DEALING WITH TIMBERLAND INVESTMENT RISK: THEORY VERSUS PRACTICE FOR INSTITUTIONAL OWNERS

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ABSTRACT

Since 1981, U.S. institutional investors have placed $5.8 billion into timberland assets. They include timberland in their portfolios because returns have competed strongly with traditional portfolio assets, are perceived as low risk, and return correlations with other portfolio assets are low. The subject of timberland returns and risk should therefore be of practical interest to timberland investment management companies (TIMCOs), the firms that manage these assets for institutions. To date, however, the application of academic research on risk to operational timberland investment problems is limited. This paper discusses which research is employed by TIMCOs, which is not, and suggests reasons why.

Keywords: Institutional investors, research impact, timberland investment
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INTRODUCTION

Institutional investors — primarily pension funds, and to a smaller extent endowments and trusts — are an increasingly visible category of timberland owner in the United States. Since the introduction of the first closed-end commingled timberland investment fund in 1981, institutions have committed an estimated $5.8 billion to the asset class (Caulfield, 1998a). The rate of investment growth became particularly pronounced during the 1990s. Assets have more than quadrupled from the $1.39 billion of institutional timberland owned in 1990 (Zinkhan, 1990a).

Timberland is viewed as an "alternative" asset class, in contrast to traditional portfolio assets such as stocks, bonds and cash. Timberland has attracted investor attention for

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three reasons. First, its returns, as measured by several performance benchmarks, are consistently reported to compete strongly with traditional assets. Second, it is perceived as a low-risk investment. Finally, the return correlation between timberland and other asset categories are generally low, implying that it offers an unusual portfolio diversification opportunity (e.g., Binkley & Washburn, 1988; Zinkhan, 1990b; Caulfield, 1994a; NCREIF, 1994).

Investors obviously will view favorably any asset with the potential to offer premium returns. But in the United States, institutional investors subject to fiduciary requirements of the Employee Retirement Income Security Act (ERISA) compliance are additionally required to pay close attention to issues of investment risk. Unlike individual investors, pension funds are legally obligated to perform substantial due diligence on any investment they consider adding to their portfolio. Properly conducted, the due diligence process includes a detailed evaluation of both expected returns and return variability.

Institutions perform due diligence both internally and through independent consulting firms. In most cases, neither of these parties tend to completely understand timberland returns and risks, because this asset class is relatively new to most portfolios, is a "niche" asset, and because the factors that drive timberland returns differ from those of traditional assets like stocks. Consequently, timberland investment management companies (TIMCOs), the firms institutional investors hire to manage timberland assets, are often the ultimate source of the information used to make timberland asset allocation decisions. It would seem to logically follow that TIMCOs should regularly utilize much of the published timberland investment risk research found in the literature. However, with some notable exceptions, this does not generally appear to be the case. This "disconnect" between theory and practice is the subject of this paper.

In the following sections, we first describe the general areas of timberland investment risk research that have appeared in the literature and then discuss the research that TIMCOs appear to have found useful, along with the reasons why.

CATEGORIES OF TIMBERLAND INVESTMENT RISK RESEARCH

The body of research on the risks of timberland investing can be classified into three broad categories: (1) timberland as a portfolio asset, (2) risk at the stand-level, and (3) risk at the forest-level.

Timberland as a Portfolio Asset

The study of timberland as a portfolio asset began in the early 1980s. This was also the period during which timberland began being acquired by institutional investors. In these studies, returns and risk of either timber or timberland are contrasted to more traditional asset classes. A major proportion of this work centers around applications of portfolio theory and the Capital Asset Pricing Model (Markowitz, 1959).

In their seminal work, Mills & Hoover (1982) present a case study using four financial investments, four farming options and ten different hardwood investments in Indiana. They demonstrate that including a forestry allocation in a mixed-enterprise farm portfolio provides a diversifying effect which increases returns over a wide range of risk levels.

Other researchers subsequently estimated systematic investment risk, or timber "betas," by regressing returns for timber by itself (Redmond & Cubbage, 1988) or timber plus land (Binkley & Washburn, 1988; Conroy 6 Miles, 1989) against a return index for equity assets like the S&P 500. In most cases the beta values reported were either low or negative. Low or negative betas indicate that investors should require a lower return for timberland vis-a-vis other asset classes. A second implication of these studies is that timber or timberland provides a beneficial portfolio diversifying effect. However, as Thomson (1987) has pointed out, these studies provide limited guidance as to the appropriate proportion of timberland to include in mixed-asset portfolios.

Thomson (1987) examined return-risk attributes of two timberland asset categories: northern hardwood and southern pine sawtimber investments for hypothetical fully regulated forests, and demonstrated that these two assets could lead to risk-efficient timberland portfolios. He extended this work by including the S&P 500, Treasury Bills and Corporate bonds into a portfolio analysis (Thomson, 1992). Mills (1988) similarly extended his original research on the diversifying influence of timberland by considering the correlation between timberland returns and assets such as mutual funds and commercial paper.

All the above mentioned studies employed various "synthetic" benchmarks to measure the performance and risks of timberland investments (e.g. Zinkhan, 1990a; Binkley *et al.*, 1996). Synthetic indexes are based on hypothetical timberland investments. While the specifics of these benchmarks differ, each employs several assumptions: (1) a land parcel of given acreage and site quality is held; (2) the land has an initial endowment of given timber volume in various product categories, and this timber grows over time; (3) a stated management regime is applied; and (4) timber prices are based on local or regional averages.

Timberland indexes that employ returns from actual properties are a more recent development. Currently, two such indexes exist (Caulfield, 1994a; NCREIF 1994) each of which measures quarterly returns from actual institutionally-owned properties from a combination of closed-end funds and separate accounts.

Research that employs asset-based indexes to consider timberland allocation issues in institutional portfolios has also appeared recently. Caulfield (1998b) used an asset-based index in the context of Markowitz (1959) optimization to determine the timberland allocation in a mixed-asset portfolio in which domestic large and small cap stocks, foreign stocks, treasury bills, long bonds, and commercial real estate were candidate assets. Results indicated that for varying rolling time periods from 5 to 15 years, for the period 1981 to 1996, timberland would receive a substantial asset allocation in optimized portfolios.

Risk at the Stand and Forest Level

The second and third categories of research share three similarities. First, studies of risk at both the stand or forest level focus on risk from the standpoint of management decision making. This often takes the form of determining the optimal thinning regime, planting density, rotation age (stand level), or harvest schedule (forest level). Other research falling into the latter two categories considers adaptive management strategies in the face of product price risk.

Second, with few exceptions, most studies employ the first moment of the distribution of the decision criterion of interest – typically expected Net Present Value or expected Internal Rate of Return – as the risk measures used. Decision-makers are usually either explicitly or implicitly assumed to be risk-neutral. The variance (or standard deviation) of the mean return is generally ignored as a measure of risk.

Finally, apart from some research on adaptive management strategies, many studies view risk in the "long term," e.g., the expected net present value resulting from alternative management strategies measured over a rotation or some other multi-year holding period.

The earliest paper to deal with the impact of risk on the forest harvest decision was Norstrom (1975) which applied an optimal control approach to the case of uncertain timber prices. As this and later analyses have shown (e.g., Lohmander, 1987; Brazee & Mendelsohn, 1988, Clarke & Reed, 1989, Morck *et al*., 1989, Haight & Holmes 1991), incorporation of risk into decision-making will generally lead to increased land expectation values when compared to the alternative of a deterministic Faustmann-type rotation (Samuelson, 1967). This is done by the landowner specifying a reservation price and then harvesting only when market prices exceed this price. As a result, the impact on rotation ages from the incorporation of risk is uncertain due to the fact that a landowner may choose to delay harvest in order to take advantage of expected future price increases, or shorten the rotation to take advantage of current price advantages.

Methodological approaches to the treatment of price risk have varied. Early work focused on the computational problems associated with arriving at an optimal solution (Kao, 1982 and 1984). However, increasing computer speeds and capacity obviated these problems. In addition, new methodological techniques greatly improved our ability to handle complex problems. In particular, the work of Dixit & Pindyck (1994) has opened up new areas for the analysis of forest management options in landowner decision-making (Yin & Newman, 1996 and 1999; Plantinga, 1998). Option pricing necessarily blends the single stand analysis based on the Faustmann formula with the need to look at the broad range of forest investments that a landowner may make at the forest level. An advantage of this technique is that both initial investment and final harvest decision problems can be evaluated simultaneously.

While much of the existing work has focused on price risks, a related area of stand-level risk research has dealt with the impact of catastrophic occurrences such as fire, hurricanes, and pests that can totally or partially obliterate a timber stand. Various authors have shown, under a variety of modeling approaches, that catastrophic risk worked to lower land expectation values and shorten rotation ages (Routledge, 1980; Martell, 1980; Reed, 1982;Reed & Errico, 1985; Caulfield, 1988; Haight *et al.*, 1995, Yin & Newman, 1996). This occurs because the probability of catastrophe effectively adds a risk premium to the discount rate, thus raising the opportunity cost on holding timber inventories.

Whole forest modeling in the presence of risk and uncertainty has received much less attention than has the single stand modeling approach discussed above. This is probably because of the lack of unambiguous results and the heavy reliance on numerical analytical methods. Reed & Errico (1986) and Gassman (1989) have evaluated the harvest-scheduling problem in the presence of catastrophic fire. They find that harvest flow constraints effectively impose a limit on each period's cut meaning that stands cannot be treated independently. Swallow *et al*. (1994) have addressed problems associated with the management of adjoining stands.

Risk Analysis Research Employed by TIMCOs

Timberland as a Portfolio Asset

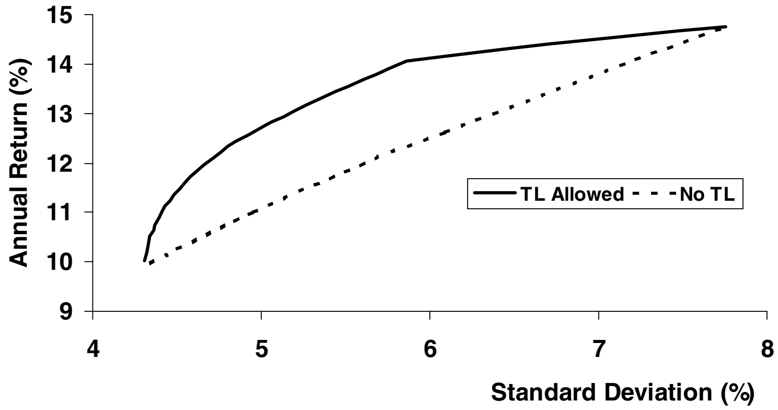
To date, only the first of the above research categories – timberland as a portfolio asset – is utilized regularly by TIMCOs. This work is almost always employed for two purposes: (1) marketing investments to investors, and (2) geographic and age-class allocations of the timberland assets held by TIMCOs.

Research on timberland as a portfolio asset is used extensively in marketing, and employed by virtually all TIMCOs. This is due both to the nature of the asset and because of institutional factors. Although timberland has existed as an investable asset for almost two decades, it has yet to become fully accepted by institutional investors. The estimated $5.8 billion worth of timberland held by U.S. institutions constitutes less than 0.1% of the value of their total holdings of $5.9 trillion in all asset classes (Caulfield, 1998a). Timberland can therefore hardly be considered a "mainstream" asset.

Statutory reporting requirements for many TIMCOs mean their clients require, at minimum, quarterly reports of investment performance. Therefore, the period-to-period value of timberland held in an investor's portfolio must be established on an ongoing and regular basis throughout the investment life. Also, just as investors require equity benchmarks like the S&P 500 to compare against their stock portfolio, they also need to compare their property returns to a timberland benchmark.

The problem timberland historically faced in being accepted by institutions was that the factors that drive its investment returns — biological growth, product price changes and land price changes — were poorly understood by non-foresters. Consequently, the longstanding lack of an asset-based performance benchmark also meant that timberland return measures based on synthetic indexes were often viewed with skepticism (Caulfield, 1998b).

The introduction of asset-based performance benchmarks may be changing this situation. Anecdotal evidence suggests that the many institutional investors and investment advisors who employ Modern Portfolio Theory (Markowitz, 1959) to make asset allocation decisions prefer using asset-based performance measures over the more limited synthetic indexes. TIMCOs therefore have focused on providing investors and their advisors with this information, and this usually occurs as part of the marketing function. Put another way, research on timberland as a portfolio asset is used in marketing because the marketing function is closely tied in with the due diligence process conducted by institutional investors and their consultants.



Source: Adapted from Caulfield 1998b

Figure 1. Efficient Frontiers for Portfolios with and without Timberland, 1988 – 1997.

Another reason research on timberland as a portfolio asset is used extensively in marketing is because, over time, the financial survival of any TIMCO ultimately depends on its success in continuing to attract new institutional assets which generate fee income. Attracting institutional funds means investors must be convinced that adding timberland to their portfolio will enhance overall returns, or preferably, enhance returns for a given level of overall portfolio risk.

Research has demonstrated consistently that, on an *ex post* basis, the addition of timberland to a typical institutional portfolio would have increased returns over a wide range of risk levels. This is the case whether a synthetic index (e.g., Thomson, 1987; Zinkhan, 1990) or an asset-based index is employed. Figure 1 shows this from results obtained by Caulfield (1998b).

Research which considers timberland as a portfolio asset is used far less extensively to make geographic and age-class allocations of timberland assets held by TIMCOs. This is despite the fact that research shows that pure geographic diversification of timberland assets, regardless of the age-class (Binkley *et al.*, 1996), or geographic plus age-class diversification (Caulfield, 1994b), leads to more risk-efficient timberland portfolios than either no diversification or naive diversification.

There are several reasons this research tends to be underemployed. One is that TIMCOs are often constrained by the need to place investor dollars quickly. When an investor for a separate account or a group of investors in a commingled fund commits funds, there is considerable pressure to acquire timberland assets within a 12- to 18-month period. This emphasis on pursuing whatever deal may be available does not always result in an optimally (or even adequately) diversified portfolio of timberland assets.

Another reason few TIMCOs use research on timberland portfolios to acquire assets is because most lack in-house expertise to carry out a formal portfolio analysis. Portfolio construction requires detailed knowledge of the return and risk characteristics of each asset considered for inclusion, as well as historical and projected return correlations with other candidate investments. Efficient frontiers are generated from these statistics, which, when combined with a client's return-risk preferences, are used to identify appropriate combinations of property to acquire. This is a time-intensive process, particularly when applied to real assets that do not trade on organized exchanges. Although TIMCOs normally possess the in-house capability to estimate timberland property returns based on discounted cashflow analysis, few have staff with the additional training required to perform a detailed asset allocation study.

Finally, some TIMCOs may not consider risk in traditional terms — i.e., the standard deviation of mean returns. Risk may be viewed in a different context, such as the probability of not achieving the investor's target rate of return. There is considerable intuitive appeal to this approach, since standard deviation as a risk measure penalizes returns both above and below the mean, and many (perhaps most) investors do not perceive the former situation as "risky" (Harlow, 1991). Although methods exist to deal with returns below the target rate, generically referred to as "downside risk" models, these are only recently becoming accepted by traditional investors (e.g., Lewis, 1990; Marmer & Ng, 1993) and are not yet widely used by the institutional investment community at large.

Stand- and Forest-Level Risk Models

Research on stand- and forest-level forest risk is seldom, if ever, employed by TIMCOs. There appear to be four major reasons for this:

1. Stand level risk models are not used because TIMCOs purchase forests rather than stands;
2. Both stand- and forest-level risk models focus on maximizing returns from optimizing management, while TIMCOs focus on acquisitions and sales rather than optimizing management, and on catastrophic risks;
3. The investment time horizon is critical for institutional investors; and
4. Risk definitions vary widely among TIMCOs.

TIMCOs almost never acquire single stands of trees. Instead they typically purchase large tracts which contain numerous stands, and a wide variety of timber age-classes.

For example, it was recently reported that since 1990, a single TIMCO (Hancock Timber Resource Group) acquired a total of 1.117 million acres of timberland in various regions of the United States, through a total of 10 individual acquisitions (Zaret, 1998).

With such large purchases, timber inventories and appraisals are usually made at the forest or strata level rather than on an individual stand basis. While inventories are designed to provide a detailed account of forest volumes and growth rates across the entire property, detailed stand-by-stand information is often unavailable. This level of aggregation is necessary to keep transactions costs at a reasonable level. Nonetheless, it makes the application of stand-level risk analysis models to such properties difficult or impossible.

Another reason traditional stand-level risk models are largely ignored is because TIMCOs focus on maximizing investment returns from the purchase and subsequent sale of timberland rather than by optimizing management activities over the ownership period. Most stand-level risk models assume that (1) either bare land is purchased, which is subsequently planted to timber, or (2) an existing forest stand is already owned.

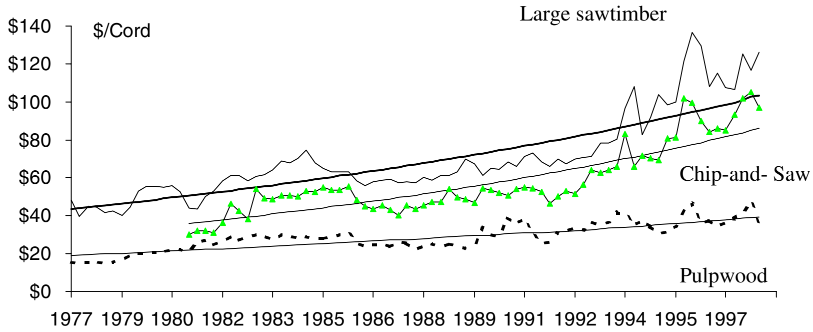


FIGURE 2. SOUTH GEORGIA TIMBER PRICES AND LONG-TERM TRENDS, 1977 TO 1997.

TIMCOs, however, normally buy and sell existing forests. This means that stumpage and land price changes at the time of acquisition, as well as their trend rates of change, are central to the decision-making process. Figure 2 shows South Georgia timber prices for the 20-year period from 1977 to 1997. TIMCOs follow such price series closely, with the objective of (ideally) entering an investment when prices are at or below the long-term trend, and exiting when prices are above the trend. In contrast, while stand-level risk models may include these prices (particularly stumpage) as analysis inputs, prices are not normally tied into the decision to enter or exit the investment. Consequently, these models are of limited usefulness to operational acquisition and/or disposition decisions.

Forest-level risk models, like stand models, also tend to be oriented either towards optimizing ongoing forest management activities or, towards evaluating the influence of catastrophic risk on forest investments. An example of the former is found in Reed & Errico (1985), who demonstrate how to optimize harvest scheduling at the forest level in the presence of the risk of fire. An example of the latter is in Yin & Newman (1996) who consider the question of investors entering and exiting a forest business when product prices are stochastic and catastrophic forest-level risk follows a Poisson jump process.

Another factor which confounds the use of both stand- and forest-level risk models is that over the period a TIMCO holds a client's property, different parcels within the property — these parcels being stands or aggregations of stands — will be held for varying periods of time. It is normal for parcels to be sold opportunistically over the life of an investment, with the objective of maximizing the rate of return on the overall investment. This type of activity is not handled easily by existing risk models.

The use of traditional stand- and forest-level risk models is made more difficult because TIMCOs usually operate within well-defined investment horizons. Until very recently, most institutional investments did not exceed 10 to 12 years in length. Timberland is still a relatively new asset class, and institutions do not yet have a "comfort level" for it that allows investments to extend for, for example, the length of a rotation. As a result, the kinds of issues that are central to traditional risk models — rotation age and the timing and extent of intermediate stand treatments — receive very limited attention by TIMCOs.

Finally, as discussed earlier, risk definitions vary widely among TIMCOs. There is greater concern for achieving a required hurdle rate or besting a timberland performance benchmark than on focusing on risk measures such as standard deviation. And from the TIMCO's standpoint, this makes sense. Not achieving a required hurdle rate for an extended period can and does result in losing a client's business. At the very least, it will result in losing the management incentive fee for the TIMCO, which is tied to a pre-specified hurdle rate in the investment management agreement between the investor and the TIMCO.

SUMMARY

Only a small proportion of the existing risk analysis research on timberland is currently employed by TIMCOs on behalf of their institutional clients. Most of the research that is used considers the topic of timberland as a portfolio asset, and this is employed primarily for marketing the asset to investors. The general lack of familiarity with timberland by institutional investors means they require research on the asset's performance and risk characteristics for their due diligence process, and significant reliance is placed on TIMCOs to provide this information.

Although research on timberland as a portfolio asset is potentially useful by TIMCOs for the construction of timberland portfolios, it is seldom employed to this end. Among the apparent reasons are that TIMCOs must often place investor dollars quickly; many lack the in-house expertise to conduct formal asset allocation research; and some view or define risk in different terms than the traditional standard deviation of returns.

Research on stand- and forest-level risk is rarely used by TIMCOs. The major reason stand-level models are seldom used is because TIMCOs buy forests rather than stands. Also, both stand- and forest-level models focus on optimizing management activities under risk, while TIMCOs tend to concentrate on adding value to investments by optimal acquisition and disposition decisions. Other factors include the relatively short time horizons common to institutional investments versus existing risk models, the fact that TIMCOs often sell pieces of properties opportunistically, and the focus on catastrophic risk in forest-level models.

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