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Assessing forestry-related assets with the intertemporal capital asset pricing model

Wenjing Yao, Bin Mei *

Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602, USA

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ABSTRACT

The intertemporal capital asset pricing model is used to assess the risk–return relationship between forestry-related assets and innovations in state variables using quarterly returns from 1988Q1 to 2011Q4. Market excess returns and innovations in the small-minus-big and high-minus-low factors, interest rate, term spread, default spread and aggregate consumption explain about 80% of the variation in cross-sectional returns of 16 forestry-related assets. Beta loadings on innovations in high-minus-low, interest rate and term spread induce significant risk premiums, and should be priced to determine the cross-sectional expected returns of the forestry-related assets. In general, average excess returns of the forestry-related assets decrease from the period of 1988Q1–1999Q4 to the period of 2000Q1–2011Q4. Significant positive excess returns are obtained in the first sub-period for private- and public-equity timberland assets but not in the second sub-period. Insignificant excess returns are obtained for forest products and timber products in the whole sample period. The results are robust to different specification tests.

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1. Introduction

The risk–return tradeoff of forestry-related assets is an important issue faced by investors who seek alternative investment opportunities. With independent biological growth from the financial market conditions, forestry-related assets distinguish themselves from financial assets or other real estate assets (Caulfield, 1998). For instance, forestry-related assets are shown to be weakly correlated with the financial markets and have low systematic risk (Sun and Zhang, 2001). In addition, Washburn and Binkley (1993), Martin (2010) and Wan et al. (2013) found that forestry-related assets have the ability to hedge against anticipated or unanticipated inflation risk. Most studies on the financial performance of forestry-related assets were based on the capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965). The CAPM is a static single factor model which states that the expected return of an asset is proportional to its covariance with the market portfolio (Bollerslev et al., 1988). It assumes that investors have homogeneous expectation and ignores the time variation in expected returns (Campbell, 1996; Merton, 1973; Roll, 1977). However, investors face a stochastic investment opportunity set, especially for long-term investments. To hedge against unfavorable shifts in the future investment opportunity set, investors can adjust their investment decisions (Bali, 2008). Therefore, in addition to the market risk, forestry-related assets may bear risks from innovations in factors which characterize the future investment opportunity set.

In this study, the intertemporal capital asset pricing model (ICAPM) is used to assess the risk–return relationship between forestry-related assets and innovations in state variables using quarterly returns from 1988Q1 to 2011Q4. Market excess returns and innovations in the small-minus-big and high-minus-low factors, interest rate, term spread, default spread and aggregate consumption as risk factors are found to explain the variation in cross-sectional returns of forestry-related assets. To our best knowledge, this is the first study that rigorously examines forest-related assets under the ICAPM framework. Results from this analysis can advance our understanding of the risk–return relationship of forest-related assets. This study also enriches the literature of empirical applications of the ICAPM.

2. Literature review

To improve the CAPM, Merton (1973) developed the multi-factor ICAPM. The model assumes that investors trade continuously and maximize their expected utility of lifetime consumption. It states that besides the market risk, risk of unfavorable shifts in the investment opportunity set, as approximated by the changes of the so-called state variables, will induce additional risk premiums and should be compensated.

The ICAPM is important in the theoretical standpoint, however, identifying state variables is difficult (Breeden, 1979). Theoretically,

* Corresponding author. Tel.: +1 706 542 5448; fax: +1 706 542 8356.
E-mail address: bmei@uga.edu (B. Mei).

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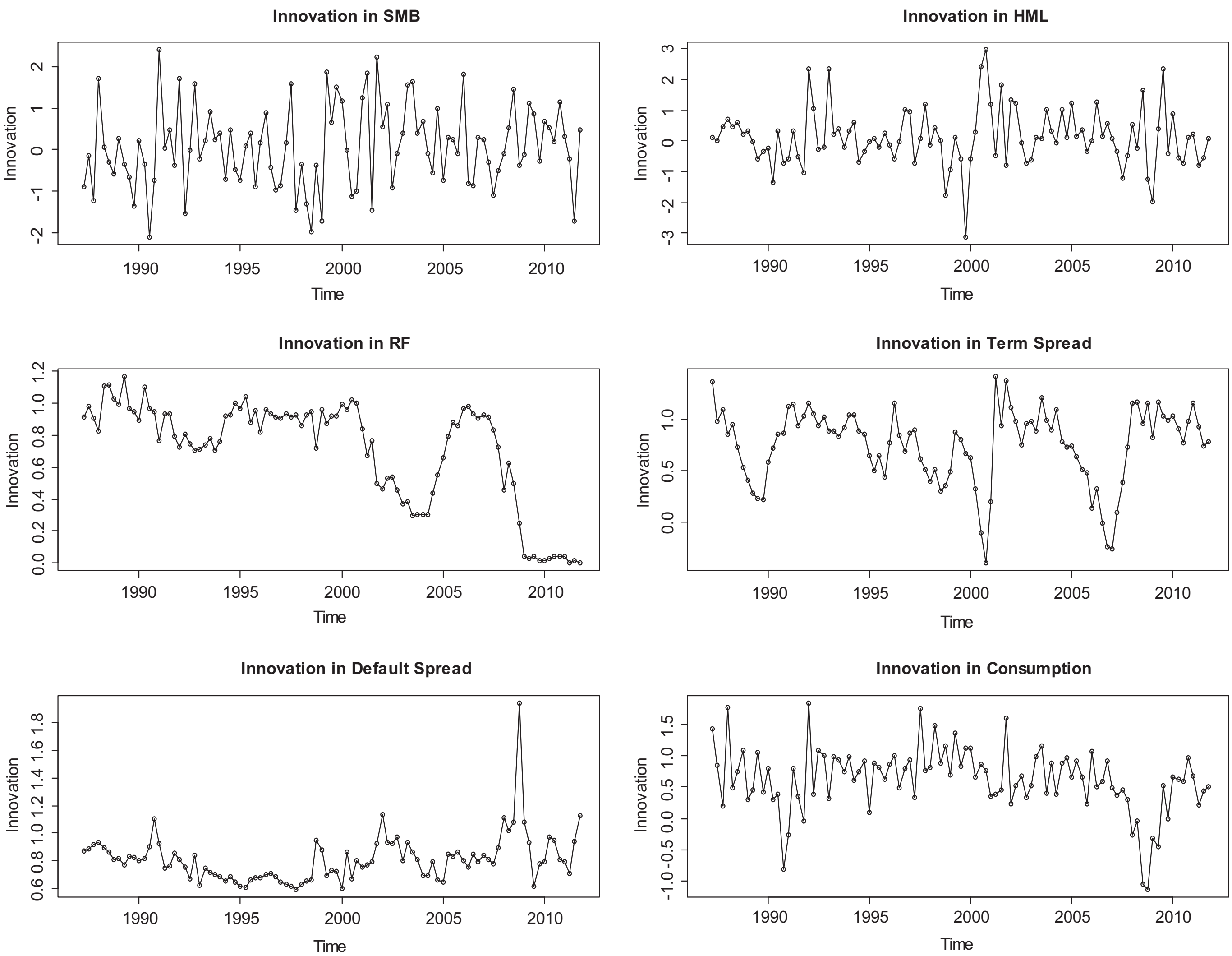

Fig. 1. Innovations in state variables.

state variables should be factors that have predicting power of the future investment opportunity set. Empirically, state variables being identified can be categorized into: 1) macroeconomic variables; 2) financial factors; and 3) aggregate consumption rate. In the first category, significant macroeconomic state variables include the interest rate, term spread and default spread. Interest rate is observable and time-varying, representing the stochastic characteristic of the investment opportunity set (Abhyankar and Gonzalez, 2009; Campbell and Vuolteenaho, 2004; Fama and French, 1993; Hui, 2006; Merton, 1973). Brennan et al. (2004) and Petkova (2006) found that innovation in interest rate was a significant factor in predicting the cross-sectional returns of 25 size and book-to-market sorted portfolios. Term spread, calculated as yield difference between long-term and short-term bond rates, is capable of tracking short-term fluctuations in the business cycle (Fama and French, 1989). Default spread measures the yield difference between bonds with different credit qualities, reflecting the macroeconomic condition. Empirical research showed that the term spread and default spread had significant impacts on expected returns (Bali, 2008; Bali and Engle, 2010; Evans, 1994; Petkova, 2006). In the second category, the small-minus-big (SMB) and high-minus-low (HML) factors found by Fama and French (1993) represent the size and value effects of stocks and successfully describe the cross-sectional variation of average stock returns. Kothari and Shanken (1997), Bali (2008), and Bali and Engle (2010) found significant relationships between SMB and HML factors and the expected returns on stocks. In the last category, the aggregate consumption rate covers a significant fraction of the true consumption and adds explanatory power to the expected returns. Previous studies showed that the aggregate consumption was important in determining investors' investment opportunity set (Bollerslev et al., 1988; Breeden, 1979; Hui, 2006).

Instead of using the aforementioned state variables directly for the empirical implementation of the ICAPM, Campbell (1996) suggested using innovations in such state variables to forecast the changes in the future investment opportunity set. To estimate innovations in state variables, Brennan et al. (2004) assumed the Ornstein–Uhlenbeck process whereas Petkova (2006) used the first-order vector autoregression model. Both studies observed significant risk premiums induced by innovations in the state variables. As an application of the ICAPM in pricing natural resource assets, Dorfman and Park (2011) applied the Bayesian approach and the bivariate generalized autoregressive conditional heteroskedasticity in the mean (GARCH-M) model and found significant positive risk–return relation between the agricultural production and food manufacturing industries and the total U.S. stock market.

This study tends to investigate the intertemporal risk–return relationships of forestry-related assets under the multi-factor ICAPM