

ANTREI LAUSTI

The Inflation-Hedging Characteristics of Forest Ownership, Private Housing and Stocks in Finland

ABSTRACT

This paper investigates the extent, which forest ownership, private housing and stocks are a hedge against the expected and unexpected components of inflation in Finland over the period 1973–2003. The expected inflation is proxied by using inflation forecasts of the Research Institute of the Finnish Economy (ETLA). Unexpected inflation is the difference between actual inflation and this inflation forecast.

Forest ownership and private housing have been effective hedges against unexpected inflation. Stocks did not provide a hedge against inflation at a statistically significant level. It is valuable to have a hedge against unexpected inflation, because the inflation hedge against expected inflation can often be obtained through bond markets.

Forest ownership is also an asset class which requires a long investment period. The longer the investment period for a particular asset is, the more important inflation hedging characteristics are. In longer five-year and ten-year holding periods, forest ownership has provided some hedge against expected inflation and very effective hedge against unexpected inflation.

Key words: *forest ownership, private housing, return and risk, inflation, hedging, expected inflation, unexpected inflation.*

ANTREI LAUSTI, M.Sc. (Econ), Associate researcher

Finnish Forest Research Institute, Vantaa Research Center • e-mail: laustia@yahoo.com

1. INTRODUCTION

It is generally accepted by practitioners and researchers that stock prices are influenced by a number of different economic factors. However, so far there is no satisfactory theory that would suggest that the relation between stock markets and the macroeconomy was entirely in one direction. (see Chen, Roll and Ross, 1986). The evidence about the relationship between stock returns and inflation is a little bit mixed as well. However, most studies support Fama's (1981) suggestion that higher inflation may proxy a drop in the money demand induced by lower growth in real activity, which simultaneously implies a drop in stock prices and hence a drop in stock returns. This means that there is a negative relationship between stock returns and inflation, and stocks do not hedge against inflation.

Asperem (1989) found that there was a negative relationship between stocks and inflation in most of the European countries (Finland, Denmark, France, Germany, the Netherlands, Norway, Sweden and Switzerland) and a positive correlation only in the United Kingdom over the period of 1968–1984. He says that the negative correlation between inflation and stock prices can be explained through a combination of the money demand theory and the Fisherian quantity theory of money. Another common hypothesis is the Fisher Hypothesis (1930), which assumes that real stock returns are independent of inflationary expectations. Many studies have rejected this hypothesis. Solnik (1983), for example, rejected this assumption for each major stock market of the world. Wahlroos & Berglund's (1986) findings also firmly reject the Fisher hypothesis, using Finnish stock returns over the period 1970–1982. They found that real returns depend negatively on unexpected inflation and expected inflation.

Lahti & Pylkkönen (1989) found that macroeconomic news explained about ten per cent of the variation in stock prices, but news concerning inflation and real interest rates was statistically significant in explaining changes in stock prices over the period 1962–1987. An unanticipated increase in inflation by one per cent led to an approximately one per cent decrease in stock prices.

Kanniainen & Kurikka (1984) suggested that firms differ from one another in their financial policy and asset composition and these differences may cause differential inflation effects on their earnings. The country-specific features of taxation of corporate income are also important in assessing the effects of inflation. They found that inflation was rather good news than bad for the stock market in Finland, i.e. there was a positive relationship between stock returns and inflation over the period 1968–1981. Viskari (1992) found that news about inflation hardly explained the variation in stock returns at all and that this relationship was insignificant over the period 1982–1990.

It is often important for the institutional investor, who has a long investment horizon, to

hedge his /her portfolio against inflation. But it seems that stocks do not provide a good hedge, another asset class perhaps having better inflation-hedging characteristics. The asset pricing mechanism may be different among other asset categories. Traditionally timber has been considered to be a good hedge against inflation. For example, Redmond & Cabbage (1988) suggest that inflationary expectations play a major role in determining the price of stumpage and, furthermore, that the negative Capital Asset Pricing Model betas for the stumpage price series might indicate that forest assets are held as a store of value against any inflation times. This hypothesis has not been tested comprehensively, because there has not been a return series available for forest ownership at individual national level. Only a few studies in the U.S.A. address this issue using stumpage price series as a proxy for individual tree species returns (Washburn & Binkley, 1993). Penttinen et al (1996) developed a methodology to estimate return series at the national level. In our earlier paper, a return series on forest ownership was constructed at areal forest board district level (Lausti & Penttinen, 1998b). The results show that the average real return of forest ownership has been about 3% over the high inflation period 1972–1983 and low inflation period 1984–1994. And Penttinen & Lausti (2004) found that the average real return has been 2.6% over the period 1972–2003. This suggests that forest ownership might have some ability to hedge against inflation. Forest ownership is also an asset class that requires a long investment period. The longer the investment period for a particular asset, the more important inflation- hedging characteristics are.

Another interesting asset class is private housing, where the increase in the rents occurs periodically and increases often more if inflation is higher. The rent is an important part of the return. For example, Fama & Schwert (1977) found that private residential real estate was a complete hedge against both expected and unexpected inflation. Önder (2000) tested the hypothesis that in Turkey the real estate investment provides a hedge against both expected and unexpected inflation. He found that in a high inflation environment, real estate did not provide hedge against inflation.

This paper investigates whether forest ownership and private housing are good hedges against inflation on their own and in a portfolio with stocks.

Asset pricing theory suggests that investors prefer a portfolio with returns that are insensitive to departures from inflation expectations. This means in an extreme case a portfolio with a regression coefficient of unexpected inflation equal to zero. Such a portfolio can be formed by combining assets that hedge higher than expected (the unexpected inflation regression coefficient is positive) with those that hedge lower than expected (the unexpected inflation regression coefficient is negative). Prior empirical work indicated that most financial assets, including stocks and bonds, have historically hedged lower than expected inflation. Thus the capacity to hedge higher than expected inflation should be priced positively in the asset markets

(Washburn and Binkley, 1993).

The purpose of this paper is to estimate the inflation hedging characteristics of forest ownership, private housing and stocks. The contribution of this study is to use first-time, comprehensive, national level return series for forest ownership to estimate their relationship to inflation. Previously this has been done only at individual regional level. For example, Washburn & Binkley (1993) estimated the relationship between some individual roundwood assortment returns (Western national forest softwood stumpage, Louisiana stumpage and Maine Stumpage without net increment) and unexpected inflation. This paper is the first to use systematically created value-weighted return series that include all economically relevant roundwood assortments (in Finland) to estimate the inflation-hedging characteristics of forest ownership. This forest ownership return includes the net increment of the growing stock in addition to stumpage prices, i.e. this is an actual return index. This paper is also the first study in Finland to estimate the inflation-hedging of other asset classes than stocks, namely private housing, in addition to forest ownership. The effect of adding forest ownership to portfolio with stocks or private housing with respect to inflation-hedging capabilities is also considered. The inflation has been divided into unexpected and expected components, which is a common practice in inflation-hedging studies of different asset classes (for example Fama & Schwert 1977, Solnik 1983). The relationship of forest ownership with respect to expected inflation and unexpected inflation has been little researched.

This paper is organised as follows: Section 2 reviews the previous studies. Section 3 presents the data and estimation methodology for forest ownership value-weighted return series. The method of constructing return series for private housing is also presented. This section includes test methodology as well. Section 4 discovers the descriptive statistics of the asset classes. Section 5 presents results and sensitivity analysis, and section 6 concludes the paper.

2. PREVIOUS STUDIES

The inflation-hedging capabilities of different asset classes have extensively been studied. A seminal paper for estimating asset returns and inflation was produced by Fama & Schwert (1977), who found that U.S. government bonds and bills were a complete hedge against expected inflation, and that private residential real estate was a complete hedge against both expected and unexpected inflation. Common stocks were negatively related to the expected component of the inflation rate and to the unexpected component as well over the period 1953–1971.

Solnik (1983) studied the empirical evidence on the relation between stock returns and inflationary expectations for nine countries over the period 1971–1980. He investigated the

Fisherian assumption that real stock returns are independent of inflationary expectations. Solnik rejected this assumption for each major stock market of the world. He found a significant negative relation between the stock returns and inflationary expectations for every country in the study.

Miles & Mahoney (1997) studied the inflation hedging characteristics of commercial real estate. In addition to quarterly holding periods, they used longer investment holding periods of ten years. When they used quarterly data, commercial real estate was a complete hedge against expected inflation, but an incomplete hedge against unexpected inflation. When they used a ten-year holding period return, the results were the same, except that the relationship between stocks and expected inflation was now positive.

Murphy & Kleiman (1989) studied the inflation-hedging characteristics of equity real estate investment trusts (REITs). According to them, previous studies have invariably used appraisal-biased or cost-based valuation series to measure real estate returns, so that such real estate data suffers from data deficiencies. Appraisal-based valuation series are smoothed and so underestimate the true variability in real estate values. When using monthly holding periods they found that equity REITs had a negative regression coefficient with both expected and unexpected inflation rates, but the significance of the negative association declined when the holding period increased. The overall results were that REITs did not represent effective inflation hedges and may instead magnify purchasing power loss over short holding periods. Lu & So (2001) investigated the relationship among REITs returns, real activities, monetary policy and inflation through Vector Error Correction Model. They found that the observed negative relationship between Reits returns and inflation was merely a proxy for the fundamental relationship between REITs returns and other macroeconomic variables.

In studies with Finnish data, Wahlroos & Berglund (1986) found highly a significant negative relationship between nominal stock returns and expected inflation. Real stock returns were found to depend negatively on unexpected inflation as well. Martikainen and Yli-Olli (1991) found that various inflation measures are identified as Arbitrage Pricing Model factors on Finnish stock returns.

There are few studies that investigate the inflation hedging potential of forest assets. These studies have been done with respect to some regional tree species. Washburn and Binkley (1993) studied the inflation-hedging properties of the forests in national forests in the West, private forests in the Louisiana and private forests in Maine. They used variation in historical rates of change in the price of sawtimber stumpage as a proxy for variation in rates of return for entire forest properties. They measured the inflation-hedging properties of forest assets in a portfolio context with stocks. They also measured the relationship between forest assets and unexpected inflation, the expected inflation was not included at all. Results indicate that for-

ests in the West and in Louisiana have been effective hedges against higher than anticipated inflation. The regression coefficient of unexpected inflation changed from 3.1 to 6.1 in the West and from 2.3 to 5.9 in Louisiana in a portfolio context with stocks. Maine forests were less effective hedges against unexpected inflation. The regression coefficient also changed from 0.37 to 0.84 in a portfolio context with stocks.

Washburn and Binkley (1990) studied the informal efficiency of markets for pine sawtimber stumpage in the U.S. South. In their analysis they used weak-form efficiency tests with stock-market models and inflation-based market models. Analyses of annual and quarterly rates of price change indicated that stumpage markets are efficient. When viewed over monthly intervals, stumpage markets did not pass the tests for weak-form efficiency.

3 DATA, ESTIMATION METHODOLOGY FOR RETURN SERIES AND TEST METHODOLOGY

3.1 Forest Ownership Asset Class

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

Forest ownership is considered as an asset class in this study. The market return for stocks is composed of the stock price appreciation plus dividends. A similar construct may be derived for 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 the increment of the standing timber. This total amount reflects the total return on forest ownership. Only non-industrial private forest ownership is included in this study.¹

The National Forest Inventories (NFI) has a long tradition in Finland. The sixth NFI was carried out in 1971–1976, the seventh in 1977–1984, and the eighth in 1986–1994. Since the NFI9 results from 1996–2003 are available from twelve forest centre areas (Peltola 2003), NFI 8 is also used to cover the years after 1994 by extrapolation for Lapland.

There are two points of focus: (i) roundwood assortment volume and (ii) net roundwood assortment increment.² In the three inventories there are thus three measured growing stocks of all six (6) roundwood types and net increment point estimates of three (3) tree species, pine,

¹ Forest ownership means non-industrial private forest ownership in this study.

² In order to provide net increment volume estimates, natural losses were subtracted from gross increment volumes (see the terminology of the United Nations 1992, p. 67).

spruce, and broadleaves. The six (6) roundwood assortments are pine logs, spruce logs, broadleaf logs, pine, pulpwood, spruce pulpwood and broadleaf pulpwood. These estimates are for all nineteen (19) Forestry Board Districts (FBDs).³ The measurement methodology developed to tackle the separate estimation problems of growing stock, net increment, roundwood assortment and commercial roundwood fellings has been listed in Lausti and Penttinen (1998a).

3.1.2 The Definition of the Return on Non-industrial Private Forest (NIPF) Ownership

In this study, the roundwood assortment stumpage price vector P forms a cornerstone of the estimation process in the return on non-industrial private forest (NIPF) ownership. The other cornerstone is the volume of the roundwood assortment growing stock vector V . The change in the growing stock over a year is based on the net volume increment vector after the natural losses I , also called net increment of the growing stock, and the fellings vector F .

In order to be more descriptive, the return on roundwood assortment has been calculated separately for each roundwood type a , $a = 1, 2, \dots, 6$, and each year y , $y = 1972 \dots 2003$. The return on NIPF ownership of a roundwood type is estimated using the following formula (see Binkley and Washburn 1990):

$$(1) \quad r_{ya} = LN \left(\frac{P_{ya} V_{y-1,a} + P_{ya} I_{ya}}{P_{y-1,a} V_{y-1,a}} \right)$$

- where
- a = Roundwood type a
 - y = the year considered
 - r_{ya} = Return on roundwood type a during year y
 - $P_{ya}(P_{y-1,a})$ = Roundwood type a stumpage price at the end of year y (at the end of year $y-1$)
 - $V_{y-1,a}$ = Roundwood type a volume at the end of year $y-1$
 - I_{ya} = Roundwood type a net increment stock during year y

A return formula based on stumpage prices, growing stock index, harvesting volume, and cost has also been proposed also by Thomson (1989, p. 1386). However, he assumes a constant growing stock index, which is actually constant only for a fully regulated forest. This limitation does not fit the empirical Finnish NFI evidence.

³ The organisation into 19 FBDs has now changed. A new regional organisation for 14 Forestry Centres was established on March 1, 1996. Calculations are based on Forestry Centre data from 1983 onwards.

First, the return on NIPF ownership $r_{y,NIPF}$ during year y at the national level is produced here by estimating the sum of the growing stock, the change in the growing stock and felling values across the roundwood assortment.

$$(2) \quad r_{y,NIPF} = LN \left(\frac{\sum_{a=1}^6 P_{ya} (V_{y-1,a} + I_{ya} - F_{ya}) + \sum_{a=1}^6 P_{ya} F_{ya} - C_y}{\sum_{a=1}^6 P_{y-1,a} V_{y-1,a}} \right),$$

where the sigma Σ stands for a sum and

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

C_y = Silvicultural and forest improvement costs reduced by state subsidies during year y .⁴

The commercial fellings are needed, however, only for the return component split and sensitivity analysis section in this study. Second, the bare land value is considered. Some studies include the value of bare land (LV_y) in the return formula (5) above, both LV_y in the numerator and LV_{y-1} in the denominator (Thomson, 1991a, 1991b). This inclusion is not actually corroborated by the empirical findings of Finnish forest evaluation studies, which suggest that the felling values of forest holdings have in most cases been higher than their actual market prices. For example, the fellings value exceeded the actual market values in 1985 on average by 20% (Hannelius 1988). Consequently, the bare land value is ignored in the calculations because of the empirical market price evidence.

Moreover, the discounted value of future harvests as suggested by Thomson (1991a, 1991b) suffers from the serious circularity problem already discussed by Speidel (1984). An assumed "theoretical" input discount rate is needed in order to achieve an "empirical" output rate of return. Wagner and Rideout (1991) discussed a similar problem, which occurs in estimating the cost of capital and the systematic variability of firms which do not have publicly traded stock.⁵

Third, the forest land market price changes are focused on. If the forest land market value appreciates or depreciates by the same amount as stumpage prices, the return result based on the land market values is the same as the return estimate based on the stumpage price and the

⁴ One has to emphasise that the empirical cost data are available only at the national level. No disaggregation on areal basis, by tree species or by roundwood assortment, the last of which would be needed in (5), can be estimated.

⁵ Market proxy data associated with an asset might be generated using a cost of capital based on its CAPM beta. However, since a CAPM beta cannot be estimated using traditional methodology until this data becomes available. Wagner & Rideout (1991) used an income growth model as an alternative approach in estimating a cost of capital for an unlisted firm.

net increment series. If forest land value changed less than the return on NIPF ownership (5), the returns would be less than those based on the stumpage price and net increment series (Cubbage et al. 1989).

The change in the annual median (unweighted) of the forest land sales price was 2.1% in 1983–1997. These sales statistics include unimproved land and forest holdings. The price change component of the NIPF ownership return based on the felling value estimate was 2.8% over the same period

3.2 Private Housing

Private housing data includes a large sample, covering 20 largest cities in Finland. It also includes smaller cities that have been combined into larger regions. From 1983 onward the sample has included at least 12 000 trades yearly. The statistics are based on real trades, buying offers without actual trades not being included. The private housing rents sample included 7473 rentals in 1994. The rent data are on an annual basis. Rents are gathered as a divided sample, the population being divided by size, location, type of finance and type of private housing. Rent statistics have been compiled by Statistics Finland. The cost side included, for example, 1387 housing corporations comprehensively located around Finland in 1994, and 797 in 1982. The cost side includes the maintenance charge and capital charge of private housing. Cost statistics have been compiled by Statistics Finland.

The return on housing and offices investment includes capital appreciation and the rent component minus the cost component:

$$(3) \quad R_{y(h)} = LN \left(\frac{P_y + N_y - C_y}{P_{y-1}} \right)$$

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 private housing costs per square metre.

3.3 Stocks

Over the period 1972–1989 the WI-index returns were used. WI-index has been calculated by the Swedish School of Economics and it is described in greater detail in Berglund, Wahlroos and Grandell (1983). This index is the value-weighted sum of individual stock return indexes based on the average trading price for the day, or in its absence, on the bid price, corrected for dividends, splits, stock dividends and new issues. The corrections are based on the assumption that all proceeds are reinvested into the stock from which they derive at no transac-

tion cost (Wahlroos & Berglund, 1986). From 1990 to 2003 Helsinki Stocks exchange Hex-return index has been used. All the stock returns include dividend payments and share issues of the companies. All the returns and indices are logarithmic.

3.4 Expected Inflation and Actual Inflation

The expected inflation has been estimated by using inflation forecasts of the Research Institute of the Finnish Economy (ETLA). ETLA makes inflation forecasts in their quarterly publication series called "Suhdanne". At the beginning of March they forecast inflation for the current year and following year level and provide some basic reasoning for their forecast. Then they give another revised inflation forecast for the current year and for the following year in the beginning of September. Research Institute of the Finnish Economy started their inflation forecasts back in 1973.

In this study ETLA's inflation forecast for the current year published in March is used as an estimate of expected inflation for use in annual data. With semiannual data the following procedure is used for expected inflation: the first half of the year is derived by dividing the March forecast into two equal parts, assuming that inflation expectations are equal for both parts of the year. The expected inflation for the second half of the year is then derived by using the September forecast. The actual inflation for the first six months of the current year is deducted from the September inflation forecast figure, and the remaining part of this forecast is used as expected inflation for the second half of the year. The advantage of this forecast is that is regularly available to the public at a predetermined time.

To summarise, the expected inflation is estimated as:

$$\text{yearly data} = E_{f, \text{march}}$$

$$\text{semiannual data, 1. half of the year} = \frac{E_{f, \text{march}}}{2}$$

$$\text{semiannual data, 2. half of the year} = E_{f, \text{september}} - P_{\text{january, june}}$$

where $E_{f, \text{month}}$ is ETLA's inflation forecast for the current year, and the publishing month of the forecast and $P_{\text{january, june}}$ is the actual inflation during the first half of the year.

Research Institute of the Finnish Economy attempts to forecast the change in the consumer price index. However, this study uses the change in cost-of-living index to calculate actual inflation. This index tracks the consumer price index very closely. Statistics Finland recommends that in examinations extending more than five years, it is better to use the cost-of-living index. A different measure for inflation may not affect the results. Wahlroos & Berglund (1986) found that different measures of inflation produced almost identical results with stock returns.

3.5 Test Methodology

Irving Fisher (1930) showed that any one-period nominal return on an asset can be broken into an expected real return and an expected inflation component.

$$(4) \quad E(R_t | \phi_{t-1}) = E(r_t | \phi_{t-1}) + E(P_t | \phi_{t-1}),$$

where R_t is the nominal return on the asset, $E(r_t | \phi_{t-1})$ is the equilibrium expected real rate, and $E(P_t | \phi_{t-1})$ is the expected inflation rate. The market uses the information set ϕ at time $t-1$ to assess the expected rate of inflation and to determine the expected real return on assets with an appropriate risk premium. Prices are then set such that the expected nominal return is the sum of the equilibrium expected real return and the best possible assessment of the expected inflation. The generalised Fisher hypothesis for asset markets is of the joint type, stating that (a) the market is efficient, and (b) expected real returns are independent of the inflation rate.

First, to evaluate the direct relationship between the inflation and the forest ownership return, the following regression is employed.

$$(5) \quad R_t = \alpha_0 + \alpha_1 P_t + \varepsilon_t$$

The t subscripts indicate the time period, P is the actual inflation rate, the α terms are the model parameters to be estimated, and ε is the error term. Positive estimates for the α_1 term would indicate some effectiveness against inflation. The null hypotheses for regression coefficient is used: $H_0: \alpha_1 = 0$ or $H_0: \alpha_1 = 1$. The hypothesis that α_1 equals zero suggests that an asset has no ability to hedge against inflation. The hypothesis that α_1 equals one tests the Fisher hypothesis.⁶

In order to examine the inflation-hedging characteristics of forest ownership return within the context of a complete return-generating model, it is necessary to incorporate other factors that influence equilibrium returns as independent variables. In particular, the return on the stock market could be included in the regression (Murphy and Kleiman, 1989).

$$(6) \quad R_t = \alpha_0 + \alpha_1 P_t + \beta_1 R_{mt} + \varepsilon_t,$$

where R_{mt} represents the return on the value-weighted index of the Helsinki Stock Exchange main list. The regression coefficient β_1 quantifies the magnitude of response of forest owner-

⁶ P-values are in brackets. W/R 0 means testing first hypothesis and w/r 1 means testing second hypothesis.

ship return to general stock-market activity, while α_1 measures the response of forest ownership return to inflation when the returns generated by market movements have been factored out. Thus α_1 in this regression provides some indication of the marginal contribution of forest ownership return to inflation risk in a market portfolio and of the usefulness of forest ownership return as an inflation hedge in a portfolio context.

The direct relationship between unexpected and expected inflation is estimated by employing the following regression equation suggested by Fama and Schwert (1977). This Fisher hypothesis (equation 4) can be tested in the form of this regression:

$$(7) \quad R_t = \alpha_0 + \alpha_1 E(P_t) + \alpha_2 \{P_t - E(P_t)\} + \varepsilon_t.$$

The Fisher model says that all assets should have a coefficient $\alpha_1 = 1.0$ for the expected inflation rate. But to obtain a hypothesis about the coefficient α_2 for the unexpected inflation rate we must rely largely on intuition, and the coefficient α_2 may be different for different assets. For example there is a general belief that private housing and common stocks are hedges against inflation, unexpected as well as expected, so that α_2 for these assets should be positive (Fama and Schwert, 1977). If the test suggests that $\alpha_1 = 1.0$ it can be said that asset is a complete hedge against expected inflation. If the test suggests that $\alpha_2 = 1.0$ it can be said that asset is a complete hedge against unexpected inflation. If α_2 is greater than one, an asset provides protection against unexpected inflation beyond its portion of the mixed-asset portfolio (Miles and Mahoney, 1997).

ETLA's inflation forecasts have been used in this study to compute expected inflation $E(P_t)$ as the price level change anticipated by financial market participants. The March forecast for the current year has been used as an estimate of inflation expectations in annual analysis. The unexpected inflation is simply measured as the difference between actual inflation P_t and expected inflation $E(P_t)$. Positive estimates for the α_1 term indicate some effectiveness in hedging against expected inflation and positive estimates for the α_2 indicate some effectiveness against unexpected inflation.

The forest ownership inflation hedging characteristics are considered in a portfolio context. Forest ownership assets are combined with the stocks in a portfolio.

$$(8) \quad R_t = \alpha_0 + \alpha_1 E(P_t) + \alpha_2 \{P_t - E(P_t)\} + \beta_1 R_{mt} + \varepsilon_t,$$

where β_1 is the regression coefficient for stock market return.

All the regressions are estimated by using the ordinary least squares method and adjusted for heteroskedasticity using the formula suggested by White (1980). This is because the infla-

tion rate has fluctuated considerably. The 1973–1978 inflation rate, for example, was well over 10% (as much as 6.6% in 1975) while in 1995, 1996, 1998 and 2003 it was under 1%.

4. DESCRIPTIVE STATISTICS

4.1 Returns and Risks

The average annual nominal return on forest ownership has been 8.4% and the standard deviation 13.4% over the period 1972–2003.⁷ The average real return on forest ownership has been 2.6% and the standard deviation 12.9%. The average return has been 2% lower level than for private housing and the standard deviation has been higher. The return to risk relationship of forest ownership has not been as good as that of stocks or private housing over this period (table 1).

TABLE 1. Annual Returns (Logarithmic Returns) and Standard Deviations of Different Asset Classes in Finland 1972–2003.

	Return Average Annual Return %	Risk Standard deviation %
Stocks	14.8	32.5
Private Housing	10.4	11.4
Forest Ownership	8.4	13.4
Inflation rate	5.8	4.7

4.2 Correlations and Cross-correlations between Inflation and Forest Ownership

The correlation coefficient between inflation and forest ownership return has been 0.28 (p-value 0.12) over the whole period from 1972 to 2003. The correlation coefficient was between inflation and private housing 0.27 (p-value 0.14) and between inflation and stocks it was –0.15 (p-value 0.43). During the first subperiod, 1972–1987 the correlation coefficient between inflation and forest ownership was 0.18 (p-value 0.51) and 0.03 (p-value 0.91) during the second subperiod, 1988–2003. All the p values are non-significant, thus there has not been a correlation between forest ownership and inflation, between private housing and inflation and between stocks and inflation.

⁷ The time period here is 1972–2003, because this is the same period as in other articles by the author.

The cross-correlation function shows the lead-and-lag relations between two series. Surprisingly, the inflation does not act as a leading indicator for forest ownership return in different lags (figure 1). When the inflation has been lagged by 1 year, the cross-correlation function has been 0.08 and when it has been lagged by 2 years, the cross correlation function has been -0.12 . This means that the inflation trend can not predict the development of forestry return.

It seems rather that the forest ownership return has been a leading indicator for inflation when the forest ownership return lag is 1. The cross-correlation function is 0.48, which is statistically significant (5% risk level). This is a specific feature in Finland, which has been the case in the past particularly, when devaluations were possible.

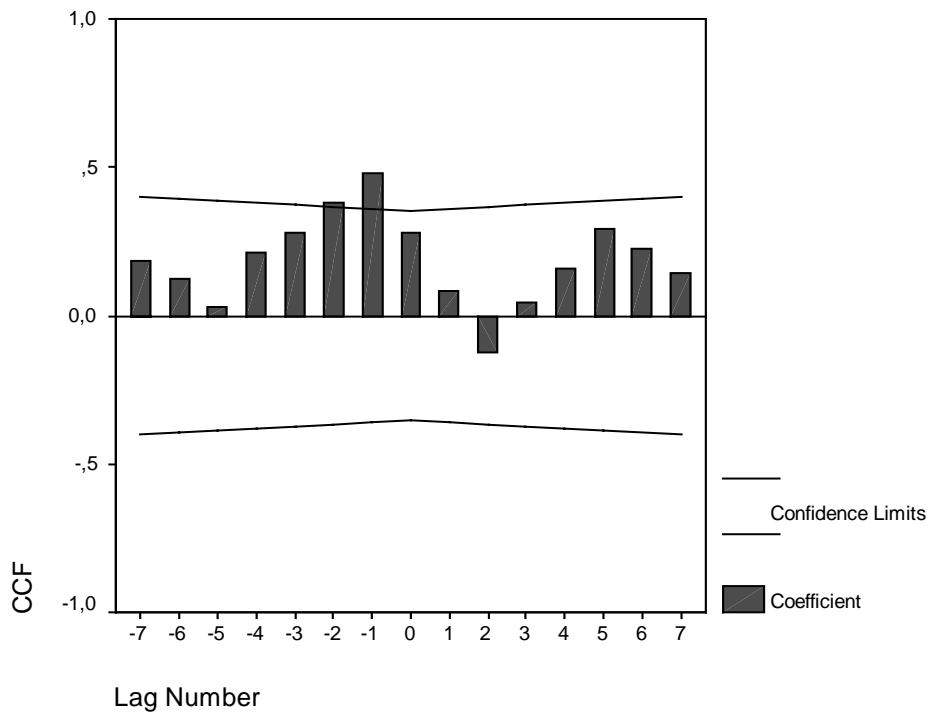


FIGURE 1. Cross-Correlation Functions, Inflation with Forest Ownership Return in 1973–2003.

An explanation for this relationship is that if there is an increase in aggregate demand, it can first be seen as a rise in stumpage prices and then in the inflation figures. Another explanation might be that for the forest owner timber is an asset. But to the forest industries, timber is a raw material and a factor of production, along with labour and capital. Stumpage price

change is a major component of the forest ownership return. Stumpage prices determine the forest-owner's remuneration for the factor of production provided by him and movements in stumpage prices are readily reflected in the demands of producers of other production factors. The stronger the income distribution struggle, the more readily a rise in stumpage prices will elicit wage demands in the forest sector. The stronger the wage links between different sectors of the economy, the more certain it is that pressures for wage increases will move to a sheltered sector, including the public sector (Spolander 1994).

5. RESULTS

5.1 Inflation Hedging with Respect to Actual Inflation

If inflation expectations are for some reason systematically biased, it is important to check inflation hedging-characteristics against actual inflation as well.

TABLE 2. *Forest Ownership and Inflation.*

Annual holding period 1973-2003					
α_0	Inflation		R^2	F	DW
	α_1	p-value			
		w/r 0			
		w/r 1			
3.66 (0.33)	0.81	(0.12)	0.08	2.61 (0.12)	1.87
		(0.71)			

The forest ownership has not provided a hedge against actual inflation over the period 1973–2003. The α_1 coefficient is 0.81 but p-value is 0.12 and the explanatory power of this regression is only 8%. The null hypothesis, that forest ownership has not provided hedge against actual remains valid.

When the forest ownership is combined with the stocks in a portfolio, it has not provided a hedge against actual inflation over the period 1973–2003. The α_1 coefficient is 0.89 and p-value is 0.09 but the explanatory power of this regression is only 12%. The null hypothesis, that forest ownership has not provided hedge against actual inflation in a portfolio with stocks, remains valid.

TABLE 3. Forest Ownership, Inflation and Stocks.

Annual holding period 1973-2003						
α_0	Inflation		Stocks	R^2	F	DW
	α_1	p-value	β_1			
1.99 (0.62)	0.89	w/r 0 w/r 1 (0.09) (0.84)	0.08(0.28)	0.12	1.93 (0.16)	2.07

5.2 Inflation-hedging Characteristics of Forest Ownership, Private Housing and Stocks

It is usually more relevant to hedge ex-ante against the expected inflation than ex-post against the actual inflation. The expected return required on an asset is equal to the real rate of return plus a premium for the expected rate of inflation over the life of the asset to compensate investors for their loss of purchasing power.

Clearly the Fisher hypothesis that nominal stock returns vary with a one to one correspondence with real returns can be rejected. The coefficient α_1 of stocks is zero. Wahlroos & Berglund's (1986) findings firmly reject the Fisher hypothesis over the 1970–1982 period. Real returns were found to depend negatively on both unexpected inflation and expected inflation. They used three different methods of proxying expectations and results were quite robust to changes in the underlying expectations model. Schwert (1981) found with U.S data that the stock market reacted negatively to the announcement of unexpected inflation in the Consumer Price Index, although the magnitude of the reaction was small.

Private housing provided a hedge against unexpected inflation at a statistically significant level. Fama & Schwert (1977) also found that residential real estate provided a hedge against inflation, being a complete hedge against both expected and unexpected inflation in the United States over the period 1953–1971. In Finland the hedge against expected inflation has not been at statistically significant level. Murphy & Kleiman (1989) found that equity REITs had a negative regression coefficient with both expected and unexpected inflation rates, although REITs might have different return characteristics from actual private real estate. The explanatory power of the regression with private housing was better than with forest ownership or stocks.

Over the period 1978–2003 forest ownership has been a better hedge against unexpected inflation than stocks. Stocks have not provided a hedge against inflation at all. Private housing

and forest ownership have, however, provided a hedge against unexpected inflation during this period. The inflation hedging characteristics of forest ownership are investigated in more detail in the next section.

TABLE 4. Private Housing, Stocks and Forest Ownership with Respect to Expected Inflation and Unexpected Inflation.

Annual holding period 1978-2003										
	Expected			Unexpected			R^2	F	p	DW
	α_0	α_1	p	α_2	p					
Stocks	20.1	-0.71	(0.76)	2.34	(0.69)	0.01	0.13	(0.88)	1.29	
Private housing	9.44	0.32	(0.66)	4.88	(0.01)	0.25	3.79	(0.04)	1.27	
Forest ownership	4.03	0.88	(0.17)	2.89	(0.08)	0.19	2.68	(0.09)	1.38	

5.3 Forest Ownership Inflation Hedging with Respect to Expected and Unexpected Inflation

Forest ownership has not provided a hedge against expected inflation. But forest ownership has been effective in hedging against unexpected inflation. The α_2 coefficient has been 3.78 and significant at the 0.01 level.

TABLE 5. Forest Ownership, Unexpected Inflation and Expected Inflation.

Annual holding period 1973-2003								
α_0	Expected		Unexpected		R^2	F		DW ⁸
	α_1	p	α_2	p				
7.24 (0.07)		w/r 0		w/r 0	0.24	4.46 (0.02)		2.39
		w/r 1		w/r 1				
	0.12	(0.82)	3.78	(0.01)				
		(0.13)	(0.05)					

⁸ For example, the critical value of Durbin-Watson test with $p=0.05$, $n=26$ and $k=2$ is 1.55. When the DW is higher than 1.55 there is no autocorrelation in error terms.

Before studying the semiannual holding period, the same period, 1978–2003, is used for the annual holding period. Both 1973 and 1974 were special, since the forest ownership return was as high as 42.8% and 38.1% respectively. Also, Önder (2000) found that in high inflationary environment, real estates did not provide hedge against expected and unexpected inflation. And the average annual inflation was exceptionally high 13.9% over the period 1973–1977 in Finland.

Over the period 1978–2003 forest ownership has been an effective hedge against unexpected inflation and has not been a hedge against expected inflation ($\alpha_1 = 0.88$ with p-value 0.17). Thus there is not much difference between the 1973–1998 and 1978–1998 periods. There was very high inflation rate in the 1970's, but this does not change the results. The Durbin-Watson test suggests that there may be some autocorrelation in error terms in this regression.

TABLE 6. Forest Ownership, Expected Inflation and Unexpected Inflation.

Annual holding period 1978-2003							
α_0	Expected		Unexpected		R^2	F	DW
	α_1	p	α_2	p			
		w/r 0		w/r 0			
		w/r 1		w/r 1			
4.03 (0.25)	0.88	(0.17)	2.89	(0.08)	0.19	2.68 (0.09)	1.38
		(0.86)		(0.25)			

The results are sensitive to whether annual or semiannual data is used. If the semiannual holding period is used instead of annual holding period, forest ownership has not provided a hedge against unexpected inflation. One reason for this difference might be that the inflation forecasts are more accurate on the semiannual than annual level. The more important results are probably with annual level results, because the explanatory powers (r-squared) are much higher annually (0.24 or 0.19) than semiannually (0.04). The semiannual data probably includes more noise than the annual data. Forest ownership has been an effective hedge against unexpected inflation. The unexpected regression coefficients have been high, which is similar to U.S. studies (Washburn & Binkley 1993), which found that most of the western and southern forests had hedged higher than expected inflation, but that the Northeast forest were less effective against unexpectedly high inflation. They used a two-factor model with CAPM beta and unexpected inflation.

5.4 Inflation Hedging in a Portfolio Context

Next the inflation hedging is considered in a portfolio context. The methodology of this was considered in section 3.5 (for example equation 8.).

TABLE 7. Forest Ownership, Unexpected Inflation, Expected Inflation and Stocks.

Annual holding period 1973-2003								
α_0	Expected		Unexpected		Stocks	R^2	F	DW
	α_1	p	α_2	p	β_1			
		w/r 0		w/r 0				
		w/r 1		w/r 1				
6.37 (0.15)	0.19	(0.74)	3.67	(0.01)	0.03 (0.64)	0.25	2.96 (0.05)	2.46
		(0.18)		(0.06)				

When inflation-hedging characteristics of forest ownership are studied in a portfolio context with stock returns, the results do not change. Forest ownership remains an effective asset class to hedge against unexpected inflation, but not against expected inflation.

Forestry owners invest in private housing as well in many cases. Private housing is a good substitute for the capital of non-industrial private forest owners. In the next regression the stock class is replaced by the private housing asset class. The inflation hedging characteristics of forest ownership are considered in a portfolio context with private housing. β_2 being the regression coefficient for private housing.

TABLE 8. Forest Ownership, Expected Inflation, Unexpected Inflation, and Private Housing.

Annual holding period 1973-2003								
α_0	Expected		Unexpected		Private housing	R^2	F	DW
	α_1	p	α_2	p	β_2			
		w/r 0		w/r 0				
		w/r 1		w/r 1				
2.41 (0.58)	0.14	(0.78)	2.07	(0.17)	0.47 (0.04)	0.35	4.90 (0.01)	2.46
		(0.11)		(0.47)				

Private housing has inflation hedging capabilities as well, the coefficient of β_2 being statistically significantly different from zero and the hedge against expected inflation is not statistically significant any more.

5.5 Inflation Hedging in Long Holding Periods

There are also some reasons to use longer holding periods than semiannual or annual. Previous studies suggest that the shorter the holding period the more measurement problems occur in the data series. The longer the holding period, the more stable the results are. Another reason is that institutional investors have different expected holding periods based on different needs, but in many cases they exceed holding periods of six months or a year.

Five-year and ten-year holding periods are used to study long-run interactions between forest ownership return and inflation. An ideal would be to use non-overlapping periods, but the data is not available for that long. Using rolling five- and ten- year periods is a form of averaging, and clearly introduces strong autoregressive characteristics in the error terms, as the Durbin-Watson test verifies. The Newey-West procedure will be used in order to correct the standard errors. Regression coefficients are from ordinary least squares regression.

TABLE 9. Forest Ownership, Unexpected Inflation and Expected Inflation in Five-Year and Ten-Year Investment Periods.

Five-year (rolling) holding period 1973-2003					
	Expected	Unexpected			
α_0	α_1	α_2	R^2	DW	
27.5 (0.00)	0.39 (0.10)	2.09 (0.02)	0.24	0.67	
Ten-year (rolling) holding period 1973-2003					
α_0	α_1	α_2	R^2	DW	
64.3 (0.00)	0.36 (0.02)	4.63 (0.00)	0.67	0.90	

It turns out that in longer holding periods, forest ownership has also provided a some hedge against expected inflation. Using a one-year holding period, the coefficient for expected inflation is zero, while with a five-year holding period it is 0.39, and with a ten-year holding period 0.36. With five-year holding period and 10-year holding period forest ownership has provided very effective hedge against unexpected inflation. Thus forest ownership has been relatively good asset class to give hedge against inflation in these longer holding periods.

5.6 Sensitivity Analysis

5.6.1 Forest Ownership

The sensitivity of forest ownership return can be estimated by using the parameter s , which relates the market value of forest holdings to its fellings value. The actual commercial fellings and silvicultural costs are not corrected because they are obtained from monetary transactions and are not estimates; The value of s is difficult to estimate; however, the felling values⁹ of forest holdings have in most cases been higher than their actual market prices. For example, the fellings value exceeded the actual market values in 1985 on average by 20% (Hannelius 1988). When the sensitivity parameter s is included, the return on forest ownership is defined as:

$$(9) \quad r_{y,NIPF} = LN \left(\frac{\sum_{a=1}^6 (s\{P_{ya} X_{y-1,a} + P_{ya} (B_{ya} - F_{ya})\} + P_{ya} F_{ya} - C_y)}{\sum_{a=1}^6 s(P_{y-1,a} X_{y-1,a})} \right)$$

For example, if parameter $s=0.8$ the average nominal return on forest ownership has been 9.1% and the standard deviation 13.5% in 1972–2003. The nominal return on forest ownership improves on average by 0.68% annually. Inflation hedging regression will now be tested with a parameter value of 0.8.

TABLE 10. Forest Ownership (parameter value $s=0.8$), Expected Inflation and Unexpected Inflation.

Annual holding period 1973-2003							
$\alpha 0$	Expected		Unexpected			F	DW
	$\alpha 1$	p	$\alpha 2$	p	R^2		
8.1 (0.04)	0.09	w/r 0				4.44 (0.02)	2.39
		w/r 1					
		(0.87)	3.81	(0.01)	0.24		
		(0.12)		(0.05)			

If the parameter value is $s=0.8$, forest ownership has not been a hedge against expected inflation and has been a very effective hedge against unexpected inflation over the period. The inflation hedging capacity of forest ownership turns out not to be that sensitive to changes in the parameter value s .

9 This study uses the fellings value approach.

5.6.2 ETLA's Inflation Forecasts

The inflation hedging characteristics of forest ownership are now considered with respect to different inflation forecasts by ETLA. First, the forecast from the previous year is used instead of the current year's forecast. This forecast is released four months before the period that ETLA tries to forecast (panel a). Second, another forecast is released ten months before the period that ETLA tries to forecast (panel b).

TABLE 11. Forest Ownership, Expected Inflation (Different Forecast for Expected inflation) and Unexpected Inflation.

Panel a. ETLA's previous year September forecast								
Annual holding period 1973-2003								
$\alpha 0$	Expected		Unexpected		R^2	F	DW	
	$\alpha 1$	p	$\alpha 2$	p				
		w/r 0		w/r 0				
		w/r 1		w/r 1				
7.86 (0.10)	-0.12	(0.87)	1.86	(0.03)	0.16	2.60 (0.09)	2.04	
		(0.16)		(0.31)				
Panel b. ETLA's previous year March forecast								
Annual holding period 1973-2003								
$\alpha 0$	Expected		Unexpected		R^2	F	DW	
	$\alpha 1$	p	$\alpha 2$	p				
		w/r 0		w/r 0				
		w/r 1		w/r 1				

The results show that in both cases the coefficient of unexpected inflation are lower than in the case of ETLA's current year inflation forecast.

When the previous year's inflation forecasts (either September or March) is used as a proxy for expected inflation, forest ownership has not offered any hedge against expected inflation. And when previous years September forecast is used, the forest ownership has provided a hedge against unexpected inflation. But when earlier March forecast, and less accurate forecast, is used, forest ownership has not provided hedge against unexpected inflation any more. In latter case forest ownership has not provided any hedge against inflation at all, because the explanatory power of this regression is very low 10% and p-value of F Test is only 0.24. Thus hedge against unexpected inflation is fairly sensitive to inflation forecasts.

6. CONCLUSIONS

This paper examined the extent to which forest ownership, private housing and stocks provided a hedge against actual inflation, expected inflation, and unexpected inflation. The inflation-hedging characteristics of forest ownership were also examined in a portfolio context, forest ownership with stocks or private housing. The expected inflation was proxied by the inflation forecasts of the Research Institute of the Finnish Economy (ETLA). Unexpected inflation was the difference between the actual inflation and the inflation forecast.

Results indicate that forest ownership was not a hedge against actual inflation. They show that stocks did not provide a hedge at all against expected inflation or unexpected inflation. It seems that forest ownership and private housing are better assets for the institutional investor in terms of inflation hedging. Both these asset categories have provided effective hedges against unexpected inflation. It is valuable to have a hedge against unexpected inflation, because the inflation hedge against expected inflation can often be obtained through bond markets.

Forest ownership did not provide a hedge at all against expected inflation over the period 1973–2003, but it has offered a very effective hedge against unexpected inflation. This means that in a portfolio with other assets, forest ownership provides protection against unexpected inflation beyond its portion of the mixed-asset portfolio. This is a valuable feature, especially when other assets in a portfolio hedge lower than unexpected inflation.

When longer five- and ten-year holding periods are considered, the results differ considering a hedge against expected inflation. Forest ownership has a hedge against expected inflation provided to some extent and a very effective hedge against unexpected inflation. It turned out that the longer the holding period is, the more effectively forest ownership acts as a hedge against expected inflation.

The results were not sensitive to the forest ownership return estimation process. If parameter s was 0.8 (equation 9), forest ownership supplied an effective hedge against unexpected inflation. If ETLA's previous year's September forecast is used as a proxy for expected inflation instead of the current year's March forecast, forest ownership has still been an effective hedge against unexpected inflation. In this case forest ownership did not provide a hedge against expected inflation at all (the regression coefficient of expected inflation having been negative). The results might be sensitive to an inflation expectations generating model. Future research could investigate the robustness of these results by using different inflation expectation proxies.

ACKNOWLEDGEMENTS

The paper has benefited from the comments and criticism of Markku Kaustia, Markku Penttinen, Vesa Puttonen, Jari Kuuluvainen, Teppo Martikainen, Tom Berglund and Chunyang

Huang. This paper has also benefited from the comments and criticism of the Joint Finance Research Seminar participants. Financial support from Helsinki School of Economics Foundation, the Jenny and Antti Wihuri Foundation, Foundation for Research of Natural Resources in Finland, OKOBANK and Metsämiesten Säätiö Foundation is gratefully acknowledged. The English language has been checked and improved by Dr. Roderick McConchie. ■

REFERENCES

- ASPREM, MADS**, (1989). Stock Prices, Asset Portfolios and Macroeconomic Variables in Ten European Countries. *Journal of Banking and Finance*, 13, 589–612.
- BERGLUND, T, WAHLROOS, B and GRANDELL, L.** (1983). The Kop and Unitas Stock Market Indexes in Light of New Value-Weighted Index. *Finnish Journal of Business Economics*, 32, 30–40.
- CHEN, N-F, ROLL, R and ROSS S.A.** (1986). Economic Forces and the Stock Market. *Journal of Business*, 59(3), 383–403.
- CUBBAGE, FREDERICK W., THOMAS G. HARRIS, and CLAIR H. REDMOND.** (1989). Measuring Risk and Returns of Timber Investments Using the Capital Asset Pricing Model. Working Paper, The Georgia Agricultural Experiment Stations, College of Agriculture, The University of Georgia.
- FAMA, EUGENE and SCHWERT, G.WILLIAM.** (1977). Asset Returns and Inflation. *Journal of Financial Economics*, 5, 115–146.
- FAMA, EUGENE.** (1981). Stock Returns, Real Activity, Inflation and Money. 1981. *American Economic Review*, 65, 545–564.
- FISHER, IRVING.** (1930). *The Theory of Interest*. The Macmillan Company, 566 p.
- HANNELIUS, SIMO.** (1988). Metsälöiden kiinteistökauppa ja arvonmääritys. Metsäntutkimuslaitoksen tiedonantoja 293, 96 p.
- KANNIAINEN, VESA and KURIKKA, VESA.** (1984). On the Effects of Inflation in the Stock Market: Empirical Evidence with Finnish Data. *Journal of Business Finance and Accounting*, 11(2), 139–150.
- LAHTI, ARI and PYLKKÖNEN, PERTTI.** (1989). News and Stock Prices. *Finnish Journal of Business Economics*, 38(3), 184–193.
- LAUSTI, ANTREI and PENTTINEN, MARKKU.** (1998a). Forest Ownership and Forest Industry Investments Analysed in a Risk Return and Capital Asset Pricing Framework. Working Paper, Helsinki School of Economics and Business Administration. W-201. 39 p.
- LAUSTI, ANTREI and PENTTINEN, MARKKU.** (1998b). 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.
- LU, CHIULING and SO, RAYMOND. W.** (2001). The Relationship Between REITs Returns and Inflation: A Vector Error Correction Approach. *Review of Quantitative Finance and Accounting*, 16(2):103–115.
- MARTIKAINEN, TEPPO and YLI-OLLI, PAAVO.** (1991). Macroeconomic Factors and Stock Returns: The Case of the Helsinki Stock Exchange. *The Finnish Journal of Business Economics*, 40(3), 232–252.
- MILES, MIKE and JOSEPH MAHONEY.** (1997). Is Commercial Real Estate an Inflation Hedge. *Real Estate Finance*, 14(4), 31–45.
- MILLS, W. L. JR. and HOOVER, W. L.** (1982). Investment in Forest Land: Aspects of Risk and Diversification. *Land Economics* 58(1): 33–51.
- MURPHY, J. AUSTIN and ROBER. T. KLEIMAN.** (1989). The Inflation-Hedging Characteristics of Equity REITs: An Empirical Study. *Quarterly Review of Economics and Business*, 29(3), 95–101.
- PELTOLA, A.** (ed.) (2003). *Statistical Yearbook of Finnish Forestry (Metsätilastollinen vuosikirja)*, 388 pp. Finnish Forest Research Institute, Helsinki. ISBN 951-40-1894-X
- PENTTINEN, MARKKU, LAUSTI, ANTREI, KASANEN, EERO and PUTTONEN, VESA.** (1996). Risks and Returns in Forest Investments in Finland. *The Finnish Journal of Business Economics*, 45(1), 111–124.
- PENTTINEN, MARKKU and LAUSTI, ANTREI.** (2004). The Competitiveness and Return Components of NIPF Ownership in Finland. *The Finnish Journal of Business Economics*, 53(2), 141–154.

- REDMOND, CLAIR H. AND CUBBAGE, FREDERICK W.** (1988). Portfolio Risk and Returns from Timber Asset Investment. *Land Economics*, 64(4), 325–337.
- SCHWERT, G.W.** (1981). The Adjustment of Stock Prices to Information about Inflation. *Journal of Finance*, 36, 15–29.
- SOLNIK, BRUNO.** (1983). The Relation between Stock Prices and Inflationary Expectations: The International Evidence. *Journal of Finance*, 38, March, 35–48.
- SPEIDEL, G.** (1984). Forstliche Betriebswirtschaftlehre. 2. Auflage, Verlag Paul Parey, Hamburg. 226 p.
- SPOLANDER, MIKKO.** (1994). The Role of Asset Prices in the Inflation Process in Finland. *The Bank of Finland Bulletin*, 8, 9–14.
- THOMSON, T.A.** (1989). Evaluating Some Financial Uncertainties of Tree Improvement Using the Capital Asset Pricing Model and Dominance Analysis. *Canadian Journal of Forest Research*, 19 (11), p. 1380–1388.
- THOMSON, T.A.** (1991a). Timber And Financial Portfolios: 1937–1986. Proceedings of the 1991 Symposium of System Analysis in Forest Resources. USDA Forest Service, Southeastern Forest Experiment Station. General Technical Report SE-74. p. 217–224.
- THOMSON, THOMAS A.** (1991b,) Efficient Combinations of Timber and Financial Market Investments in Single-Period and Multiperiod Portfolios. *Forest Science*, 37(2), 461–480.
- VISKARI, JYRKI.** (1992). News and Stock Prices: Some Further Results. *The Finnish Journal of Business Economics*, 41(4), 371–376.
- WAGNER, JOHN E. and RIDEOUT, DOUGLAS B.** (1992). The Stability of the Capital Asset Pricing Model's Parameters in Analysing Forest Investments. *Canadian Journal of Forest Research*, 22(11), 1639–1645.
- WAHLROOS, BJÖRN and BERGLUND, TOM.** (1986). Stock Returns, Inflationary Expectations and Real Activity. *Journal of Banking and Finance*, 10, 377–389.
- WASHBURN, COURTLAND L. and BINKLEY, CLARK S.** (1993). Do Forest Assets Hedge Inflation? *Land Economics*, 69(3), 215–224.
- WASHBURN, COURTLAND L. and BINKLEY, CLARK S.** (1990). Informational Efficiency of Markets for Stumpage. *American Journal of Agricultural Economics*, 72(2), 394–405.
- WHITE, HALBERT.** (1980). A Heteroskedasticity-consistent Covariance Matrix. *Econometrica*, 48(X), 721–746.
- ÖNDER, ZEYNEP.** (2002). High Inflation and Returns on Residential Real Estate: Evidence from Turkey. *Applied Economics*, 2000, 32(7), 917–931