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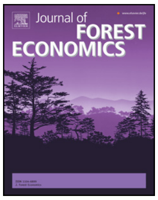

Hedging with trees: Tail-hedge discounting of long-term forestry returns

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ABSTRACT

Tail-hedge discounting is based on decomposition of returns from long-term investments in a fraction (gamma) that is correlated with consumption and another that is not. The first part is discounted at a discount rate that includes a risk premium, the other with the risk-free rate. We estimate gamma for forestry on Swedish data for stumpage prices and GDP per capita 1909–2012. We demonstrate that the result considerably changes the expected present value of medium-term and long-term forest investments.

Introduction

In several places, owners of forest land plant trees although the internal rate of return on a tree plantation is substantially lower than the normal return on other investments. For instance in Sweden, 50 percent of all tree planting was made in the northern half of the country (*Norrland*), which also has about half of the countryís productive forest land (Swedish Forest Agency, 2016), although only a small fraction of the forest land in this region can yield an expected return of 3 percent or more from such investments.[2] Policy makers and many forest professionals have since long defended such practices, irrespective of whether they result from deliberate forest management policies or legal reforestation requirements by various arguments, one of them being that forest investments are safe,[3] so the relevant opportunity cost of capital is not the return on other productive investments but on government bonds, with a long run, so called risk-free, yield at one to two percent in real terms.[4] In this study, we investigate to what extent this claim can be corroborated, based on long historical time series for Sweden.

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[1] Deceased.

[2] Hultkrantz (1987) estimated that the share of the forest land area with a positive soil (bare land) value was 1 and 14 percent in the northern and southern halves of Norrland, respectively.

[3] This matter was actually a main topic at the very first meeting of the Swedish Economic Association in 1887 in which a lecture was held by "merchant Sörensen" on the "future of our forests" (Sörensen, 1887). He presented tables demonstrating the "astonishing" effects from discounting future revenues from young forest stands, but argued that forest resources would always be demanded and there would be fewer sellers than buyers. Prices would therefore always be set so as to cover the cost of cultivation, so there was no risk in cultivating forest resources by planting trees (pp. 17–18), in particular, he added, since planting could be made by "oldsters and under-aged people" (p. 19).

[4] For historical records on the real rate of return on «a relatively riskless» asset in the US, UK, Japan, German and France, see Mehra, 2003. The inflation-adjusted return on long-term government bonds in Sweden 1901–2012 was 2.1 percent (geometrical average), see Waldenström (2014).

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Forest resource investments have indeed a number of features that could possibly be held as an argument for regarding them as safer than other investments. Timber is not just wood but a general purpose source for building materials, fibres, hydrocarbons and energy. Also, forests provide multiple environmental and recreational services. An important economic consequence is that in a long-term perspective demand for timber is derived from multiple end-products in a seemingly infinite sequence of overlapping product cycles (for instance from charcoal to newsprint to liquid packaging to biodiesel). This leads to risk mitigation through diversification over the long time span. In short and medium term perspectives forest resources can, as other real-valued assets, provide some hedge against inflationary pulses (see more on this below). Further, since production of timber (harvesting) is the result of sequential decisions made at several times (in advance and at the time of production) it can be shown (Berck, 1999) that a rational expectations equilibrium will exhibit mean-reverting prices. In fact, such a property is also what has been previously found (Hultkrantz et al., 2014a) for the Swedish stumpage price that will be used in the present study. This is different from what is normally expected on theoretical grounds and empirically found for financial assets and may imply differences with respect to risk characteristics as well, which is what we investigate in the present study.

In recent forest economics literature, some authors have discussed implications for forestry of the precautionary savings argument in macroeconomics. This argument is based on the observation that there is uncertainty over the long-term development of the overall macro economy, including future rates of interest. It can be shown that given this uncertainty the certainty equivalent term structure of the discount rate is declining. This therefore reduces the effect from discounting on the present value of returns that come a long time after the initial investment. Hepburn and Koundouri (2007) estimated such certainty-equivalent term structures from analysis with various statistical methods of historical UK rate of interest data and show that the they lead to substantially higher discounted benefits from forest projects.[5]

However, the precautionary savings motive is an argument for raising investments in capital in general, not specifically in forest resources. While the rates of return from other assets may vary over time, this is true also for the return from forest resources. In fact, there is no point in increasing the share of forest assets in an asset portfolio if the payoff from forestry is highly correlated with returns from other assets. As the finance literature persistently insists, it is the covariant, non-diversifiable, risk that is relevant for investment decisions.

The standard models in finance are usually applied to investments with horizons that are much shorter than for instance the normal rotation periods of forestry in Sweden. Recently, Weitzman (2012, 2013) has suggested an approach for discounting very long-term future benefits at a societal level based on the idea is that the return of an investment can be (linearly) decomposed into one portion that is covariant with the non-diversifiable systematic risk of the macro-economy and another portion that is independent of it. He then argues that it would be justified to require an average rate of return from risky investments on the first portion and a return on the second that corresponds to the return on government bonds and similar assets that are considered as "safe" assets. Calculating an exponentially weighted average of these rates then yields a discount rate that is declining over time at a rate that depends on the portion of the covariant risk. Weitzman calls the proportion of the expected payoff that is correlated with the macro-economy *the real project gamma*, henceforth gamma for short. As he shows, the weighted average formula has the same form as the conventional CAPM in a two period setting, with gamma replacing the CAPM beta.

Weitzman does not show, however, how the gamma can be estimated. In Mantalos and Hultkrantz (2018) it is demonstrated that such estimation is not trivial and that different estimation methods have to be used depending on the dynamic properties of the relevant time series and their correlation. We also suggest suitable approaches. In this paper we consider a series of annual stumpage prices in Sweden from 1909 to 2012 that was previously studied in Hultkrantz et al. (2014a) and GDP per capita for the same period. We estimate gamma for this case and show how the result can be used to evaluate forest investments. Our perspective is that of a strategic planner taking a societal view, as for instance that of a national forest regulatory body or of an administration of public forest land.[6] While the main implications for forest management from our results are similar to the conclusions in Hepburn and Koundouri (2007), we derive them on different theoretical grounds and with a different empirical approach.

The paper is organized as follows. In the next section we briefly review the standard CAPM model for valuation of risky assets and Weitzman's "tail-hedge" discounting model. Section 3 describes how we estimated the gamma, after having made some small modifications. A more extensive description of the empirical estimation is found in the Appendix. In Section 4 we demonstrate the result by evaluation of three long-term investment forestry cases. Section 5 contains a discussion and some final conclusions.

Theory

In this section we review first the standard CAPM model for valuation of risky assets and then the "tail-hedge discounting" approach of Weitzman (2012, 2013).

CAPM

The Capital Asset Pricing Model, or the CAPM, is a model of asset prices (Sharpe, 1966; Lintner, 1965; Mossin, 1966).[7] The model states that in equilibrium investors get a return r_i on a risky asset that is equal to the return r^f on a riskfree asset plus a risk premium that is equal to the equity premium $r^m - r^f$ on a fully diversified market portfolio times β_i, the latter factor being a measure of the non-diversifiable systematic risk, equal to the co-variance over the variance, or the slope coefficient in a linear regression of the return on the specific asset with market portfolio return. Thus:

$$r_i = r^f + \beta_i(r^m - r^f) \tag{2.1}$$

where $\beta_i = \frac{Cov(r_i, r^m)}{\sigma_m^2}$.

For analysis at a societal level, the consumption capital asset pricing model (CCAPM) was developed in the late 1970′s. It extends the CAPM by focusing on the correlation between the yield from a specific asset and overall consumption. However, in spite of its strong theoretical merits, the CCAPM is difficult to apply empirically, among others because of the diversity of the population with respect to possession of various kinds of assets (see the review by Breeden et al., 2015).

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[5] Amacher et al., 2009 Section 9.2.2 studies how forestry is affected by interest rate uncertainty, see also Gong and Löfgren (2003).

[6] In particular we will not consider the idiosyncratic risk of the useof a specific forest-management practice on a specific site.

[7] Merton (1973) extended the CAPM framework to cover inter-temporal portfolio choices (ICAPM).