Dissertationes Forestales 43

Portfolio management and the competitiveness of forest ownership

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Academic dissertation

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ABSTRACT

Few forms of production can compete with forestry regarding the amount of conflicting theories, paradigms, beliefs, passions and interests that have been engendered. This is also true for forest economics, where forest rent theory and land rent theory have been accompanied with interest theory to produce various foundations for profitability calculations. Many researchers and practitioners assume a steady-state economy, but most rely on the deterministic world in their modelling. However, risk inclusion has recently attained a dominant position in the investment analyses. The purpose of this study has been to develop novel solutions and constructions for return on forest ownership, and to apply new approaches to the profitability of forestry and the assessment of competitiveness of non-industrial forest ownership.

First, financial and cost accounting has been developed for non-industrial private forestry (NIPF), implementing the solutions for a test enterprise. Financial accounting will also be developed for both the net profit of the enterprise and the calculated profit of the property applying extensive, balance and intensive strategies. The requirements of the International Financial Reporting Standards (IFRS) were researched and implemented in the forestry accounting of agricultural profitability book-keeping farms and the EconomyDoctor service of the MTT Agrifood Research Finland..

Secondly, returns on stocks, debentures, offices, bonds and housing were estimated in addition to the return on forest ownership estimates, showing that NIPF ownership was not as competitive as expected, with a statistically significant correlation with private housing and the market portfolio. The return on NIPF ownership was divided into price change, felling, cost and change in growing stock components, the first of which was compared with the inflation rate.

Finally, optimal harvesting age solutions and numerical results recognising price drift, price and growth volatility, volume growth, value growth and stand establishment costs, as well as thinning benefits, were provided by proxying the stumpage price and volume growth processes by geometric Brownian motions. Moreover, comparative static and sensitivity solutions, including numerical results, showed the impact of the discount rate, price drift, and price and growth volatilities on optimal harvesting age.

In all, solutions have been implemented in the METINFO Internet service and tested for the farm accountancy data network (FADN) of the EU. Moreover, developed optimal rotation programs can be incorporated into forest management planning software products such as MOTTI and MELA, which are widely used in Finland.

Keywords: modern portfolio theory, accounting, profitability of forestry, return on forest ownership, return components of forest ownership, optimal timber harvesting age

ACKNOWLEDGEMENTS

This dissertation summarises the results of the Finnish Forest Research Institute (FFRI) projects 3009 The Profitability of Forestry 1989-1996, 3189 The Forest Owner's Business Economic Decision-making 1997-2001, and 3337 The Competitiveness of the Forestry and Woodworking Industries 2002-2006. The project research work is based on external financing from the Ministry of Agriculture and Forestry, the Academy of Finland, Metsämiesten Säätiö [The Forest-Men Foundation], the Research Foundation of OP Bank Group, the Jenny and Antti Wihuri Foundation, the Foundation for Economic Education, and the Finnish Society of Forest Science. This support has enabled the productive work and activities of the research group to be carried out.

The bottleneck in this research has been the availability of empirical evidence. The leader of the Forestry Centre Lapland, Jukka Ylimartimo, proposed that jointly-owned forests (JOFs) of Lapland could be investigated, an initiative which activated research into the profitability of forestry resulting in several publications (e.g., Penttinen 1992, Penttinen and Kinnunen 1992). Many JOFs have supplied not only annual reports but also their forest management plans, which have allowed analyses of forest management planning procedures. Comprehensive co-operation with the University of Joensuu was established at the same time (cf. Hyttinen 1995, Hyttinen et al. 1994, 1996). Moreover, some book-keeping farms of the agricultural profitability network have also provided their forest management plans for research purposes via the Economics Department of Agrifood Research Finland, which has contributed the forestry accounting and forest property evaluation studies (e.g., Penttinen et al. 2004, Latukka et al. 2005). Several forest management associations have supplied cost information. The Forest Statistics Information Service (FSIS) and the National Forest Inventory (NFI) of the FFRI have provided all the relevant empirical evidence, which has enabled not only publications, but also constructive product development (e.g., Lausti and Penttinen 1997, 1998a, 1998b, Penttinen and Lausti 2004). Empirical evidence concerning apartments, stocks, bonds, debentures, offices, inflation, etc. have been obtained for analysis from Statistics Finland, the Helsinki Stock Exchange, Sampo Bank, the Institute for Real Estate Economics (see Lausti and Penttinen 1997, 1998a, 1998b, 2007, Penttinen and Lausti 1995, 1996, 1999, 2002, 2004).

The scholarly support of Professor Olli Saastamoinen is gratefully acknowledged. Stimulating discussions with and the teaching of Professor Matti Keltikangas from University of Helsinki have inspired the research during all these projects. The constructive criticism and support of Professor Vesa Puttonen from the Helsinki School of Economics has been crucial in the publishing process. Some of the papers are results of co-operation with Professor Lars Lönnstedt at the Swedish University of Agricultural Sciences (e.g., Hyder et al. 1994, 1997, 1999), which has provided new ideas and a Scandinavian perspective. Professor Timo Pukkala, Teppo Martikainen, Matti Keloharju and Markku Kallio have commented on the research papers. The criticism of both Esko Mäkeläinen, Senior Adviser at Stora Enso, and Henrik Nieminen, Finance Director of Tornator, corrected industry related concepts and inspired the argument (e.g. Penttinen 2004).

Antrei Lausti, M.Sc (econ.), has done the programming and data processing of risk/return studies and has been co-author of several papers on competitive studies (e.g., Lausti and Penttinen 1998a, 1998b, Penttinen and Lausti 1995, 1996, 1999, 2002, 2004). My colleagues, Jukka Aarnio, M.Sc (for.) and Esa Uotila, M.Sc (for.) have contributed as co-authors of several papers (e.g., Penttinen et al. 1995; Penttinen and Uotila 1996; Penttinen et al. 2001) and have brought the view of non-industrial private forestry practice

to the research process (e.g. Penttinen 1997). Co-operation with the economics department of Agrifood Research Finland, especially with its accounting director, Arto Latukka, Lic.Sc. (agr. econ.), has provided the opportunity not only to use the forest management plans but also produced several papers (Penttinen et al. 2004; Latukka et al. 2005). Moreover, the Agrifood Research project has improved the user interface of the net version of the forest management planning system MELA (Redsven et al. 2005) and completed MARTTI, the agricultural book-keeping farm information system with forestry accounting. The MELA and MARTTI systems have been linked via the Internet by building a system interface applying the XML protocol.

Sakari Salminen, M.Sc. (for.), has generously supported with his expertise in the National Forest Inventory (NFI), which was essential in applying the NFI database. Helpful comments from Martti Aarne and Markku Kaustia have solved many problems and improved the contribution (Penttinen and Lausti 2002, 2004; Uotila and Penttinen 2004, Uotila and Lausti 2006, 2007). Professor Tuula Nuutinen and Professor Jari Hynynen from FFRI have supported the research work by providing software such as MELA (Redsven et al. 2005) and MOTTI (Hynynen et al. 2005) for use with empirical evidence for producing papers and improving information systems. Professor Jarmo Eronen from the Helsinki School of Economics and Timo Saksa, Dr. Sc. (for.) from the FFRI have contributed forest regeneration studies (Eronen et al. 1996) and asked pertinent questions about forest economics and silviculture. Jarmo Mikkola, M.Sc (pol. sc.) conducted the statistical tests. Dr. Roderick McConchie of the University of Helsinki corrected and improved the English.

The forestry accounting study had already been activated by the IUFRO Small-Scale Forestry project group 3.08 meeting in 1989 (IUFRO 1989) headed by Professor Helmut Brandl, who has supported this research for many years. Professor Emeritus Horst D. Brabänder, Georg-August University Göttingen, as the grand old man of forestry accounting, has offered his views and comments. The support of Professor Peter Glück at the University of Natural Resources and Applied Life Sciences, Vienna, Professors Reinhard Mosandl and Martin Moog at the Technical University Munich and Professor Finn Helles at the Royal Veterinary Agricultural University provided the opportunity to work at Faculties in Vienna, Freising and Copenhagen. The criticism of Professor Hans A. Jöbstl from the University of Natural Resources and Applied Life Sciences at Vienna and group leader of IUFRO Unit 4.05.01, Managerial, Social and Environmental Accounting and Unit 4.05.02, Managerial Economics, is gratefully acknowledged. The discussions with Professor Richard J. Brazee, University Illinois at Urbana, John Douglas Brodie, College of Forestry, Oregon State University, and Bruce B. Bare, College of Forestry, University of Washington and many other international scholars have encouraged the publication process.

Helsinki, August 2007

Markku Penttinen

LIST OF ORIGINAL ACTICLES

The dissertation consists of an extended summary and the followed by five research articles, referred to in the text by Roman numerals I-V. These papers are reproduced with the permission of the journals in question

I **Penttinen, M**., Lausti, A., Kasanen, E. & Puttonen, V. 1996. Risks and returns in forest investments in Finland. The Finnish Journal of Business Economics 45(1): 111-124.

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

III Hyder, A., Lönnstedt, L. & **Penttinen, M.** 1999. Accounting as a management tool for nonindustrial private forestry. Scandinavian Journal of Management 15(2): 173-191.

IV **Penttinen, M.** & Lausti, A. 2004. The competitiveness and return components of NIPF ownership in Finland. The Finnish Journal of Business Economics 53(2): 135, 143-156.

V **Penttinen, M.** 2006. Impact of stochastic price and growth processes on optimal rotation age. European Journal of Forest Research 125(4): 335-343.

In all, this dissertation summarises the results of the Finnish Forest Research Institute (FFRI) projects 3009 *The profitability of forestry* 1989-1996, 3189 *The forest owner's business economic decision making* 1997-2001, and 3337 *The competitiveness of forestry and woodworking industries* 2002-2006.

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1 INTRODUCTION

1.1 Historical remarks on various traditions from the point of view of profitability

The first saw mills, the so-called crown saw mills, had been established in Finland as early as the 1530s (Kuisma, 1993, p. 46) the annual production being roughly 100,000 m^3 in 1780 (Kuisma 1993, p. 53). The first modest mechanical pulp factory was established in 1859, and the first break-throughs in pulp production occurred in the 1860s (Kuisma 1993, p. 254).

Common village forests had been the traditional form of proprietorship, but the act of 1734 tried to divide these forests between the farms, because common property was not maintained properly (Helander 1949, p. 47). Even thereafter slash-and-burn agriculture and settlement was widespread, especially in Eastern Finland. Concerns over the status of forests arose after the Finnish forest industry expanded production in the second half of the 19th century. The lack of sustainability inspired the establishment of the first forestry education institute in 1858. In 1859 the Finnish Senate asked Edmund von Berg, the Dean of the Faculty of Agriculture and Forestry in Tharandt, Germany, to evaluate the status of Finnish forests. His gloomy statement stung the government into action. The first forestry law, which banned forest devastation, was enacted in 1886. (Helander 1949).

During the years immediately following independence in 1917, private land was made available to tenant farmers by the so-called Lex Kallio (1922). Moreover, forest land bought by forest industries was repossessed by the state under a law called Lex Pulkkinen (1922), which was passed by the parliament in 1922, but was ratified in 1924 (Helander 1949). After the Winter War (1939-40) refugees were given small farms and, likewise, after the continuation war of 1942-1944. The restrictions on the buying and selling of forest land have been strict since the wars. The laws limited the purchase of forest land by the forest industry. However, the restrictions have been relaxed little by little so that from January 1, 1998 there were no restrictions at all (Hannelius 1998). Nowadays anybody, even foreigners, and any firm can buy and sell forest land. (see Penttinen and Rimmler 2005).

Traditionally, a lower interest rate has been accepted in forestry in Finland, so that it need not be at the same level with other investments (Ervasti et. al. 1970). However, bank deposits and government bonds as investments for a forest owner have been evaluated (Hämäläinen 1971). This lower interest rate requirement means that the effective allocation notion applying to the economy does not hold in forestry. Recall that the strong professional ethos in forestry culture relies on four premises: (i) the doctrine of timber primacy, (ii) the doctrine of sustained yield, (iii) the doctrine of the long run, and (iv) the doctrine of absolute standards, where the last means that the successful managers finds his goals and leads in the forest itself, as in planting trees which are best suited to the site and carrying the stock of growing timber which nature has shown it is capable of carrying (Duerr and Duerr 1975). These doctrines completely ignore profitability, the link between forestry and industrial activities and the competitiveness of forest ownership as an investment (Keipi 1977).

The classic article by Samuelson (1976) argues that maximising the net present value (NPV) is the right paradigm in forestry, applied as the main line in the US and Scandinavia. This paradigm, which is in line with the traditional timber harvesting findings of Faustmann (1849), is called *land rent theory* or *soil rent theory*. Recall that the solution of the timber harvesting problem is well-defined provided that, among other things, the capital market is perfect in the sense that one can lend and borrow any amount at the prevailing interest rate,

and the forest land can be bought and sold in a perfect market (Löfgren 1990). However, using the internal rate of return (IRR) as the objective in timber harvesting studies, leads to the unsatisfactory conclusion of either infinite or zero profits, depending on the viewpoint (Hirschleifer 1970). Moreover, using IRR maximisation assumes that the amount of land available for forestry is infinite and that access to all capital markets is closed (Newman 1988).

The paradigm competing with the land rent theory is the *forest rent theory* of Ostwald (Markus 1967, Urich 1904). There has been a debate, indeed sometimes a conflict, between these theories, and the forest rent theory will be applied even to day in Central Europe (Möhring 2001). Forest rent theory in fact develops from the land rent theory when the interest rate is assumed to be zero (Bentley and Fight 1966). This zero rent approach postpones timber harvesting compared with land rent theory and means "greener" forestry. Although this "green" option can be supported in the name of the benefit of all citizens in an industrialised country, it is not beneficial to the forest owner (Hyytiäinen and Tahvonen 2003).

Historically, forests and forest industries have been key items in power games and war preparations and even an emotional part of ideological movements. For example, the third Reich of the Nazi Germany saw forestry and forest industries as a key power source (Geiger 1950, p. 76-95). Under their regime, a so-called natural forest was seen as stronger, and as being of a healthier race than alternatives, and the near-natural approach to silviculture was required by law 'Reichsnaturschutzgesetz' in 1935 (Bratton 1999). Clear-cutting was banned and the permanent forest ‘Dauerwald’ required (Bruggemeier et al. 2005). Forests were conceived of as an important societal good, capable of providing recreational opportunities while at the same time producing high-quality timber (Gamborg and Larsen 2003). The third Reich tried to apply forestry species act (“Forstliche Artgesetz”), because land rent theory had lead to use of non-endemic spruce and pine races (Rubner 1985, p. 120).

The Soviet Union provides another historical example of strong state dominance in forestry. The state owned the forests and forestry was based on Marxism-Leninism (Mikhailov 1974). Even today 'the Russian forest stock is federal property' (PROFOR 2003). The Russian Forestry Law (2006), which came into force at the beginning of 2007, confirms that wood is a federal property [§20.2] [1]. Recall that the amount of forest land in Russian federation exceeds 850 million hectares compared with 20 million in Finland (Statistical Yearbook 2006, p. 369-370).

The classic forms of forestry rely on two objectives: (i) the former aims at the net profit per cubic metre of wood produced, while (ii) the latter maximises the benefit per area unit, such as the hectare, but the former leads to exploitation. (Sundberg and Silversides 1988, p. 10). In practice, the type of forestry will be defined after the regeneration cutting (Vaara 1998, p. 101). Will the regeneration area be taken care of or will it be abandoned? However, a central limitation and objective is the principle of sustainability applied in Finland. The realisation of growing stock and transferring the net income to other use without allocating resources to forest regeneration is not acceptable. Unfortunately, there is worldwide exploitation in which nothing has been ploughed back into reforestation after the

1 The Government of Russia has decided to increase the wood export customs duty to 10 euro per cubic metre on July 1, 2007 and to 50 euro on January 1, 2009. The decision can be found at http://www.government.gov.ru/government/governmentactivity/rfgovernmentdecisions/archive/2007/02/07/2375452.htm. This page has a link (Приложение) to its appendix page, which contains the duty percentages and other details.

regeneration felling. Reasons may be high subjective interest rates and poverty, which have been described in the considerable forest policy and deforestation literature (e.g. Amacher 2002, Sage et al. 2003).

1.2 Changing approaches to profitability assessment

The business environment of the forest industry has changed since the 1970s. Inflation then exceeded 16% for several years. In a sense, inflation paid the debts, at least in part. Moreover, where the domestic labour, raw material and capital costs increased so that the profitability of forest industry was threatened, devaluation was available to offset these problems. On the other hand, the Bank of Finland, which made the devaluation decisions, had the right to accept or to refuse investment in new paper and pulp mills. Subsequently, especially after the depression of the 1990s, the whole industry and the three big companies, Stora-Enso, UPM Kymmene and Metsäliitto Group in particular, have become global players after mergers and acquisitions. The international owner base makes stakeholder value the first priority of the business. All these changes have been reflected in the behaviour of the forest industry stocks so that the relatively modest return in the 1970s has systematically improved, especially since the depression of the 1990s. The return on all stocks of Helsinki Stock Exchange, its forest industry stock sector, the return on Finnish non-industrial private forest (NIPF) ownership and apartments have undergone both fluctuations and structural change from 1972 to 2006 (Figure 1).

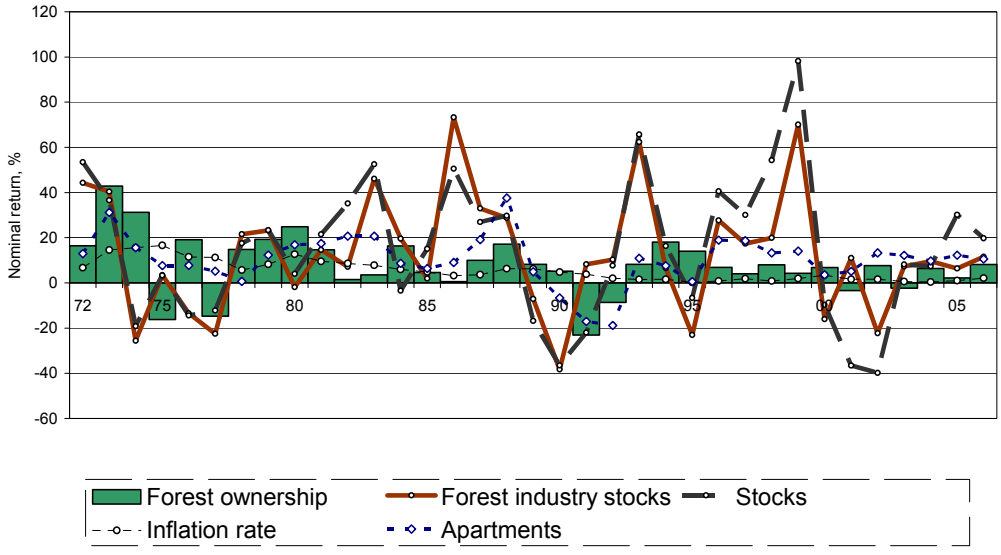

Figure 1. Nominal returns on forest ownership, forest industry stocks, all stocks and apartments in 1972-2006 (Uotila and Lausti 2007)

Surprisingly, even basic accounting concepts such as the leverage of liabilities were poorly known and even less understood until the last depression. Since the depression, the proportion of equity capital has essentially increased, including the forest industry. On the other hand, the present stakeholder value approach requires that the capital must not be idle. In recent years, predefined internal interest rate targets used in forest industry companies have been applied even to forests themselves.

The Finnish forest industry corporations StoraEnso, UPM-Kymmene and the M-real group are publicly quoted and own large tracts of forest. However, the forests of StoraEnso, roughly some 600,000 hectares, have been sold to its associated company Tornator, 59% of whose shares were sold to institutional investors such as insurance companies and pension funds (Tornator 2003). At the same time, dramatic changes have occurred in the business environment because of globalisation (DANA 2006).

Moreover, the whole corporate accounting philosophy and practice have changed. In fact, companies whose shares can be publicly quoted have had to follow the EU's new International Financial Reporting Standards (IFRS) (IFRS 2002) from January 1, 2005, including the International Accounting Standard (IAS) 41 Agriculture, which came into force at the beginning of 2003 (IAS 2002). The basic requirement of the IFRS is that market-based 'fair values' be used which, according to IAS 41, refers to the price of the commodity in the relevant commodity market: 'If an active market exists for a biological asset or agricultural produce, the quoted price in that market is the appropriate basis for determining the fair value of that asset' (IAS 2002, §17). ´A biological asset should be measured on initial recognition and at each balance sheet date its fair value less estimated point-of-sale costs (IAS 2002, §12). In the case of the forests, the market-determined prices and values may not be available. The fair value calculation is then defined 'as the present value of expected net cash flow from that asset' according to IAS 41 and the International Financial Reporting Interpretations Committee (IFRIC) meeting 30.9-1.10.2003 (IFRIC 2003). The present value of the expected net cash flows are discounted at a 'current market-determined pre-tax rate' (IAS 2002, §20; Eckel et al., 2003). For example, the calculation in the Swedish forest industry has been made for the next 70-100 years, and the pre-tax cash flows are discounted at 6.25% interest rate (Burnside 2005, p. 44).

Recall that the Finnish expenditure revenue theory originating from Saario is an inductive theory in the classical approach, in which net profit is based on the realised values. According to the normative-deductive theory of the classical approach, the profit is based on the change in the value of the enterprise between two points of time, which can be interpreted as a comprehensive income (Lukka 1989, see also Riahi-Belkaoui 2000). The IFRS has replaced the traditional Finnish historical cost based expenditure revenue theory accounting, and is based on market-based 'fair value' accounting.

The forest economics tradition relies on the profitability measure of €/hectare year (Sundberg and Silversides 1988) due to its easy interpretation. However, the paradigm of business economics is based on the interest theory of Fisher (1930). Fisher pinpoints human impatience and its consequent time preference and focuses on the marginal rate of return over costs, a practice which laid the foundation for various return on investment (ROI) measures. The benefit of this method is that it provides an understanding of how the return is generated (Figure 2).

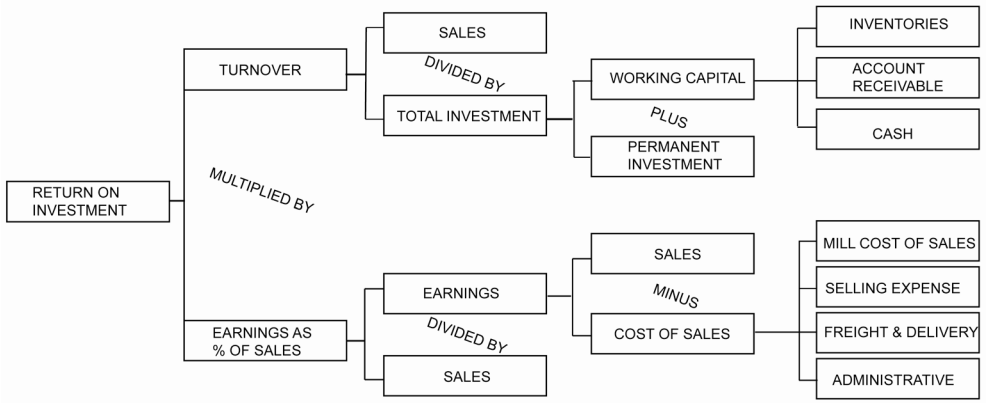

Figure 2. The Du Pont return on investment formula (Johnson and Kaplan 1987)

A combination of financial ratios in a series to evaluate the return on assets (ROA) of an investment is of the form: ROA = net profit / total assets = sales margin * capital turnover and the return on equity (ROE) of the form ROE = net profit / equity = ROA * leverage, where leverage = total assets / equity. ROI figures have been used even applying the *ex ante* approach in the form of internal interest rate requirement for investments, which may be, say, 15%. Moreover, different ROI figures have been used even in forestry for *ex post* calculations in order to estimate the ROE and ROA of a forest holding. Empirical evidence suggests a 2-4% ROE for test forest holdings as well as for the relatively large distribution of the ROE among holdings (Figure 3)

Compared with the forest industry, forests may represent lazy property, especially in the new market-based IFRS/IAS 'fair value' accounting as required by EU. The equity capital turnover = sales / equity -equation gives on the other hand the capital turnover time = equity / sales -equation. This has been estimated using the accounting and forest management planning data of jointly-owned forests (JOFs) and found to be 26 years (Penttinen 1992). In all, when property values are the key issue, as is the case with IFRS/IAS, this change from the expenditure revenue theory approach obviously brings relative profitability figures such as ROI obvious into use.

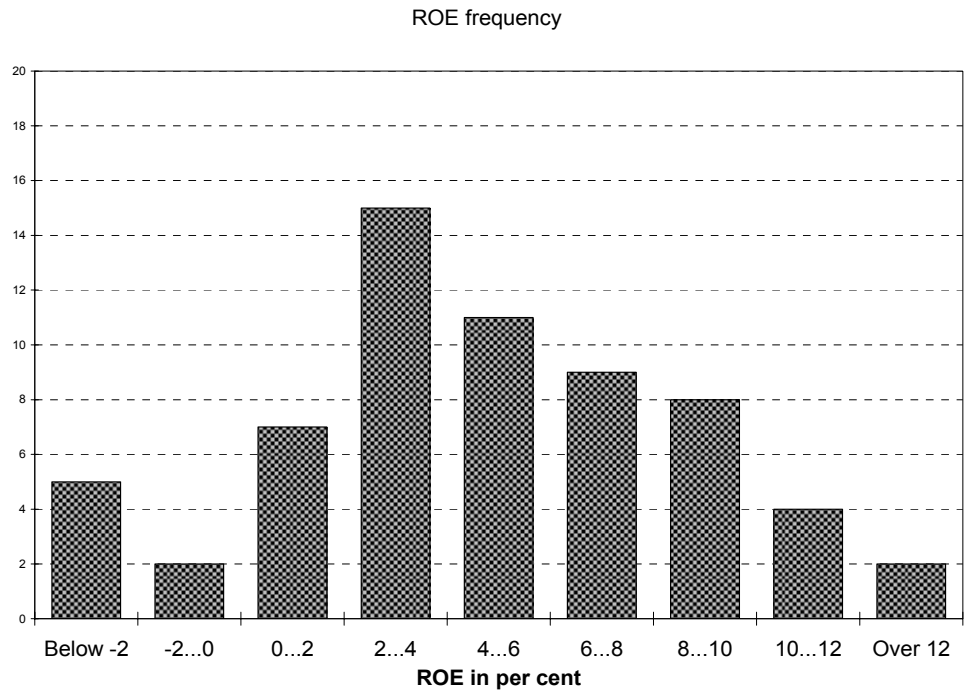

Figure 3. The return on equity (ROE) of individual forest holdings (Penttinen and Uotila, 1996)

1.3 Profit, return and time preference

The decision-making of NIPF owners benefits from data on (i) profitability (financial accounting), (ii) cost structure (management accounting), including (iii) product costs, and (vi) forest investment/improvement (project accounting) (Hyder et al. 1994). There are two alternative approaches to the calculations: (a) to measure the net margin of the forestry entrepreneur in the spirit of the private enterprise theory, or (b) measure the net margin of the forest property, which can be compared with other forest holdings and investments (Schneider 1970). The former is hereafter referred to as the *net profit of the enterprise* and the latter as the *calculated profit of the property* (Hyder et al. 1999). Both approaches have inspired profit and loss statement as well as balance sheet proposals for NIPF enterprises (Hyder et al. 1994). The strictly regulated accounting is complemented by contingent adjustments focusing on change in forest value and compensation for the owner's own work (Hyder et al. 1999).

Profitability has been shown to be the best overall indicator of performance (Brozik 1984). At the aggregate national level, only gross earnings of non-industrial private forestry (NIPF), which consist of gross stumpage earnings minus total costs and plus state subsidies have been estimated. These were €89.4 / hectare in 2005 in Finland (Statistical Yearbook 2006, p. 366). Among NIPF enterprises only jointly-owned forests (JOFs) have compulsory book-keeping and forest management plans (FMPs). However, the JOFs do not provide any balance sheet at all (Silvadata 2005). Their accounting and FMP data demonstrated that net profit has fluctuated considerably, but was at the level of only €20/hectare in Lapland (Penttinen and Kinnunen 1992).

Recall that the pitfall of forestry accounting is the value of the growing stock, especially its change, known as a timber balance (Keltikangas 1938). Instead of property valuation, the comparison between the planned and actual fellings of the FMP provides the impact of property value change for the profit and loss statement (see Hakkarainen et al. 1995, cf. Jöbstl 1981).

A proposal for the classification of forestry costs inspired by the Central European cost accounting solutions with groupings into *direct* and *overhead* costs, the first of which contains the groups: *direct logging* and *direct silvicultural* costs (Sekot 1987, 1998; Jöbstl 1990) has been modified for Scandinavian forestry (Hyder et al. 1994). Empirical evidence reveals the role of harvesting (cutting as well as haulage and storage together) performed by the forest owner, as well as the surprising differences in silviculture and overhead costs (Figure 4).

One faces unexpected distinctions in estimating the difference between the average timber price and the total cost per sold m^3 of timber. These forest holdings suggest that forestry is hardly a business in the North. Moreover, there is also a considerable distinction, even in the South, between large and small. In all, these test forest holdings favour the South and economies of scale (Figure 5).

Note that the calculated profit is used here as a proxy for 'earnings before interest and taxes' (EBIT), which is the most common profit used in ROI calculations (Westerlund 1984). The calculated profit is related to the total property of the forest enterprise, as a proxy for the ROI (Figure 6).

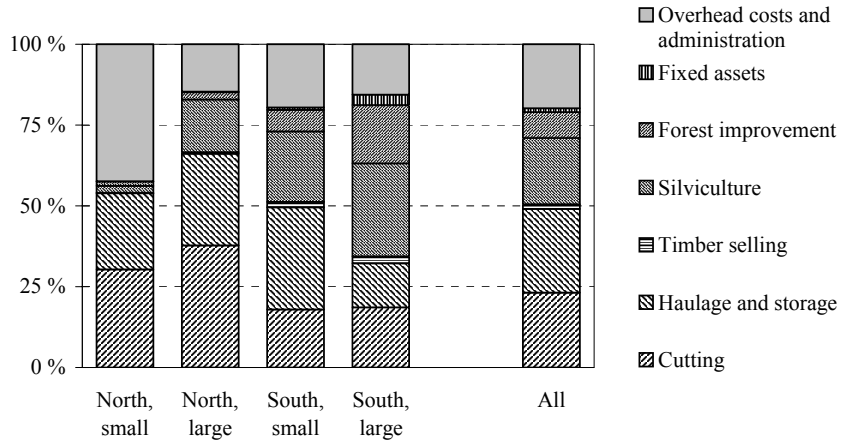

Figure 4. The distribution of costs by cost centres depending on the size of forest holding and on its geographical location (Penttinen and Uotila 1996)

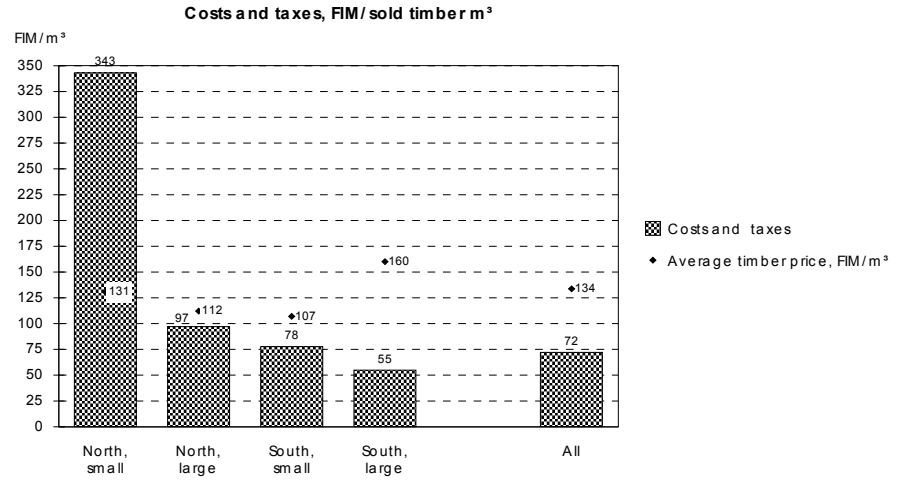

Figure 5. Average timber prices and costs and taxes, FIM / timber sold m3, 1 € = 5.94 FIM (Penttinen and Uotila 1996)

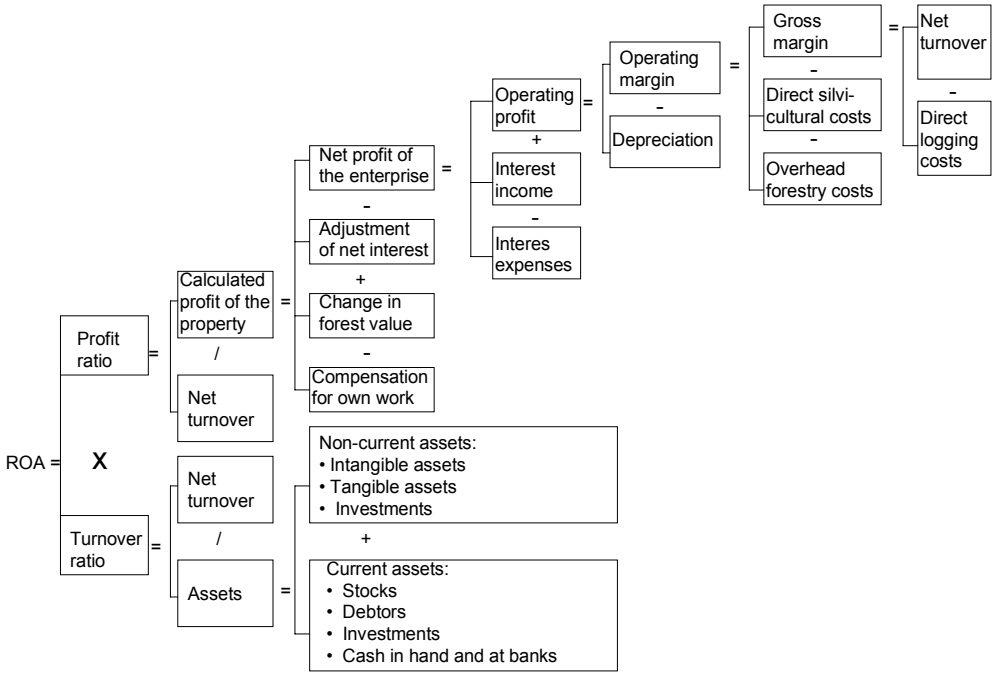

Figure 6. Formation of return on assets (ROA) in forestry (Hyder et al. 1994, 1999, Accounting Act and Ordinance 2005)

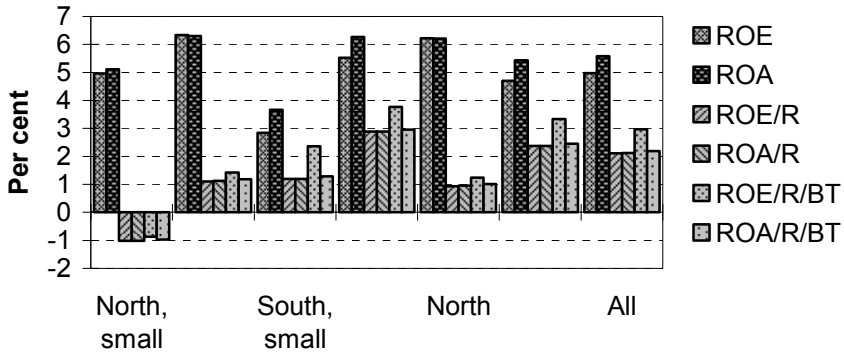

Figure 7. Return on equity (ROE) and return on assets (ROA) when applying calculated, realised (R) profit, and realised profit before tax (R/BT) (see Penttinen and Uotila 1996, p. 185)

Overall results present both ROA and ROE, first estimating the calculated profit of the property, then the realised net profit (R) of the enterprise, and finally the realised net profit before tax (BT) (Figure 7).

Moreover, one has to recognise that the difference, especially in stumpage prices, at the beginning and end of the fiscal year and in the timber balance may have a great impact on the annual ROI figures (Penttinen and Uotila 1996). Especially after the recession in the 1990s, one could obtain very different ROEs depending on the inclusion of timber balance volumes and/or timber prices (Figure 8).

Note that the ratio analysis can focus on comparisons within the enterprise but also between enterprises, using direct or indirect comparison, using actual as against plan comparisons, the same or different time period comparisons, etc. (Figure 9).

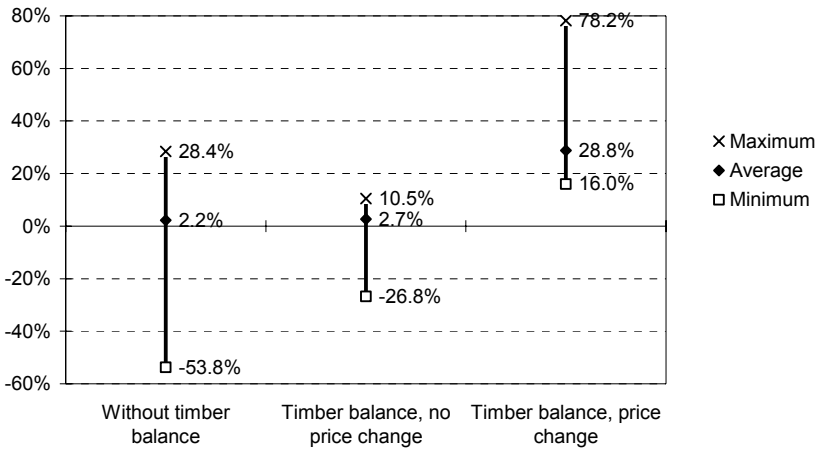

Figure 8. The return on equity (ROE) of case forest holdings in Southern Finland in the early 1990s without timber balance, with the timber balance volume changes and with both timber balance volume and price changes (Penttinen and Uotila 1996)

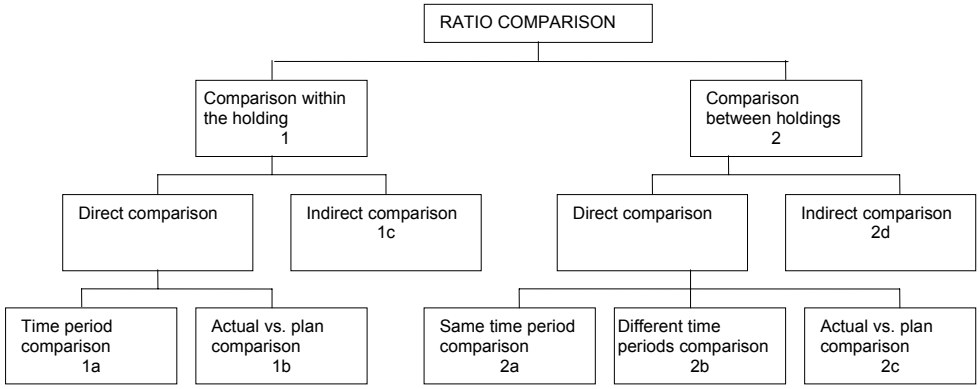

Figure 9. The comparison system of ratios (Merkle 1982)

As a result of empirical estimations using NIPF holdings, the recommended profitability ratios are: (i) overall result per hectare with and without the forest owner's own work, (ii) operating profit per hectare, and (iii) return on assets (ROA) (Penttinen and Hakkarainen 1998)

In all, the accounting developments of the dissertation rely on three sources: (i) the Finnish accounting tradition, (ii) the forestry accounting tradition, especially in the German-speaking Europe, and (iii) general accounting research. Moreover, the recent IFRS/IAS accounting standards of the EU (IFRS 2002, IAS 2002) and the proposal of the Finnish government for an accounting act (Government proposal 2004) will also be recognised.

1.4 Return, risk and portfolio management

Both the interest theory approach with relative profitability and the accounting approach with absolute profitability operate assuming a risk-less deterministic world, although the time horizon in forestry is decades. However, the work of Markowitz (1952) and that of Sharpe (1964) have laid the foundation for including risk as well as return. Their paradigm, which could be called portfolio management, portfolio theory or modern portfolio theory (MPT), has already been widely applied from stock behaviour analysis to forest industries and forestry.

More generally, the return and risk of forest ownership can be considered as part of the asset portfolio of an investor (Penttinen et al. 1996, Lausti and Penttinen 1998a, 1998b) in the context of portfolio theory. The comparison between asset classes demonstrate considerable distinctions in assessing their returns, risks and risk-adjusted ratios (Table 1)

Table 1. Average annual returns, standard deviations and Sharpe ratios [2] and the average market value shares of various asset classes in Finland 1972–2003 (Penttinen and Lausti 2004)

TOTAL PERIOD: 1972–2003 (* means the 1972–1994 period)	Return	Risk	Risk-adjusted	Market
	Return %	Standard deviation %	Sharpe Ratio	Share Percentage%
Offices	15.5	15.6	0.46	28.4
Stocks	14.8	32.5	0.20	11.8
- Forest industry stocks	13.4	27.7	0.18	2.8
Corporate Debentures	10.9*	3.3*	0.58*	2.1
Housing	10.4	11.4	0.18	37.3
Forest Ownership	8.4	13.4	0.01	15.7
Government Bonds	8.3	5.5	0.00	4.7
Inflation rate	5.8	4.7		
Market Portfolio	2.9	14.2	0.32	100

2 The historic ex post Sharpe ratio of an asset a is based on the differential return in period t: $d_t = r_{at} - r_{bt}$, where r_{at} is the return of asset a and r_{bt} that of the benchmark asset such as the risk-free asset. The sum of these differential returns divided by the standard deviation of asset a is the ex post, or historic Sharpe ratio (Sharpe1994).

The competitiveness of different asset classes depends not only on returns and risks but also on their correlation. The Finnish empirical evidence revealed a very significant correlation only between forestry and private housing (Penttinen et al. 1996). The systematic risk β of forest ownership is relatively high at 0.6 or 60%, and the risk-related (abnormal) return α of forestry was negative -2.4% [3] (Lausti and Penttinen 1998b, Lausti and Penttinen 2007). However, some American studies have shown that forests have low or even negative systematic risk β (Zinkhan 1990), which means that they do not follow market fluctuations.

Risk is always a key element in a market economy. Banks have to report their risks (Basel II 2007). Value at risk (VaR) techniques are used in the internal analyses of insurance companies and banks. Moreover, even wood production is facing two risk sources: The standard deviation of the annual volume growth is roughly 5.5% (Kangas 1998), but the standard deviation of the annual pine log series in 1949-2004 was 25.2%, that of pine pulpwood being 28.0% (Penttinen 2005a, 2006), which gives ex post risks.

2 OBJECTIVES OF THE STUDY

The notion of this dissertation is to tackle and contribute to the understanding of the profitability of forestry. The role of forests and other assets will be approached from the point of view of the owner's portfolio management. The perspective is first of all that of an institutional investor, then of a forest industry company and non-industrial private forest (NIPF) owners.

The purpose of this dissertation is to establish the accounting and financial basis of forestry as well as its production economics for decision-making primarily concerning forest ownership and wood production. General frameworks, procedures, tools and guidelines will be created. Moreover, novel constructions will be developed and introduced into for the METINFO service to provide return on forest ownership measures and their component split into felling, price change, change in the growing stock, and silvicultural costs. A key construction is the estimator for the market value of NIP forests. Forest industries, forests, apartments, stocks, offices, bonds and debentures will be investigated in the portfolio management framework. The impact of market turbulence has been considered as well.

The main aims of this dissertation are to create a new understanding and knowledge of

- the profitability of forestry
- developments of novel constructions of market value estimates for NIPF forests and for return on forest ownership and its split into felling, price change, change in the growing stock, and silvicultural costs implemented by the METINFO (2007) service.
- forests, forest industry stocks, all stocks, apartments, offices, bonds and debentures as investment classes in an asset portfolio (cf. Statistics 2007)
- the role of forests in the management portfolio of a forest owner
- forestry accounting and the new IFRS/IAS accounting of the EU applied to forestry implemented by the EconomyDoctor (2007) service.
- profitability improvement by reducing timber harvesting age

[3] The systematic risk β stands for the capital asset pricing model (CAPM) regression of the return R_a of an asset a upon that of the market portfolio R_m, $R_a = \alpha + \beta R_m$. Asset a has its risk-related return α adjusted by subtracting expected returns from actual returns in the CAPM regression (Sharpe 1964, 1991, Elton et al. 2003).

- the information support for the forest owner's decision-making

The disciplines and contents of both the National Forest Inventory (NFI) and growth and yield science have provided a foundation for the volume estimation of the growing stock. Moreover, Finnish industrial economics studies such as the constructive (Lukka 2000, 2003, Kasanen et al. 1991, 1993) and nomothetic approaches (Neilimo and Näsi 1980, Olkkonen 1993) provide the methodological framework for research and development.

3 PROJECTS AND CONTRIBUTIONS

3.1 Profitability of forestry and returns on forest ownership project developments

The profitability of a forest holding was studied by Saari (1929, 1935, 1938). The business economics of Finnish forestry including profitability issues were developed by V. Keltikangas (1934, 1938, 1940, 1942, 1945, 1962, 1965, 1969, 1970). The problem settings of forest economics and especially the handling of the time factor in investment calculations concerning timber growing were analysed by M. Keltikangas (1973, 1986). Note that time preference is the key specialty of forestry due to the long production period. Its role in the discounting value in forest holding pricing has been examined by Ahonen (1970). Both the profitability and planning of a forest holding have been studied by Hämäläinen (1973a, 1973b, 1989), and Hämäläinen and Kuula (1992). These theoretical and practical contributions paved the foundation for profitability analysis.

This dissertation consists of individual studies under the same overall topic with historical connections. The IUFRO Small-case forestry meeting (IUFRO 1989) and especially the chairman of the small-scale forestry group, Professor Brandl, proposed starting forestry profitability studies in Finland, which motivated the implementation of FFRI project 3009, The profitability of forestry, 1989-1996. The key problem was the availability of empirical evidence, and the first solution to this dilemma was provided by the book-keeping and forest management plans of jointly-owned forests (JOFs). The profitability of the JOFs was reported (Penttinen and Kinnunen, 1992), and initial attempt to develop the accounting published (Penttinen 1989, 1992). The development of forestry accounting for the needs of the Scandinavian non-industrial private forestry (NIPF) subsequently, took over the central role resulting in Hyder et al. (1994), which reviews the state of the art of forestry accounting and develops both financial and cost accounting applying three different strategies for a forest holding. It also compares the return on assets (ROA) of forest property with other investment alternatives such as government bonds, stocks, fund, and savings accounts. Subsequently, the first attempts were made to develop cost accounting together with the Work Efficiency Institute (Penttinen et al. 1995). Research was also focused on advancing and implementing NIPF profitability studies (Penttinen 1997).

The co-operation with the University of Joensuu inspired attempts to monitor forestry costs and revenues (Kinnunen et al. 1993, Hyttinen 1995, Hyttinen et al. 1994, 1996, 1997). For example, cost accountancy developments (Hyttinen and Kallio 1998), a book establishing farm forestry accounting, the MOSEFA network (Niskanen and Sekot 2001) and an accounting textbook for students (Niskanen et al. 2002) were accomplished among other things. Unfortunately, the notion of implementing a non-industrial private forest (NIPF) holdings book-keeping network as in Central Europe could not be realised with the

available resources. However, similar monitoring networks were implemented at the European level (see Sekot 1990, 1998, 2000, 2001a, 2001b, Penttinen 1991). The **only** remaining systematic outcome was the aggregate profitability of forestry figures by forestry centre produced by the Forest Statistics Information Service (FSIS) of the FFRI and published in the Statistical Yearbook (2006).

However, hints mainly from US studies then suggested using return on NIPF ownership as a proxy of profitability, which could be applied in *The profitability of forestry,* 1989-1996, project. This return estimation requires many steps, such as splitting non-industrial forest from the others, splitting by tree species and by roundwood assortment. In all, the national forest inventory (NFI) and the statistical stumpage price and cost data enabled this estimation, the first results of which appeared in an IUFRO 1995 congress paper (Penttinen and Lausti 1995) and article I (Penttinen et al. 1996).

The new FFRI project 3189, *The forest owner's business economic decision making* 1997-2001, enabled the continuation of accounting and risk/return studies producing articles II (Lausti and Penttinen 1998a) and III (Hyder et al. 1999). At the same time, the first results of applying and developing ratio analysis were obtained (Penttinen and Hakkarainen 1998, Hakkarainen et al. 1999). Problems of manpower and machine cost accounting were tackled and a cost accounting proposal for forestry practice published (Penttinen et al. 2001).

Return results and comparisons between asset classes have subsequently been developed in the context of FFRI project 3337, *The competitiveness of forestry and woodworking industries* 2002-2006, and resulted acticle IV (Penttinen and Lausti 2004), Penttinen et al. (2004, 2005a, 2005b) together with MTT Agrifood Research Finland and article V (Penttinen 2006) together with the MOTTI (see Hynynen et al. 2005) development group of the FFRI.

Note that economic research of Agrifood Research Finland is in charge of maintaining and producing FADN results (Accountancy 2007) for the Ministry of Agriculture and Forestry and the EU, where it was originally developed to provide information for Common Agricultural Policy (CAP) implementation (Niskanen and Sekot 2001). The forestry accounting data from the FADN book-keeping farms is based on the forest property taxation values. There are some 70,000 farms in Finland owning 4,490,000 hectares of forest altogether, approximately 900 of which provide annually accounting data to the farm accountancy data network (FADN) of the EU (Figure 10). The developed IFRS/IAS solutions (Penttinen et al. 2004 and Latukka et al. 2005) have been implemented by the Economy Doctor service of the MTT Agrifood Research Finland (Economy Doctor 2007).

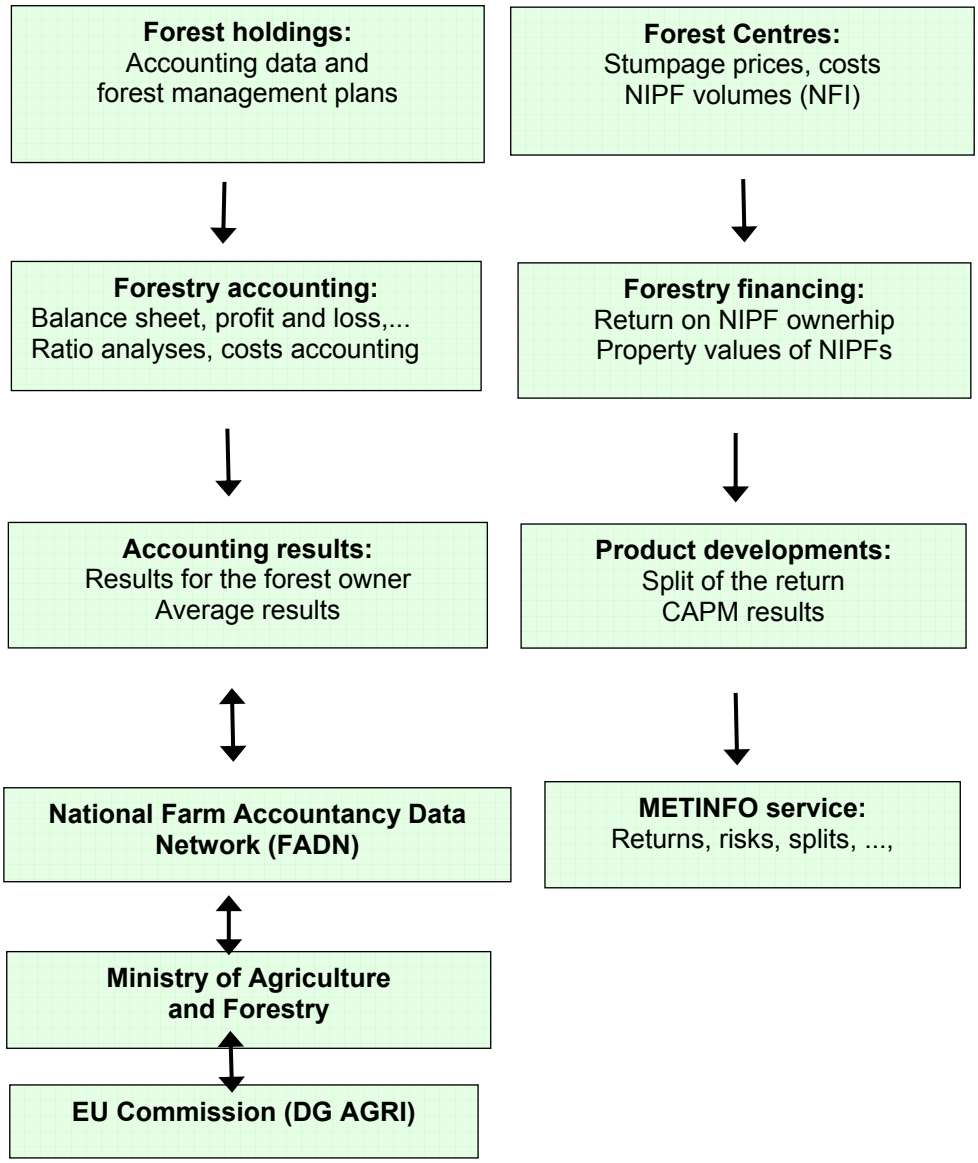

Figure 10. The empirical evidence, development of accounting and finance as well as product developments in the context of the profitability reporting of farms

The product developments of the projects for the METINFO service (METINFO 2007) and the return-risk studies are based on the Forest Statistics Information Service (FSIS) and the National Forest Inventory (NFI) of the FFRI. The NFI has been in existence for nearly 90 years already (the most recent being NFI 10: see NFI 2007). Nowadays it is using the most modern satellite-image based techniques (Multi-source NFI 2007).

Recall that the measurement and field work of the NFIs will be done only every tenth year. The annual figures above have been estimated using all available FSIS information, such as annual felling volume and calculated growth provided by growth modelling. Recently, annual NFI sample measurements have been started and the annual update is now in production.

3.2 Structure of the study

This dissertation consists of two main parts: this summary report and the enclosed five articles. The summary part offers an overview, and five research articles are discussed in the second part. The articles in part two have been published in international peer reviewed journals. They tackle the profitability of forestry problem at three disciplines and levels: Articles I, II and IV discuss the return on the forest ownership at post at the forest board and country levels. Article III develops forestry accounting ex post at the forest holding level. Article V and Penttinen (2005a, 2005b, 2005c) study optimal timber harvesting ex ante as opportunity to improve the profitability at the forest stand level.

The lack of detailed enterprise-level empirical data recognised by the profitability of forestry network inspired the need to determine the return on forest ownership. US findings were applied, developed and published in article I, which provides not only the returns on NIPF ownership in Finland starting in 1972 but also a comparison with other asset classes. This study demonstrates a significant correlation between return on NIPF ownership and housing (62%) and offices (63%), and with the market portfolio (81%) in particular. This contradicts much US research, which documents a negative correlation with the market portfolio (Zinkhan et al., 1992). The paper uses all relevant data of the Forest Statistics Information Service (FSIS) such as stumpage prices, silvicultural costs, subsidies, as well as that of the national forest inventory (NFI).

Furthermore, based on article I, article II develops a more systematic solution to the return by forestry board district (FBD), as well as the innovative split of return on forest ownership into stumpage price change, fellings and change in the growing stock at the FBD level. This article has been refereed and its results applied in Sweden (Lönnstedt and Svensson 2000). All the components were depicted at the national and FBD levels, and the forestry return was compared with apartments in a FBD. The findings laid the foundation for article IV, and were introduced into the METINFO service.

Financial and cost accounting based on Hyder et al. (1994) and Penttinen et al. (1995) was simultaneously developed for Scandinavian forestry, resulting in article III. Principles for profit and loss accounts and balance sheets were proposed, and the strictly regulated accounting was complemented with contingent adjustment, especially to cope with the change in forest value and compensation for the owner's own work. An economic analysis of a medium-sized forest holding demonstrated both the importance of this type of adjustment and the impact of various owner strategies, as well as comparing the ROI of forest property with other investment opportunities.

Article IV finalised the return on forest ownership studies in articles I and II and

established the final aggregated national level solutions for the return on NIPF ownership, including a constructed split into price change, fellings, and change in growing stock and costs at the national level. This research demonstrates the relatively low risk/return competitiveness of forestry as measured by the Sharpe ratio and that the price change component of 4.5% was 1.2% less than the inflation of 5.8% in 1972-2003. Moreover, while the correlation of return on NIPF ownership is significant only with private housing, NIPFs were accepted in the optimal so-called tangency portfolio for risk-free interest rate of $r_f < 2.9\%$ rather than apartments because of covariance.

All these new solutions and findings on return on forest ownership and its split have been implemented into the METINFO Internet service of the FFRI (METINFO 2007).

Article V completes the previous *ex post* analyses by providing *ex ante* considerations. The owner might be interested not only in observed profitability and return results but also in improving the capital turnover and return on forest ownership *ex ante*. The optimal rotation results then offer easy-to-use recommendations such as those of the Forestry Development Centre Tapio (2001, 2006).

The articles of this dissertation:

I Penttinen, M., Lausti, A., Kasanen, E. & Puttonen, V. (1996) Risks and returns in forest investments in Finland. The Finnish Journal of Business Economics 45(1): 111-124.

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

III Hyder, A., Lönnstedt, L. & Penttinen, M. (1999) Accounting as a management tool for nonindustrial private forestry. Scandinavian Journal of Management 15(2): 173-191.

IV Penttinen, M. & Lausti, A. (2004) The competitiveness and return components of NIPF ownership in Finland. The Finnish Journal of Business Economics 53(2): 135, 143-156.

V Penttinen, M. (2006) Impact of stochastic price and growth processes on optimal rotation age. European Journal of Forest Research 125(4): 335-343.

In all, these publications are the fundamentals of developments in accounting, finance and production economics for the Finnish forest sector. All the findings and solutions tend to be practical constructions with the economic theory as the cornerstone: (i) Traditional forest economics relies on absolute profitability such as €/hectare annually, deterministic world and net present value (NPV) in the spirit of Samuelson (1976). (ii) Enterprises tend to favour return on investment (ROI) such as %/year and its background in interest theory Fisher (1930). However, (iii) modern portfolio theory (MPT), which originates from Markowitz (1952), speaks the language of contemporary management. The research priorities reflect the changes in desired results. Nowadays, risk and its measurement has become a key issue in portfolio management, even in forestry (cf. Heikkinen 2003, Reeves and Haight 2000).

4 RESEARCH METHODOLOGIES

The purpose of this chapter is to review the recent theoretical and methodological orientations in business- and industrial economics and accounting, as well as to present the research methodologies used in this study.

Burrel and Morgan (1979, p. 1) postulate that 'all theories of organisation are based upon a philosophy of science and a theory of society'. They analyse both the two major dimensions - science and society - and summarise the relation between them in four paradigms: radical humanist, radical structuralist, interpretative, and functionalist (Figure 11). Although each of these paradigms shares a common set of features with its neighbours on the horizontal and vertical axes in terms of one of the two dimensions, each is differentiated on the other dimension. In all, they should be viewed as contiguous but separate (Burrel and Morgan 1979, p. 23).

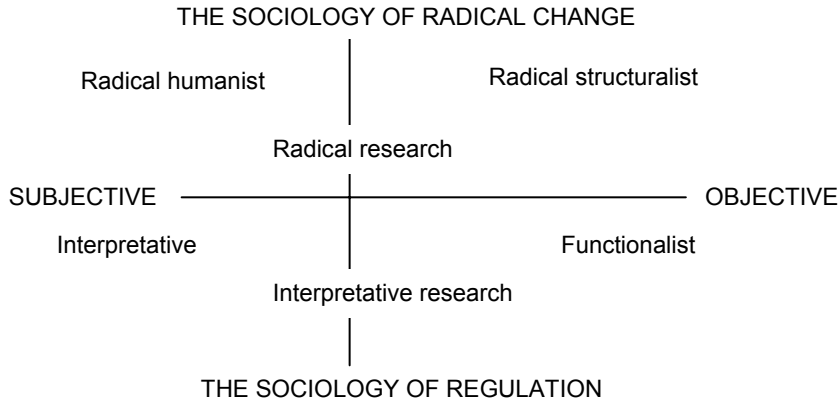

Figure 11. Accounting research and sociological paradigms (Kasanen et al. 1991, Burrel and Morgan 1979, p. 22)

The initiative of Burrel and Morgan (1979) has inspired the commonly used classification of Finnish business and industrial research of Neilimo and Näsi (1980), who modify these paradigms and identify four basic methodological approaches: conceptual, decision-oriented, nomothetic and action-oriented research. Since this dissertation applies features from several of the four above approaches, it is appropriate to survey work of Neilimo and Näsi (1980) briefly:

A. **The conceptual approach.** The notion of the approach is to describe, create and improve existing concepts and conceptual systems, or to construct completely new concepts. This approach prefers to describe the reality than to understand it. The results typically state and recommend, and are validated by reasoning and argument.

B. **The decision-oriented approach**. This approach aims at constructing models for decision-making and problem-solving. The resulting models may be simulations or mathematical formulae. The method is based on the principles of logic and mathematics. Although theoretical, empirical material can be used in this approach for testing and validation of the solutions created. This approach is favoured in operational research and management science.

C. **The nomothetic approach**. This is based on the positivistic and natural-scientific tradition [4], the use of empirical material which is often large and statistical analyses being distinctive features. This approach aims at establishing new causal laws and explanations mainly through statistically tested results typically operating with hypotheses which test the objectiveness and observability of reality, and are independent of the observer.

D. **The action-oriented approach**. Reality is conceived as objective and independent of the observer in the positivistic view. However, the action-oriented approach aims to create better, often subjective understanding of the reality that is, in practice, always tied to the observer. Typically only a few objects are studied in detail, and the empirical material of the case studies normally has a rather limited but important role. This approach has philosophically been linked to hermeneutics with its central concepts such as understanding, intentionality, teleological explanation and the historical background of phenomena (Lukka 1991).

The constructive approach. In addition to the four approaches, Kasanen et al. (1991, 1993), have added the constructive approach to the classification above. Recall that "innovative spirit" can be recaptured to develop new concepts for designing relevant management accounting systems (Johnson and Kaplan 1987, p. 17-18). Innovation is also a key issue in the constructive approach, which combines theoretical background knowledge with relevant practical problems and produces practical functioning solutions, even with a theoretical contribution (Figure 12).

4 This approach has its roots in logical empiricism, which can be considered as the main line of Finnish science since the 1930s, when professor Eino Kaila published his Der logistische Neupositivismus (Niiniluoto et al. 1992).

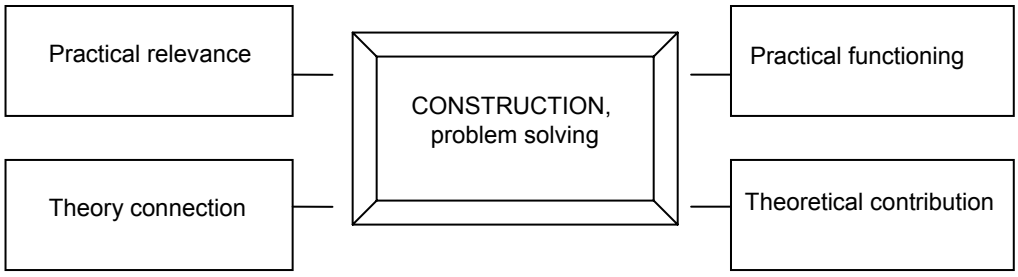

Figure 12. Elements of constructive research (Kasanen et al. 1993)

An example of using the constructive approach can be found in the doctoral thesis of Kasanen (1986). His strategic capital budgeting support system was later implemented at Farmos, a pharmaceutical company, as part of their strategic planning.

The "lost relevance" of academic research has inspired a lot of discussion (e.g., Johnson and Kaplan 1987, Lukka and Shields 1999), and has motivated the constructive approach research. Lukka and Tuomela (1998) report practical experiences in applying the constructive approach in enterprises and discuss the pitfalls of this approach. Lukka and Shields (1999) report 'intense interest in practice-oriented management accounting research'. Lukka (2000) argues that the need for constructive field research is linked to the issue of relevance. Lukka (2000) also outlines the core features of the constructive research approach and pinpoints management issues, including the potential benefits and risks of this approach. Kekäle (2001) applies this approach in his doctoral thesis that combines total quality management (TQM) and organisational culture.

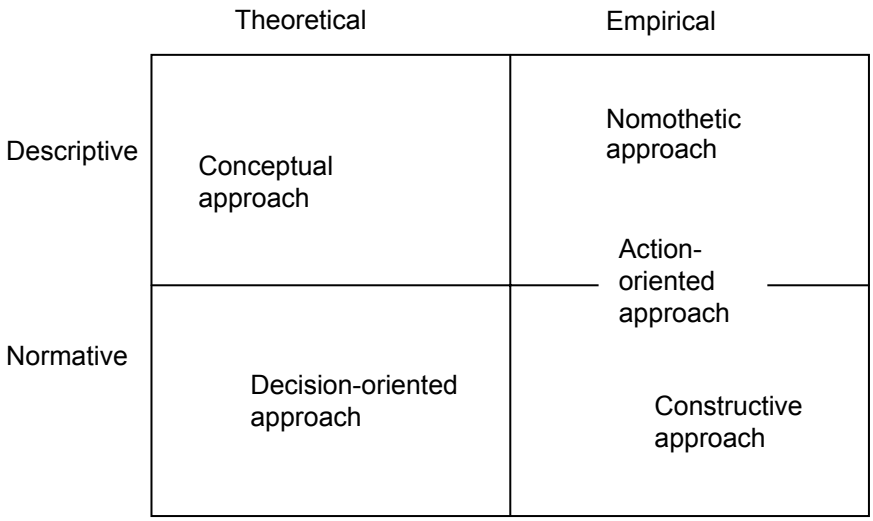

Figure 13. The location of the constructive approach in established business and industrial economics research (Kasanen et al. 1991, 1993)

The major criteria for a working solution and practical feasibility in applied sciences are the solution be relevant, simple and easy to use (Niiniluoto 1985, Kasanen et al. 1993). The constructive approach tends to be primarily positivistic and follows the procedure of developing constructions and testing them in practice (Olkkonen 1993). The constructive approach relies on the pragmatic notion of truth: what works is true. True ideas are those we can assimilate, validate, corroborate and verify (James 1955, p. 133, Lukka 2000, 2003). The requirement is that the new construction be implemented, which can be regarded as rather demanding (Lukka 2000).

Recall that the constructive approach can also be described by presenting it as a process. Kasanen et al. (1991) (1993) and Lukka (2000, 2003) have suggested the following stages:

1. Find a practically relevant problem, which also has potential theoretical significance.
2. Examine the potential for long-term research co-operation with the target organisation(s).
3. Obtain deep understanding of the topic both practically and theoretically.
4. Innovate a solution idea and develop a problem-solving construction which also has potential theoretical significance.
5. Implement the solution and see how it works.
6. Consider the scope of applicability of the solution.
7. Identify and analyse the theoretical contribution.

In all, the constructive approach emphasises creativity, innovation, and heuristics. The creativity and innovation are sources of the construction of a solution method while heuristics is the stepwise development of the solution and the testing of each step (Olkkonen 1993, p. 76). The potential benefits of conducting constructive research on

enterprises relate to the intention to put relevant managerial problems under critical scrutiny and have them processed in order to resolve them. However, there is also some risk that the research subject is too sensitive to be published and that the commitment of the target organisation cannot be maintained (Lukka 2003).

Kasanen (1986) and Kasanen et al. (1993) propose following market tests based on the concept of innovation diffusion:

- weak market test: has a business responsible manager been willing to apply the construction in his or her actual decision-making?
- semi-strong market test: has the construction been widely adopted by companies?
- strong market test: have the business units applying the construction systematically produced better financial results than those which are not using it?

Even the weak market test is relatively strict. It is probable that a tentative construction is rarely able to pass it (Kasanen et al. 1993, p. 253).

Summarising, the international discussion concerning research methodologies in business and industrial economics has been related to the following themes (Kasanen et al. 1991, 1993):

1. quantitative vs. qualitative research
2. positivistic vs. interpretative and critical research
3. extensive vs. small (case) data research.

This dissertation relies on quantitative and positivistic methodologies, but applies both extensive statistical data and case data research. Recall that the conceptual analysis can be seen as a natural element in studying current theories and concepts of accounting and forest economics. Here, precise accounting concepts and those of the national forest inventory (NFI) and portfolio management, for example, are needed. The decision-oriented approach is in line with the objectives of timber harvesting studies focusing on the optimal age for final felling in particular, with optimal portfolio and management accounting studies. The nomothetic approach has been applied in using statistical analyses and testing the competitiveness of forest ownership using risk-return and the capital asset pricing model (CAPM) at the national level. Finally, the constructive approach has been used in developing return on forest ownership measures and its splits at various levels and in applying IFRS/IAS accounting to the profitability book-keeping of the MTT Agrifood Research Finland. The constructions of this dissertation have been adopted into the METINFO (2007) of the FFRI and the EconomyDoctor (2007) of the MTT Agrifood Research Finland. The results of article V are ready for application in practice (FFRI 2006).

5 SUMMARY OF THE ARTICLES

This chapter deals with the content and some major contributions of the articles. The value of the whole study, as well as the limitations and future research will be discussed in chapter 7 below.

Article I. Risks and returns in forest ownership in Finland.
This article examines the return and risk of forest ownership in the spirit of modern portfolio theory (MPT), comparing forestry and other investments such as stocks, public bonds, private real estate, commercial real estate, and corporate debentures. The forestry return is based on stumpage prices, commercial felling volumes, silvicultural costs, and the growing stock volumes of the National Forest Inventories (NFIs). The novel solution constructions for estimation of return on non-industrial private forest (NIPF) ownership relies on NFI and means division of NIPFs from all forests, division both by tree species and by roundwood assortment. Moreover, annual volumes are needed and estimated using measurements performed only every tenth year of the NFI, annual felling volumes and calculated growth estimates. The data-base offered for return studies by the NFI could be described by the recent development of the total volume of growing stock by roundwood assortment (Figure 14).

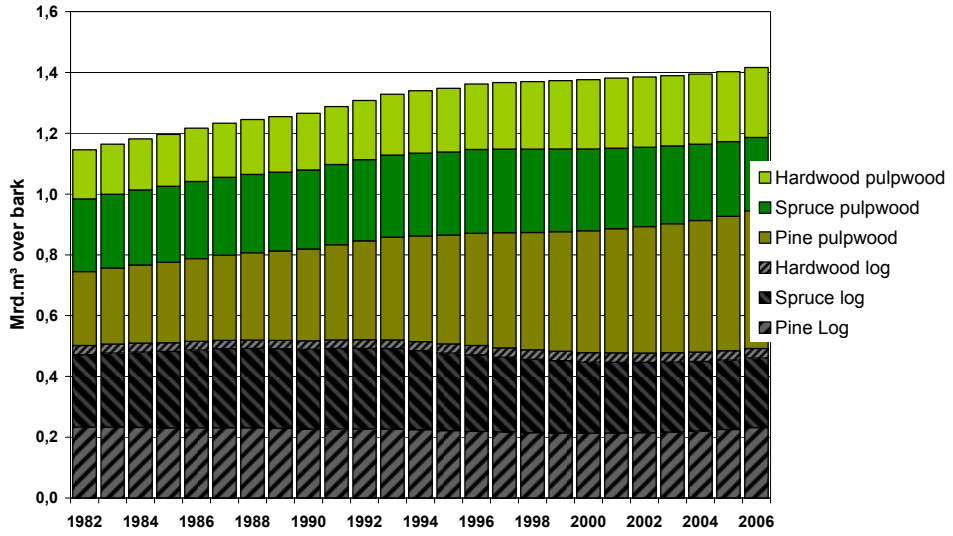

Figure 14. The growing stock development of non-industrial private forestry in Finland by roundwood assortment in 1982-2006

The analysis also includes inflation. Surprisingly, the results show that forestry has been both a high risk (15.5%) and low return (10.8%) investment in Finland over the period 1972-1994 with average inflation of 7.5%. The estimation methods have been developed applying the international, mainly U. S methodological tradition. In 1973, the non-industrial private forests (NIPF) market value was as much as 33% of the market portfolio but, only 9.9% in 1994, private real estate being the largest individual asset class. The correlation of forest ownership was significant with both private (0.62) and commercial (0.62) real estates. The risk-related Sharpe performance measure was surprisingly negative for forests in 1984-1994, which might have been influenced by the recession at the beginning of the 1990s.

The contribution and innovations of article I typically represent the constructive approach. However, the statistical analyses of return series clearly represent the nomothetic (positivistic) approach. Both lines have been developed further in subsequent articles II and IV. Lausti and Penttinen (1998b) have been provided Capital asset pricing model (CAPM) results.

Article II. The analysis of return and its components of nonindustrial private forest ownership by forestry board district in Finland.
This article constructs the estimation of return on non-industrial private forest (NIPF) ownership at the Forestry Board District (FBD) level. This estimation is based on the complete count of the commercial felling volumes, stumpage prices, silvicultural costs and state subsidies as well as the growing stock as defined in the National Forest Inventory (NFI). The NIPF ownership returns and risk in Finland are both estimated and disaggregated to local Forest Board District (FBD) level. Additionally, the FDB level returns are divided into price change, felling and change in the growing stock components, which are compared with the inflation rate. The forest ownership returns are compared with that of housing in the case of the largest one, the North Savo FBD. Moreover, the influence of taxation is discussed as well.

Results show that price component has been larger in northern FBDs, as much as 0.9% above the inflation in Lapland FBD, than in southern FBDs, 1.5% less than the inflation rate in Helsinki FBD. The net increase, however, has been larger in southern FBDs than in northern, 0.6% above the average in the south Karelia FBD compared with 1.8% less than the average in the North-eastern FBD. The real returns on NIPF ownership and on private housing are of the same size, roughly 3%, their correlation being 0.6. The taxation drops the real return to the level of 2.5%. In all, the differences between FBDs were greater than expected, even in forest-owner behaviour such as fellings, which is why the average volume change component was typically 1.1%-2.1% in southern FDBs but only -0.7% and +0.3% in north-eastern and Lapland FBDs.

Finally, the estimation methodology developed also serves as a spin-off product development for METINFO, the Internet service of the Forest Statistics Information Service (FSIS) of the Finnish Forest Research Institute (FFRI).

Article II is a construction which lays the foundation for the results at the national level in article IV.

Article III. Accounting as a management tool for nonindustrial private forestry.
Forest owners have to decide whether to invest more in their property, or to disinvest. They have to find ways in to increase revenue and cut costs. The notion of this article is to develop forestry accounting theory and to evaluate various profit concepts, analyse the

powerful fluctuations that are typical of forestry beyond the reach of regular accounting, and eliminate the impact of inflation and evaluate future opportunities. The article proposes principles for profit and loss accounts and balance sheets for non-industrial private forest (NIPF) owners by applying business accounting practices to traditional forest accounting. Moreover, it argues that it is important for the forest owner to complement the strictly regulated accounting with contingent adjustments. The harmonisation of forestry accounting with the EU directives and the EU's Farm Accountancy Data Network (FADN) are also recognised and applied. The article offers a covering review of forestry accounting literature and practice. An economic analysis of a medium-sized forest holding illustrates the importance of this type of adjustment, and depicts extensive, balance and intensive owner strategies.

Article III is primarily an accounting construction, although the concepts and the conceptual approach are fundamental to it. The results have been used and developed further together with the MTT Agrifood Research (Penttinen et al. 2004, 2005a, 2005b) employing an IAS/IFRS construction of forestry accounting and an estimated construction of the value of forest holdings. These applied results have been applied to profitability farms, in which the MARTTI profitability bookkeeping system of MTT Agrifood Research Finland and the MELA forest management planning system of the FFRI discuss via Internet applying the XML protocol (Latukka et al. 2005).

Article IV. The competitiveness and return components of NIPF ownership in Finland.
The return on non-industrial private forest (NIPF) ownership has been constructed at the national level. Moreover, an innovation has been provided by dividing the return into (i) felling, (ii) price change, (iii) change in growing stock and (iv) silvicultural cost components. The sensitivity of the return on forest ownership has also been analysed as decreasing or increasing the non-monetary items of the felling value using the sensitivity parameters.

These constructions allow comparison between stumpage price change and inflation as well as between forests and other assets. The return on private housing, offices, bonds, debentures and stock as well as its subset, forest industry stocks, have been estimated as well. The competitiveness of forest and forest industry stocks has been assessed in the framework of the Finnish portfolio using the risk-adjusted Sharpe ratio, correlation, etc.

Forest industry stocks produced a real return of 7.6% in the 1972-2003 period, housing 4.6% and forest ownership only 2.6%. However, forest holding market price studies suggest that the felling values of forest property which are used should be reduced by 10-20% in order to obtain the market value. The 2.6% return should be replaced by 3.0%-3.4%. The nominal return on forest ownership of 8.4% in 1972-2003 consisted of a stumpage price change rate of 4.6%, commercial fellings 3.1%, costs -0.35% and volume change component 1.0%. One may note that stumpage price change did not exceed the inflation level of 5.8%. The correlation with forest ownership was statistically significant only with private housing (0.55), which raises the question of whether forest owners use timber sales income to buy apartments for themselves and their children. In all, competitiveness benchmarking places forests slightly behind housing. The findings of this publication have been incorporated into the METINFO Internet service (METINFO 2007) of the Finnish Forest Research Institute. The same spin-off product can be shown in form of a picture (Figure 15)

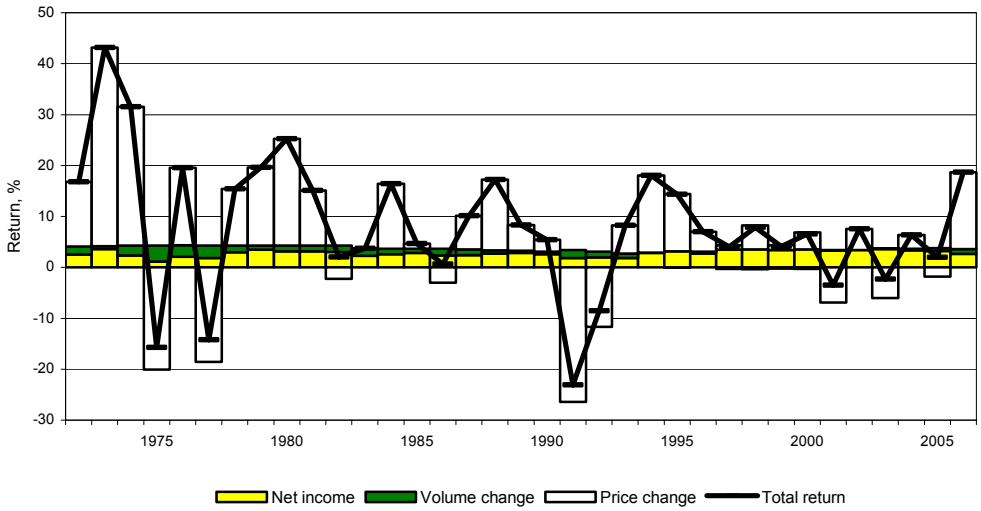

Figure 15. Nominal return on forest ownership and its components 1983-2006 (Uotila and Lausti 2007)

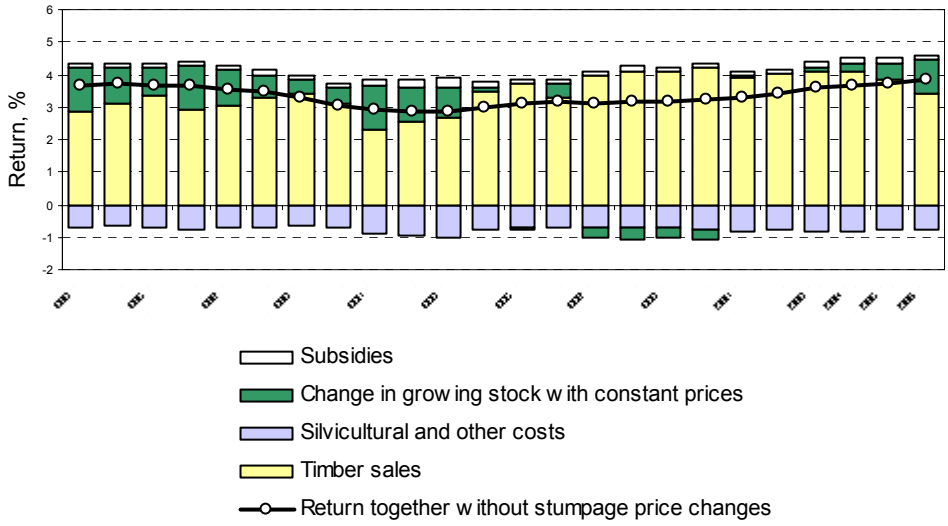

Figure 16. Real return on forest ownership without stumpage price changes and its split into timber sales, costs, value of the volume change in the growing stock, and subsidies 1972-2006 (Uotila and Lausti 2007)

Article IV finalises the return on forestry and its split construction, but also contains some nomothetic statistical analyses. The results suggest further studies concentrating on the sensitivity and accuracy of the estimates, especially that of NIP forests market value estimates. As an illustration, Figure 16 depicts the return on NIPF ownership and its split 1983-2006 without stumpage price changes.

Article V. Impact of stochastic price and growth processes on optimal rotation age.
Some forest industry enterprises see their own forests as "idle capital", which stems from slow turnover in ROI ratios (see Figure 2) such as ROA (Figure 6). This article questions whether the Forestry Development Centre Tapio (2001) timber harvesting age recommendation applied in Finland is too conservative. The recommended lowest timber harvesting age of the case stand is 80 years, but the optimal rotation age is roughly 70-75, depending on the interest rate. The crux of this article is, however, the impact of stochastic prises and growth on the optimal rotation age, both volatilities which lengthen the optimal rotation age. However, the impact of growth volatility is modest.

The Finnish empirical evidence including stumpage prices, silvicultural costs, etc., since 1949 covers all non-industrial private forestry (NIPF). Optimal harvesting age solutions and numerical results recognising price drift, price and growth volatility, volume growth, value growth and stand establishment costs, as well as thinning benefits, are provided for Scots pine by proxying the stumpage price and volume growth processes by geometric Brownian motions. Moreover, comparative static and sensitivity solutions, including numerical results, show the impact of the discount rate, price drift, and price and growth volatilities on optimal harvesting age.

Price volatility prolonged harvesting age by some 5-9 years, and growth volatility by about 1- 2, but negative price drift for discount rates from 5% to 2% fell by roughly 6-10 years. Ignoring the future thinning benefits prolonged the harvesting age only by 1 – 2 years, but ignoring future stand establishment costs reduced it by 2 – 4 years. Including the price drift and volatility broke the 70 year age limit in the Forest Act for discount rates exceeding 3.5%. The recommended harvesting age of 80 years could be established only by ignoring the price drift.

Here, stumpage price and volume growth volatilities has been recognised in addition to other economic parameters and timber growth models. The result suggests that a *Vaccinium type* (VT) pine stand (height at the age of hundred years 24 metres, $H_{100} = 24$) should be harvested at an age of years, when the observed negative price trend is recognised as well. The negative price and cost trend also shorten the optimal rotation age also with deterministic models (Penttinen 2000). At the same time one can see what the loss is should the stand be harvested at the recommended age of 80 years, which is the recommendation of the Forestry Development Centre Tapio (2001). This has been relaxed to 70 years in the new recommendations (Tapio 2006) (Figure 17).

Article V is a typical operational research contribution thus representing the decision-oriented approach. The study produces solutions and programs that can be incorporated into MOTTI Hynynen et al. 2005) and MELA (Redsven et al. 2005) forest management planning software products widely used in Finland.

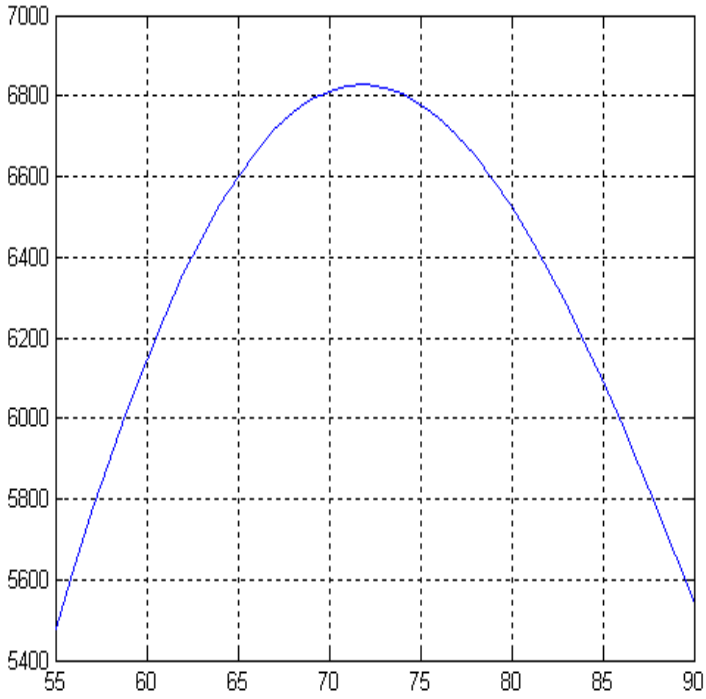

Figure 17. The value of a forest stand as a function of final felling age discounted to the age of 70 years (Penttinen 2006)

6 DISCUSSION AND CONCLUSION

This chapter assesses the general value of this dissertation and its contribution to present knowledge, and discusses its limitations and some ideas for further research.

6.1 The contribution of this research

This dissertation provides new insight into present knowledge of the management of forest assets. Both politicians and scientists have had and still espouse dramatically conflicting theories, paradigms and views concerning this issue.

The present studies start with the preliminary research analysing the profitability of forestry in the forest economics tradition. Forestry accounting is then needed to develop and test book-keeping and cost accounting frameworks. Moreover, estimates for return on forest ownership as a proxy for forestry profitability are constructed using notions of finance. These return on investment (ROI) figures require an estimate of the non-industrial private forests at the forest centre (FC) and national levels. Finally, splits have been constructed for fellings, price change, change in the growing stock value and costs components both at the FC and national levels.

The studies provide

- estimates of the profitability of forestry using the difference between the planned cut of the forest management plan and the actual cut for the estimate of the change in value of the property,
- forestry accounting results for book-keeping, ratio analyses, and cost accounting
- an estimate of return on forest ownership at the FC and national levels
- a comparison between asset classes such as forests, stocks, its subclass forest industry stocks, as well as apartments, offices, bonds and debentures
- a split of return on forest ownership at the FC and national levels into felling, price change, value of growing stock change, and cost components
- the optimal rotation age
- sensitivity and error considerations to evaluate the impact of parameter and input changes on the results.

The research covers crucial areas of business economics of forestry, forestry accounting and forestry related finance. The key finding is the observation that the risk estimate, long-term return series and modern portfolio theory (MPT) approaches are needed in order to evaluate the competitiveness of forests as against other investments as demonstrated by Hyytiäinen and Penttinen (2007) (Figure 18).

Neither profit nor return on investment (ROI) estimates are sufficient for decision-making. The applicability of the capital asset pricing model (CAPM) was also tested in Lausti and Penttinen (1998b, 2007).

The constructions developed to estimate the return on forest ownership and to split into price change, felling, change of the value of the growing stock and costs have been implemented in the METINFO Internet service.

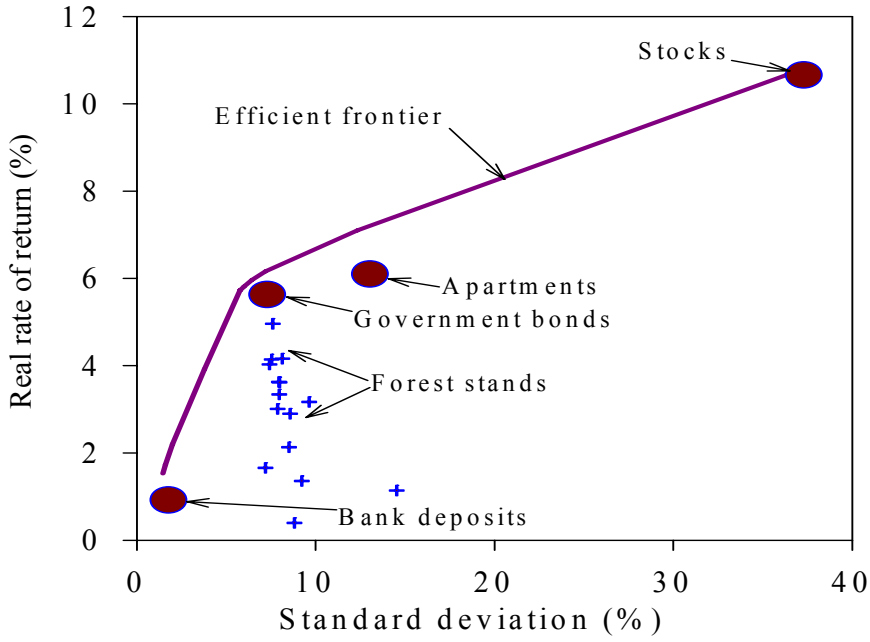

Figure 18. Efficient frontier and combination of returns and risks for alternative asset classes (Hyytiäinen and Penttinen 2007)

6.2 Limitations of the study and possible improvements

The assessment by the taxes on real property values when proxying the return on forest ownership (Larsen & Riis 1997, Lundgren 2005) hardly reflects the market economy. On the one hand, the fluctuations in the developed return on forest ownership proxy may in fact lead to excessive risk estimates compared to the forest-holding markets. On the other hand, most forest owners usually never buy or sell holdings. This means that using forest-holding market prices for return estimates leads to bias, especially because most holdings offered have a modest or very modest allowable cut. The limitations of these different market processes invite analysis of both markets and their relations together.

There are limitations both in the empirical evidence and methods. Long return series are needed for comparisons. The 1972-2005 time-series are affected by the almost complete turn-around in the economic environment. In the 1970s, the Finnish economy was closed, inflation was high, and devaluation was used as a standard solution to profitability and productivity problems. Nevertheless, forest industries entered in competitive international markets. Nowadays, the Finnish economy is open, inflation is low, and no devaluation option exists, but the floating euro exchange rates in US dollars, Swedish crowns and other currencies impact on business opportunities.

Since the capital asset pricing model (CAPM) employs primarily nominal returns (Elton et al. 2003), figures from the 1970s to recent years can be incorporated into a model. Moreover, diagrams of real returns rather than nominal returns illustrate a different

economic era.

Advancement in methodology also suffers from the limitations of the empirical evidence. For example, advanced conditional CAPM models with heteroscedastic variances would benefit from semi-annual and quarterly return series. The non-conditional CAPM focuses on correlation in addition to returns and risks, but ignores both skewness and kurtosis. Moreover, there is no forestry profitability bookkeeping as is the case in central Europe, which limits the application of modern accounting methods. Sensitivity and error analyses can be developed further in future studies. An important advance might be the inclusion of foreign assets such as the return series of the customers of the Finnish forest industry as in a CAPM study. Leading indicators could also have been sought from central European and other markets. Moreover, an analysis connecting the returns to national economy using arbitrage pricing theory (APT) would be needed.

6.3 Suggestions for further research

This dissertation has laid the foundation for forestry profitability and forest ownership returns, which are nowadays included in the METINFO Internet service of the Finnish Forest Research Institute. There are obvious needs to improve the empirical base; e.g., by implementing annual national forest inventory (NFI) measurements, semi-annual return estimates, and by implementing a covering forestry profitability monitoring, perhaps as part of agricultural profitability book-keeping network of MTT Agrifood Research Finland. Moreover, product development of the MOTTI forest stand level planning software (Hynynen et al. 2005) would benefit from applying a real option approach (Dixit and Pindyck 1994, Yin 2001, Jacobsen and Thorsen 2003, Malchow-Møller et al. 2004) and solving optimal rotation problems using mean-reverting processes (Insley and Rollins 2005).

One important area to work through is the optimisation studies such as the optimal portfolio of an institutional investor and of individual forest owners with and without short sale of those assets called negative holdings (Sharpe 1991). The observed investment behaviour of institutional investors and forest owners could be included as background information. Moreover, various funds could be included in the assets as well. The optimal portfolio could be searched for different types of owners and owner groups with special limitations.

The availability of forest management plans enables the connection between forest stands and asset classes in the modern portfolio theory (MPT) framework. It would then be possible to build aids and tools in which all stands have been linked with asset classes using the expected return and risks of all stands and assets as well as covariance between stands and assets. This connection allows a new approach to implementing optimal rotation, also called timber-harvesting solutions. Then an interesting research question concerning the optimal harvesting policy is the influence of the initial wealth of forest owners, which tends to impact heavily on the felling behaviour. (Hyytiäinen and Penttinen 2007)

In analysing the competitiveness of forests and the forest industry, both advanced CAPM, arbitrage pricing theory (APT), co-integration and system dynamics models in the European and world context would produce additional and more detailed results. Finally, Bayesian and fuzzy portfolio selection methods would produce some additional insights to the forest owner's investment and financing strategies.

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