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Risk, returns and possible speculative bubbles in the price of Danish forest land?

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Abstract
In this short paper I analyse the development of returns to forest land in Denmark for the period 1947 to 2007. The data used are fairly unique time series of forest enterprises annual accounts in combination with property value assessments over the entire period. They allow for a dissection of returns into operational returns and capital gains. I draw in previous analyses using the capital asset pricing model to assess the co-variation of returns in Danish forestry with returns from the market portfolio, as represented by the major financial asset groups representing the bulk of that. I compare the development in returns and notably the role of the capital gain over the period, to the likely equilibrium market return relevant for forest enterprises. The observations raise the question if *i*) also the prices of forest land in recent decades have been subject to a speculative bubble driving up prices beyond that justified by patterns of return in forestry or *ii*) if the returns to forest owners from holding a forest property is not Ill-captured by the marketable goods derived from forestry accounts, in essence a forest may not only be productive capital but also a consumption good.

Keywords: Property prices, operational earnings, equilibrium returns, time series, CAPM.

1. Introduction

The value of forest land as a productive asset is a core question in the economics of forestry, and the work of Faustmann (1849) coined the first framework for assessing this in a deterministic setting. The focus of Faustmann and his numerous followers is primarily on the stand level or the forest as an aggregation of stands, and this is true too for many papers addressing the optimal management of a forest under uncertainty (see Newman 2002 for a review of the optimal rotation literature).

The value of forest land, or more broadly for investments in timber production, as a capital asset has, however, also been assessed using approaches from finance. These includes the mean-variance approach relying on Markowitz' (1952) original work, e.g. Lönstedt and Svenson (2000) Liao et al (2009) and Scholtens and Spierdijk (2010), but more widespread has been the use of the capital asset pricing model (CAPM) as developed by Sharpe (1964), Lintner (1965) and Jensen (1969). Early studies on forest investments include Redmond and Cubbage (1988), Zinkhan (1990), Zinkhan and Mitchell (1990), Wagner and Rideout (1991, 1992), but also Washburn and Binkley (1990, 1993) has applied the framework for analysing the performance of forest investments relative to other assets and as an inflation hedge. More recently, Sun and Zhang (2001) and Lundgren (2005) has applied these approaches to value forest investments – either as direct investments in forest land (Lundgren 2005) or buying shares in investment funds with timber management as their primary or even sole activity. More generally, several of the above papers apply changes in timber prices and sometimes also timber growth records as proxies for the return to forest investments (e.g. Redmond and Cubbage 1988; Washburn and Binkley 1990; Lundgren 2005). The value of the asset, the land as such, is often also approximated with the value of the standing stock, and more rarely with actual forest land value assessments as in Lundgren (2005).

In the present paper, I present and use a rather unique set of data based on more than 60 years of detailed accounts of Danish forest enterprises. These data include many more income and cost elements related to the ownership and management of a forest enterprise, and thus are a much better source of knowledge regarding the performance of forest enterprises as an investment than most other studies have had access to. Furthermore, I have a reasonable annual measure of the value of the forest land for those same set of enterprises and over the same time horizon. This allows for the estimation of simple nominal and real CAPM much in line with several of the mentioned studies. However, the real focus of this paper is a deeper analysis of the forest returns over time. All of the above studies of course use return data in the time domain to arrive at their correlation results, but none analyse the development over the time domain to arrive at better assessments of the current profitability of forest investments.

In this study, I draw on earlier analyses of Danish data (Møller 2001; Balling 2007) and present the Ill known measures describing the performance of in this case forest investments in three different regions of Denmark. Based on these analyses, I reproduce the finding in much of the literature mentioned that forest investments do appear to have superior characteristics and be underpriced over the period considered. However, analysing the development of real forest land values and forest returns, I show that returns have been systematically driving down towards the equilibrium returns, as estimated over the entire period. Thus forest investments are no longer likely to be superior, unless the pattern revealed is caused by increases in value flows from holding forests that are not visible in the markets for forest products and services.

2. Method and approach taken

Here I briefly outline the framework of the CAPM model, and the presentation follows much that of earlier works. The theoretical framework for the CAPM was developed in a series of papers by three different authors, namely Sharpe (1964), Lintner (1965) and Jensen (1969). They developed a framework building on the von Neumann-Morgenstern concept of risk aversion and essentially also the mean-variance framework of Markowitz (1952), where the returns, expected returns and the variation of returns, of any individual asset is evaluated up against the remaining assets available, as captured in the concept of the market portfolio. This evaluation takes into account not only the level of the individual asset's return, but also the co-variation of these returns with those of the market portfolio, taking into account utility effects of risk diversification properties – or lack thereof. Numerous applications of the CAPM and related following models exist in the finance literature as Ill as in practice.

The CAPM relies on a number of non-trivial assumptions. Fundamental is the assumption that the utility effects for any investor of any asset or combination of assets can be fully captured by information on the first two moments of the distribution of returns, i.e. expected return and return co-variance structure. This again implies a normal distribution of returns. Investors are assumed to be risk averse, price takes, and to have homogenous expectations and investment horizons. Structural assumptions on the asset market include that asset quantities are given, that assets are liquid and divisible, that the capital market is perfect implying that investors can borrow and lend at the same interest rate and finally the market is also perfect in the sense that taxes and transactions cost are absent and information is costless.

While the assumptions concerning the investors should hold as Ill for forests as an asset type as for any other asset, the same is not likely to be true for several of the asset specific assumptions and market requirements, as also Washburn and Binkley (1990) and Lundgren (2005) points out. In particular, markets for forest land as explicitly included in this study, is likely to be much less liquid than e.g. markets for shares of timber investment funds. Also, for judicial reasons that e.g. define the unit of a property one may consider the asset to be less divisible. On the other and, Danish forest properties comes in all forms and sizes (Boon et al 2004), offering some divisibility for any investor. Finally, trading in property is an exercise likely to inflict considerable transactions cost, compared to e.g. financial assets. Apart from that, most of the general market assumptions are likely to hold as Ill for this asset type as any other asset.

Clearly, as this study focus directly on the actual holding of forest enterprises and not on holding shares of an investment fund based on timber land (as e.g. reference), the CAPM assumptions are perhaps less of a suitable fit to this market. On the other hand, focusing directly on the forest enterprises and having the rather unique set of data, allows us to investigate the fundamentals of forests as a capital asset and to evaluate in particular the performance in the time domain of a specific set of such assets, which are much more stable than those underlying an investment fund would have been over a horizon as long as the one investigated here.

The CAPM estimation results reported in this study derive in part from Møller (2001) who estimated a nominal CAPM for Danish forest enterprises as capital assets using the below described data on forest land values, annual operational returns from forest enterprises and return series for the groups of bonds and stock making up the dominant part of the Danish financial asset markets. Applying standard notation, the nominal CAPM (Sharpe 1964) is described by the following relation, also called the security market line:

$$E\left(R_t^i\right) = R_f + \beta_i\left(E\left(R_t^m\right) - R_f\right). \quad (1)$$

That is, for any asset, i, the expected return $E(R^i_t)$ at any time, t, is expected to equal the risk free return, R_f, plus or minus a premium depending on the co-variation, as captured by β_i, with the excess return of the market portfolio $E(R^m_t)$, where the definition of β_i is:

$$\beta_i = \frac{Cov\left(R_t^i, R_t^m\right)}{\operatorname{var}\left(R_t^m\right)}. \quad (2)$$

The link to econometric estimates of a regression of R^i_t on R^m_t is evident. In principle, the expected returns are not directly observable, but Jensen (1969) showed that using ex post observed returns, β_i could be estimated from the regression:

$$R_t^i - R_f = \alpha_i + \beta_i\left(R_t^m - R_f\right) + \varepsilon_t. \quad (3)$$

It follows from (1) that the expected value of α_i is zero, provided the asset is on the security market line. However, as expected by Jensen (1969) one may find assets that are under (over) priced and hence have a positive (negative) α.

The CAPM results reported also rely on Balling (2007), who estimated a series of CAPMs for three different forest regions of Denmark with distinctly different return profiles. He estimated the return in real terms, i.e. he corrected all data series from inflation before estimating an equation of the form (3). This implies that the estimate of Jensen performance measure, $\alpha_{i,}$ in these real term estimations will include inflation hedging potentials of the different assets, I, relative to the market portfolio m.

3. Data applied

The data applied for the estimation of the CAPM covers the period 1947 until 1999. For the analysis of the performance of forest returns, I further include the period 1999 until 2008.

In his estimations, Møller (2001) used aggregate series of historical returns of stock and bonds provided by Parum (1999) to replicate the dominant part of the likely market portfolio. Balling (2007) used a series of returns complied by Nielsen and Risager (2001), that included a broader set of assets in terms of bonds of various duration, to estimate the market portfolio and its returns, and to compare the different assets with the forest returns. Balling used the consumer price index of Statistics Denmark to convert nominal returns to real.

Here I describe in more detail the data on forest returns and earnings. These are derived from annual financial reporting data from a larger set of Danish forest enterprises, which allow the calculation of operational earnings before corporate taxes and interests. The data are collected by the Danish Forest Association (Dansk Skovforening 1948-2009) and they are very detailed and include income and cost measures from not only timber harvesting activities, but also from other forest enterprise activities of significance, e.g. Christmas trees and greenery and hunting. Thus, the data is a much better representation of actual forest enterprise operational earnings than many measures constructed and used in the above cited literature, which often rely on national level statistics of harvest and timber prices etc., e.g. Lundgren (2005).

The forest land value estimates used are also collected from the financial reports over the period 1947-2008. These data are not based directly on observed actual forest land trades, but are instead the forest land value assessments made by the Danish tax authorities. These assessments are made for the purpose of property taxation and the assessments are required by law to represent as Ill as possible the 'value of the land in trade and exchange'. The tax authorities base their assessments on observed trades, but keep no record, unfortunately, of these. Indeed, comparing the observed data series of assessed with a smaller set of actual trades of forest land reported in a smaller hedonic study by Ravn-Jonsen (2005), shows that the forest land value assessments are nicely within the range of observed trades over the period 1999-2004. As in Lundgren (2005) the forest land value data reflects that tax authorities in particular in the earlier part of the sample period revised the value assessments in-frequently and in campaigns. This seems to create jumps in the forest value estimates at irregular intervals in the early part of the data. Møller (2001) ignored this aspect and used the data as they Ire reported, whereas Balling (2007) chose to even out the jumps over the relevant period, as did also Lundgren (2005).

In Møller (2001) aggregate operational earnings and land values at country level are used, whereas Balling (2007) and also this study used data aggregated at regional level. The Danish Forest Society aggregates the financial reports according to three geographical regions in Denmark: The Danish heath land forests in western Jutland, the forests of eastern Jutland, and the Island forests. The first region is characterised by low site quality and is dominated by coniferous plantation forests on poor alluvial sand plains, which Ire just outside the glacial border during the last ice age. The forests of eastern Jutland are generally situated on better sites; moraine landscapes left by the glaciers and with moderate clay content and has a higher percentage of beech and oak forests. The forests on the Islands on average have higher site quality again.

We denote, the returns with sup-scripts $i = \{H, J, I\}$. Furthermore, for our analysis I separate the capital gain C from the operational returns O in the following way:

$$R_t^i = \frac{L_t^i - L_{t-1}^i + O_t^i}{L_t^i} = \frac{L_t^i - L_{t-1}^i}{L_t^i} + \frac{F_t^i}{L_t^i} = C_t^i + O_t^i, \qquad (4)$$

where L is the forest land value and F is the operational earnings before interests and taxes. In Table 1, I report summary statistics of the key variables as used in the study by Balling (2007) and in this study.

Table 1: Summary statistics of key variables in real terms. For stock and bond returns, the period is 1922-1999, and for the remaining variables the period is 1947-2008.

Variable	Variable name	Mean	Std. dev.	Median	Minimum	Maximum
Inflation	*CPI*	0,0492	0,0350	0,0379	-0,0054	0,1519
Stock returns	*S*	0,0737	0,2160	0,0404	-0,2792	1,0355
Bonds, 1 year	B^1	0,0329	0,0515	0,0297	-0,1563	0,2366
Bonds, 5 year	B^5	0,0366	0,0411	0,0325	-0,0418	0,1355
Bonds, 10 year	B^{10}	0,0344	0,0437	0,0147	-0,0202	0,1647
Capital gains, *H*	C_t^H	0,0399	0,0801	0,0303	-0,1421	0,3211
Operational returns, *H*	O_t^H	0,0212	0,0242	0,0162	-0,0155	0,1028
Capital gains, *J*	C_t^J	0,0331	0,0512	0,0238	-0,0742	0,1376
Operational returns, *J*	O_t^J	0,0519	0,0371	0,0479	0,0040	0,14719
Capital gains, *I*	C_t^I	0,0266	0,0427	0,0259	-0,0536	0,1737
Operational returns, *I*	O_t^I	0,0512	0,0415	0,0328	0,0071	0,1588

4. Results

Already from the summary statistics in Table 1, we note some important findings about forest returns. Firstly, real capital gains in forest land values over the period 1947 to 2008 have on average been between 2.7 % and 4 % p.a. They are lower than real operational returns, and they are also much more volatile, as revealed by standard deviations and in particular the minimum and maximum values. Nevertheless, they have been steady enough to lift real forest land values with a factor of more than 5 on the Islands, more than 8 in eastern Jutland and more than 10 on the heath lands.

Turning to the operational returns from the forest lands, we note that they are on average remarkably high relative to their volatility, when comparing with stocks and bonds. Notice also the quite important aspect, that operational returns from the forest land are *almost never negative*. This reveals the adaptive capacity of forest enterprises and the timber harvesting problem: When prices are low, costly activities can simply be reduced and the timber left on stump and grow for another year. Taken at face value, already the facts of Table 1 suggest that over this period, investments in forestry has been worthwhile compared to stocks and bonds.

Turning to the pattern of correlations, we report in Table 2 the correlations as calculated by Balling (2007) between real returns. Clearly, forest returns are highly correlated with each other across regions, but neither are significantly correlated with the returns of stocks or bond.

Table 2: Pearson's correlation coefficients between real returns of the three forest regions, stocks and short-term bonds.

	S	B^I	R_t^H	R_t^J	R_t^I
S	1				
B^I	-0,08	1			
R_t^H	0,04	-0,004	1		
R_t^J	-0,04	-0,04	0,91	1	
R_t^I	0,03	-0,02	0,88	0,92	1

In the following we draw on Balling's (2007) estimations of β_i for a market made up of short term bonds (bonds indeed account for the major part of the asset market in Denmark over the period), the stocks and the three different forest region assets. He obtains estimates of β_i as reported here in Table 3. Stocks are seen to have a high beta and hence real returns of stocks tend to fluctuate aggressively along with the returns of the market portfolio. Short term bonds has a positive β_i less than one and hence fluctuate moderately with the market portfolio, which is to be expected given their major weigth in the market portfolio. All three forest regions have small β_i estimates, and Jutland even has a slightly negative estimate. Again this suggest that forest investments are likely to be a worthwhile endeavour for the risk averse investor.

Table 3: Estimates of β_i from Balling (2007)

	Islands	Jutland	Heath land	Stocks	Bonds 1
β_i	0,327	-0,065	0,348	3,985	0,653

Indeed, if we assume a risk free interest rate of 2 % and plot combinations of the expected returns of Table 1 and the β_i-s of Table 3 into a Security Market Line Diagram, we get the result in Figure 1. It indicates that stocks over the period have been over-priced relative to the market portfolio, notably bonds. It also indicates, however, that returns from the forest regions have been very good and indeed the forest assets have over the period on average been underpriced. Their real equilibrium return should be in the range of 2 % or the risk free interest rate, which is significantly lower than the real return experienced over the period. Møller (2001) finds a similar result in a CAPM in nominal terms, and indeed the result that forest investment perform more than well in CAPMs is widespread in the literature, e.g. Redmond and Cubbage (1988), Zinkhan (1990), Washburn and Binkley (1990) and Lundgren (2005).

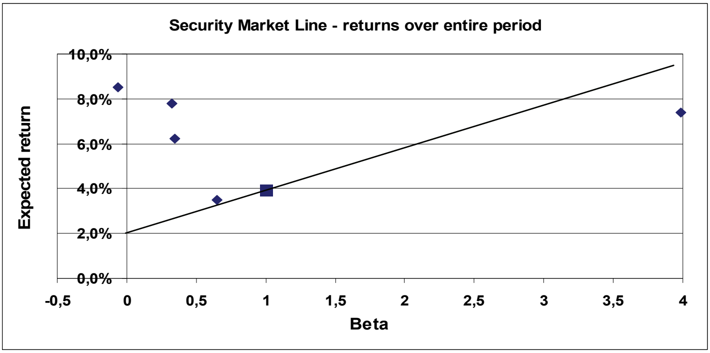

Figure 1: The Security market line and plots of (β_i, $E(R^i_t)$) over the period 1947-1999/2008

Clearly, forest should increase in value relative to each average value over this period, in order to bring forest returns closer to their equilibrium level. And indeed forest land has increased considerable in value as briefly reported above.

If we dissect the period 1947-2008 into three 20 years periods, and assume the estimated β_i-s of Table 3 to hold true for each sub-period, we get the picture in Figure 2. In the early part of the period, the real returns are in fact as high as 8-12 % p.a., over the next twenty year period it falls to 6-8 % and then in the last twenty year period to around 4 % p.a. However, inserting the most recent 5 year average, namely the period 2004-2008, it seems that performance has picked up speed again, as real returns are now spread in the interval 6-11 %, which is again a truly remarkable return on an investment asset with the risk diversification properties that all evidence, including that provided here, suggest that forest investments have. The good news, however, has a serious catch, which is revealed by the dissection of returns shown in Table 4.

Table 4: Tracking the drift in the source of returns, from operational return dominance to capital gain dominance

	Capital gain real returns C_t^i			Operational real returns O_t^i			Overall real returns R_t^i		
Period:	**Isl.**	**Jutl.**	**Heath**	**Isl.**	**Jutl.**	**Heath**	**Isl.**	**Jutl.**	**Heath**
1947-2008	0,027	0,034	0,041	0,051	0,052	0,022	0,078	0,085	0,062
1947-1968	0,028	0,045	0,040	0,098	0,078	0,036	0,126	0,123	0,076
1969-1988	0,024	0,023	0,049	0,032	0,061	0,023	0,056	0,084	0,073
1989-2008	0,029	0,033	0,033	0,020	0,014	0,005	0,049	0,047	0,038
1999-2008	0,048	0,056	0,053	0,017	0,010	0,007	0,065	0,066	0,060
2004-2008	0,051	0,086	0,091	0,014	0,014	0,012	0,065	0,100	0,103

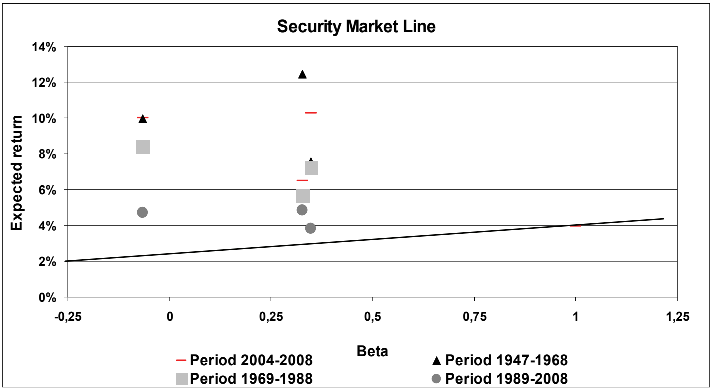

Figure 2: The Security market line and plots of (β_i, $E(R^i_t)$) over four sub-period s1947-1968, 1969-1988, 1989-2008 and 2004-2008

What these detailed data in Table 4 shows is, that while operational returns constituted by far the bigger part of overall returns for the first 40 years of the period (ranging from 3 to 10 % p.a.), the pattern looks markedly different for the last twenty years. In the last twenty year period, real operational returns are now in the range of 0-2 %, and capital gains make up much more than half the overall return. Looking at the last 5 year period this pattern becomes grotesque: Across all regions, real operational returns are in an almost all-time low as they remain in the range of 1 %, but real capital gains reaches an all-time high for such a period, ranging from 5 to 9 %. Thus real operational returns make up only one sixth or one tenth of overall real returns.

5. Concluding discussion

The results presented here has shown, that while overall forest returns has been and remain high relatively to the likely equilibrium returns as predicted in a capital asset pricing framework, their underlying composition has changed dramatically in recent decades. The finding that capital gains for the last 20 years and in particular during the last 5 years strongly dominates the returns is a significant finding for anyone owning or about to invest in forest enterprises.

Two different interpretations and conclusions seem to be available; one of which is not good news for current forest investors, and the other is hard to verify. The first interpretation follow the usual convention that large increases in the price of stocks or other assets must reflect market expectations of rising earnings to come. However, there is no pattern in current or recent operational earnings in the forest sector that suggest that an increase in income from marketed goods and services is imminent. Thus, even if no further increases in land values occur, real returns will remain low, and seem to be below likely equilibrium rates. Therefore, this interpretation leads to the conclusion that forest land is currently over priced, and the recent development may even suggest a speculative bubble. The second interpretation is, that the returns from marketed goods and services do not capture all benefits from forest ownership, and that another un-observed source of value is in play. One such source could be the joy of ownership that many smaller and larger forest owners stress as a reason fro being a forest owner (Boon et al 2004), and such a benefit can only be enjoyed by owners of course. Further indications of such values may be the finding by Ravn-Jonsen (2005) that forests closer to cities demand higher prices, *ceteris paribus*. If this flow of benefits has increased in real value over the years, then it may be the underlying driver of the land value, rather than operational earnings and risk diversification properties. This interpretation cannot, of course, be validated by this study.

A final note concerns the fact that in Denmark, forest enterprises are rarely the only source of income for the owner, and very often not even the most important one. The interaction between forest income and income sources can be a source of additional value, as the forest can offer as a buffer and reduce the costs, e.g. of credit rationing or progressive income taxations (Thorsen 1999). It does not seem credible, however, that such things are behind the recent decades surge in forest land value. Over the period, the income tax system has become less progressive, and the period has also be characterised by everything else than strict lending policies.

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