The Analysis of Return and Its Components of Non-industrial Private Forest Ownership by Forestry Board Districts in Finland

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Lausti, A. & Penttinen, M. 1998. The analysis of return and its components of non-industrial private forest ownership by forestry board districts in Finland. Silva Fennica 32(1): 75–94.

Non-industrial private forest ownership returns and risks in Finland are both estimated and disaggregated to local Forestry Board Districts (FBD) level. Additionally, the FBD level return is divided into price change, felling and change in the growing stock components, which are compared with the inflation rate. The results are based on a complete count of the stumpage prices, silvicultural costs and state subsidies as well as the National Forest Inventory (NFI) data. The influence of taxation is discussed as well. Although this database is excellent for economic studies as well, the estimation methodology is vitiated by a host of problems, the resolution of which is the major contribution of this study.

The study period is 1972–1996. The results show that there have been fairly large differences in forest ownership returns and prices depending on the Forestry Board District. Results show that the price change component has been larger in Northern Forestry Board Districts, as much as 0.9 % above the inflation rate in Lapland FBD, than in Southern Forestry Board Districts, 1.5 % less than the inflation rate in southern Helsinki FBD. The net increase, however, has been larger in Southern Forestry Board Districts than in Northern Forestry Board Districts. Using the average net increment in Finland as a comparison base, the net increment in South Karelia exceeded it by 0.6 %, but fell below it by 1.8 % in Northeastern Finland. Finally, the return over the whole period is compared to the return on private housing and inflation in the case of North Savo. In all, the estimation methodology developed also serves as spin-off product development for the Forest Statistics Information Service (FSIS).

Keywords non-industrial private forests, return, risk, portfolio management, forestry board district, performance evaluation

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Received 3 April 1997 **Accepted** 11 February 1998

1 Introduction

1.1 Profitability and Return as Performance Measures

Profitability, a notion which has its roots in Fisher's interest theory (1930), is the best overall indicator of the performance of an enterprise (Brozik 1984). The traditional profitability studies (see e.g. Penttinen and Kinnunen 1992) have suffered from the lack of a systematic sample of book-keeping forest holdings, a network which could allow statistical inference concerning profitability and other properties of all non-industrial private forest (NIPF) holdings. As against the return studies, traditional profitability research does not enjoy any covering data.

In forest economics, the yield tables or functions provide volumes used in defining the net increment of the growing stock in timber balance estimation using the so-called increment method, in which the total drain is compared with net increment (Holopainen 1976, p. 181, Speidel 1984, p. 61). The timber balance shows up the pricing dilemma. The total drain can be priced by the actual prices (Holopainen 1976) or an average price (Speidel 1984). A recommendation for the pricing of change in the growing stock is based on an entire business cycle, term average prices, in the Finnish tradition (Holopainen 1976).

Modern portfolio theory, however, originating from the ideas of Markowitz (1952) focuses on return and risk. Recall that the concepts "return" and its volatility, or "risk", are based on market prices. Loosely speaking, the "return" refers to the expected return and the "risk" to the yearly standard deviation of the return process. The return on forest ownership is defined by dividing the sum of the value change in absolute terms caused by (i) the price change and (ii) the net increment, by the estimated value of the stand.[1)]

All these expected return and risk estimates require systematic information on the return, which is based both on the market and the wood production processes. Fortunately, the stumpage price, cost and roundwood fellings information service of the Forest Statistics Information Service (FSIS), as well as the Finnish National Forest Inventory (NFI) of the Finnish Forest Research Institute (FFRI) may well be the best available database in the world. They form without any doubt an excellent database for economic studies as well. However, when using this covering data for return and risk studies, a host of problems in estimating the results emerges. Surprisingly, the return and risk of forest ownership has not been analysed for the whole country before this study, the first results of which were presented at IUFRO 1995 (Penttinen and Lausti 1995) and documented by Penttinen et al. (1996).

1.2 The Purpose of this Study

The purpose of this study is to provide systematic return and risk results by Forestry Board District (FBD). The target is, additionally, to split the district information into price, fellings and change in the growing stock components. The split reveals the differences in price development, net increment, etc. between different areas of Finland. For this purpose, all the relevant data from NFI and the FSIS concerning non-industrial private forests are needed, and the estimation methodology has to be developed. The results form a systematic body of data for decision-making purposes.

The main contribution of the study is that (i) the *estimation methodology of non-industrial private forest (NIPF) ownership return* is developed and carefully scrutinised; (ii) *return at the forestry board level* including the disaggregation with respect to (iii) the split into *price, fellings and change in the growing stock parts*. Moreover, (iv) *the forest ownership return is compared with that of housing in the case of the largest, North Savo FBD* inspired by the tendency of forest owners to invest wood sales income in apartments for their own use or that of their children (Järveläinen 1988, p. 25, Karppinen 1985, p. 39, Karppinen and Hänninen 1987, p. 20).[2)] Note that the variation on return on forest ownership and its components in different FBDs suggests the comparison between forest owners' investment alternatives by each FBD separately. Here the comparison is documented in the largest FBD, but has been performed similarly in all FBDs. The construction of forest ownership risk and returns has not yet been provided anywhere systematically at the area level, only at the roundwood species sample level, for example, by Cubbage et al. (1989) or Thomson (1991a, 1991b). However, integrating risk and attitude toward risk into forest planning has been considered by Pukkala and Kangas (1996) among others.

2 Previous Studies

The return-risk approach to forest ownership has been studied in Penttinen et al. (1996), which also covers a selection of the most important previous work, done primarily in the US (see e.g. Zinkhan et al. 1992). One has to emphasise that the methodology for this study has been discussed in the capital asset pricing model (CAPM) publications. However, although our contribution ignores the CAPM model part of the discipline and concentrates on the correctness of the return results, the estimation procedure is that of the CAPM reference base.

The CAPM studies applied to forest ownership and their methodology have been used in constructing the estimation procedure of this study. Olsen and Terpstra (1981) estimated CAPM parameters by roundwood assortment with market data from Oregon. Cathcart and Klemperer (1988) reviewed forest investment risk studies and discussed stand level investment application.[3] Thomson (1991a) examined risk and returns on timber assets along with the financial assets of common stocks, corporate bonds, US Government bonds and treasury bills. Cubbage et al. (1989) evaluated timber risk and return 1952–1986 by using the CAPM. They analysed the performance measurement of some individual tree species in the USA, constructing forest ownership return in a such way as to include market price change and timber growth dividend. They excluded land price from the analysis, because no generally accepted series of timber land prices existed.

Binkley and Washburn (1990) evaluated timber and land risk 1956–1986 using CAPM. Washburn and Binkley (1990b) tested the informational efficiency of stumpage markets for pine sawlogs in the Southern U.S. Redmond and Cubbage (1988) evaluated timber risk for individual tree species 1951–1985 by using the CAPM. The CAPM and the income growth model in evaluating forest management investments have been compared by Wagner and Rideout (1991). The stability of the CAPM parameters has been analysed in Wagner and Rideout (1992), while risk and uncertainty in forestry have been discussed by Cathcart and Klemperer (1988).

Note that forest statistics data used in this study is also available in forest statistics yearbooks (Aarne 1994, 1995, Sevola 1996, 1997). The National Forest Inventory (NFI) has been summarised by Tomppo and Siitonen (1991). Kuusela and Salminen (1983) and Salminen's (1993) forest resource findings based on the NFI have been applied in this study. Profitability studies based on the traditional accounting approach have yielded results analysed by Hämäläinen (1973), Penttinen and Kinnunen (1992) and Simula and Keltikangas (1990), among others. The accounting-based profitability results yield a comparison opportunity with return on forest ownership result estimates.

3 Material and Methods

3.1 The National Forest Inventory (NFI) Data in the Estimation

The National Forest Inventories (NFI) have a long tradition in Finland, the measurements for the first NFI being made in 1921–1924. The sixth National Forest Inventory was carried out 1971–1976, the seventh 1977–1984 and the last one in 1986–1994. In this study, the period 1972–1996 is considered, and the results of three inventories, NFI6, NFI7 and NFI8 are utilised. There are two points of focus: (i) *volumes of roundwood assortment* and (ii) *net increment of roundwood assortment.*[4] In the three inventories there were thus three measured *growing stocks* of all six (6) roundwood types and *net increment* point estimates of three (3) tree species. These estimates were for every nineteen (19) Forestry Board Districts (FBDs).

The tree species used in this study are pine, spruce, and broadleaves. The six roundwood assortment are pine logs, spruce logs, broadleaf logs, pine, pulpwood, spruce pulpwood and broadleaf pulpwood.

Our evaluation uses the following measures in order to facilitate tackling the estimation problems separately:

Growing stock:

1a) The NFI produces *the growing stock volumes* for all roundwood assortments and, during the sixth and seventh inventory, *non-industrial private forest percentage volume estimates* for tree species. The non-industrial private forest percentage is estimated for seven different regions in Finland. It was assumed in the calculation that this percentage was the same for the corresponding FBDs. During the eighth inventory the *volume estimate* for non-industrial private forest roundwood assortment were estimated directly from physical measurements. During the sixth and seventh inventory the private forestry volume percentage had to be used to calculate volume estimates of the growing stock in *non-industrial private forest*.

1b) Between the measurements in different forest inventories, e.g. NFI 6 and NFI 7, and NFI 7 and NFI 8, linear interpolation was used in estimating the growing stock volumes by roundwood assortment.

Net increment:

2a) The National Forest Inventory produces *gross annual increment* estimates for pine, spruce and broadleaves.

2b) The gross annual increment is estimated for seven different regions not for every forest board district (FBD) separately in Finland in NFI 6 and NFI 7. Each region consisted of several FBDs. It was assumed that the gross annual increment of the region was the same in each FBD as in the corresponding aggregate region the FBD belongs to. The gross annual increment was, however, provided separately for each of the 19 FBDs in NFI 8.

2c) Linear interpolation was used in estimating between inventories NFI 6 and NFI 7, and between NFI 7 and NFI 8 respectively. However, after NFI 8 it was assumed that the *net increment* remained constant, since recent empirical measurements supports this assumption. (Forest resources of Finland... 1996).

2d) The net annual increment estimates were lagged by three years, because net increment is estimated as a mean of the five previous years' growth (Salminen 1993, p. 13). The yearly growth fluctuation caused by weather changes is ignored in the estimate. The recent NFI average gross increment estimate in 1989–1994 was 75.4 million m^3 (Forest resources of Finland... 1996) for all forests in Finland. In our study, the average net increment estimate in 1989–1994 for non-industrial private forests was 49.7 million m^3. This net increment does not include the net increment part of cutting waste, because there is no financial value in doing so.

2e) The net increment in non-industrial private forests was estimated by multiplying total net increment by the private forest *volume percentage* estimates.

Roundwood assortment:

3a) *The roundwood assortment percentages estimates* and volumes were obtained assuming that the percentages in the non-industrial private forests were the same as in all forests of the FDB. The latter were obtained from the tree species volumes using distribution information on the sawlog, pulpwood and waste wood of all owner groups estimated from all forests in the FBD. The wastewood volumes are not included in the study.

3b) The net increment of different roundwood assortments in non-industrial private forests was derived by multiplying the net increment of the tree species and roundwood type percentage estimate.

3c) Between the sixth and seventh and seventh and eighth inventories linear interpolation was used to estimate log and pulpwood net increment shares, but these shares were assumed to remain constant after the eighth inventory.[5)] The sawlog and pulpwood shares were delayed by three years.

3.2 Forest Statistics Information Service (FSIS) and Other Data in the Estimation

The FSIS data used consists of commercial roundwood fellings and stumpage price statistics.[6)]

4) The commercial roundwood fellings were subtracted from the net increment volume estimates of the roundwood type, producing each volume change in the growing stock. The fuelwood consumption estimate of 5.6 million m^3 annually consists of typically non-merchantable wood and 2.1

million m^3 of split billet (Salakari and Peltola 1995). The merchantable fuelwood is also ignored.

5) Bare land is assumed to have no value. Empirical studies have shown that the felling value exceeds the market value of the forest land in most cases (Hannelius 1988). Felling value was calculated, and no expected land value was considered realistic.
6) The costs consist of silvicultural costs and so-called forest improvement costs, and the government subsidies. These subsidies for non-industrial private forestry have in fact been deducted from the costs. The state loans with low interest rates called forest improvement loans are not included in the analysis. Since the cost component is derived only for total forest return in Finland, *the returns by FBD do not include costs.*

The organisation of 19 FBDs has currently changed. A new regional organisation for 14 Forestry Centres was established on March 1, 1996. In this study we have, however, used the old organisation of 19 FBDs up to the end of 1996.

Forest ownership returns have been compared with the inflation rate, derived from the cost-of-living index. The returns do not include taxes, but its deductive impact will be estimated and discussed. The return components of commercial fellings, the growing stock volume change and the price change are estimated.

3.3 Estimation Procedure

The stumpage price vector P of each roundwood assortment forms one basis for the *NIPF ownership return estimation process.* The second basis is the volume of growing stock $X_{y-1,a}$, while the third is the net volume increment vector after the natural losses B, also called net increment in the growing stock[7)]. The fellings vector F is needed, however, only for the return component split. It is thus cancelled out in equation (1) below. In order to be more descriptive, the return on forest ownership has been calculated for each year y, $y = 1972...1996$, separately for each Forest Board District (FBD) and also separately for each roundwood type a, $a = 1,2...6$, using the following logarithmic returns formula[8)]:

$$r_{ya} = ln\left(\frac{P_{ya}X_{y-1,a} + P_{ya}\left(B_{ya} - F_{ya}\right) + P_{ya}F_{ya}}{P_{y-1,a}X_{y-1,a}}\right) \quad (1)$$

where

a = roundwood type a

y = year y

r_{ya} = return on forest ownership of roundwood type a during year y

P_{ya} = stumpage price of roundwood type a at the end of year y

$X_{y-1,a}$ = volume of roundwood type a at the end of year $y–1$

B_{ya} = net increment of the growing stock of roundwood type a during year y

F_{ya} = commercial fellings of roundwood type a during year y

Recall that the denominator in (1) above is the felling value of roundwood type a in year $y–1$ and the nominator the value of roundwood type a in year y. All six roundwood type values have then been totalled, and a proxy of forest value obtained. The felling value proxy provides some estimate of cutting potential.

The resultant income is based on the net increment evaluated by stumpage price. Note that work incomes are excluded, because the comparison with other assets requirement means that only the contribution to the property is recognised.

The return on NIPF ownership r_y, overall six roundwood type returns is estimated from the different roundwood type returns r_{ya} using the value weights. The forest ownership return r_y is thus derived from roundwood type returns as a weighted sum.

$$r_y = \sum_{a=1}^{6} r_{ya}\left(\frac{P_{ya}X_{ya}}{\sum_{a=1}^{6} P_{ya}X_{ya}}\right) \quad (2)$$

Finally, the return on NIPF ownership in Finland R_y after cost deduction is defined by

$$R_y = r_y - \frac{C_y}{\sum_{a=1}^{6} P_{y-1,a}X_{y-1,a}} \quad (3)$$

where C_y = silvicultural and so-called forest improvement costs deducted by state subsidies during year y. These costs are derived only for non-industrial private forests in the whole of Finland, not at FBD level at all.

Recall that some studies include the value of bare land in this Formula 1 both in the nominator and the denominator (Thomson 1991a, 1991b). This is not supported by the empirical evidence of Finnish forest value studies, which suggests that the felling values of forest holdings have in most cases been higher than the actual market prices.

In this paper, the return on forest ownership has been first divided into (1) price change and (2) net increment components. The notion is based on the analytic properties of formula (1). The price component $r_{y(p)}$ is

$$r_{y(p)} = \ln\left(\frac{P_{ya}}{P_{y-1,a}}\right) \tag{4}$$

and the net increment component $r_{y(i)}$ similarly,

$$r_{y(i)} = \ln\left(1+\frac{B_{ya}}{X_{y-1,a}}\right) \qquad (5)^{9)}$$

Moreover, the net increment component $r_{y(i)}$ can be split further into fellings $r_{y(f)}$ and the volume change of the growing stock $r_{y(c)}$ components. The felling component $r_{y(f)}$ is

$$r_{y(f)} = \ln\left(1+\frac{F_{ya}}{X_{y-1,a}}\right) \tag{6}$$

and the volume change component $r_{y(c)}$, similarly

$$r_{y(c)} = \ln\left(1+\frac{\left(B_{ya}-F_{ya}\right)}{X_{y-1,a}}\right) \qquad (7)^{10)}$$

Note that the second split is not exact, but the rest can be split proportionally.[11)]

For comparison purposes, the return on private housing $R_{y(h)}$ has been estimated. Return includes price change P_y and yearly rent N_y minus yearly costs C_y. The costs include the maintenance charge and capital charge of private housing. In all, the return on private housing $R_{y(h)}$ is

$$R_{y(h)} = \ln\left(\frac{P_y+N_y-C_y}{P_{y-1}}\right) \tag{8}$$

where
R_y = return on private housing during year y
P_y = price of private housing per square metre at the end of year y
N_y = yearly rent of private housing per square metre
C_y = yearly costs of private housing per square metre.

4 Results

4.1 The Volume Estimates of Private Non-industrial Forests in Finland

The total volume of the growing stock in non-industrial private forests in Finland has increased slightly (Fig. 1). Its volume estimate was 969 million m^3 in 1972, while in the eighth National Forest Inventory in 1994 it was 1877 million m^3 (Forest resources of Finland... 1996).[12)] In this study, the volume estimate for non-industrial private forests was 1239 million m^3, 66.0 % of the total volume estimate in Finland in 1994. The total volume of the growing stock in non-industrial private forests has increased annually by 1.1 % on average during the period 1972–1996 (see Fig. 1).

It has to be emphasised that the smooth total volume increase of the growing stock (Fig. 1) hides even surprising changes in the development of the stock by roundwood assortment due to changes in commercial fellings by assortments (see p. 90 note 5). The pine log amount has continually increased in recent years (Fig. 2).

The amount of spruce logs has, however, decreased in recent years, 1994 and 1995 especially (Fig. 3).

Unlike coniferous logs, the order of magnitude in Fig. 4 is thousands instead of millions. Moreover, the volume of birch logs decreased in the 1980s (Fig. 4)

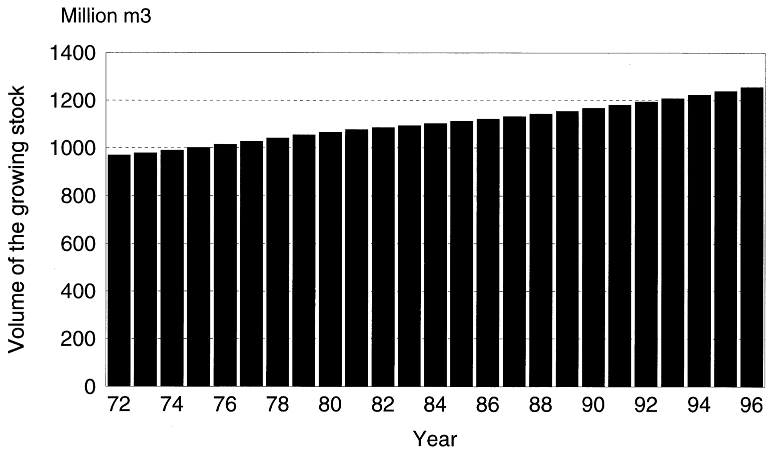

Fig. 1. Volume of the growing stock in non-industrial private forests 1972–1996.

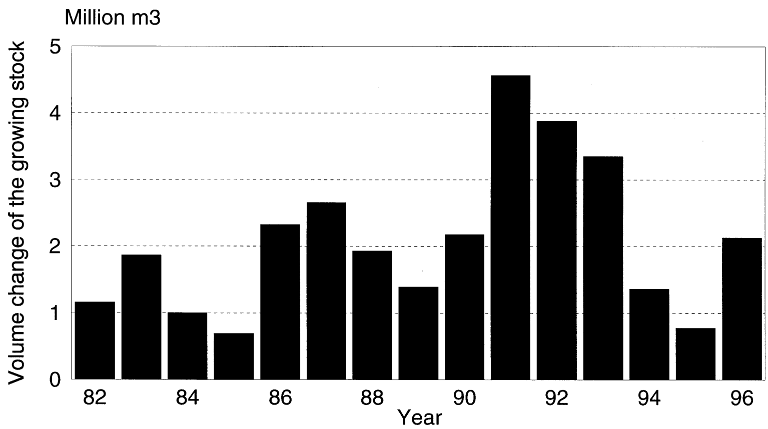

Fig. 2. Volume change in the pine log growing stock in 1982–1996.

4.2 The Value Estimates

The original nominal stumpage prices have been transformed, e.g. from 1972 to 1996 Finn marks using the cost of living index. These deflated values are subsequently called the real values. The total calculated real market value estimates of the growing stock estimated by six roundwood assortments in non-industrial private forests was 231 billion FIM in 1972 and 195 billion FIM in 1996 (Fig. 5). The highest real market value of the non-industrial private forests was 354 billion FIM 1974 during the oil crises era. The total real market value of non-industrial private forest has fluctuated greatly as Fig. 5 shows. The recession at the beginning of this decade can be seen in the forest market values as well, the real market value of non-industrial private forest estimate having fallen from 219 billion FIM (1988) to a period minimum of 137 billion FIM in 1992. Nominal market value has been calculated by multiplying each roundwood type stumpage price P_a and roundwood type volumes X_a, the numerator of formula (1) for every year. All six roundwood type market values have then been totalled. Finally, the real market values

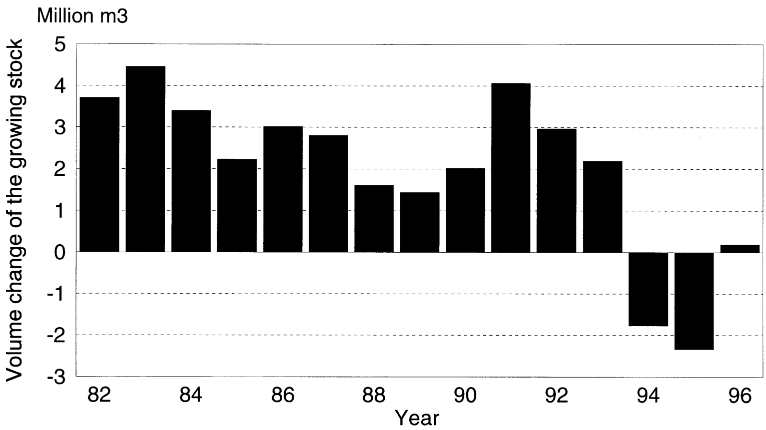

Fig. 3. Volume change in the spruce log growing stock in 1982–1996.

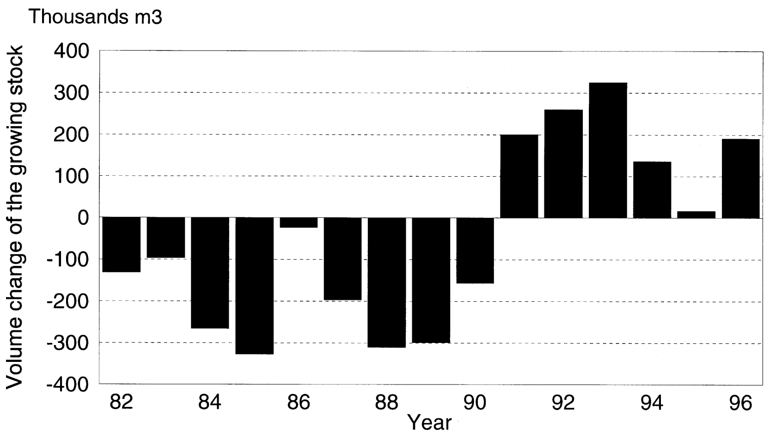

Fig. 4. Volume change in the birch log growing stock in 1982–1996.

have been derived by using the cost-of-living index as the deflator in 1996 FIM monetary value (Fig. 5).

These are the estimated values based on stumpage prices and the growing stock by roundwood assortment, but it seems that the actual market values are below these estimates. The estimated values exceeded the actual forest land sales price level by about 20 % in 1985 according to Hannelius (1988). However, if the land value appreciates or depreciates by the same amount as stumpage prices, the return result is the same. If the actual prices of forest land sales increases less than return on forest ownership, the returns would be less than those based on stumpage price and net increment series (Cubbage et al. 1989). Both the forest land sales statistics price change and the price change component of the return on forest ownership were compared. The change in the annual median (unweighted) of the forest land sales prices has been 2.6 % in 1983–1996. These sales statistics include unimproved land and forest holdings. The price change component of the return on forest

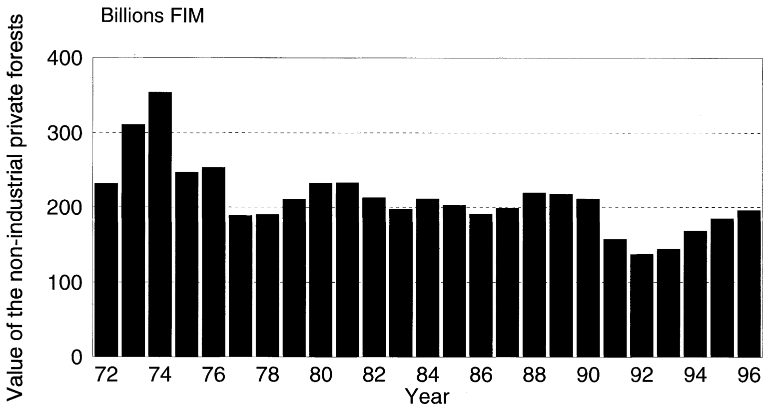

Fig. 5. Value estimate of non-industrial private forests in Finland 1972–1996 in 1996 FIM.

ownership, based on the felling value estimate has been 2.7 % during the same period.

The average value change of the growing stock in 1972–1996 was 2.8 billion FIM and average felling income 4.8 billion FIM in 1996 FIM.

4.3 Forestry Board Districts Results

All the return results were estimated by Forestry Board Districts (FBD) both for the whole period 1972–1996 and for the later period 1984–1996. The results for the whole period revealed systematic differences in the return with Helsinki FBD (district 1) at only 2.2 % after inflation of 7.0 %, and with North Karelia (district 10) at 4 % and North Ostrobothnia (district 17) at 4.2 % (Fig. 6). The nominal average return without silvicultural and forest improvement costs has been 10.4 % of the total forest property value estimate and the corresponding real return 3.4 % in Finland. The impact of the silvicultural and forest improvement costs was 0.4 %, so that the real return after these costs was 3.0 % in 1972–1996.

Note that the return on forest ownership for Åland (district 0) has been estimated as well. The commercial felling volumes have only been available from 1982 onwards. The average return on forest ownership private of non-industrial forests in Åland has been 4.8 % and the standard deviation 11.0 % during 1982–1996. The average annual return (without forest improvement costs) on forest ownership in Finland has been 6.6 % and the standard deviation 10.1 % over the same period.

An analysis of the causes requires a component split first into (i) price and net annual increment (also called net growth). The net annual increment will then be split into (ii) change in the growing stock and (iii) the fellings. Note that in the northern FDBs especially the price trend has been favourable over the whole period (Fig. 7).

The average rate of inflation is presented as a line in Fig. 7. The stumpage price change has been on average above the inflation rate only in the northern forestry board districts (16–19). In all southern board districts (1–15) the average price growth has been below the inflation rate. The lowest average price growth has been in Helsinki FBD 5.5 % and the highest in Lapland FBD 7.9 %. It seems that the lowest has been in southern FBDs, the medium in central Finland and the best in northern Finland. The average price change component (equation 4) has been 6.2 % in Finland over this period. Toppinen and Toivonen (1997) used Johansen's multivariate cointegration tests and monthly stumpage prices for 1985–1996, when analysing full market integration. Only in pine logs market the hypothesis of full market integration was accepted.

One has to emphasise that the starting price level was low in northern Finland. Moreover,

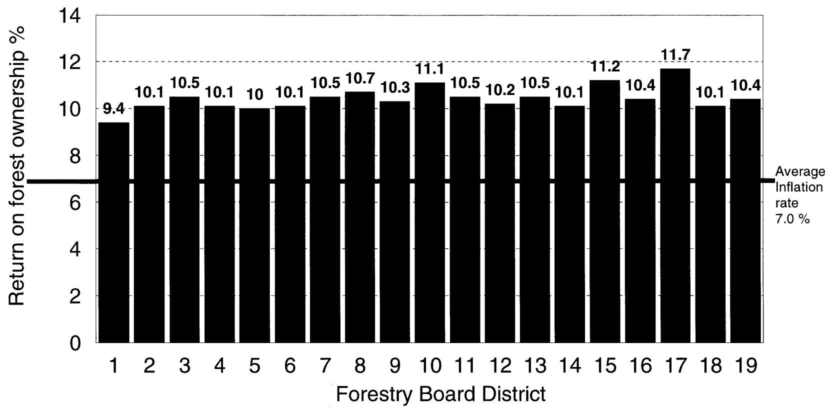

Fig. 6. Average annual returns on forest ownership in 19 Forestry board districts 1972–1996.

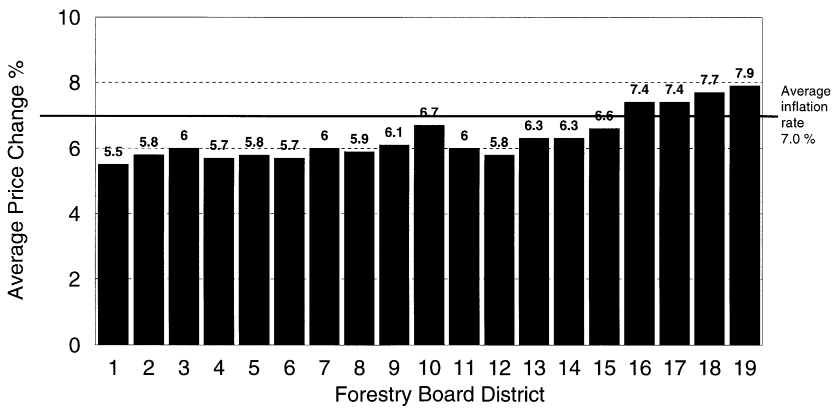

Fig. 7. Average price change component of 19 Forestry board districts in 1972–1996.

both the growing stock and the growth levels there have always been modest. In all, in spite of these favourable price change results, both the business volumes and the net profit in absolute FIM/ha have been low in the North (see Penttinen and Kinnunen 1992).

The net annual increment (equation 5) demonstrates that the net growth is related to the return on forest ownership. It has been very stable during the whole period in all FBDs, but there are substantial differences between the FBDs (Fig. 8). Net annual increment has varied quite a lot depending on natural circumstances and the structure of the forests. The net increment has been largest in South Karelia (district 8) 4.8 %, Central Ostrobothnia (district 15) 4.6 %, and Satakunta and South Savo (district 3 and district 7) 4.5 %. The smallest net increment averages have been in Northeastern Finland (district 18) 2.4 %, Lapland (district 19) 2.6 % and Kainuu (in district 16) 3.0 %. Thus the difference between largest and smallest net increment district has been 2.4 % during this 1972–1996 period. The average net increment component in Finland has been 4.2 %.

The differences in price change components between various FBDs suggests the influence of

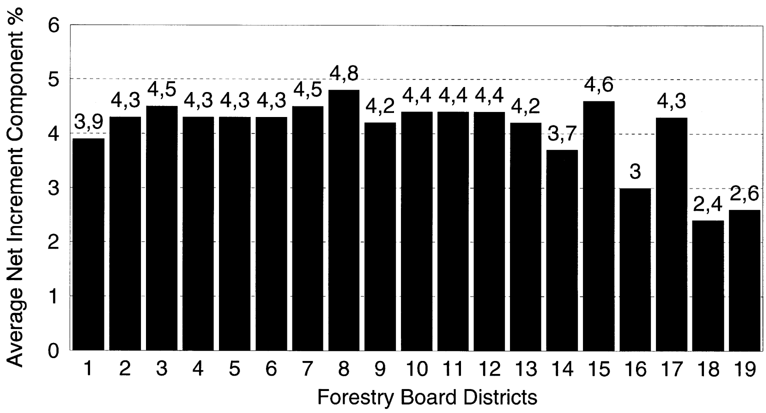

Fig. 8. Average net increment component of 19 Forestry board districts in 1972–1996.

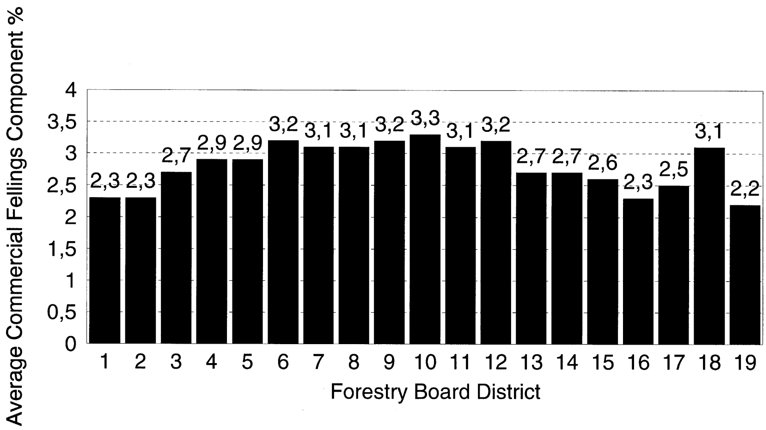

Fig. 9. Average commercial fellings component of 19 Forestry board districts in 1972–1996.

regulated markets. The forest industry and the Central Union of Agricultural Producers and Forest Owners (MTK) agreed upon stumpage prices until 1991. Moreover, the zero boundary concept in northern Finland may have had its influence on the price level until the 1970s. The exceptionally favourable development in North Karelia (FBD 10) compared with, say, Central Finland (FBD 12) may have been influenced by the forest industry investments in North Karelia, which have raised the price levels nearer to those of more central areas.

The average commercial fellings component (equation 6) in Finland has been 2.9 % of the forest market value estimate. In the Central Finland FBD 6–12 and in Northeastern Finland (district 18) the commercial fellings component has been above average. The smallest commercial fellings, 2.2 %–2.3 %, have been in Helsinki, Southwestern Finland and Lapland (districts 1, 2 and 19).

The net increment reflects the differences in the natural conditions and in the growing stock. Central and North Ostrobothnia (FBDs 15 and 17) have enjoyed the favourable impact of peatland drainage. In Häme (FBDs 4, 5 and 6) there

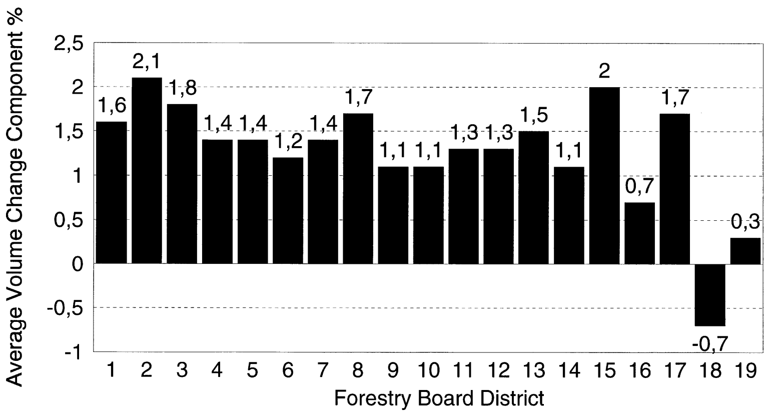

Fig. 10. Average volume change component of 19 Forestry board districts in 1972–1996.

are more old stands than in other FBDs, which may have caused a lower growth level. In South Karelia (FDB 8), the natural conditions have been favourable for forestry and the proportion of old stands less than in Häme. Moreover, South Karelia is the heart of the forest industry, which speaks for an effective wood production and relatively high prices.

The volume change component (equation 7) has been smallest, –0.7 % of the forest value estimate, in North-eastern Finland (Fig. 10). The average volume change component in Finland has been 1.3 %.

Note that the average return was 4.8 % in Åland in 1982–1996, which gives only 0.7 % after 4.1 % inflation. The average price change component has been 2.6 %, i.e. 1.5 % below inflation. The volume change component 1.0 % and the commercial fellings component was only 1.2 % in 1982–1996. It may be that the exceptionally high figures of central and North Ostrobothnia (FBD 15 and 17) reflect the impact of peatland drainage. Moreover, one may ask whether North-eastern Finland (FDB 18) has suffered from excessive fellings.

Recall that the net increment component includes both the change in the growing stock and the fellings. The net increment directly represents the numerator in the return estimate. The component split for the “low inflation” era 1984–1996 has been demonstrated in Appendices 1 and 2. The FBD deviations from the average real returns, price change and net increment in Finland over the period 1972–1996 are shown in Fig. 11.

19 FBDs in Finland are shown on the map. The relative real returns and net increment components of FBDs in Finland are also shown in Fig. 11. For example the first bar in the Helsinki FBD has been –0.9 %, which means that the real return in Helsinki FBD districts has been on average –0.9 % below the average real return on forest ownership in the whole of Finland over the period 1972–1996.

4.4 North Savo Forestry Board District as a Case Study

Finally, the case of the North Savo (district 11) will be analysed. North Savo has been the largest Forestry Board District in Finland in terms of non-industrial private forest land market values, the market value estimate of the forests in North Savo has been on average 8.7 % of all non-industrial private forests in Finland 1972–1996. The return on forest ownership in North Savo has been 10.5 %, which has been only 0.1 percentage unit above average in Finland (without the forest improvement costs). The standard deviation has been 16.1 %, which has been above the 14.8 % for all of Finland.

Next, the return on forest ownership will be compared with the return on private housing.

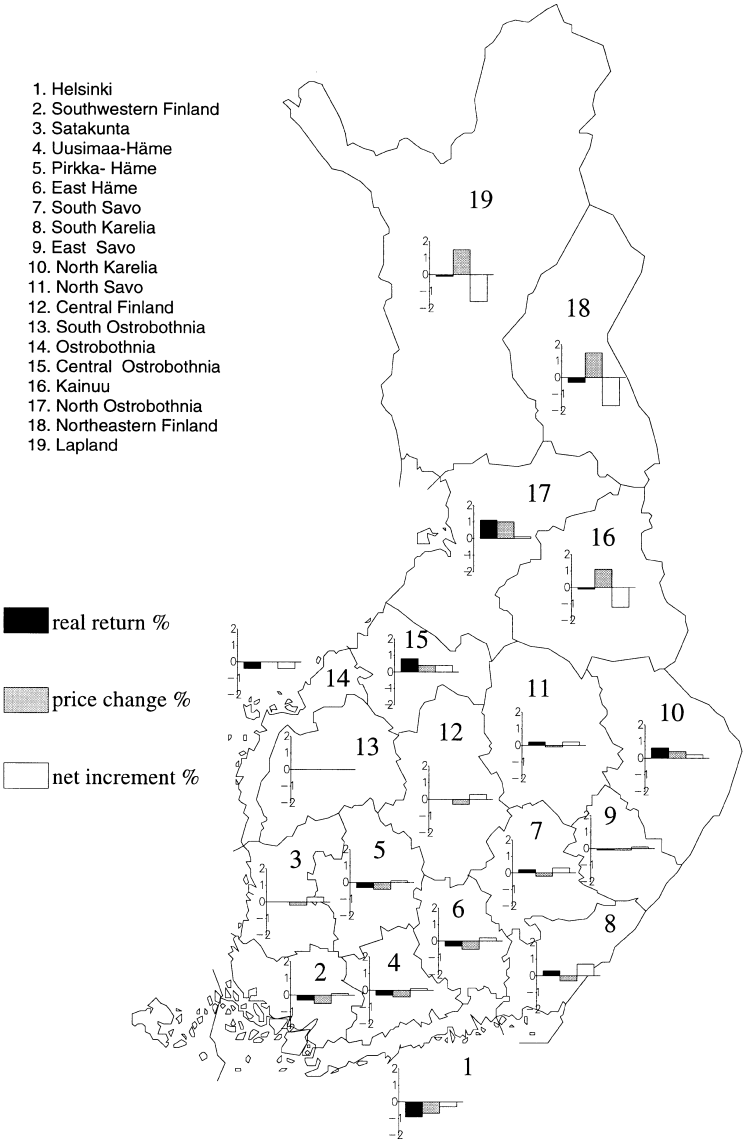

Fig. 11. Relative real return, price change and net increment components in the forestry board districts related to the corresponding national averages in Finland.

Private housing investment is good substitute for the capital of non-industrial private forest owners. Private housing return in Finland has been 10.0 %, standard deviation 12.6 %, and the inflation rate 7.0 % during this 1972–1996 period. In other words the North Savo Forestry has been almost an equally good investment in terms of return and a little riskier than private housing in Finland. Fig. 12 shows the annual returns on these asset classes.

The time series of Fig. 12 shows that the correlation between the return on forest ownership in North Savo and housing in Finland has been fairly high and the correlation coefficient has

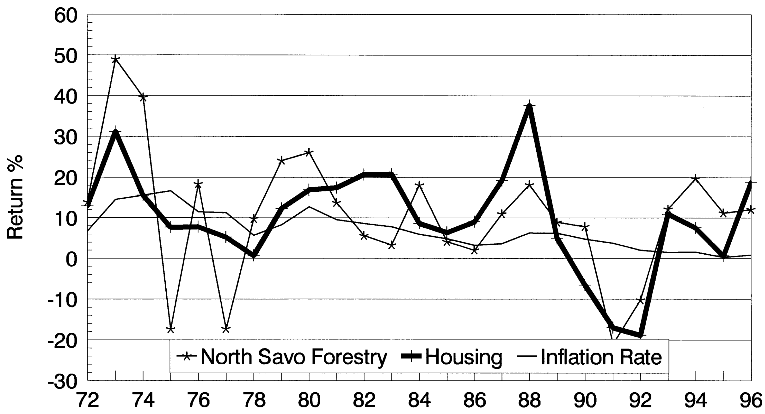

Fig. 12. Annual return on forest ownership in North Savo district and private housing in Finland 1972–1996.

been 0.60 during this 1972–1996 period. In all, the private housing investment has been competitive, depending heavily on the time of purchase. On average, however, the private housing investment has given a return on the same level as that of forestry.

4.5 Inflation and Taxation Notions

The return can vary greatly if the background variables change. First, consider the period length and location by comparing the "high" inflation era 1972–1983 and the "low" inflation era 1984–1996. During the high inflation era the nominal return on forest ownership in Finland (including forest improvement costs) has been 13.6 % and the standard deviation 17.9 % The change in nominal returns is large between these periods, because during the low inflation period the return has been 6.6 % and standard deviation 10.9 %. Most importantly, however, the real returns have been fairly close to each other during these periods. The inflation rate has been 10.7 % during the "high" inflation era and 3.5 % during the "low" inflation era. The real return on NIPF ownership has been 2.9 % and 3.1 % respectively, which shows that even dramatic changes in the inflation rate have not caused similar changes in real returns. The forestry board district results for 1984–1996 are shown in Appendices 1 and 2.

Moreover, the impact of taxation has been estimated at national level. An average 36 % tax rate among non-industrial private forest (NIPF) owners was estimated by Pesonen and Räsänen (1993). This tax effect on the return has been estimated such that the cost component C_y in equation 3 has been replaced by the estimated value taxes paid by the non-industrial forest owners.

Assuming a tax rate of 36 %, the estimated impact on the return is 0.5 %, and thus the real return on forest ownership after taxes is 2.5 % in 1972–1996 and 2.7 % in 1984–1996, respectively. For sensitivity purposes the impact of the average marginal rate is considered. If the marginal tax rate varies from 31 % to 41 %, the impact on the return correspondingly varies from 0.43 % to 0.58 % during the period 1980–1995.

5 Discussion and Conclusions

Both the agriculture and forestry have faced dramatic changes recently. The economic difficulties of farmers after EU membership put the focus on forestry as a life buoy. Moreover, all the forest laws and the environmental law have been changed. These new acts came into force on January 1, 1997. The economic interest of the non-industrial private forest (NIPF) owners and the ecological interest of both society and owners involve complicated evaluation problems.

Profitability studies have been published for years; however, the lack of a statistically representative sample of book-keeping forest holdings limits the opportunity to generalise the results. This key deficiency has been tackled in this return and risk study, the results of which are based on the stumpage price, cost and commercial fellings data of the Forest Statistics Information Service (FSIS/FFRI) as well as the volume data of the National Forest Inventory (NFI/FFRI). These data services have a long tradition and are a database even for international comparison. Our recent studies show that the return on forest NIPF ownership emerges as spin-off products for which the original data collection was not intended. In all, the results provide a systematic basis for economic consideration of NIPF owners, forest politicians and other interest groups.

In spite of the covering database, estimating the return and risk on forest ownership of NIPF produces a host of problems such as the split in the net increment and growing stock both between different owner groups and between logs and pulpwood. Moreover, both the FSIS and the NFI have data deficiencies especially in the 1970s and before. The development of the estimation methodology as well as tackling the numerous problems arising from the data deficiencies are the main contributions of this study.

The study covers the 25 years 1972–1996. The period includes several business cycles and even one or two severe recessions. The study consists of several tasks: (i) the analysis and conceptual study of the available data base, (ii) the development of the estimation methodology, and (iii) the production of both the aggregated results for Finland and disaggregation by Forest Board Districts as well as (iv) splitting the return on each FBD into price change, felling and the net change in growing stock components.

It turned out that the real return has been favourable in the north, being 4.7 % in North Ostrobothnia but only 2.4 % in the Helsinki Forestry Board District (FBD). The price development has been systematically favourable in the north, being 0.9 % above inflation in Lapland FBD, but 1.5 % below inflation in Helsinki FBD. This is due to the low starting price level in northern Finland. Note that both the growing stock and the growth levels there have always been modest. In spite of the favourable price change both the business volumes and profitability have been modest in the North (see Penttinen and Kinnunen 1992). After price change component elimination, the remaining average net increment was 4.8 % in South Karelia and 4.6 % in Central Ostrobothnia FBD, but only 2.4 % in North-eastern Finland and 2.6 % in Lapland FBD. Fellings changed greatly causing 3.3 % impact in North Karelia, but only 2.2 % in Helsinki, South-western Finland, and Lapland FBDs. The average volume change after fellings caused as much as 2.1 % contribution in South-western Finland but decrease with –0.7 % impact in North-eastern Finland FBDs. Summary results show the log volume development by tree species, which exhibited a decrease in spruce logs in 1994 and more so in 1995. Moreover, the total value of forests was 195 billion in 1996 but only 137 billion in 1992 both in the 1996 FIM currency based on the heavy price fluctuation during the recession.

As a special case the return on the biggest FBD, North Savo, has been compared with inflation and of private housing return. It turned out that the level of return was the same, but the point of time of roundwood sales and an apartment purchase were quite essential. The results of the “low” inflation era 1984–1996 are compared with those of the original 1972–1996 period in the sensitivity section.

The real return on NIPF ownership was 3.4 % in Finland in 1972–1996 and, after the 0.4 % impact of the silvicultural and forest improvement costs, 3.0 %. Moreover, the influence of taxation is estimated as being 0.5 %, making the average after-tax return on forest investments in Finland 2.5 %. During the low inflation era of 1984–1996 the real forestry return has been 3.5 %, and 3.1 % after the 0.4 % impact of silvicultural and forest improvement costs. Finally, after the 0.5 % taxation estimate, the real return in 1984–1996 was 2.6 %.

Recall that profitability studies have provided a comparison basis. Hämäläinen (1973) found a profit contributing 6–7 % of delivery sale revenue to forest holding. Penttinen and Kinnunen (1972) estimate a 2.8 % rate of return on forest holdings with the data of jointly-owned forests.

Simula (1994) results even a 5 to 5.5 % rate of return with the data of bookkeeping farms.

The split in the return is beneficial in many ways, not only in analysing factors contributing to the "ex post" economic result, but also in evaluating the "ex ante" influence of various changes and new features of the today's turbulent forestry world. The return split shows, the variation in return components in different parts of Finland.These findings provide results covering return and risk on forest ownership of non-industrial private forests (NIPF), and provide much background information for price, fellings, change of the growing stock and forest improvement considerations. Another advantage is that the price change component can be compared with inflation. Moreover, if today's roundwood price negotiations resulted in a recommendation of, say, a 10 % price decrease, its impact on NIPF owner returns could be assessed immediately. In the same way, supposing that environmental requirements or pollution decreased the net increment by 5 %, its impact could also be evaluated easily.

The correlation between each component and with the forest value, as well as the sensitivity of results with respect to input data and the estimation procedure would be challenges for further research.

The modifications in the calculation of forest value and their relation to greatest cutting potential estimate and the results linking, say, cutting value and market price of a forest holding is a particularly challenging research topic as such.

Acknowledgements

The empirical data of the National Forest Inventory (NFI) and Forest Statistics Information Service (FSIS) generously provided by the Finnish Forest Research Institute was the basis of this study. This financial support from the Ministry of Agriculture and Forestry made this study, part of the Return, risk and competitiveness of non-industrial private forestry project possible. The Helsinki School of Economics and Business Administration has also supported this study. The support is gratefully acknowledged. Many of the NFI and FSIS experts have continuously supported the research, of whom Mr. Sakari Salminen, M.Sc., and Mr. Eero Mikkola, M.Sc., especially have sacrificed their time. Prof. Vesa Puttonen has made many helpful comments. Prof. Kullervo Kuusela has generously helped with the concepts related to NFI. The authors are grateful to the two referees, who made detailed criticism and suggested many essential improvements. We also thank Dr. R. McConchie, who corrected the English.

Notes to the Text

1 The market return for stocks represents the stock price appreciation return plus dividends. A similar construct may be derived for the forest ownership. Stands of timber may not simply appreciate or depreciate in price (like a stock), but also offer value appreciation each year because of biological growth, just as a firm issues dividends each year. Thus a measure of a timber stand's actual return is the sum of the stumpage price change plus net increment of the standing timber. This total amount would reflect the total returns on forest ownership (see Cubbage et al. 1989).

2 The timber revenues were mainly used for personal consumption; the agricultural, forest and building, etc. investment in the holding; taxes, loans and savings. However, the "outside" investments typically meant buying a residence. Average figures suggest that 5 %–29 % of the forest owners in different groups used timber sales income for that purpose (Järveläinen 1988); 13 % (Karppinen 1985); 8 % (Karppinen and Hänninen 1987).

3 Risk inclusion originated from the pioneering work of Markowitz (1952) on portfolio management. Since then portfolio management and its developments have been extensively studied, and its applications to forestry have been collected in Zihkhan (1992).

4 In order to provide net increment volume estimates natural losses were subtracted from gross increment volumes (for the terminology of the United Nations, see Forest resources of the... 1992, p. 67).

5 The sawlog proportion of industry purchases fluctuates according to the market situation. This fluctuation cannot be measured properly between the inventories and is therefore ignored.

6 Annual commercial fellings in the study are taken from Table 5.13.B 'Commercial roundwood production in non-industrial private forests' of the Statistical Yearbook of Forestry 1996 (Sevola 1996, p. 167). The information is equally available from the electronic version of Forest Statistics Information Service (FSIS).

7 Note that the wastewood is not included in any of the items.

8 Washburn and Binkley (1990b) used first differences of the natural logarithm when calculating rates of change in stumpage price, stock market value and inflation. As well, for example Liljeblom et al. (1997) used average monthly natural logarithmic returns when calculating stock market returns.

9 Consider formula (1) in the form in which the fellings are ignored. Denote for a while $P_{y-1,a}$ by p and $X_{y-1,a}$ by x, and correspondingly $P_{y,a} - P_{y-1,a}$ by Δp and $X_{y,a} - X_{y-1,a} = B_{y,a}$ by Δx. Using the above notations one obtains from (1)

$$\ln (1 + \Delta p/p + \Delta x/x + (\Delta p/p)(\Delta x/x))$$
$$= \ln (1 + \Delta p/p) \ln(1 + \Delta x/x),$$

which gives (4) and (5).

10 Moreover, consider formula (5). Denote for a while $F_{y,a} / X_{y-1,a}$ by Δf and $(B_{y,a} - F_{y.a}) / X_{y-1,a}$ by Δc. Dividing (5) by $\ln((1 + \Delta f/x)(1 + \Delta c/x)$ formulas (6) and (7) result, but the correction term

$$\delta(\Delta f/x, \Delta c/x)$$
$$= \ln (1 - ((\Delta f/x)(\Delta c/x))/((1 + \Delta f/x)(1 + \Delta c/x)))$$

remains. With the whole net increment being of the order of 0.04, the error term causes not more than 1/100 deviation from the true sum $r_{y(I)}$, as noted when adding components $r_{y(f)}$ and $r_{y(c)}$.

11 Recall the correction term $\delta(\Delta f/x, \Delta c/x)$. Note that $\delta(0,\Delta x/x) = \delta(\Delta x/x,0) = 0$. Moreover, consider $\delta(.,.)$ as the series expansion

$$\delta(\Delta f/x, \Delta c/x)$$
$$= -(\Delta f/x)(\Delta c/x)/\{(1 + \Delta f/x)(1 + \Delta c/x)\} + \dots .$$

Note that higher terms are of order

$$o\{(\Delta f/x)^2\}\ o\{(\Delta c/x)^2\} \leq o\{(\Delta x/x)^4\}$$

and are out of numerical visibility, because the relative net increase $\Delta x/x < 0.05$ and $\Delta f/x$, $\Delta c/x \leq \Delta x/x$. In all, $\delta(.,.)$ is a function of the felling share

$$\lambda = \Delta f/\Delta x = \Delta f/B_{y,a},\ \delta(\Delta f/x, \Delta c/x)$$
$$= -\lambda(1 - \lambda)(\Delta x/x)^2/\{(1 + \lambda\ \Delta x/x)$$
$$(1 + (1 - \lambda)\ \Delta x/x)\}.$$

Denote the share of the correction term $\delta(\Delta f/x, \Delta c/x)$ dedicated to felling component by $\rho(\lambda)$. Note that $\rho(0) = 0$ and $\rho(1) = 1$. Assume that $\rho(1/2) = 1/2$. Consider a polynomial of lowest possible degree that takes these values. The three points generate of quadratic function, which actually reduces to $\rho(\lambda) = \lambda$, and the split problem is solved in detail.

12 Non-coniferous, 60 million m^3, not included

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Appendix 1. Returns, standard deviations, price change components, volume change components, commercial fellings components and net increase components of 19 Forestry Board Districts in Finland 1972–1996.

	Return	Standard deviation	Price change component	Volume change	Commercial fellings	Net increment
1. Helsinki	9.4 %	14.4 %	5.5 %	1.6 %	2.3 %	3.9 %
2. Southwestern Finland	10.0 %	13.8 %	5.7 %	2.1 %	2.3 %	4.3 %
3. Satakunta	10.4 %	14.8 %	5.9 %	1.8 %	2.7 %	4.5 %
4. Uusimaa-Häme	10.1 %	13.7 %	5.8 %	1.4 %	2.9 %	4.3 %
5. Pirkka-Häme	10.1 %	14.0 %	5.8 %	1.4 %	2.9 %	4.3 %
6. East Häme	10.1 %	13.8 %	5.7 %	1.2 %	3.2 %	4.3 %
7. South Savo	10.5 %	15.5 %	6.0 %	1.4 %	3.1 %	4.5 %
8. South Karelia	10.7 %	15.2 %	5.8 %	1.7 %	3.1 %	4.8 %
9. East Savo	10.3 %	16.3 %	6.0 %	1.1 %	3.2 %	4.2 %
10. North Karelia	11.0 %	16.9 %	6.6 %	1.1 %	3.3 %	4.4 %
11. North Savo	10.5 %	16.1 %	6.1 %	1.3 %	3.1 %	4.4 %
12. Central Finland	10.3 %	14.9 %	5.9 %	1.3 %	3.2 %	4.4 %
13. South Ostrobothnia	10.4 %	15.6 %	6.2 %	1.5 %	2.7 %	4.2 %
14. Ostrobothnia	9.9 %	15.3 %	6.2 %	1.1 %	2.7 %	3.7 %
15. Central Ostrobothnia	11.2 %	16.9 %	6.6 %	2.0 %	2.6 %	4.6 %
16. Kainuu	10.3 %	16.4 %	7.3 %	0.7 %	2.3 %	3.0 %
17. North Ostrobothnia	11.5 %	17.6 %	7.2 %	1.7 %	2.5 %	4.3 %
18. Northeastern Finland	10.1 %	17.2 %	7.7 %	–0.7 %	3.1 %	2.4 %
19. Lapland	10.3 %	18.7 %	7.7 %	0.3 %	2.2 %	2.6 %

Appendix 2. Returns, standard deviations, price change components, volume change components, commercial fellings components and net increase components of 20 Forestry Board Districts in Finland 1984–1996.

	Return	Standard deviation	Price change component	Volume change	Commercial fellings	Net increment
0. Åland	4.4 %	7.7 %	1.8 %	0.7 %	2.0 %	2.6 %
1. Helsinki	6.3 %	12.1 %	2.6 %	1.4 %	2.3 %	3.7 %
2. Southwestern Finland	6.8 %	11.3 %	2.7 %	2.0 %	2.2 %	4.2 %
3. Satakunta	6.9 %	11.5 %	2.8 %	1.5 %	2.7 %	4.2 %
4. Uusimaa-Häme	7.1 %	10.7 %	3.0 %	0.9 %	3.3 %	4.2 %
5. Pirkka-Häme	7.0 %	10.6 %	2.8 %	1.0 %	3.2 %	4.2 %
6. East Häme	7.1 %	10.8 %	2.9 %	0.7 %	3.5 %	4.2 %
7. South Savo	7.5 %	11.1 %	2.9 %	1.1 %	3.5 %	4.5 %
8. South Karelia	7.7 %	10.6 %	2.8 %	1.5 %	3.5 %	5.0 %
9. East Savo	6.9 %	11.8 %	2.7 %	0.4 %	3.7 %	4.2 %
10. North Karelia	7.4 %	11.5 %	2.8 %	1.0 %	3.6 %	4.6 %
11. North Savo	7.2 %	11.6 %	3.0 %	0.9 %	3.4 %	4.3 %
12. Central Finland	7.3 %	11.2 %	2.9 %	0.7 %	3.7 %	4.4 %
13. South Ostrobothnia	6.7 %	10.9 %	2.6 %	1.3 %	2.8 %	4.1 %
14. Ostrobothnia	6.5 %	12.2 %	2.7 %	1.0 %	2.8 %	3.8 %
15. Central Ostrobothnia	7.3 %	11.6 %	3.0 %	1.7 %	2.6 %	4.2 %
16. Kainuu	6.5 %	13.3 %	3.2 %	0.8 %	2.6 %	3.3 %
17. North Ostrobothnia	7.2 %	12.4 %	3.1 %	1.6 %	2.6 %	4.1 %
18. Northeastern Finland	5.7 %	12.6 %	3.0 %	–0.2 %	2.9 %	2.7 %
19. Lapland	6.6 %	16.2 %	3.9 %	0.6 %	2.1 %	2.7 %