-40	277.4	38 224.5	23.2	137.8
41-60	214.4	50 502.3	30.7	235.6
61-80	112.8	36 278.4	22.1	321.7
81-100	58.6	22 316.4	13.6	381.1
101-120	20.2	8 565.5	5.2	424.5
121-140	5.4	2 396.7	1.5	447.2
141 160	1.6	744.5	0.5	461.4
161-180	0.3	116.8	0.1	408.1
181 +	0.2	107.8	0.1	483.6
Total	810.6	164 426.9	100.0	202.8
Average age	45.2	58.9		

Oak — total

Age class	Area	Stock	% stock	m³/ha
1-20	255.6	740.7	0.2	2.9
21-40	327.0	10 973.0	2.7	33.6
41-60	485.7	32 621.5	8.0	67.2
61-80	592.9	54 553.4	13.4	92.0
81-100	507.3	62 134.6	15.2	122.5
101-120	471.7	68 019.0	16.7	144.2
121-140	416.8	68 309.6	16.8	163.9
141 160	282.7	50 785.2	12.5	179.6
161-180	160.7	31 085.1	7.6	193.5
181- 200	78..3	16 122.9	4.0	206.0
201-220	31.1	6 612.6	1.6	212.9
221-+	27.1	5 583.5	0.8	206.0
Total	3 636.8	407 641.3	0.6	112.1
Average age	90.0	113.9	100.0	

Spruce — total

Age class	Area	Stock	%	m³/ha
1-20	148.2	6 196.7	2.9	41.8
21-40	320.3	44 047.2	20.9	137.5
41-60	254.2	59 980.5	28.4	235.9
61-80	142.7	46 308.5	21.9	324.5
81-100	80.2	31 010.0	14.7	386.4
101-120	33.3	14 493.7	6.9	435.4
121-140	11.6	5 467.3	2.6	472.3
141 160	4.7	2 436.7	1.2	513.9
161-180	1.4	764.7	0.4	546.0
181-200	0.5	313.4	0.1	614.0
201 -+	0.2	144.1	0.1	625.4
Total	997.5	211 162.8	100.0	211.7
Average age	47.4	63.0		

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 73: France: oak, net present value and consumption value, 1991

		Oak central government forests				Oak private forests				Oak local government			
Ø cm	Price FF/m³	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		27				30				36			
10	51	44	1 817.6	1 208	93	51	19 369.9	4 869	988	59	2 092.9	3 116	107
15	51	60	2 901.3	1 531	148	67	34 038.1	7 445	1 736	79	3 271.6	3 438	167
20	51	75	3 554.8	1 864	181	81	37 210.3	9 155	1 898	96	4 355.3	3 782	222
25	51	90	4 663.7	2 389	238	94	34 927.8	10 900	1 781	112	5 701.4	4 525	291
30	249	104	5 750.3	3 079	1 432	106	34 665.1	13 476	8 632	127	7 400.3	5 245	1 843
35	249	119	7 403.7	3 733	1 844	118	35 222.7	14 545	8 770	142	8 935.4	5 941	2 225
40	249	133	7 612.8	4 253	1 896	129	32 303.5	15 341	8 044	156	9 319.7	6 475	2 321
45	249	147	8 106.9	4 882	2 019	140	30 757.0	16 724	7 659	170	10 160.8	7 235	2 530
50	812	160	7 382.8	5 277	5 995	151	24 540.2	17 329	19 927	184	9 419.6	7 624	7 649
55	812	173	6 307.1	4 437	5 121	162	18 099.5	12 677	14 697	196	7 987.2	6 313	6 486
60	812	185	5 293.1	3 753	4 298	172	12 285.3	8 440	9 976	208	6 456.0	5 051	5 242
65	812	198	4 078.8	2 867	3 312	182	7 642.8	5 137	6 206	220	4 428.4	3 491	3 596
70	812	209	2 561.3	1 800	2 080	192	5 080.6	3 364	4 125	231	3 162.3	2 415	2 568
75	812	221	1 727.2	1 203	1 402	201	3 109.3	1 970	2 525	242	1 722.6	1 318	1 399
80	812	233	1 098.5	749	892	211	1 523.5	912	1 237	252	1 072.4	802	871
85	812	243	731.7	520	594	221	1 183.1	672	961	261	648.3	483	526
90	812	253	539.4	385	438	231	806.2	508	655	271	378.4	240	307
95	812	266	173.8	35	141	242	503.4	337	409	281	133.6	82	109
100	812	279	311.7	71	253	253	271.3	15	220	290	129.5	69	105
105	812	291	105.0	28	85	264	121.0	11	98	300	15.8	19	13
110	812	304	82.7	26	67	275	95.6	14	78	310	40.5	31	33
115	812	317	17.7	7	14	286	46.5	8	38				
120	812	330	79.2	30	64	297	119.6	19	97				
125	812	342	15.3	9	12	308	1.3	1	1				
130	812	355	70.6	40	57	319	21.2	8	17				
135	812	368	15.6	7	13	330							
140	812	381				341	10.0	3	8				
145	812	393				352							
150	812	406	21.8	12	18	363							
155	812	419				374							
160	812	431	44.2	33	36	384	18.0	13	15				
Total			72468,4	44 226	32 743		333 972,8	143 892	100 795		86 832,1	67 694	38 608

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 74: France: beech, net present value and consumption value 1991

		Beech central government forests				Beech private forests				Beech local government			
Ø cm	Price FF/m³	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		29				37				35			
10	53	48	2 274,9	962	121	62	6 443,7	1 634	342	59	3 123,2	1 574	166
15	53	64	3 381,3	1 218	179	81	9 266,9	2 135	491	78	4 720,9	1 930	250
20	53	79	4 558,5	1 490	242	97	10 653,2	2 602	565	95	5 740,2	2 347	304
25	53	92	5 086,5	1 775	270	111	10 816,0	2 975	573	109	6 388,7	2 590	339
30	143	105	5 668,8	2 057	811	124	10 640,4	3 395	1 522	123	7 174,1	2 920	1 026
35	143	117	6 221,3	2 310	890	135	9 947,4	3 403	1 422	135	7 946,5	3 153	1 136
40	420	128	5 780,8	2 418	2 428	146	8 013,1	3 385	3 366	147	7 233,7	3 219	3 038
45	420	140	5 522,4	2 216	2 319	156	7 136,3	2 910	2 997	158	7 213,7	3 024	3 030
50	420	150	5 127,4	1 977	2 153	166	6 242,0	2 469	2 622	169	6 847,0	2 749	2 876
55	420	161	4 206,5	1 562	1 767	175	4 590,6	1 767	1 928	180	5 883,2	2 323	2 471
60	420	171	3 030,5	1 116	1 273	184	3 562,1	1 339	1 496	190	4 767,9	1 845	2 003
65	420	181	2 383,6	862	1 001	192	2 733,2	1 020	1 148	200	3 963,6	1 489	1 665
70	420	191	1 976,1	713	830	201	1 675,5	607	704	210	2 894,5	1 077	1 216
75	420	201	1 328,6	470	558	210	1 261,3	453	530	220	1 843,3	707	774
80	420	210	1 107,5	409	465	218	745,4	274	313	230	1 104,6	409	464
85	420	220	597,3	219	251	227	563,6	198	237	239	650,1	236	273
90	420	229	478,9	182	201	236	418,2	145	176	248	350,0	126	147
95	420	237	200,7	73	84	246	253,9	40	107	260	119,7	4	50
100	420	247	70,4	10	30	256	179,2	39	75	271	160,4	8	67
105	420	257	42,2	7	18	266	57,6	10	24	283	47,6	3	20
110	420	267	42,3	7	18	276	221,3	52	93	294	67,3	7	28
115	420	277	37,1	7	16	286	85,2	23	36	305	11,6	1	5
120	420	287	5,4	1	2	296	37,3	10	16	317			
125	420	297	12,3	2	5	306	8,5	6	4	328			
130	420	307				316	39,6	8	17	339	1,2	2	1
135	420	317	10,3	4	4	326	30,3	12	13	351	16,2	3	7
140										362	10,3	3	4
145										374			
150										385	24,4	9	10
Total			59 151,7	22 067	15 934		95 621,9	30 909	20 813		78 303,8	31 755	21 369

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 75: France: spruce & fir, net present value and consumption value 1991

Ø cm	Price FF/m³	Spruce & fir central government forests: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Spruce & fir private forests: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Spruce & fir local government: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		15				15				16			
10	47	25	1 301,5	449	61	25	7 348,2	2 214	345	26	2 825,5	856	133
15	47	34	2 604,4	614	122	33	16 132,7	3 108	758	36	5 479,8	1 167	258
20	47	42	3 423,4	800	161	41	21 048,8	4 131	989	45	6 965,4	1 610	327
25	305	51	4 017,4	1 116	1 225	49	21 064,4	5 438	6 425	55	8 259,4	2 235	2 519
30	305	60	4 605,0	1 138	1 405	57	19 993,3	4 674	6 098	65	9 879,7	2 379	3 013
35	305	69	4 891,2	1 099	1 492	65	18 169,2	4 016	5 542	76	11 098,7	2 472	3 385
40	305	79	4 668,1	971	1 424	74	15 926,3	3 331	4 858	87	11 484,7	2 432	3 503
45	305	89	4 708,6	966	1 436	83	13 494,5	2 773	4 116	97	11 255,8	2 385	3 433
50	305	99	4 093,8	853	1 249	91	10 313,3	2 178	3 146	108	10 085,1	2 153	3 076
55	305	108	3 258,4	676	994	100	7 504,9	1 594	2 289	118	8 423,9	1 808	2 569
60	305	118	2 648,1	550	808	108	4 719,4	1 000	1 439	128	7 017,2	1 550	2 140
65	305	128	1 918,9	396	585	116	3 029,4	642	924	138	4 537,9	976	1 384
70	305	138	1 327,2	270	405	124	1 633,3	343	498	148	3 650,7	818	1 113
75	305	147	936,8	194	286	133	1 085,7	228	331	158	2 181,8	469	665
80	305	157	800,3	182	244	141	565,0	126	172	168	1 455,2	325	444
85	305	166	489,8	110	149	151	296,3	1	90	176	706,3	161	215
90	305	178	285,0	23	87	160	377,7	5	115	188	519,9	12	159
95	305	190	193,6	20	59	170	55,8	2	17	200	283,3	13	86
100	305	201	96,7	14	30	179	61,0	4	19	212	333,9	20	102
105	305	213	57,1	9	17	189	40,7	3	12	223	131,5	12	40
110	305	224	60,6	15	18	199	27,4	3	8	235	64,6	9	20
115						208				247	27,5	10	8
120						218	39,7	10	12	259	22,0	6	7
Total			46 386,1	10 466	12 257		162 926,9	35 823	38 204		106 689,9	23 878	28 601

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 76: France: maritime pine, net present value and consumption value 1991

Ø cm	Price FF/m^3	Maritime pine central government forests: Age years	Standing Volume 1000 m^3	present value million FF	consumption value million FF	Maritime pine private forests: Age years	Standing Volume 1000 m^3	present value million FF	consumption value million FF	Maritime pine local government: Age years	Standing Volume 1000 m^3	present value million FF	consumption value million FF
3,75		9				8				7			
10	36	15	239,3	63	9	14	4 052,7	1 794	146	12	199,2	36	7
15	36	22	570,4	97	21	20	9 594,7	2 152	345	17	382,6	51	14
20	36	30	1 099,2	154	40	26	14 082,0	2 828	507	24	508,9	83	18
25	166	39	1 285,2	208	213	33	18 810,3	3 717	3 123	32	732,5	118	122
30	166	48	1 580,8	232	262	40	26 656,7	4 423	4 425	39	978,3	138	162
35	166	58	1 218,8	172	202	48	28 608,5	4 361	4 749	47	1 099,7	146	183
40	166	67	933,3	128	155	55	24 851,0	3 608	4 125	56	849,0	104	141
45	166	77	483,3	65	80	63	17 940,1	2 544	2 978	65	539,7	60	90
50	166	87	312,9	41	52	71	12 272,2	1 730	2 037	75	479,3	56	80
55	166	97	187,7	25	31	78	7 426,9	1 036	1 233	87	231,0	22	38
60	166	107	76,0	9	13	86	3 578,0	490	594	99	123,1	10	20
65	166	118	56,3	3	9	93	1 980,8	268	329	114	120,6	11	20
70	166	129	59,2	4	10	101	1 082,0	146	180	131	90,6	0	15
75	166	140	18,9	2	3	107	564,3	74	94	148	65,0	0	11
80	166	151	9,6	1	2	114	394,8	20	66	166	73,0	0	12
85	166	163				121	181,9	11	30	183	10,8	0	2
90	166	174				128	191,7	13	32	201	15,5	0	3
95	166	185	15,5	2	3	135	50,7	5	8	218	5,0	0	1
100						142	48,9	4	8	236	5,7	1	1
110						148	14,8	2	2				
115						155	22,5	3	4				
Total			8 146,3	1 207	1 104		172 405,7	29 229	25 015		6 509,4	837	939

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 77: France: other broadleaves, net present value and consumption value 1991

		Other broadleaves central govt forests				Other broadleaves private forests				Other broadleaves local government			
Ø cm	Price FF/m³	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		35				27				35			
10	180	59	6 043,7	1 362	1 088	46	71 259,6	13 906	12 827	58	12 342,0	2 658	2 222
15	180	78	6 616,3	1 360	1 191	61	82 451,2	14 122	14 841	76	11 778,1	2 456	2 120
20	180	93	5 938,3	1 129	1 069	75	68 489,0	11 104	12 328	91	10 180,2	1 973	1 832
25	180	107	4 571,3	809	823	87	46 614,5	7 119	8 391	104	8 356,5	1 541	1 504
30	180	121	3 400,5	595	612	99	33 420,4	4 883	6 016	117	6 287,0	1 114	1 132
35	180	134	2 466,9	415	444	110	23 336,8	3 267	4 201	129	4 365,7	759	786
40	180	146	1 475,0	243	265	121	14 386,8	1 846	2 590	140	2 850,1	484	513
45	180	158	985,1	161	177	131	10 390,8	1 278	1 870	151	1 756,3	291	316
50	180	169	651,8	104	117	142	7 123,2	801	1 282	161	1 059,8	171	191
55	180	179	436,5	68	79	153	5 013,3	528	902	171	790,6	122	142
60	180	190	251,4	38	45	164	3 976,0	409	716	180	472,0	70	85
65	180	201	170,0	24	31	177	2 459,9	199	443	192	261,3	*	47
70	180	212	66,7	-3	12	190	2 017,6	164	363	203	166,0	*	30
75	180	224	101,4	-2	18	203	1 565,4	131	282	215	57,9	*	10
80	180	236	71,6	0	13	216	1 433,4	150	258	227	49,2	*	9
85	180	248	25,9	0	5	235	1 103,5	123	199	238	39,0	*	7
90	180	259	7,3	0	1	252	872,5	*	157	250	37,1	*	7
95	180	271	2,9	0	1	269	625,5	*	113	262	21,1	*	4
100	180	283	1,0	0	0	286	641,3	*	115	273	7,2	*	1
105	180	295	10,1	1	2	303	220,5	*	40	285			
110	180	306	0,0	0	0	320	287,0	*	52	296	2,5	*	0
115	180	318	8,5	1	2	337	240,5	*	43	308	1,5	*	0
120	180					354	240,7	*	43	320			
125	180					371	112,2	*	20	331	4,2	*	1
130	180					388	75,9	*	14	343	12,8	*	2
135	180					405	72,2	*	13	355	5,5	*	1
140	180					422	65,6	*	12	366			
145	180					439	123,5	*	22	378	8,4	*	2
150	180					457	87,5	*	16	390			
155	180					474	96,4	*	17	401			
160	180					491	21,1	*	4	413			
165+	180					508+	268,8	0,6	48,4	425+	20.9	*	4
Total			33 302,0	6 307	5 994		379 092,2	60 029	68 237		60 932,9	11 638	10 968

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 78: France: scotch pine, net present value and consumption value 1991

Ø cm	Price FF/m³	Scotch pine central government forests: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Scotch pine private forests: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Scotch pine local government forests: Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		19				22				21			
10	29	31	555,0	159	16	37	4 450,1	1 395	129	35	613,2	178	18
15	29	45	1 306,8	256	38	51	10 953,4	1 887	318	49	1 230,8	250	36
20	29	59	2 070,4	375	60	65	16 786,2	2 552	487	65	1 969,3	387	57
25	181	73	2 306,2	481	417	79	18 709,1	3 364	3 386	80	2 683,1	518	486
30	181	87	2 422,5	460	438	93	17 249,9	2 921	3 122	98	3 138,1	555	568
35	181	101	2 423,1	425	439	107	13 881,5	2 258	2 513	116	3 002,5	511	543
40	181	117	2 374,2	384	430	121	8 344,2	1 318	1 510	134	2 338,3	380	423
45	181	133	2 283,3	361	413	135	5 075,5	793	919	152	1 947,7	302	353
50	181	148	1 717,6	270	311	149	2 858,4	439	517	171	1 273,7	190	231
55	181	163	1 068,0	166	193	162	1 317,6	201	238	189	690,7	94	125
60	181	177	484,7	75	88	175	729,8	54	132	207	369,3	*	67
65	181	191	195,8	30	35	187	293,7	23	53	224	180,7	*	33
70	181	202	150,8	25	27	200	161,4	16	29	242	63,9	*	12
75	181	216	49,3	7	9	213	25,8	3	5	259	22,8	*	4
80	181	229	3,1	0	1	226	37,8	4	7	277	10,4	0	2
85	181	243	7,8	1	1	239	21,8	3	4	295	0,0	0	0
90						252	47,6	8	9	312	1,2	0	0
95										330	2,7	0	0
100										347	3,8	1	1
Total			19 418,6	3 476	2 917		100 943,8	17 241	13 378		19 541,9	3 366	2 957

Source: Eurostat calculations based on Tessier and Peyron (1998)

Table 79: France: other coniferous, net present value and consumption value 1991

		Other coniferous central govt forests				Other coniferous private forests				Other coniferous local government			
Ø cm	Price FF/m³	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF	Age years	Standing Volume 1000 m³	present value million FF	consumption value million FF
3,75		15				12				14			
10	32	24	853,7	154	27	20	3 711,3	1 433	119	23	828,0	223	26
15	32	35	2 058,7	262	66	27	8 895,2	1 690	285	32	2 063,5	293	66
20	32	47	3 079,5	424	99	34	13 003,0	2 129	416	41	3 100,2	392	99
25	173	59	3 355,0	584	580	41	13 427,7	2 487	2 323	52	3 175,6	535	549
30	173	72	3 564,6	583	617	48	11 584,2	1 981	2 004	64	3 339,4	494	578
35	173	85	2 784,8	449	482	56	8 310,1	1 372	1 438	79	2 999,5	414	519
40	173	98	1 843,4	298	319	64	5 266,2	842	911	95	2 220,1	292	384
45	173	110	1 336,4	212	231	72	3 861,4	609	668	111	1 733,1	227	300
50	173	122	1 096,4	170	190	79	2 583,4	397	447	128	1 268,1	166	219
55	173	134	851,3	132	147	87	1 726,1	273	299	142	889,4	114	154
60	173	144	564,3	82	98	94	1 178,3	181	204	159	748,8	97	130
65	173	156	570,7	79	99	102	722,7	116	125	173	507,5	65	88
70	173	171	423,8	56	73	109	465,4	68	81	188	319,0	36	55
75	173	186	301,6	40	52	117	271,1	*	47	208	314,6	*	54
80	173	200	253,4	35	44	125	229,8	*	40	228	179,0	*	31
85	173	222	103,2	*	18	133	102,5	*	18	249	124,4	*	22
90	173	244	100,2	*	17	142	57,5	*	10	269	136,9	*	24
95	173	266	101,0	*	17	150	36,7	*	6	289	49,6	*	9
100	173	288	23,1	*	4	158	7,9	0	1	310	42,5	*	7
105	173	310	3,7	*	1	166	10,5	*	2	330	18,7	*	3
110	173	332	53,8	*	9	175	10,7	0	2	350	19,3	*	3
115	173	354	12,7	*	2	183	4,1	0	1	371			
120	173	376				191	41,4	0	7	391	3,6	*	1
125	173	398				199				411			
130	173	420				207				432			
135	173	442				216				452			
140	173	464				224				472	18,5	*	3
145	173	487	16,4	2	3	232	33,6	1	6	493			
150						240				513			
155						248				533	2,8	0	0
160						257							
165						265							
170						273	15,7	2	3				
Total			23 351,9	3 561	3 195		75 556,4	13 580	9 460		24 102,1	3 349	3 325

Source: Eurostat calculations based on Tessier and Peyron (1998)

Figure 15: France: comparison of net present and consumption values (maritime pine, private)

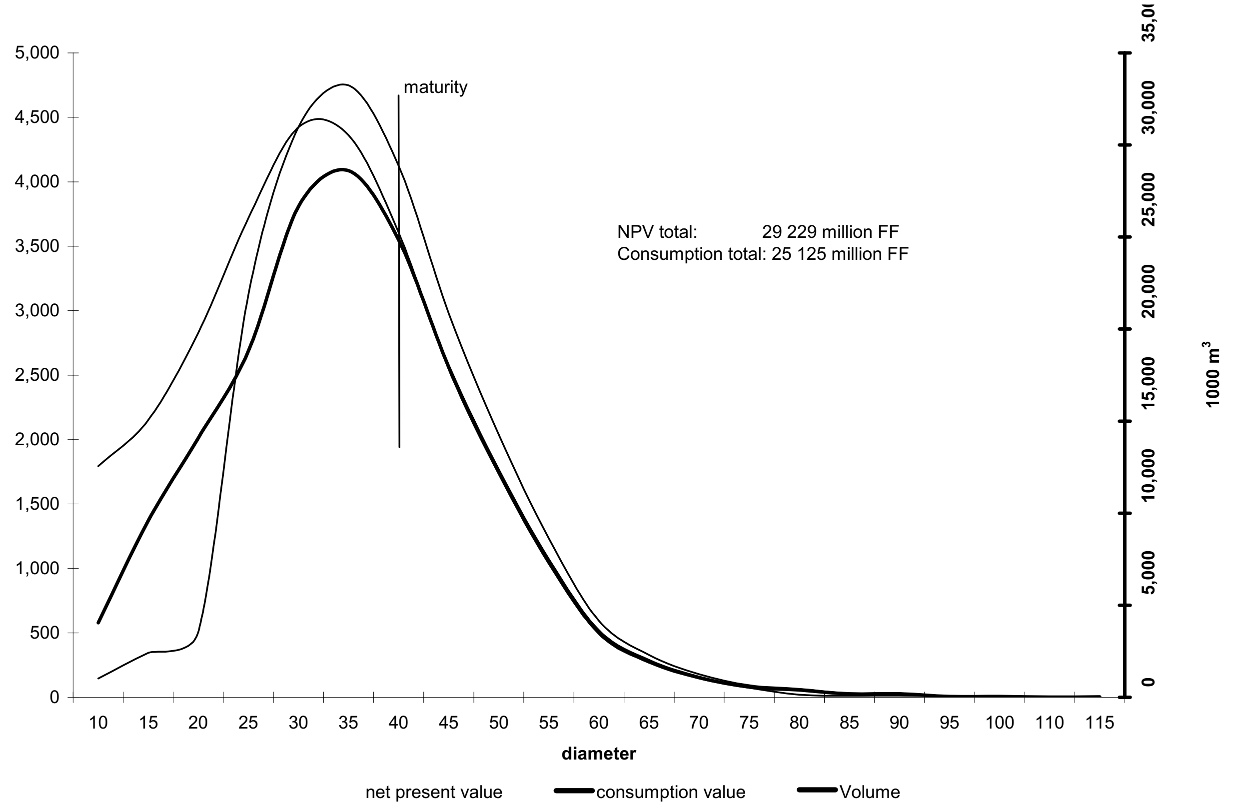


Figure 16: France: comparison of net present and consumption values (Scotch pine, private)

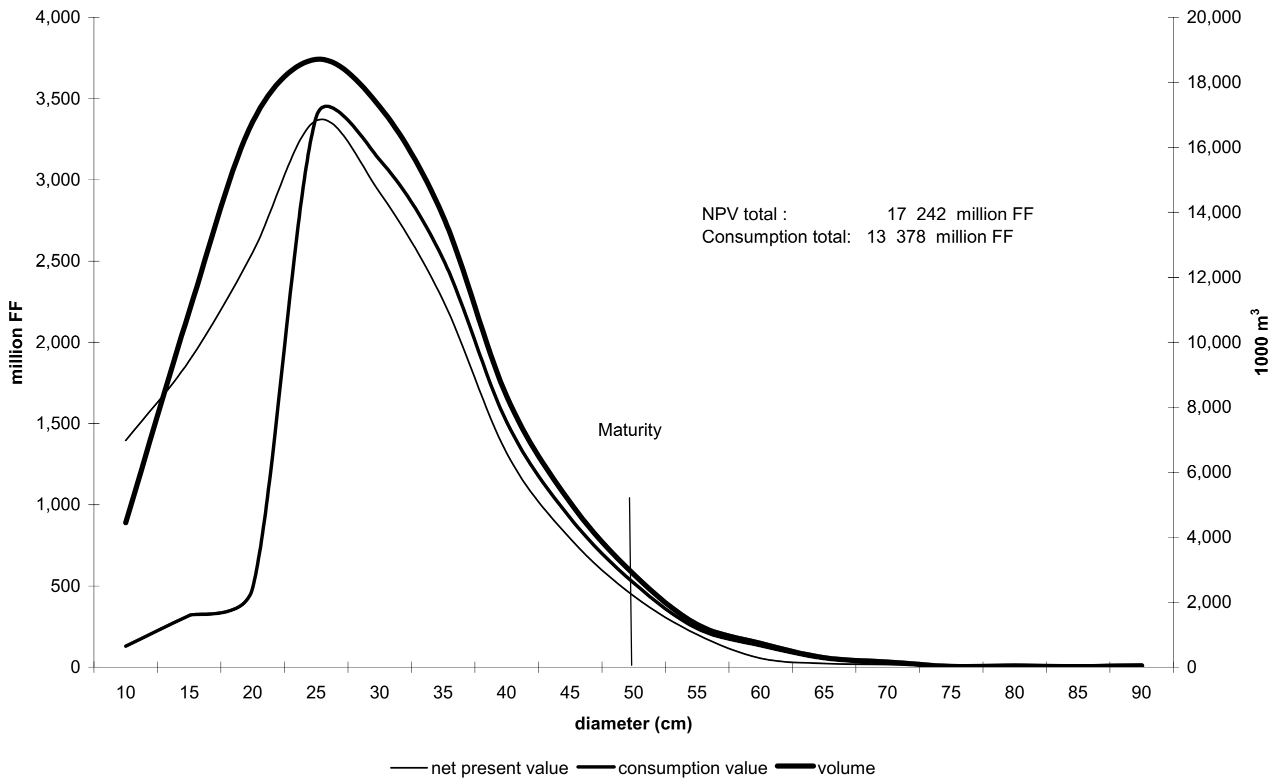


Figure 17: France: comparison of net present and consumption values (beech, private)

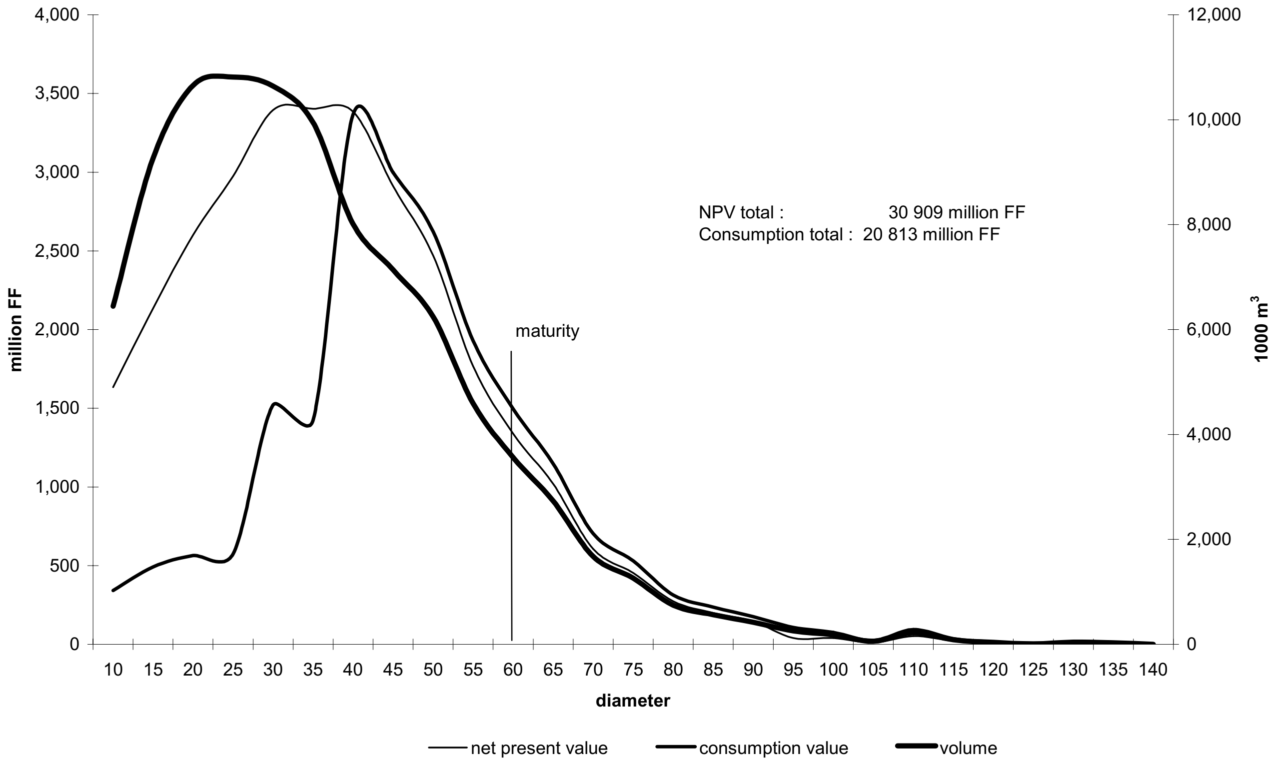


Figure 18: France: comparison of net present and consumption values (oak, private)

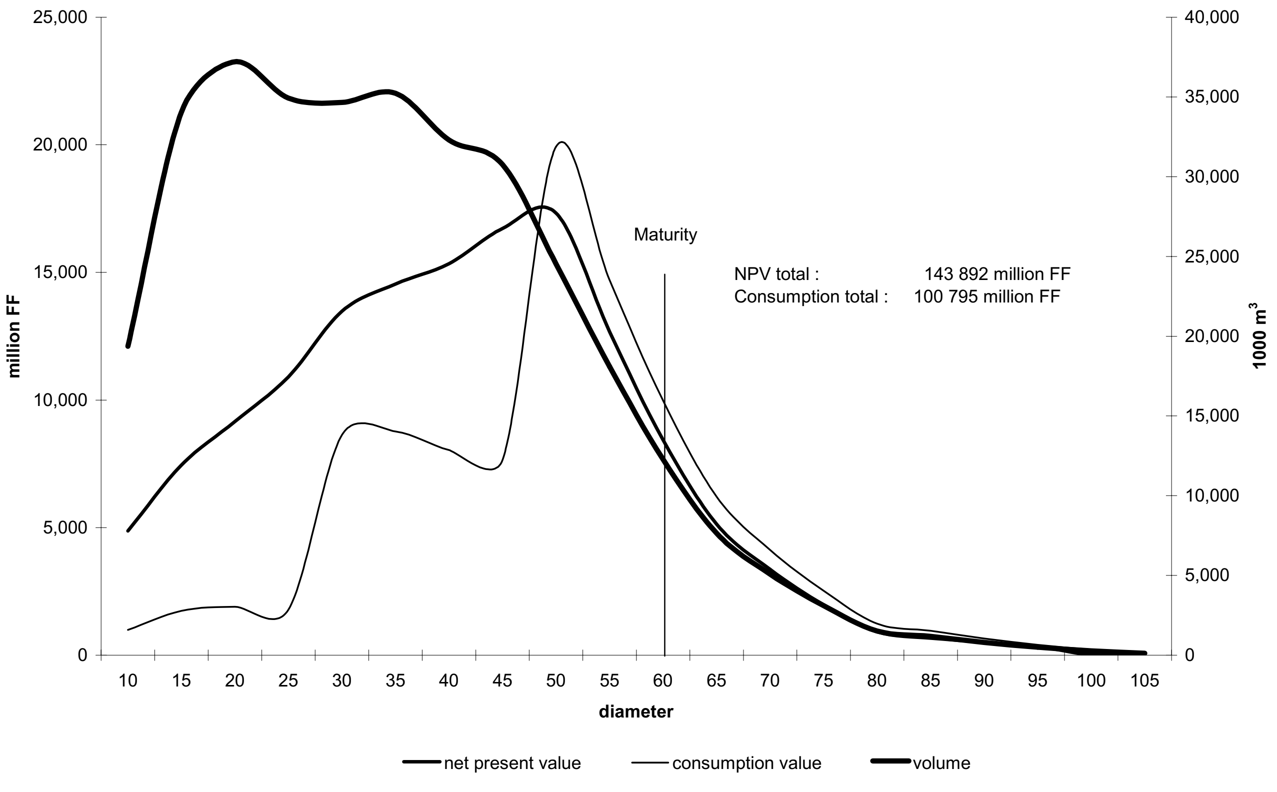


Figure 19: France: comparison of net present and consumption values (oak, public)

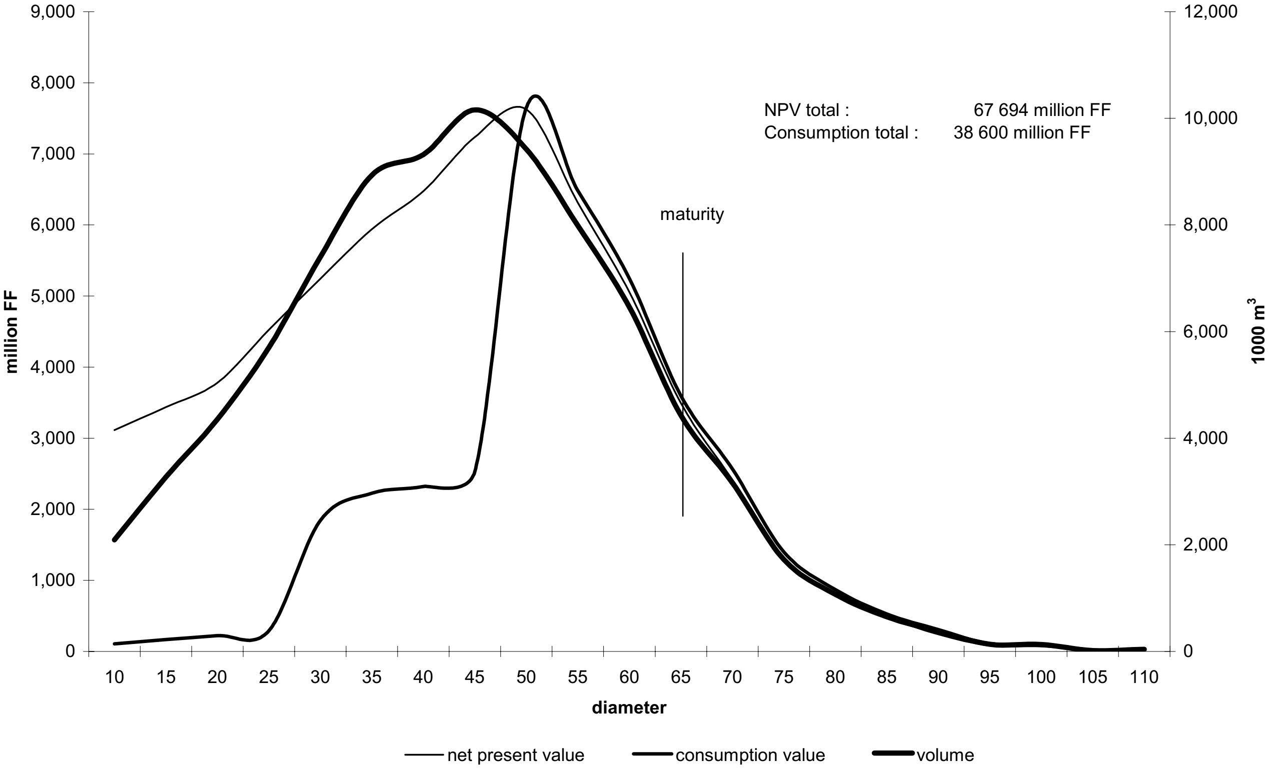
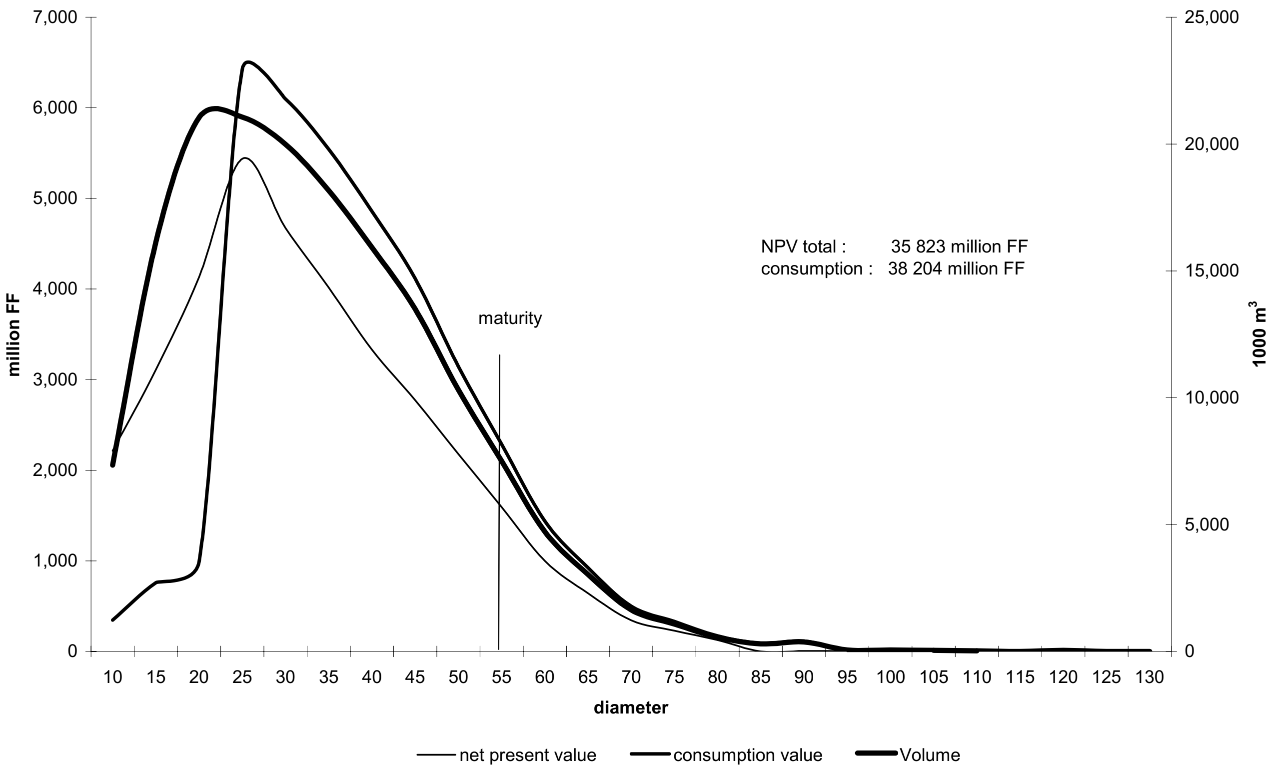


Figure 20: France: comparison of net present and consumption values (spruce and fir, private)



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Annex 4: Germany – Tables and Figures

Table 80: Germany: consumption value by age classes, by species, 1991 and 1995

1991

Oak	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	75	85	114	100	149	136	107	91	857	83,9 years
Standing volume (1000 m^3)	375	13 345	22 458	25 300	43 210	40 392	33 598	29 575	208 253	98,1 years
m^3/ha o.b.	5	157	197	253	290	297	314	325	243	
Diameter(cm)	3	16	22	28	34	39	43	50	35	
Total value (billion DM)	0	0	118	639	2 288	2 957	3 076	3 420	12 498	
value/ha	0	0	1 030	6 366	15 360	21 720	28 876	37 766	14 583	
value (DM/m^3)	0,0	0,0	5,3	25,3	53,0	73,2	91,6	115,6	60,0	
value (ECU/m^3)	0,0	0,0	2,6	12,3	25,8	35,7	44,7	56,4	29,3	
area (%)	0,088	0,099	0,133	0,117	0,174	0,159	0,125	0,106	1,000	
volume (%)	0,002	0,064	0,108	0,121	0,207	0,194	0,161	0,142	1,000	

Beech	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	375	462	444	334	303	244	203	142	2 507	67,5 years
Standing volume (1000 m^3)	3 375	58 212	101 232	102 872	112 716	98 088	84 245	53 250	613 990	90,4 years
m^3/ha o.b.	9	126	228	308	372	402	415	375	245	
Diameter(cm)	3	16	22	28	34	38	43	48	0	
Total value (billion DM)	0	51	1 027	2 047	3 339	3 746	4 169	3 242	17 621	
value/ha	0	110	2 314	6 152	11 033	15 322	20 522	22 801	7 029	
value (DM/m^3)	0,0	0,9	10,1	19,9	29,6	38,2	49,5	60,9	28,7	
value (ECU/m^3)	0,0	0,4	4,9	9,7	14,5	18,6	24,1	29,7	14,0	
area (%)	0,150	0,184	0,177	0,133	0,121	0,097	0,081	0,057	1,000	
volume (%)	0,005	0,095	0,165	0,168	0,184	0,160	0,137	0,087	1,000	

Oak + Beech	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	450	547	558	434	452	380	310	233	3 364	70,4 years
Standing volume (1000 m^3)	3 750	71 557	123 690	128 172	155 926	138 480	117 843	82 825	822 243	90,4 years
m^3/ha o.b.	8	131	222	295	345	364	380	355	244	
Diameter(cm)									0	
Total value (billion DM)	0	51	1 145	2 686	5 627	6 703	7 245	6 662	30 119	
value/ha	0	93	2 052	6 189	12 449	17 639	23 371	28 592	8 953	
value (DM/m^3)	0,0	0,7	9,3	21,0	36,1	48,4	61,5	80,4	36,6	
value (ECU/m^3)	0,0	0,3	4,5	10,2	17,6	23,6	30,0	39,2	17,9	
area (%)	0,134	0,163	0,166	0,129	0,134	0,113	0,092	0,069	1,000	
volume (%)	0,005	0,087	0,150	0,156	0,190	0,168	0,143	0,101	1,000	

Spruce	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	706	882	568	624	479	192	50	13	3 514	50,7 years
Standing volume (1000 m^3)	21 180	209 916	219 816	304 512	253 391	101 376	26 150	5 980	1 142 321	67,5 years
m^3/ha o.b.	30	238	387	488	529	528	523	460	325	
Diameter(cm)	4	16	24	30	34	39	42	45	0	
Total value (billion DM)	0	0	2 541	6 954	6 936	3 144	853	200	20 628	
value/ha	0	0	4 476	11 136	14 476	16 409	17 133	15 997	5 870	
value (DM/m^3)	0,0	0,0	11,6	22,8	27,4	31,0	32,6	33,4	18,1	
value (ECU/m^3)	0,0	0,0	5,6	11,1	13,4	15,1	15,9	16,3	8,8	
area (%)	0,201	0,251	0,162	0,178	0,136	0,055	0,014	0,004	1,000	
volume (%)	0,019	0,184	0,192	0,267	0,222	0,089	0,023	0,005	1,000	

Source: Eurostat calculations based on Englert, Küppers and Thoroe (1999)

1991 (Table 80 continued)

Pine	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	356	702	573	523	466	260	108	29	3 017	59,3 years
Standing volume (1000 m^3)	3 204	108 810	138 093	146 440	137 470	79 560	33 480	8 729	655 786	72,0 years
m^3/ha o.b.	9	155	241	280	295	306	310	301	217	
Diameter(cm)	3	15	22	27	31	34	38	42	0	
Total value (billion DM)	0	0	814	2 845	3 910	2 835	1 412	462	12 278	
value/ha	0	0	1 420	5 436	8 395	10 901	13 038	15 698	4 070	
value (DM/m^3)	0,0	0,0	5,9	19,4	28,4	35,6	42,2	52,9	18,7	
value (ECU/m^3)	0,0	0,0	2,9	9,5	13,9	17,4	20,6	25,8	9,1	
area (%)	0,118	0,233	0,190	0,173	0,154	0,086	0,036	0,010	1,000	
volume (%)	0,005	0,166	0,211	0,223	0,210	0,121	0,051	0,013	1,000	

Spruce + Pine	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	1 062	1 584	1 141	1 147	945	452	158	42	6 531	54,7 years
Standing volume (1000 m^3)	24 384	318 726	357 909	450 952	390 861	180 936	59 630	14 709	1 798 107	69,1 years
m^3/ha o.b.	23	201	314	393	414	400	377	350	275	
Diameter(cm)									0	
Total value (billion DM)	0	0	3 355	9 799	10 846	5 979	2 265	662	32 906	
value/ha	0	0	2 940	8 543	11 477	13 228	14 335	15 762	5 038	
value (DM/m^3)	0,0	0,0	9,4	21,7	27,7	33,0	38,0	45,0	18,3	
value (ECU/m^3)	0,0	0,0	4,6	10,6	13,5	16,1	18,5	22,0	8,9	
area (%)	0,163	0,243	0,175	0,176	0,145	0,069	0,024	0,006	1,000	
volume (%)	0,014	0,177	0,199	0,251	0,217	0,101	0,033	0,008	1,000	

Total	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	1 511	2 130	1 699	1 582	1 397	832	468	275	9 894	60,0 years
Standing volume (1000 m^3)	27 198	387 660	480 817	579 012	547 624	319 488	177 372	97 350	2 616 521	75,9 years
m^3/ha o.b.	18	182	283	366	392	384	379	354	265	
Diameter(cm)	3	16	23	29	33	37	42	48	0	
Total value (billion DM)	0	51	4 500	12 484	16 473	12 682	9 509	7 324	63 023	
value/ha	0	24	2 648	7 892	11 796	15 238	20 331	26 663	6 370	
value (DM/m^3)	0,0	0,1	9,4	21,6	30,1	39,7	53,6	75,3	24,0	
value (ECU/m^3)	0,0	0,1	4,6	10,5	14,7	19,4	26,2	36,7	11,7	
area (%)	0,153	0,215	0,172	0,160	0,141	0,084	0,047	0,028	1,000	
volume (%)	0,010	0,148	0,184	0,221	0,209	0,122	0,068	0,037	1,000	

1995

Oak	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	89	75	123	93	141	137	117	80	855	91,2 years
Standing volume (1000 m^3)	89	10 425	28 167	26 505	45 543	45 073	40 248	28 400	224 450	110,0 years
m^3/ha o.b.	1	139	229	285	323	329	344	355	263	
Diameter(cm)	2	14	23	29	34	40	44	50	36	
Total value (billion DM)	0	0	124	754	2 471	4 107	4 418	3 952	15 826	
value/ha	0	0	1 010	8 142	17 500	29 905	37 899	49 373	19	
value (DM/m^3)	0,0	0,0	4,4	28,4	54,3	91,1	109,8	139,2	70,5	
value (ECU/m^3)	0,0	0,0	2,4	15,2	29,0	48,7	58,7	74,4	37,7	
area (%)	0,104	0,088	0,144	0,109	0,165	0,160	0,137	0,094	1,000	
volume (%)	0,000	0,046	0,125	0,118	0,203	0,201	0,179	0,127	1,000	

Beech	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	419	427	486	343	306	253	179	89	2 502	63,9 years
Standing volume (1000 m^3)	1 257	49 959	139 968	123 137	129 132	115 621	84 309	38 181	681 564	87,0 years
m^3/ha o.b.	3	117	288	359	422	457	471	429	272	
Diameter(cm)	1	13	24	30	35	39	44	49	24	
Total value (billion DM)	0	110	1 314	2 867	5 035	6 057	5 756	3 289	24 428	
value/ha	0	258	2 703	8 368	16 435	23 896	3 228	37 061	9 763	
value (DM/m^3)	0,0	2,2	9,4	23,3	39,0	52,4	68,3	86,1	35,8	
value (ECU/m^3)	0,0	1,2	5,0	12,5	20,9	28,0	36,5	46,1	19,2	
area (%)	0,167	0,171	0,194	0,137	0,122	0,101	0,072	0,036	1,000	
volume (%)	0,002	0,073	0,205	0,181	0,189	0,170	0,124	0,056	1,000	

1995 (Table 80 continued)

Oak + Beech	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	508	502	609	436	447	390	296	169	3 357	69,4 years
Standing volume (1000 m^3)	1 346	60 384	168 135	149 642	174 675	160 694	124 557	66 581	906 014	90,8 years
m^3/ha o.b.	3	120	276	343	391	412	421	394	270	
Diameter(cm)	2	14	23	29	34	40	44	50	0	
Total value (billion DM)	0	110	1 438	3 621	7 506	10 164	10 174	7 241	40 254	
value/ha	0	219	2 361	8 305	16 792	26 062	34 372	42 846	11 991	
value (DM/m^3)	0,0	1,8	8,6	24,2	43,0	63,3	81,7	108,8	44,4	
value (ECU/m^3)	0,0	1,0	4,6	12,9	23,0	33,8	43,7	58,2	23,8	
area (%)	0,151	0,150	0,181	0,130	0,133	0,116	0,088	0,050	1,000	
volume (%)	0,001	0,067	0,186	0,165	0,193	0,177	0,137	0,073	1,000	

Spruce	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	719	848	641	591	506	172	27	2	3 506	49,7 years
Standing volume (1000 m^3)	17 256	236 592	263 451	305 547	282 348	95 116	15 012	974	1 216 296	65,6 years
m^3/ha o.b.	24	279	411	517	558	553	556	487	347	
Diameter(cm)	2	15	24	32	36	40	43	44	0	
Total value (billion DM)	0	11	6 728	16 525	17 477	6 360	1 071	57	48 229	
value/ha	0	13	10 493	27 974	34 532	36 995	38 979	34 458	14	
value (DM/m^3)	0,0	0,0	25,5	54,1	61,9	66,9	71,3	58,5	39,7	
value (ECU/m^3)	0,0	0,0	13,7	28,9	33,1	35,8	38,2	31,3	21,2	
area (%)	0,205	0,242	0,183	0,169	0,144	0,049	0,008	0,001	1,000	
volume (%)	0,014	0,195	0,217	0,251	0,232	0,078	0,012	0,001	1,000	

Pine	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	392	567	673	522	471	281	90	12	3 008	59,1 years
Standing volume (1000 m^3)	1 176	93 555	177 672	162 342	152 133	92 168	30 600	4 128	713 774	72,1 years
m^3/ha o.b.	3	165	264	311	323	328	340	344	237	
Diameter(cm)	3	13	22	29	32	35	38	42	22	
Total value (billion DM)	0	0	1 298	4 036	5 139	3 750	1 504	250	15 977	
value/ha	0	0	1 927	7 739	10 909	13 344	16 753	20 370	5 312	
value (DM/m^3)	0,0	0,0	7,3	24,9	33,8	40,7	49,2	60,6	22,4	
value (ECU/m^3)	0,0	0,0	3,9	13,3	18,1	21,8	26,3	32,4	12,0	
area (%)	0,130	0,188	0,224	0,174	0,157	0,093	0,030	0,004	1,000	
volume (%)	0,002	0,131	0,249	0,227	0,213	0,129	0,043	0,006	1,000	

Spruce + Pine	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	1 111	1 415	1 314	1 113	977	453	117	14	6 514	54,1 years
Standing volume (1000 m^3)	18 432	330 147	441 123	467 889	434 481	187 284	45 612	5 102	1 930 070	68,0 years
m^3/ha o.b.	17	233	336	420	445	413	390	364	296	
Diameter(cm)									0	
Total value (billion DM)	0	11	8 026	20 561	22 616	10 110	2 575	307	64 206	
value/ha	0	0	6	18	23	22	22	22	10	
value (DM/m^3)	0,0	0,0	18,2	43,9	52,1	54,0	56,5	60,2	33,3	
value (ECU/m^3)	0,0	0,0	9,7	23,5	27,8	28,9	30,2	32,2	17,8	
area (%)	0,171	0,217	0,202	0,171	0,150	0,070	0,018	0,002	1,000	
volume (%)	0,010	0,171	0,229	0,242	0,225	0,097	0,024	0,003	1,000	

Total	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141+	Total	Average
Area (1000 ha)	1 620	1 917	1 924	1 548	1 425	844	412	182	9 872	58,8 years
Standing volume (1000 m^3)	19 440	389 151	609 908	617 652	609 900	348 572	169 744	71 162	2 835 529	74,6 years
m^3/ha o.b.	12	203	317	399	428	413	412	391	287	
Diameter(cm)	2	14	23	30	34	38	43	49	23	
Total value (billion DM)	0	121	9 464	24 182	30 122	20 274	12 749	7 528	104 440	
value/ha	0	63	4 919	15 621	21 138	24 021	30 944	41 363	10 579	
value (DM/m^3)	0,0	0,3	15,5	39,2	49,4	58,2	75,1	105,8	36,9	
value (ECU/m^3)	0,0	0,2	8,3	20,9	26,4	31,1	40,2	56,6	19,7	
area (%)	0,164	0,194	0,195	0,157	0,144	0,085	0,042	0,018	1,000	
volume (%)	0,007	0,137	0,215	0,218	0,215	0,123	0,060	0,025	1,000	

Table 81: Germany: prices of marginal agricultural land, DM/ha

	Länder				
Year	Lower Saxony	Hesse	North Rhine Westphalia	Bavaria	Former Länder
1980	28 820	22 935	47 008	24 517	27 613
1981	29 314	21 440	48 645	29 704	28 025
1982	27 424	18 812	48 033	33 424	26 628
1983	25 974	19 416	54 393	31 660	27 241
1984	24 562	23 708	50 717	32 761	26 108
1985	24 782	22 737	51 323	34 240	25 860
1986	23 306	19 895	47 782	33 083	23 684
1987	21 248	19 110	41 339	32 604	22 346
1988	20 686	16 269	38 279	30 085	21 503
1989	21 430	19 690	38 739	32 117	22 455
1990	21 669	17 066	42 056	31 698	22 613
1991	24 358	18 453	38 871	34 038	24 358
1992	25 111	17 198	41 849	33 388	24 151
1993	24 605	15 869	43 338	35 317	23 682
1994	23 852	19 854	45 902	35 774	24 122
1995	23 055	19 860	38 918	41 495	24 581
1996	21 265	23 850	41 991	32 187	23 648
1997	23 346	21 091	44 233	30 650	24 601
1998	23 670	19 607	47 730	34 198	26 508
Average	24 156	19 847	44 634	32708	24623

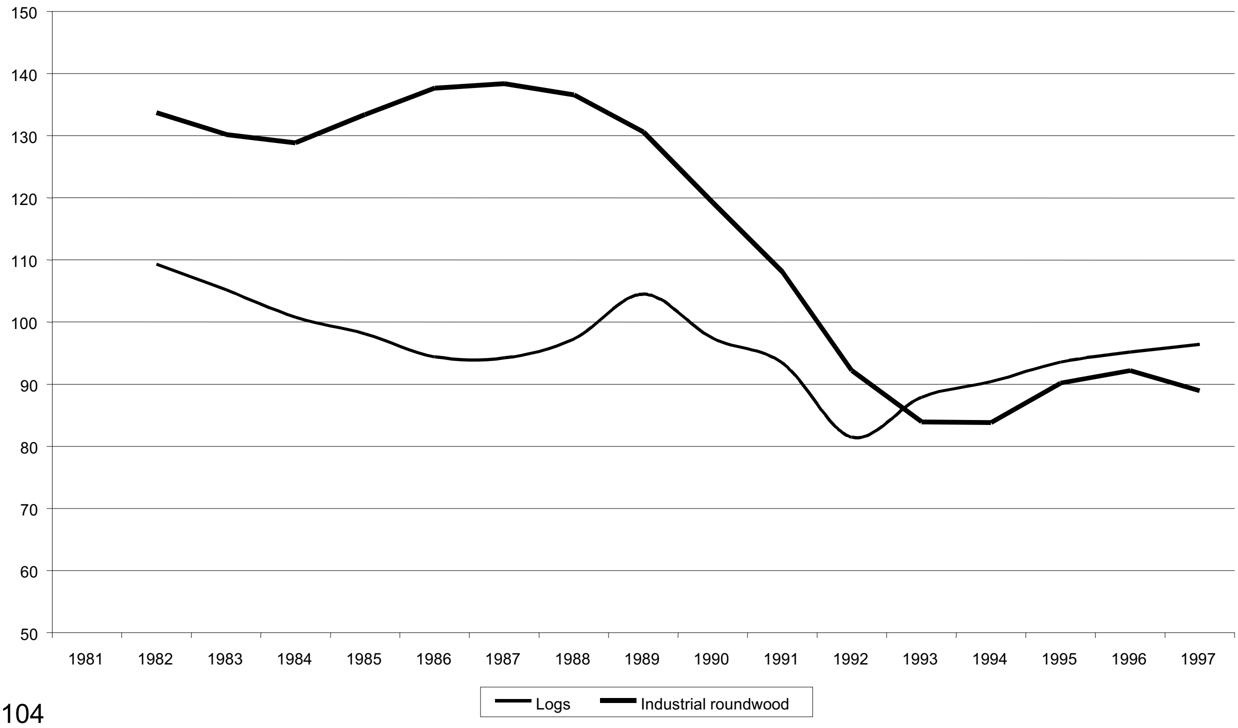
Source: Eurostat calculations based on Englert, Küppers and Thoroe (1999)

Table 82: Germany: wood prices by assortments, DM/m^3

		Assortments										
Species	**Year**	IS	IL	L1a	L1b	L2a	L2b	L3a	L3b	L4	L5	L6
Oak	1991	38	49	44	51	76	122	160	202	246	280	496
Beech	1991	31	58	44	69	83	87	82	109	121	172	202
Spruce	1991	42	61	56	59	73	78	79	79	84	84	83
Pine	1991	26	48	55	64	74	80	95	112	155	197	195
Oak	1995	35	45	40	46	69	110	177	223	291	350	620
Beech	1995	30	55	40	63	76	80	103	138	170	226	266
Spruce	1995	41	60	86	90	112	120	125	130	132	132	130
Pine	1995	30	55	56	65	75	88	108	131	167	212	210

Source: Eurostat calculations based on Englert, Küppers and Thoroe (1999)

Figure 21: Germany: Price of raw wood, 1995 = 100, 3 years moving average



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