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Working Paper

77

International Timberland Investments: Linking the Mean-Variance Approach to Country Assessments

William J. Turner

October 2001

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EXECUTIVE SUMMARY

Given the entrance of institutional investors such as pension funds, onto the timberland ownership scene, timberland as an asset is viewed differently now than it was in the past. Traditional asset management practices based on the portfolio selection framework are chiefly responsible for demonstrating the diversification benefits of U.S. timberland investments. This research evaluates international timberland investments by utilizing traditional asset allocation practices and individual country assessments.

Asset performance descriptive statistics are documented for the sample (1981-1998) and an analysis of correlation between international timberland investments and assets of portfolios of U.S. pension funds (e.g. stocks, bonds, treasury bills) is conducted in order to gauge basic asset return relationships.

The correlation analysis is followed by a portfolio selection process and then the study addresses characteristics specific to international investments, such as foreign currency exchange issues and qualitatively assessing countries risk characteristics as they specifically relate to international timberland investments.

When analyzing international timberland investments, a distinction is be made regarding the treatment of currency exchange. Two, separate international timberland asset classes are considered. One includes returns influenced by changing exchange rates and is based on a return in U.S. Dollars. The other international timberland asset class only considers the returns in the foreign currency and attempts to eliminate exchange rate effects through hedging.

The underlying research objective is to demonstrate the effects of investors adding international timberland investments to an investment portfolio by including an examination of currency exchange effects and an assessment of country-specific risk characteristics.

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An acknowledgement is also in order for Jack Lutz his open discussions of timberland investments and sharing of resources.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

INTRODUCTION

Since the early 1980's, portfolio selection theory has played a large role in assessing and helping to explain the changing ownership structure of timberland in the United States. Spurred by the passage of the 1974 federal Employee Retirement Income Security Act (ERISA) and similar legislation for public pension plans, institutional investors were motivated to diversify away from the traditional investment instruments: corporate and government bonds. Concurrently, several forest products companies were realizing that strategically they did not need to own timberland and could use their timberland as a source of capital for processing facilities (Freeman, 1986). Today, institutional investors such as pension funds, banks, insurance companies, foundations, universities and other endowments enjoy a diversification benefit by owning timberland. In fact, institutional investors (mainly pension funds) held more than 5.6 billion dollars in timberland at the end of 1997 according to two estimates (Caufield, 1998; Zinkan, et al. 1992).

Referred to by many as "patient money", pension funds' long-term investment objectives enable the investors to be advantageously equipped to face liquidity and price volatility issues associated with timberland investments. Pension funds also have a favorable tax structure relative to other potential timberland owners (Binkley, et al. 1996). For these reasons, pension funds have emerged as the major players in the arena of timberland investment and are the class of investors on which this research focuses.

Pension fund managers are responsible for the task of overseeing the investment of pension fund capital and/or managing contracted money managers. Inherently present in this responsibility is the allocation of investment to asset classes. It is through asset allocation that pension fund managers can diversify risk and analyze the risk and return relationship of their portfolios. So how do portfolio managers know what portfolios to select? How do portfolio managers analyze choices between different asset allocations? The most common applied approaches are based on the theoretical models of portfolio selection developed by Harry Markowitz and James Tobin, which provide explanations and normative rules for the diversification of risky assets. The degree to which diversification can reduce risk, however, depends upon the correlation of the different assets' returns to each other. If the assets' returns were not correlated to each other or completely independent, diversification among the uncorrelated assets would eliminate risk[1]. However, the practical side, as well as the theoretical importance of portfolio selection, stems from the fact that the assets' returns don't have to be completely uncorrelated for diversification to result in some reduction of risk. Assets' returns can be correlated, just not perfectly correlated in order for some reduction of risk to occur. It is quite clear from the general forestry literature that the low, and even negative, correlation between U.S. timberland investments and other financial assets, such as the benchmark Standard & Poor's 500, enables investors, such as pension funds, to benefit from a reduction in portfolio risk by allocating some percentage of their investments to timberland (Mills, 1988; Redmond, et al. 1988).

In a similar fashion to the development of the theoretical portfolio selection model previously mentioned, arguments in favor of international diversification were also developed. Grubel (1968), Solnik (1974), and others have discovered and shown empirically how the performance of financial assets from different countries, lack strong positive correlation. This simple existence of low asset return correlation translated into portfolio risk reduction for investors who ventured into foreign markets for investment opportunities.

[1] An illustration of diversification reducing risk when asset returns are independent is presented in Silberberg (1990). Silberberg demonstrates that if the returns of n assets are independent, the total risk premium is only 1/n of the risk premium for the single undiversified asset.

With the supply of timber restricted on public lands in the U.S. West, global demand for timber has been met increasingly by other regions such as New Zealand, Australia, Chile, Brazil, and Argentina. While many of these supply regions have remaining natural forests, they also have characteristics that make commercial plantation forestry economically feasible (Sedjo, 1994). The general consensus seems to be that these countries are the best potential future sources of investment grade timberland (Lutz, 1997). Forest type, industry, and political structure can characterize investment grade timberland regions. Desirable forest types usually consist of familiar species or climates that make plantation of these species silviculturally feasible. In addition, long-term investment horizons are more closely aligned with long-term forest planning and sustainable forestry management practices as the accepted management practice of the region. Industry considerations tend to focus on a region's infrastructure, timber markets, and timberland markets. Finally, the political structure of a region is really defined in terms of stability; stability of economic policies, natural resource policies, national governments, and laws regarding the private ownership of timberlands (more generally how ownership of capital is treated). Some countries may have the perception of possessing substantial political risk and being poor sources of investment grade timberland in terms of stability. Countries such as Argentina, Brazil, Russia, China, Indonesia, and Malaysia all have more instability (Lutz, 1997). While they may not fit into the mean-variance framework like the previously mentioned countries, a qualitative country-specific risk assessment can be helpful in determining any potential diversification benefits from this type of timberland investment.

Given the entrance of institutional investors such as pension funds, onto the timberland ownership scene, timberland as an asset is viewed differently now than it was in the past. Portfolio diversification benefits of owning U.S. timberland have been demonstrated to exist and long-term oriented pension funds are now capitalizing and holding timberland assets in their portfolios.

Traditional asset management practices based on the portfolio selection framework are chiefly responsible for demonstrating the diversification benefits of U.S. timberland investments. This research evaluates international timberland investments by utilizing traditional asset allocation practices and individual country assessments.

Asset performance descriptive statistics are documented for the sample (1981-1998) and an analysis of correlation between international timberland investments and assets of portfolios of U.S. pension funds (e.g. stocks, bonds, treasury bills) is conducted in order to gauge basic asset return relationships.

A portfolio selection process to be described in Chapter 2 follows the correlation analysis. The study then addresses characteristics specific to international investments, such as foreign currency exchange issues and qualitatively assessing countries risk characteristics as they specifically relate to timberland investments.

When analyzing international timberland investments, a distinction will be made regarding the treatment of currency exchange. Two, separate international timberland asset classes will be considered; One will include returns influenced by changing exchange rates and will be based on a return in U.S. Dollars. The other international timberland asset class will only consider the returns in the foreign currency and will attempt to eliminate exchange rate effects through hedging.

The underlying research objective is to demonstrate the effects of investors adding international timberland investments to an investment portfolio by including an examination of currency exchange effects and an assessment of country-specific risk characteristics.

At this point in time, the private research community has conducted only limited research in this area, and most all research results are not public information. This study's contribution is the first empirical portfolio selection analysis including international timberland investments and associated currency exchange implications. This research also makes a breakthrough in that both practitioners and researchers will have an added framework to supplement portfolio selection outcomes with country risk assessments specific to timberland investments. The country risk assessment framework identifies specific attributes important to international timberland investments and provides a starting point in which to gauge countries that are unable to be included into the portfolio selection analysis due to a lack of market data.

CHAPTER 1: LITERATURE REVIEW

1.1. LITERATURE REVIEW INTRODUCTION

This research takes on a multidisciplinary approach. Each discipline area of portfolio theory, international investments, and forestry is integral and only together do an understanding of these areas provide a solid foundation for this study.

The portfolio selection literature provides the theory for the asset allocation framework. The asset allocation framework developed in the literature is then expanded by empirically including traditional financial assets into the framework.

It is the international finance literature, which establishes that potential risk reduction may exist when foreign assets are added to a portfolio and highlights the importance of each country's risk characteristics.

Once theory from the portfolio selection literature and international investment literature is reviewed, recent research on U.S. timberland investments is also integrated from the forestry literature. Research on U.S. timberland investments illustrates the unique characteristics of timberland investments stemming from the biological growth of trees and calculates the historical relationships between U.S. timberland investments and other investment assets. The forestry literature also investigates methods for calculating timberland returns.

1.2. TRADITIONAL FINANCIAL ASSETS AND PORTFOLIO THEORY

Portfolio theory is so well established in the literature, that it is the base of much of the theory in financial economics. Single period portfolio selection is analogous to the canceling of risks in the insurance industry. As previously mentioned, if asset returns are not perfectly correlated, then some level of diversification can occur. Portfolio selection is carried out by what many refer to as the mean-variance (MV) framework (Markowitz, 1952; Tobin, 1952; Markowitz, 1959). The MV framework has defined the standard approach to asset allocation decision making by characterizing an asset by its historical mean return and variance of return. The MV framework is essentially one decision criterion that can be used to choose among possible investment alternatives based on expected returns and standard deviations.

The MV model allocates or mixes the proportion of assets to arrive at a portfolio with a minimum variance for a given return. The model can also be constructed to maximize a portfolio's return for a given variance. The model seeks MV-efficient portfolios subject to any system of linear equality or inequality constraints. The MV-efficient portfolio or solution, however, is not only a computing procedure. It is a body of propositions and formulas concerning the shapes and properties of mean-variance efficient sets. In addition, these propositions and formulas have implications for financial theory and practice (Markowitz, 1987).

Of the numerous extensions to the more original work in this area, Farrell (1974) and Tobin (1984) particularly relate to this study. The first analyzes homogeneous stock groupings and the later applies the MV framework to fundamental asset valuations.

Since risk is one of the more important components to the model but the most unclear in the literature, it was helpful to review the concept of risk and the relative relation to investment portfolios (Jensen, 1969; Blume, 1971; and Jeffery, 1984).

No body of literature is without its share of problems. Portfolio theory assumes that the multivariate distribution of asset returns is completely known to the investor. Even in the pioneering work of Markowitz (1952), it was pointed out that this particular assumption might present a problem in the practical application of the theory. This concern has led to considerable work that strives to minimize the impact of perceived risk induced by the deviation of estimates of the distribution of asset return from the true distribution (Bawa, et. al. 1979; Michand, 1989; Markowitz, 1987). MV portfolio optimization is sensitive to errors in the estimates of the inputs, which are the historical asset returns. Chopra (1993) shows that even small changes in the input parameter can result in large changes in composition of the optimal portfolios. Best and Grauer (1991) present some results on the sensitivity of optimal portfolios to changes in means and Chopra and Ziemba (1993) examine the relative impact of estimation errors in means, variances, and covariances of asset returns. Kallberg and Ziemba (1984) examine the question of mis-specification in normally distributed portfolio selection problems. They discuss three areas of mis-specification: the investor's utility function, the vector of mean returns, and the covariance matrix of the return distribution. They find that utility functions with similar levels of risk aversion result in similar optimal portfolios, irrespective of the functional form of the utility. Thus mis-specification of the utility function is not a major concern because several different utility functions (quadratic, negative exponential, logarithmic, power) result in similar portfolio allocation for similar levels of risk. However, mis-specification of the parameters of the return distribution does make a difference. For this reason, Chapter 6 discusses the use of constrained allocations. Errors in mean returns are approximately ten times as important as errors in variances and covariances. In addition, the relative impact of errors in mean, variances, and covariances also depends on the investor's risk tolerance. For a risk tolerance of 50[2], errors in means are approximately eleven times as important as errors in variances. The results of Kallberg and Ziemba's 1984 study revealed implications for the allocation of resources according to the MV framework. The primary emphasis should be on obtaining estimates of means, followed by estimates of variances. Estimates of covariances are the least important in terms of their influence on the optimal portfolio.

1.3. INTERNATIONAL FINANCIAL ASSETS

Portfolio selection via the Markowitz MV approach was eventually extended beyond the scope of a particular country's domestic market. Several studies have used MV analysis to demonstrate that international diversification can result in major gains (i.e. increased returns for given level of risk or reduced risk for a given level of returns) from international economic relationships (Grubel, 1968; Levy and Sarnat, 1970; Solnik, 1974). These studies point out that with the existence of a high degree of positive correlation within a domestic market it may be possible for risk reduction to occur by diversifying securities portfolios internationally. Cone and Weaver (1979) go on to illustrate, via the Sharpe model (1964), this effect by a means exhibiting domestic and international systematic risk and how a reduction of systematic risk occurs through international diversification.

Several empirical studies also exist in this arena. One specific study analyzes portfolio benefits of investing in international debt and equity (Grauer and Hakansson, 1987). In other studies, each uses Latin American equity investments to illustrate their point that many international equity investments lack strong positive correlation with U.S. investments (Geyikdagi and Geyikdagi, 1989; Lessard, 1973). In addition, empirical evidence shows that diversification across international industries can result in a reduction of portfolio risk (Meric and Meric, 1989).

In the similar mean-variance fashion, corporations also utilize strategies to stabilize cash flows through international diversification. While shareholders can always diversify on their own, corporations may still desire to stabilize cash flows in order to satisfy creditors and achieve a lower cost of capital. This slightly different angle demonstrates diversification benefits of direct foreign investment. (Madura and Whyte, 1990).

[2] The risk tolerance reflects the investor's desired trade-off between additional return and additional risk (variance). It is the inverse slope of the investor's indifference curve in the mean-variance framework. The greater the risk tolerance, the more risk an investor is willing to take for a little additional return. According to Kallberg and Ziemba, under fairly general input assumptions, a risk tolerance of 50 describes the typical portfolio allocations of large U.S. pension funds and other institutional investors. Risk tolerances of 25 to 75 characterize extremely conservative and aggressive investors respectively.

1.4. TIMBERLAND INVESTMENTS

In the United States applied financial methods were being utilized by foresters and being published as early as 1909 by Schenck. Even earlier (mid-1800's), Faustman's research led to the development of timber production under the idea of basic capital theory. Portfolio selection theory, of course, was not being applied until much later. In fact, early studies analyze the risk and returns from growing timber using the Capital Asset Pricing Model (CAPM) (Sharpe, 1964). Even though the CAPM has been criticized both empirically and theoretically, it endures as the model of choice when comparing the risk and return of various assets[3]. The CAPM defines a relationship between asset's expected rate of return (r_i), the risk-free[4] rate of return (r_f), and the expected risk premium on the market portfolio of all assets in the economy[5], which is the difference between the expected market rate (r_m) and the risk-free rate (r_f):

$$r_i = r_f + b_i(r_m - r_f) \qquad (1.1)$$

Since expected returns are unknown, the model is estimated ex post data. Thus the CAPM has been widely used in ex post analyses as a means to gauge systematic risk and return. In modern financial theory, risk is divided into two components: unsystematic risk and systematic risk. Unsystematic risk reflects risks that are unique to a particular asset or the line of business or industry in which the asset is. It is possible for an investor to invest in a variety of assets in different industries or with different characteristics in order to eliminate or reduce unsystematic risk. Systematic risk, often referred to as market risk or nondiversifiable risk, is the variation in market as a whole, which causes changes in value of the particular asset. It is also this systematic risk that can be altered by selecting certain combinations of assets in a portfolio.

Researchers have used the CAPM model in an ex post fashion to measure the historical risk and return relationships between various financial assets and timberland investments (Redmond and Cubbage, 1988; Cubbage, Harris, and Redmond, 1989; Binkley and Washburn, 1988; Zinkhan, 1988; Conroy and Miles, 1989; Washburn and Binkley, 1990). The results of these studies vary. They all support the fact that timberland investments can be expected to add diversification benefits to an investment portfolio. These studies find that b_i in equation 1.1, which is commonly referred to as 'beta'[6], is small and in some cases negative. In most cases, the beta computed, was not significant, meaning the hypothesis of beta equals zero cannot be rejected. Because timber investment betas tend to be small or zero, timber investments can be expected to be favorable components of investment portfolios. Since the CAPM framework does not address the optimal proportion of timberland assets, MV analysis is utilized to perform this task.

Several forest economists have utilized the MV framework to show optimal proportions of timberland investments (Caulfield, 1997; Caufield, 1998; Cubbage, et al. 1991; Thomson, 1991; DeForest, et al. 1991). The main point of their research is two-fold. One is to develop an index or mechanism to quantify timberland returns in the U.S. The second is to illustrate the benefits of adding timberland to an investment portfolio at different timber allocation levels. The correlation of timberland returns to other more traditional assets in this research mirrors that in previously mentioned CAPM studies and calculates minimum variance and efficient sets containing a timberland allocation under the assumptions of the MV framework.

Hydahl and Baumgartner (1991) summarize the remaining literature in their overview of the subject matter.

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[3] Both Roll (1977) and Ross (1978) have tested the validity of the CAPM. As a result, several other pricing models have been developed. The Arbitrage Pricing Theory (APT) as introduced by Ross (1976) and the New Equilibrium Theory (Ibbotson, Diermeirer, and Siegel 1984) which was introduced later have not been practically applied to forest and alternative financial assets such as real estate, due to data limitations and market liquidity.

[4] Risk free rates of return are usually calculated from a proxy for a risk free asset, such as U.S. Treasury Bills.

[5] Applications traditionally have used the Standard and Poor's 500, or a similar benchmark.

[6] The covariance of returns between timberland and the market portfolio.

CHAPTER 2: RESEARCH METHODOLOGY AND THEORETICAL DERIVATION OF THE GENERAL MEAN-VARIANCE MODEL

2.1. RESEARCH METHODOLOGY INTRODUCTION

In order to test the diversification effects of international timberland, methodologies need to be employed to verify the correlation of financial asset returns and simulate possible portfolios of different assets and their respective expected return and variance.

To assist in the correlation analysis of asset performance a correlation matrix is constructed using the Pearson Correlation Coefficient. The correlation analysis is followed by a portfolio selection process focusing on an assets distribution of mean returns and variance of returns. While this chapter discusses the simple input to the model for a traditional investment, it also describes the methodology used to estimate the returns of timberland investments. Finally this chapter depicts the foreign currency exchange aspect of international investments and introduces the approach to hedging international assets with currency swaps and forward contracts.

2.2. PEARSON CORRELATION COEFFICIENT

The simple Pearson correlation coefficient is used to measure the strength of the linear relationship between assets. Unlike the slope measured by least squares coefficients, the correlation coefficient is without scale and is always between -1 and 1.

In equation 2.1, *x* and *y* are the yearly returns of two different assets.

$$r = \frac{\sum x_i y_i - \frac{(\sum x_i)(\sum y_i)}{n}}{\sqrt{(\sum x_i^2 - \frac{(\sum x_i)^2}{n})(\sum y_i^2 - \frac{(\sum y_i)^2}{n})}} \quad (2.1)$$

One of the key concepts in portfolio analysis that is related to the Pearson Correlation Pearson Correlation Coefficient is covariance. Covariance is a measure that reflects both the variance (or volatility) of an asset's returns and the tendency of those returns to move up or down at the same time other assets move up or down. For example, the covariance between asset A and asset B tells us whether the returns of the two assets tend to rise and fall together, and how large those movements tend to be. However, it is difficult to interpret the magnitude of the covariance term. Therefore, a related statistic the Pearson Correlation Coefficient, has been developed to measure the degree of co-movement between two variables. As previously stated, the correlation coefficient is without scale and is always between -1 and 1. In addition, the sign of the Pearson Correlation Coefficient is the same as the sign of the covariance, so a positive sign means that the assets move together, a negative sign indicates that they move in opposite directions, and if r is close to zero, they move independently of one another.

2.3. PORTFOLIO THEORY AND THE MEAN-VARIANCE FRAMEWORK

Portfolio theory is grounded in the arena of analyzing the risk of assets held in portfolios, or combinations of assets, as opposed to assumption that assets are held by themselves in isolation. As previously stated in the introduction, an asset held as part of a portfolio is generally less risky than the same asset held in isolation (Silberberg, 1990). Thus, an asset that would be relatively risky if held in isolation may not be risky at all if it is held in a diversified portfolio. Therefore considering risk in a portfolio context could completely change a decision based on an analysis of total risk.

As shown formally below in equation 3.2, expected return on a portfolio is simply a weighted average of the expected returns on the individual assets in the portfolio. The assets weight or proportion of that asset in the overall portfolio denotes each asset's contribution to the expected portfolio return. However, unlike the situation with returns, portfolio risk or the variance of a portfolio, is generally not a weighted average of the variances of the individual assets in the portfolio, and each asset's contribution to the portfolio's variance is not denoted by the assets weight. It is theoretically possible to combine two assets, which are, individually, quite risky as measured by their variances, and to form from these risky assets a portfolio which is completely without risk, with a variance of zero. This is possible if the returns of the two assets move counter-cyclically to one another. In this case, the counter-cyclical movement is referred to as perfectly negatively correlation. In terms of the previously discussed Pearson Correlation Coefficient, perfectly negative correlation would result in a correlation coefficient of –1.

The opposite of perfect negative correlation is perfect positive correlation or a correlation coefficient of +1. Returns of two perfectly positively correlated assets would move up and down together, and a portfolio consisting of two such assets would be just as risky as the individual assets. In this extreme case the variance would be equal to that of the individual assets, indicating that diversification does nothing to reduce risk if the portfolio consists of perfectly positively correlated stocks.

In reality, most assets are not perfectly correlated. The point here is that the portfolio's variance in not an average of the variances of its component assets but a function of the assets covariance, as measured by the assets correlation coefficient. Thus, diversification usually reduces risk but does not eliminate it completely.

2.3.1. Minimum Variance Frontiers

This research computes Mean Variance (MV), minimum variance frontiers using the framework developed by Markowitz (1952).

Given the full set of potential portfolios that could be constructed from the available assets, which portfolio should actually be held? This choice involves two separate decisions: determining the minimum variance set of portfolios, and then choosing from the minimum variance set the single portfolio that is best for the individual investor. Given the scope of this study, the first decision is of primary relevance in illustrating the diversification benefits to international timberland investments. The minimum variance frontier identifies the portfolios with the minimum variances (or standard deviation) for each target level of expected portfolio return (A in Figure 1). The portfolios to the left of the frontier are not possible because they lie outside the attainable set (B in Figure 1). Inferior portfolios to the right of the frontier (C in Figure 1) are not efficient because some other portfolio would provide a lower risk for the same targeted expected portfolio return and are thus dominated by the portfolios making up the minimum variance frontier.

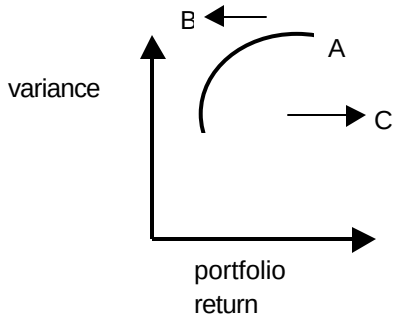


Figure 1. The Minimum Variance Frontier.

The following is a list of minimum variance frontiers that are computed. Table 1 also summarizes the asset classes included in the different frontiers. The goal here is to analyze the different frontiers computed under varying constraints with different assets. Under the assumptions of the MV framework the portfolio means are characterized by their variance and assumed to be mean reverting thus when comparing portfolios of different frontiers the mean and variance resulting form different asset proportions are assumed to be significant and representative of the population distribution.

By starting with a baseline case using traditional U.S. assets and then adding Domestic and International timberland assets, changes in the minimum variance frontier will reveal whether for a given return a reduction in risk is obtainable.

- Minimum Variance Frontier 1. A baseline case is developed using traditional U.S. pension fund assets. (U.S. stocks, international stocks, U.S. fixed income, Treasury Bills, and real estate)

- Minimum Variance Frontier 2. An U.S. timberland portfolio (HTRG-Market) is added to the traditional baseline assets in Minimum Variance Frontier 1. This illustrates the diversification effects of U.S. timberland investments when constrained to a hypothetical timberland portfolio.

- Minimum Variance Frontier 3. Rather than constrain individual, geographical region oriented assets with a predetermined portfolio (HTRG-Market); each individual asset within the U.S. timberland portfolio (HTRG-S, HTRG-PNW, and HTRG-NE) is allowed to interact with the baseline traditional assets. This enables the covariance of each individual U.S. timberland asset to interact with the traditional assets instead of the covariance of a predetermined portfolio interacting with the traditional assets.

- Minimum Variance Frontier 4. Next, international timberland investments with returns denominated in U.S. dollars (unhedged) are added to Minimum Variance Frontier 2. Thus the impacts of currency exchange fluctuations are present in the optimal allocations depicted by the overall MV relationships of the frontier.

- Minimum Variance Frontier 5. International timberland investments with returns denominated in U.S. dollars (unhedged) are added to Minimum Variance Frontier 3. Thus the impacts of currency exchange fluctuations are present in the optimal allocations depicted by the overall MV relationships of the frontier and individual U.S. timberland investments are considered for different geographical regions.

- Minimum Variance Frontier 6. Similar to Minimum Variance Frontier 4 only the international timberland investments are hedged in order to eliminate the impacts of currency exchange fluctuations.

- Minimum Variance Frontier 7. Similar to Minimum Variance Frontier 5 only the international timberland investments are hedged in order to eliminate the impacts of currency exchange fluctuations.

- Minimum Variance Frontiers 8-14. Minimum Variance Frontiers 8-14 are identical to Minimum Variance Frontiers 1-7 with the exception of key traditional assets having minimum asset allocation constraints. As further discussed in Model Results 4.0, portfolio managers are often constrained by guidelines specifying asset allocation ranges. Minimum Variance Frontiers 8-14 are subject to the following minimum asset allocation in order to simulate these hypothetical guidelines: 35 percent U.S. stocks, 25 percent corporate bonds, and 5 percent U.S. Treasury Bills.

- Minimum Variance Frontier 15. Like Minimum Variance Frontier 2, this frontier includes a portfolio of timberland investments. However, this frontier includes a portfolio of international timberland investments with the following weights: 40 percent HTRG-S, 30 percent HTRG-PNW, 10 percent HTRG-NE, 10 percent Chile-Hedged, and 10 percent New Zealand-Hedged. In addition, this frontier is subject to the same minimum asset allocation constraints as Minimum Variance Frontiers 8-14.

Table 1. Summary of Minimum Variance Frontiers.

FRONTIER	CONSTRAINED	ASSETS
1		Traditional
2		Traditional, Bundled US Timberland
3		Traditional, Unbundled US Timberland
4		Traditional, Bundled US Timberland, Unhedged International
5		Traditional, Unbundled US Timberland, Unhedged International
6		Traditional, Bundled US Timberland, Hedged International
7		Traditional, Unbundled US Timberland, Hedged International
8		Traditional
9	X	Traditional, Bundled US Timberland
10	X	Traditional, Unbundled US Timberland
11	X	Traditional, Bundled US Timberland, Unhedged International
12	X	Traditional, Unbundled US Timberland, Unhedged International
13	X	Traditional, Bundled US Timberland, Hedged International
14	X	Traditional, Unbundled US Timberland, Hedged International
15	X	Traditional, World Timberland Portfolio

Minimum Variance frontiers are estimated using portfolios of U.S. timberland and international timberland investments and also using individual, specific international timberland investments and U.S. timberland investments characterized by geographic region.

2.3.2. Constructing a Minimum Variance Frontier

In a mean-variance framework, investors' preferences can be represented by a (derived) utility function defined over the mean and the variance of a portfolio's return, $U(\bar{r}_p, s^2)$. Using the notation from below, the expected return and variance of a portfolio are as follows.

$$\bar{r}_p = w^T \bar{r} = \sum_{i=1}^{n} w_i \bar{r}_i \qquad (2.2)$$

$$s^2 = w^T \Omega w = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j s_{ij} \qquad (2.3)$$

We can determine the efficient frontier by finding the minimum variance portfolio of risky assets for any desired $\bar{r}_p$, or portfolio return. The following notation further describes equations (2.2) and (2.3).

w = vector of asset weights or asset allocations; $0 < w_i < 1, \sum_{i=1}^{n} w_i = 1$

Ω = variance-covariance matrix

$\underline{1}$ = vector of ones

$\bar{r}$ = vector of expected returns

$\bar{r}_p$ = target portfolio expected return

To solve the model minimize: $(1/2)w^T\Omega w$ (2.4)

subject to: $w^T\underline{1} = 1$ (2.5)

and: $\bar{r}^T w = \bar{r}_p$ (2.6)

The Lagrangian for this problem is

$$L(.) = (1/2)w^T\Omega w + l(1 - w^T\underline{1}) + g(\bar{r}_p - \bar{r}^T w) \quad (2.7)$$

And the first order conditions are as follows:

$$\frac{\partial L}{\partial w} = \Omega w - l\underline{1} - g\bar{r}^T = 0 \quad (2.8)$$

$$\frac{\partial L}{\partial l} = w^T 1 - 1 = 0 \quad (2.9)$$

$$\frac{\partial L}{\partial g} = \bar{r}^T w - \bar{r}_p = 0 \quad (2.10)$$

Note that Ω^{-1} exists since Ω is positive definite.

Let $\mathrm{V} = \Omega^{-1}$. Also note $\Omega^T = \Omega$ and $\mathrm{V}^T = \mathrm{V}$.

Solving equation (2.8) for *w* and with substitution, a linear function is derived:

$$w = a + h\bar{r}_P \quad (2.11)$$

with: $$a = \frac{\mathrm{C}[\Omega^{-1}\underline{1}] - \mathrm{B}[\Omega^{-1}\bar{r}_P]}{\Delta} \quad (2.12)$$

and: $$h = \frac{\mathrm{A}[\Omega^{-1}\bar{r}_P] - \mathrm{B}[\Omega^{-1}\underline{1}]}{\Delta} \quad (2.13)$$

Where: $A = \underline{1}^T \mathrm{V}\underline{1}$ (2.14)

$$B = \underline{1}^T \mathrm{V}\bar{r} \quad (2.15)$$

$$C = \bar{r}^T \mathrm{V}\bar{r} \quad (2.16)$$

$$\Delta = (AC - B^2) \quad (2.17)$$

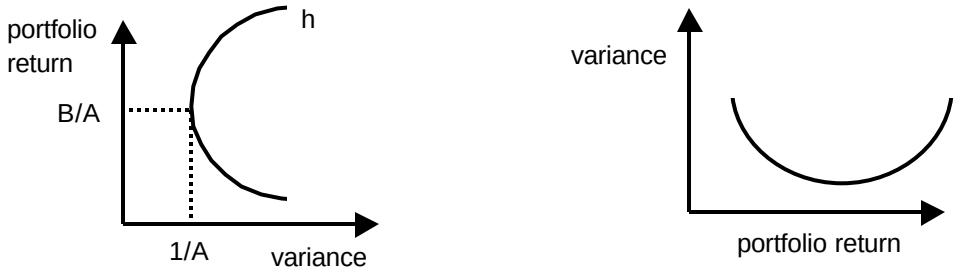
With more substitution back into the variance, s^2 is a quadratic function of $\bar{r}_P$ and quadratic functions take the form of parabolas.

$$s^2 = \frac{\mathrm{A}\bar{r}_P{}^2 - 2\mathrm{B}\bar{r}_P + \mathrm{C}}{\Delta} \quad (2.18)$$

The global minimum variance is found by setting:

$$\frac{\partial s^2}{\partial \bar{r}_P} = \frac{2A\bar{r}_P - 2B}{\Delta} = 0 \qquad (2.19)$$

where: $\bar{r}_P = \frac{B}{A}$ and $s^2 = \frac{1}{A}$ (2.20)



(resulting in a more common graph)

This standard MV framework finds the global minimum variance on the frontier. For ease of computation and to allow for more rigorous inequality constraints the Solver program was used in Microsoft Excel to generate all the portfolios making up the minimum variance frontiers for this study.

Microsoft Excel Solver uses the Generalized Reduced Gradient (GRG2) nonlinear optimization code developed by Leon Lasdon, University of Texas; and Allen Waren, Cleveland State University.

Linear and integer problems utilize the Simplex method with bounds on the variables and the branch-and-bound method, implemented by John Watson and Dan Fylstra, Frontline Systems Inc. Both Frontline Systems and Microsoft Corp copyright the Microsoft Excel Solver code.

The various minimum variance frontiers are computed by minimizing the portfolio standard deviation for a range of target portfolio mean returns. An optimal portfolio is found after an iterative process, altering asset proportions or weights. The program constraints are set such that each asset proportion in the portfolio must be non-negative and that all asset proportions within the portfolio must sum to one. In addition, the constrained portfolios place minimum asset proportions on certain asset classes. The constraints levied on selected scenarios are 5 percent, T-Bills; 25 percent, Corporate Bonds; 35 percent, U.S. Equities. The constraint on U.S. equities does not allow a combination of the S&P500 and the Small Cap asset class of less than 35 percent.

2.4. MEAN-VARIANCE INPUTS

The data input for portfolio problems is the periodic returns for each asset that is to be considered in the model. standard method for computing simple financial returns of a security is:

$$r_n = \frac{V_n + D_n}{V_{n-1}} - 1 \qquad (2.21)$$

where:

r_n = the rate of return in period n.

V_n = the value (price) of the security in period n.

V_{n-1} = the value (price) of the security in the previous period, n-1.

D_n = the dividend received in period n.

Unlike returns for financial assets, timberland returns are not easily measured. Records of returns for actual international timberland are very difficult to obtain. In fact, prior to the mid-80's, when institutional investment started to take place, records of past returns for U.S. timberland investments were very difficult to obtain.

Given this lack of information, researchers have used a combination of past timber prices, timber growth characteristics, historical timberland and growing stock values, and management expenses to construct a proxy for returns for a normal forest, which is usually fully regulated.

Most research starts with a fully regulated forest, which allows for an equal volume of timber to be harvested each year. In addition, the growing stock and growth remains constant over time. This assumption is important and provides a generalized asset return. If additional information is known regarding a specific property, specific parameters (growth and variable harvest scheduling) can be accounted for and a more [MM1]custom expected return may be computed for a unique property of forest management regime. Most research also assumes that land and growing stock track timber prices and that management expense are a constant proportion of forest value. These assumptions are parameters of the term this research refers to as a normal or model forest. Under these assumptions, all of the variation in the timberland returns is caused by the variation in timber prices. Even when considering other more complex assumptions about the components of returns for forests, the fluctuation in timber prices accounts for most of the variation in timberland return estimates. As a result, most all estimates of timberland returns generate similar results.

The John Hancock Timber Index[7] (1997) is one example of a model used to estimate timberland returns. The index is relatively simple and reasonably accurate compared to past research (Washburn 1990). Timberland returns are estimated using the formula previously shown for a security, with the following differences.

$$r_n = \frac{V_n + D_n}{V_{n-1}} - 1 \qquad (2.22)$$

Where: r_n = the rate of return in period n.

V_n = the index of the value of the land and growing stock during period n.

V_{n-1} = the index of the value of the land and growing stock during the previous period.

[7] As a result of timberland investors and investment advisors desire for an independent, industry-wide measure of timberland returns, the National Council of Real Estate Investment Fiduciaries (NCRIEF) began publishing their version of the John Hancock Timber Index in 1994. Joined by Prudential Timber Investments, Forest Investment Associates, and the Frank Russell Company, the Hancock Timber Resource Group helped develop the NCRIEF Timberland Index. The NCRIEF Timberland Index is similar to the John Hancock Timber Index in the sense that it is still based on an income return component and a capital return component. However, the NCRIEF Timberland Index is not based on a hypothetical, fully regulated forest. Instead, the NCRIEF Timberland Index relies on reported data from participating, timberland investment advisors and managers. The result is an index that more closely measures returns on the actual performance of the managed tree farms and has computational similarities to that of the NCRIEF Property Index, which is used for commercial real estate. A more thorough explanation of the subject matter is detailed in *The NCRIEF Timberland Index, Research Notes #3* (Hancock Timber Resource Group, 1999).

D_n = the index of net revenue produced by the timberland in period n.

The net revenue is a function of the income rate and timber price. The value of timberland and growing stock is a function of weighted average past timber prices. Timber prices are determined by proportionate timber quality[8] (i.e. 1/2 pulpwood & 1/2 sawtimber for the U.S. South). A more complete description can be found in The John Hancock Timber Index: Historical Returns for Timberland (1994). A slightly more complex but similar method is outlined in detail by Thompson (1991) and a more recent fund-based index has been developed by Caulfield (1997). While the Timberland Performance Index developed by Caulfield provides quarterly measures the index is not as geographically diversified as the John Hancock Timber Index and is limited to fewer participating funds.

2.5. INTERNATIONAL INVESTMENTS AND DIVERSIFICATION

The minimum variance frontier can be found in exactly the same way as described earlier when considering unhedged international assets. The only feature that is different is the way in which foreign securities are considered in the portfolio selection problem. In particular their returns are entered as:

$$r = (1 + r^f)(1 + r^c) - 1 \qquad (2.23)$$

where: $r^f = (P_1^f + D_1^f) / P_0^f - 1$ (2.24)

return on the asset in terms of the foreign currency

and: $r^c = (X_1^{\$/f}) / (X_0^{\$/f}) - 1$ (2.25)

return on the currency transaction

The above expression for the returns shows that three factors are important: (2.24) the return on the underlying asset, (2.25) the rate of currency appreciation or depreciation, and the interaction term. Unlike U.S. assets denominated in U.S. dollars, international investment returns are denominated in the local foreign currency and must be converted to U.S. dollars. It is during this conversion that currency exchange rates become important to investors since the currency exchange rates can fluctuate from period to period and these fluctuations will affect the overall investment return. Timberland investments are no different since there is periodic income from harvests and the possibility of an asset disposition.

2.5.1. Hedging with Currency Swaps

In this study, currency swaps are examined as a hedge for overseas timberland investments. Currency swaps are better suited for this application since they are most effective at hedging currency risk for several years rather than months. Since their inception in 1979, foreign currency swaps have emerged as one of the most widely used vehicles for hedging currency risk in the world. According to the International Swaps and Derivatives Association outstanding interest rate swaps, currency swaps, and interest rate options were valued at $50.9 trillion at the end of 1998.

[8] For the U.S. South, the price is based on 1/2 pulpwood and 1/2 sawtimber. For the PNW, the price is based on ¾ Douglas fir and ¼ hemlock sawtimber. For U.S. NE, the price is based on ½ pulpwood and ½ sawtimber.

The most basic type of currency swap involves three separate sets of cash flows and is driven by the need to obtain funds denominated in a foreign currency. Initially, the two parties physically exchange equivalent amounts of two different currencies so that each has the quantity of foreign currency they desire. In other words, they begin by loaning each other the same amount of cash, albeit each in a different currency. Then they make periodic interest payments to each other during the life of the contract. These interest payments are made in the borrowed currency and reflect the level of the interest rates in the home country of borrowed currency. Finally, the swap is completed when the principle sums of cash originally borrowed are re-exchanged. This type of currency swap is often referred to as a Plain Vanilla Swap. Swaps are not without their obvious problems. It is necessary to find someone to take the opposite side of a swap and broker and dealer fees may be expensive. In addition, there is the issue of creditworthiness of the swap partner because there is no guarantor of the swap. A far more complete discussion of swaps and the swap market can be found in Marshall and Kapner (1993).

In a typical currency swap, a U.S. investor who would like to invest in international timberland will find another party who needs an equivalent amount of U.S. dollars. The counterparty may be a foreign investor who needs U.S. dollars to purchase an U.S. asset of approximately equal value and would like a similar holding period. Generally, under these terms, the value of an U.S. investor's international holdings, hedged with a currency swap at the end of the first period can be estimated with:

$$P_{f1} = V(1+r_{f1}) - i_f + \frac{i_{us}}{S_1} \qquad (2.26)$$

where, $V(1+r_{f1})$, is the foreign value of the international timberland at the end of the first period, i_f, is the foreign denominated interest payment to the counterparty, $i_{us,}$ is the dollar denominated interest payment from the counterparty to the U.S. investor, S_i is the exchange rate at the end of the first period and the, $-i_f+i_{us}/S_i$, term is first period's profit or loss on the swap. At the end of n periods the value of the international timberland is:

$$P_{fn} = P_{f(n-1)}(1+r_{fn}) - i_f + \frac{i_{us}}{S_n} \qquad (2.27)$$

where, S_n , is the exchange rate on the nth period in dollars per foreign currency. This assumes that all proceeds of the previous year (from both the international timberland and the currency swap) are reinvested in the same international asset. Finally, to convert the value of the international timberlands at the end of the duration back to U.S. dollars, P_{10}, use:

$$P_{10} = V(S_0) + (P_{f10} - V)S_{10} \qquad (2.28)$$

It is worth noting that only the initial investment of, $V(S_0)$, dollars is actually shielded from currency risk. All returns above that original amount, $(P_{f10} - V)$, are subject to exchange rate losses or gains.

2.5.2. Hedging with Forward Contracts

Timberland investments are capital intensive in terms of the initial capital required to initiate the long-term investments. Thus by definition, currency swaps are utilized to hedge the capital outlay to currency exchange exposure. However, with currency swaps only able to hedge the capital portion of the long-term investment another vehicle is necessary to hedge the periodic income component of the returns, due to timber harvests, described in 3.3 *Mean-Variance Inputs*.

For many traditional financial assets hedged returns for different time horizons are often available directly from the data source. When hedged returns are not available, hedging can be performed using forward contracts. Utilizing the same approach presented in Stone and Hensel (1989), with the exception of hedging on a yearly basis rather than utilizing one-month forward contracts, end of the year income can be reinitialized with a spot market foreign exchange trade to the new beginning value, and the hedge can be rolled forward another year (Ziobrowski and Ziobrowski, 1995). The result of currency swaps coupled with currency exchange forward contracts, mimics or acts as a proxy for returns denominated in the local currency, minus 50 basis points[9] to account for the transaction cost for the hedge.

Exchange rate data is utilized from the Food and Agriculture Organization of the United Nations (FAO) Forest Products Yearbook and the Foreign Exchange Policy Center at the University of British Columbia.

[9] A basis point is equal to 1/100th of a percent. Thus, 50 basis points are equal to 0.50 percent.

CHAPTER 3: DATA SOURCES AND ANALYSIS

3.1. U.S. TIMBERLAND RETURNS

In an effort to keep data series consistent, this research utilizes yearly data. While both the John Hancock Timber Index and the Timberland Performance Index (TPI) provide total returns for domestic timberland investments, this study utilizes the John Hancock Timberland Index. Compared to the TPI, The John Hancock Timber Index accounts for a larger percentage of U.S. timberland assets and is unique in the sense that it is computed on a regional level.

3.2. INTERNATIONAL TIMBERLAND RETURNS

Through the course of this research, it became clear that international timber prices are not publicly available for most countries and when data is available more times than not a historical time series of more than five years does not exist. For this reason countries such as Argentina, Brazil, Indonesia, Malaysia, Philippines, and South Africa do not have sufficient historical data to formulate a sample and include into the quantitative framework. However, Chile and New Zealand being pioneers in plantation forestry have the most readily available and complete data on timber and various forest products. For Chile, Instituto Forestal de Chile (INFOR) is the major source of Radiata Pine timber prices as is the FAO Forest Products Yearbook. In a similar fashion, New Zealand Radiata Pine timber prices are available from the New Zealand Ministry of Agriculture and Forestry and the FAO Forest Products Yearbook. A return series is then constructed from these prices for each country following the same methodology used for the John Hancock Timber Index.

3.3. COUNTRY RISK ASSESSMENTS AND ANALYSIS

In addition to the quantitative total return data for domestic and international timberland investments, qualitative country ratings and assessments were compiled from numerous sources. Where data is unavailable for inclusion into the MV framework, the country ratings and assessments will be used in relating MV framework results to countries with similar rankings and which serve similar timber markets.

Euromoney publishes a bi-annual review of county risk ratings based on three broad groups and nine subcategories. The broad groups include analytical, credit, and market indicators. Within each group the nine subcategories are as follows: economic data, political risk, debt indicators, default or scheduled, credit ratings, access to bank finance, access to short term finance, access to international bond and syndicated loan markets, and access to discount on forfeiting. Euromoney also publishes a ranking of economic projections for various countries around the world.

Transparency International is an organization sponsored by Gottingen University in Germany. Transparency International is a leader in reviewing and assessing country corruption and publishes a corruption perception index. The index attempts to scale the corruption and bribery on an international level through a survey instrument. Their review is incorporated into the qualitative international timberland investment county review.

This research also benefits from both the U.S.-based Heritage Foundation's index of economic freedom and the Fraser Institute's Economic Freedom Review. The Heritage Foundation's recent publication *1999 Index of Economic Freedom* shows that countries with the most free economies had average annual growth rates of 2.9 percent from 1980 to 1993 and that countries with "mostly free" economies had average long-term growth rates of just under 1 percent (Johnson, et al. 1999). Ratings on the Heritage Foundation's Index of Economic Freedom are based on an analysis of 50 different economic variables, grouped into 10 broad categories: banking, foreign investment, monetary policy, taxation, trade policy, wage and price policies, the size of government, property rights, regulatory restrictions, and black-market activity. Countries are rated one to five in each category, one being best five the worst.

The Fraser Institute in Canada also publishes an economic freedom index. The index comprises 25 components designed to identify the consistency of economic freedom in seven major areas (Gwartney and Lauson, 1995). The areas accounted for by the index are size of government, economic structure and use of markets, monetary policy and price stability, freedom to use alternative currencies, legal structure and security of private ownership, freedom to trade with foreigners, and freedom of exchange in capital markets.

World competitiveness is also considered in compiling the qualitative assessment. The Swiss-based Insatiate for Management Development's (IMD) published reviews are utilized. IMD's philosophy is that a country's competitiveness cannot be reduced to simple measures of GDP and growth. Instead, IMD believes that countries compete by creating an environment with the most efficient structure, institutions, and policies in which enterprises can compete successfully. The World Competitiveness Yearbook ranks countries in order of competitiveness by analyzing data of 47 industrialized and emerging economies. IMD uses 288 measures that are grouped into eight competitive input factors.

In addition to the global macroeconomic data that is utilized, timber species, biological and physical stand risk information is adapted from *The Tree Farm and Managed Forest Industry* (Neilson and Manners, 1997).

MV inputs include a diverse range of assets in order to represent a multi-asset portfolio. Table 2 lists these assets including their means and standard deviations in an attempt to summarize the assets and for comparative purposes. Comparisons are made for large company U.S. stocks[10], small company U.S. stocks[11], U.S. corporate bonds[12], U.S. treasury bills[13], international stocks[14], U.S. real estate[15], U.S. timberland[16], and international timberland[17].

Also included in Table 2 is the Sharpe ratio (Brigham and Gapenski, 1990), which can be viewed as a reward-to-variability measure. The Sharpe ratio is computed by subtracting the risk-free rate from the mean asset return and dividing the difference by the assets standard deviation. In this regard, the ratio represents the excess return per unit of standard deviation and is used when comparing the benefits of different assets.

[10] Total returns for the S&P500 is used for large company stocks.

[11] Total returns for small company stocks published by Ibbotson Associates are used for U.S. stocks.

[12] Total returns for long-term corporate bonds published by Ibbotson Associates are used for U.S. corporate bonds.

[13] Total returns for U.S. Treasury Bills published by Ibbotson Associates are utilized.

[14] The Morgan Stanley Capital International Europe, Australasia Far East Total Return Index is utilized for international stocks.

[15] The NCREIF Real Estate Index is used for U.S. Real Estate.

[16] The John Hancock Timber Index is used for returns from 1981 to 1986 and from 1987 to 1998 the NCREIF Timberland Index is used. HTRG-S represents returns from the Southern U.S. HTRG-PNW represents returns from the Pacific Northwest. HTRG-NE represents returns from the Northeastern U.S. HTRG-Market represents a portfolio of timberland investments that includes 50 percent HTRG-S, 40 percent HTRG-PNW, and 10 percent HTRG-NE.

[17] International timberland is included in five different total return series: hedged and unhedged Chilean timberland returns, hedged and unhedged New Zealand returns, and the World Timber series. The World Timber series is a portfolio of timberland investments that includes 10 percent hedged-Chile and 10 percent hedged New Zealand timberland assets as well as 40 percent HTRG-S, 30 percent HTRG-PNW, and 10 percent HTRG-NE.

Table 2. Nominal Asset Performance Characteristics 1981-1998.

Asset Class	Geometric Mean	Arithmetic Mean	Standard Deviation	Sharpe Ratio
S&P 500	0.1694	0.1768	0.1301	0.9747
Small Caps	0.1248	0.1390	0.1760	0.5057
Corp. Bonds	0.1257	0.1316	0.1169	0.6979
T-Bills	0.0678	0.0681	0.0281	0.6440
MSCI EAFE	0.1315	0.1510	0.2179	0.4638
NCRIEF	0.0794	0.0811	0.0611	0.5100
HTRG-S	0.1047	0.1073	0.0736	0.7785
STRG-PNW	0.1591	0.1848	0.2599	0.5188
HTRG-NE	0.1031	0.1059	0.0809	0.6904
HTRG-Market	0.1319	0.1382	0.1207	0.7304
Chile	0.0200	0.0296	0.1526	-0.1335
New Zealand	0.0844	0.1221	0.3247	0.2222
Chile – Hedged	0.1724	0.2081	0.3155	0.5012
New Zealand-Hedged	0.1203	0.1602	0.3308	0.3333
World Timber Portfolio	0.1411	0.1458	0.1056	0.9072

3.4. TRADITIONAL ASSETS

Of the traditional, non-timberland assets, the S&P500, which represents the stocks of the largest 500 companies in the U.S, generated the most favorable returns by providing an average return of 17.68 percent (Table 2). The next asset class with the highest average return is international stocks (MSCI EAFE), which provided investors average returns of 15.1 percent. However, when comparing the S&P500 with the MSCI EAFE, the S&P500 provides investors with a higher return-risk relationship. This is evident by the Sharpe ratio of 0.97 for the S&P500 and 0.46 for MSCI EAFE. The difference in Sharpe ratios for these two assets means that the S&P500 provides a higher average return for excess units of risk (standard deviation) for average returns above the risk-free rate[18].

The traditional asset with the lowest return is the index of T-Bills, which generated a return of 6.78 percent. The T-Bill asset class also had the lowest standard deviation, 2.81. Being an index of risk-free assets we might expect the level of risk to be close to zero on the T-Bill asset class. However, because the index is a basket of T-Bills with different maturities and durations over the 1981-1998 time period, the average return will be different than the risk-free rate for any one period and there may be a very small amount of risk due to price fluctuations of T-Bills not held to maturity.

3.5. TIMBERLAND ASSETS

U.S. timberland investments (HTRG-S, HTRG-PNW, HTRG-NE, and HTRG-Market) generated the highest return-risk tradeoffs, which is evident by their respective Sharpe ratios in Table 2. Only the hedged Chilean timberland asset even came close in terms of a Sharpe ratio. The hedged Chilean asset has a Sharpe ratio of 0.50 while the U.S. timberland assets' Sharpe ratios ranged from 0.78 to 0.52.

In fact, one international timberland asset, the unhedged Chilean asset, had a negative Sharpe ratio. The negative Sharpe ratio is a result of the unhedged Chilean timberland average returns being less than the assumed risk-free rate of 5 percent, yet having a standard deviation of 0.15. On a one to one comparison the risk-free asset has a higher return with a standard deviation of zero.

[18] An assumed risk-free rate of 5 percent is utilized in this study.

Ignoring for a moment, the associated risk attributed to generated returns above the risk-free rate, the hedged international timberland assets generated impressive returns. The average HTRG-S, HTRG-PNW, HTRG-NE, and HTRG-Market returns are 10.73 percent, 18.48 percent, 10.59 percent, and 13.82 percent respectively. During the same time period, hedged timberland assets in Chile and New Zealand yielded 20.81 percent and 16.02 percent respectively. It is clear from the previous analysis of Sharpe ratios though, that over the same period volatility was much higher for the international timberland assets (Table 2).

One interesting observation is the change in volatility from the unhedged international timberland assets to the hedged assets. The Chilean timberland assets' standard deviations are 0.1526 when unhedged and 0.3155 when hedged. The New Zealand timberland asset standard deviation only increases slightly, moving from 0.3247 when unhedged, then to 0.3308 when hedged.

The reason why the Chilean timberland asset essentially doubles in standard deviation has to do with the currency exchange rate during the period. As previously discussed, it is important to note the importance log prices play in generating timberland asset returns. Log prices from 1981-1998 in Chile increased on average when denominated in U.S. dollars. At the same time though, the dollar on average increased in strength vs. the Chilean Peso, resulting in price changes of less magnitude than price changes denominated in Chilean Pesos. It is these higher magnitudes of change in log prices denominated in Chilean Pesos that result in higher standard deviations for the hedged assets, which act as a proxy for returns denominated in the international currency.

The same relationship also is true when analyzing the volatility differences between unhedged and hedged New Zealand assets. Although in New Zealand's case, the average increase in strength of the U.S. dollar vs. the New Zealand dollar is much smaller than experienced in Chile, resulting in a much smaller increase in volatility.

3.6. CORRELATION COEFFICIENTS

If investors only invested in single assets, then implications and asset comparisons alone, like those just discussed, are extremely useful. However, investors construct portfolios of assets. Portfolio performance depends greatly on how assets interact with one another not just solely on individual return-risk performance.

The minimum variance frontier discussion and analysis that follows will rely heavily on the correlation of the different assets (Table 3). Some correlation coefficients of interest are those between the timberland assets and the traditional assets as well as those between the timberland assets themselves.

Table 3. Asset Correlation Matrix 1981-1998.

	S&P 500	Small Caps	Corp. Bonds	T-Bills	MSCI-EAFE	NORIEF	HTRG-S	HTRG-PNW	HTRG-NE	HTRG-Market	Chile – Un-hedged	NZ – Un-hedged	Chile – Hedged	NZ – Hedged	World Timber Portfolio
S&P 500	1.000	0.589	0.575	-0.216	0.323	0.098	-0.115	0.056	0.016	0.014	-0.262	-0.468	-0.172	-0.478	-0.191
Small Caps	0.589	1.000	0.397	0.049	0.099	-0.148	-0.087	0.042	-0.453	-0.021	-0.273	-0.358	-0.214	-0.384	-0.212
Corp. Bonds	0.575	0.397	1.000	0.149	0.231	-0.061	-0.530	-0.109	-0.361	-0.280	-0.139	-0.236	0.068	-0.157	-0.285
T-Bills	-0.216	0.049	0.149	1.000	-0.174	0.505	-0.396	-0.375	-0.408	-0.471	-0.332	-0.091	-0.154	0.036	-0.454
MSCIEAFE	0.323	0.099	0.231	-0.174	1.000	0.178	-0.561	-0.014	-0.038	-0.186	0.219	0.204	0.424	0.230	0.029
NORIEF	0.098	-0.148	-0.061	0.505	0.178	1.000	-0.146	-0.493	0.232	-0.453	-0.385	-0.202	-0.139	-0.114	-0.464
HTRG-S	-0.115	-0.087	-0.530	-0.396	-0.561	-0.146	1.000	0.276	0.360	0.567	0.136	-0.050	-0.109	-0.221	0.409
HTRG-PNW	0.056	0.042	-0.109	-0.375	-0.014	-0.493	0.276	1.000	0.008	0.946	0.376	0.196	0.045	0.027	0.838
HTRG-NE	0.016	-0.453	-0.361	-0.408	-0.038	0.232	0.360	0.008	1.000	0.184	0.257	-0.040	0.098	-0.012	0.208
HTRG- Market	0.014	-0.021	-0.280	-0.471	-0.186	-0.453	0.567	0.946	0.184	1.000	0.382	0.150	0.012	-0.045	0.860
Chile – Unhedged	-0.262	-0.273	-0.139	-0.332	0.219	-0.385	0.136	0.376	0.257	0.382	1.000	0.570	0.747	0.523	0.722
NZ – Unhedged	-0.468	-0.358	-0.236	-0.091	0.204	-0.202	-0.050	0.196	-0.040	0.150	0.570	1.000	0.312	0.947	0.518
Chile – Hedged	-0.172	-0.214	0.068	-0.154	0.424	-0.139	-0.109	0.045	0.098	0.012	0.747	0.312	1.000	0.396	0.433
NZ – Hedged	-0.478	-0.384	-0.157	0.036	0.230	-0.114	-0.221	0.027	-0.012	-0.045	0.523	0.947	0.396	1.000	0.389
World Timber Portfolio	-0.191	-0.212	-0.285	-0.454	0.029	-0.464	0.409	0.838	0.208	0.860	0.722	0.518	0.433	0.389	1.000

The correlation coefficients between the traditional assets and the U.S. timberland assets are either negative or slightly positive meaning that fluctuations in the returns of these assets do not move together and where the correlation coefficients are negative the returns of theses assets actually fluctuate in opposite directions. This lack of correlation and often negative correlation between traditional assets and U.S. timberland assets is discussed in the Literature Review and is partially attributable to the biological growth of trees, which occurs regardless of changes in the business cycle.

Like the U.S. timberland assets, most all of the correlation coefficients between international timberland assets are either negative or slightly positive with the exception of the correlation coefficients between international stocks (MSCI EAFE) and the international timberland assets. This positive correlation between these asset classes reflects the international essence of the assets and highlights the correlation among international economies and industries. Still, the correlation here ranges from only 0.20 to 0.42, which does not suggest strong correlation or closely related fluctuations in asset class returns.

The correlation coefficients between the various timberland assets both U.S. and international, can help supplement later discussions of different minimum variance frontiers. Among U.S. timberland assets, correlation coefficients range from 0.01 (HTRG-PNW and HTRG-NE) to 0.36 (HTRG-S and HTRG-NE) revealing that timberland assets can be quite different in terms of average returns and volatility. The different U.S. geographical regions represent different tree species, markets served, and local government policies. These differences result in timberland assets that are not strongly correlated due to their unique characteristics.

Among international timberland assets, correlation coefficients range from 0.31 (NZ and Chile-hedged) to 0.95 (NZ and NZ-hedged). The correlation coefficients between hedged and unhedged international timberland assets represent the effect of currency exchange rates of U.S. dollars, markets served, forest species, and are moderately to strongly positive.

Interpreting and discussing the correlation coefficients between U.S. and international timberland assets is more difficult. Particularly the correlation coefficient between HTRG-PNW and both Chile and New Zealand warrant more analysis. Unlike the other U.S. timberland assets, HTRG-PNW partially serves a similar market as Chile and New Zealand: The Pacific Rim/Asia. However, HTRG-PNW is only slightly, positively correlated to Chilean and New Zealand unhedged timberland assets and uncorrelated to Chilean and New Zealand hedged timberland assets for two reasons: (1) HTRG-PNW and the international timberland assets only partially serve the same market, and (2) they produce different species that are not perfect substitutes;

Using 1995 as an example, only 49 percent of Chile's forest products (both logs and lumber) found their way to Asian markets. During the same year, 20 percent and 17 percent of Chile's forest products were sold in Europe and South America respectively, illustrating how Chile serves different markets. New Zealand in 1995 only exported 50 percent of its forest products (both logs and lumber) to Asian markets. New Zealand also exported 31 percent and 15 percent to Australia and Europe respectively. In addition to the 1995 figures supporting the fact that HTRG-PNW and the international timberland assets only partially serve the same markets, and the species grown in the two areas are not perfect substitutes, the returns for the assets form 1981 to 1998 did not fluctuate in unison due to the different movements in price within HTRG-PNW return series and the international timberland asset series.

3.7. MINIMUM VARIANCE FRONTIERS

Figure 2 illustrates the effects of adding to a portfolio, domestic timberland assets in the form of a domestic timberland portfolio (HTRG-Market) as well as individual domestic timberland assets (HTRG-S, HTRG-PNW, and HTRG-NE). The result is that a portfolio with timberland assets has a lower risk for a given return or higher returns for a given level of risk.

In fact, the frontier with individual domestic assets, which are not constrained by a predetermined U.S. timberland portfolio (HTRG-Market), outperforms both the minimum variance frontier of traditional assets, where no timberland is included and the minimum variance frontier, where a preconceived portfolio of U.S. timberland assets is included.

Using the global minimum variance portfolios on each frontier for comparison, we can examine the different asset allocations of portfolios with a mean return of 9 percent in Figure 2.

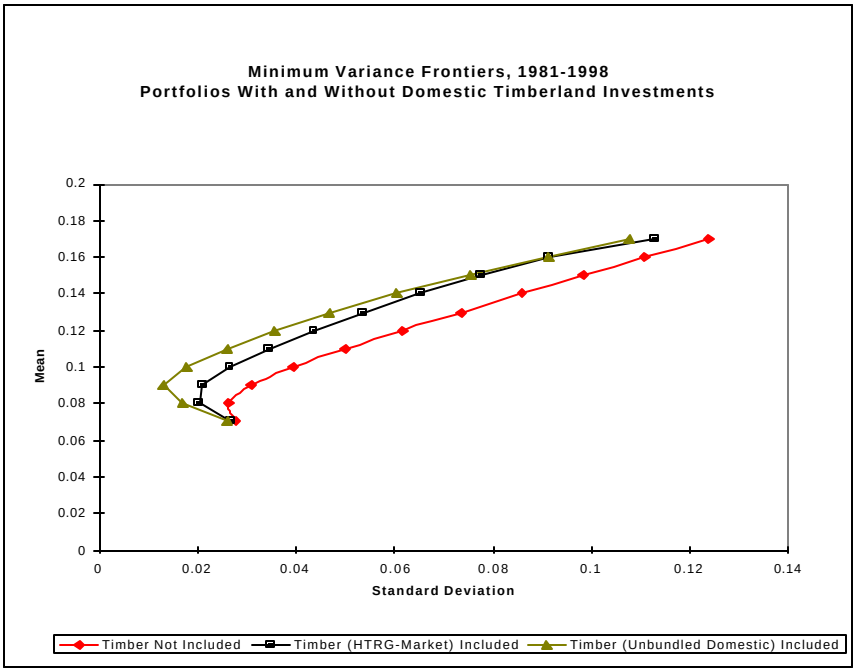


Figure 2. Traditional Assets With and Without Domestic Timberland.

At a mean portfolio return of 9 percent, which is the global minimum variance portfolio, the portfolio without timberland is primarily comprised of T-Bills (79.19 percent) and S&P500 (17.96 percent). When the U.S. Timberland (HTRG-Market) asset is introduced at the same target return of 9 percent, allocation to timberland (HTRG-Market) is 15.26 percent (Table 4). Table 4 depicts each minimum variance frontier and the portfolios within the frontier in detail. The portfolios are identified by their mean return and standard deviation. Table 4 also reveals each asset class within a particular portfolio and the proportion in which the asset class is represented within the portfolio. When HTRG-Market is included allocations to the S&P500 and T-Bills drop to 6.23 percent and 69.5 percent respectively. When individual U.S. timberland assets are included in the portfolio with a mean target return of 9 percent, allocation to the S&P500 is eliminated and allocations to T-Bills is further reduced to 56.7 (Table 4).

Table 4. Asset Allocations for Figure 2.

Minimum Variance Frontiers, 1981 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	Std. Dev.	Mean(rp)
0.0049	0.0000	0.0000	0.9789	0.0162	0.0000	0.0278	0.07
0.0923	0.0000	0.0000	0.8854	0.0223	0.0000	0.0263	0.08
0.1796	0.0000	0.0000	0.7919	0.0285	0.0000	0.0309	0.09
0.2669	0.0000	0.0000	0.6984	0.0347	0.0000	0.0395	0.10
0.3542	0.0000	0.0000	0.6050	0.0408	0.0000	0.0500	0.11
0.4414	0.0000	0.0000	0.5098	0.0469	0.0020	0.0616	0.12
0.5132	0.0000	0.0225	0.3732	0.0500	0.0411	0.0736	0.13
0.5849	0.0000	0.0451	0.2365	0.0531	0.0803	0.0859	0.14
0.6567	0.0000	0.0678	0.0998	0.0562	0.1195	0.0983	0.15
0.7381	0.0000	0.0787	0.0000	0.0614	0.1218	0.1108	0.16
0.8457	0.0000	0.0577	0.0000	0.0723	0.0243	0.1237	0.17

Timber (HTRG-Market) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-M	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9732	0.0000	0.0000	0.0268	0.0268	0.07
0.0179	0.0000	0.0000	0.8454	0.0277	0.0000	0.1091	0.0204	0.08
0.0623	0.0000	0.0185	0.6950	0.0331	0.0385	0.1526	0.0211	0.09
0.0784	0.0000	0.0705	0.4819	0.0346	0.1301	0.2044	0.0266	0.1
0.0944	0.0000	0.1226	0.2687	0.0362	0.2218	0.2563	0.0345	0.11
0.1026	0.0066	0.1768	0.0429	0.0378	0.3235	0.3098	0.0436	0.12
0.1832	0.0000	0.1742	0.0000	0.0471	0.2578	0.3377	0.0537	0.13
0.2760	0.0000	0.1554	0.0000	0.0592	0.1502	0.3592	0.0653	0.14
0.3688	0.0000	0.1365	0.0000	0.0713	0.0426	0.3808	0.0777	0.15
0.5458	0.0000	0.0227	0.0000	0.0701	0.0000	0.3614	0.0914	0.16
0.8241	0.0000	0.0000	0.0000	0.0000	0.0000	0.1759	0.1128	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9506	0.0000	0.0000	0.0086	0.0000	0.0408	0.0261	0.07
0.0000	0.0000	0.0023	0.7599	0.0441	0.0000	0.1873	0.0063	0.0000	0.0170	0.08
0.0000	0.0000	0.0689	0.5670	0.0524	0.0000	0.2212	0.0136	0.0768	0.0131	0.09
0.0000	0.0089	0.1279	0.3829	0.0693	0.0000	0.2978	0.0183	0.0948	0.0177	0.10
0.0058	0.0136	0.1847	0.2030	0.0856	0.0016	0.3749	0.0232	0.1076	0.0261	0.11
0.0188	0.0156	0.2362	0.0000	0.0958	0.0561	0.4403	0.0335	0.1038	0.0356	0.12
0.1410	0.0000	0.1997	0.0000	0.1001	0.0000	0.4318	0.0489	0.0784	0.0468	0.13
0.2791	0.0000	0.1360	0.0000	0.0933	0.0000	0.3689	0.0773	0.0454	0.0605	0.14
0.4172	0.0000	0.0722	0.0000	0.0866	0.0000	0.3059	0.1056	0.0125	0.0755	0.15
0.5565	0.0000	0.0077	0.0000	0.0764	0.0000	0.2240	0.1355	0.0000	0.0913	0.16
0.6741	0.0000	0.0000	0.0000	0.0541	0.0000	0.0978	0.1740	0.0000	0.1077	0.17

At a 9 percent mean return, the individual U.S. timberland assets received allocations of 22.12 percent (HTRG-S), 1.36 percent (HTRG-PNW), and 7.68 percent (HTRG-NE).

The total individual U.S. timberland asset allocation is 31.16 percent compared to the total allocation to HTRG-Market of 15.26 percent. The HTRG-Market can be further broken down to individual timberland allocations of 7.63 percent (HTRG-S), 6.104 percent (HTRG-PNW), and 1.53 percent (HTRG-NE).

In addition to analyzing the particular asset allocations of the different global minimum variance portfolios, a more important implication is revealed in Figure 2. At all mean portfolio returns, the portfolios with individual U.S. timberland assets dominate the portfolios with a preconceived portfolio of U.S. timberlands. This means that if investors want to capture the full diversification benefits of adding U.S. timberland investments to their portfolios, investors will want to allow each individual U.S. timberland asset to interact with the other assets in their portfolios. By definition it is expected that the individual timberland assets would do at least as well as the constrained or preconceived portfolio of U.S. timberlands. In this case though they actually did better according to the MV framework, where the distribution of asset returns is mean reverting and characterized by the variance of returns.

In Figure 3, at the global minimum variance, unhedged international timberland assets added to the portfolio with HTRG-Market results in a portfolio that is dominated by the portfolio with only U.S. individual assets, further illustrating the benefits of the unbundled individual U.S. timberland assets.

The minimum variance frontier with unhedged international assets and individual U.S. timberland assets is dominant over the other minimum variance frontiers in Figure 3. This means that by adding both unhedged international assets and individual U.S. timberland assets, investors can realize the largest benefits to diversification. It is important to note however, that this dominate portfolio allocates 0 percent of capital to the unhedged Chilean timberland asset and less than 1 percent of capital to the New Zealand timberland assets at the global minimum variance (Table 5). At higher target returns, the unhedged New Zealand allocation increases. So while unhedged international assets are integral to maximum diversification benefits, they receive little in any actual capital allocations.

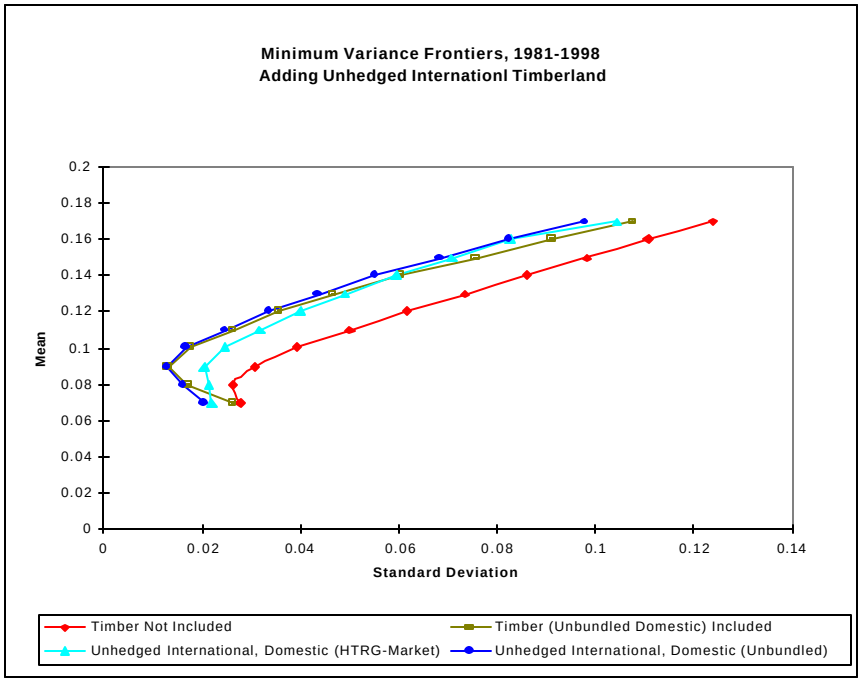


Figure 3. Minimum Variance Frontiers with Domestic and Unhedged International.

Table 5. Asset Allocations for Figure 3.

Minimum Variance Frontiers, 1981 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0049	0.0000	0.0000	0.9789	0.0162	0.0000	0.0278	0.07
0.0923	0.0000	0.0000	0.8854	0.0223	0.0000	0.0263	0.08
0.1796	0.0000	0.0000	0.7919	0.0285	0.0000	0.0309	0.09
0.2669	0.0000	0.0000	0.6984	0.0347	0.0000	0.0395	0.10
0.3542	0.0000	0.0000	0.6050	0.0408	0.0000	0.0500	0.11
0.4414	0.0000	0.0000	0.5098	0.0469	0.0020	0.0616	0.12
0.5132	0.0000	0.0225	0.3732	0.0500	0.0411	0.0736	0.13
0.5849	0.0000	0.0451	0.2365	0.0531	0.0803	0.0859	0.14
0.6567	0.0000	0.0678	0.0998	0.0562	0.1195	0.0983	0.15
0.7381	0.0000	0.0787	0.0000	0.0614	0.1218	0.1108	0.16
0.8457	0.0000	0.0577	0.0000	0.0723	0.0243	0.1237	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9506	0.0000	0.0000	0.0086	0.0000	0.0408	0.0261	0.07
0.0000	0.0000	0.0023	0.7599	0.0441	0.0000	0.1873	0.0063	0.0000	0.0170	0.08
0.0000	0.0000	0.0689	0.5670	0.0524	0.0000	0.2212	0.0136	0.0768	0.0131	0.09
0.0000	0.0089	0.1279	0.3829	0.0693	0.0000	0.2978	0.0183	0.0948	0.0177	0.10
0.0058	0.0136	0.1847	0.2030	0.0856	0.0016	0.3749	0.0232	0.1076	0.0261	0.11
0.0188	0.0156	0.2362	0.0000	0.0958	0.0561	0.4403	0.0335	0.1038	0.0356	0.12
0.1410	0.0000	0.1997	0.0000	0.1001	0.0000	0.4318	0.0489	0.0784	0.0468	0.13
0.2791	0.0000	0.1360	0.0000	0.0933	0.0000	0.3689	0.0773	0.0454	0.0605	0.14
0.4172	0.0000	0.0722	0.0000	0.0866	0.0000	0.3059	0.1056	0.0125	0.0755	0.15
0.5565	0.0000	0.0077	0.0000	0.0764	0.0000	0.2240	0.1355	0.0000	0.0913	0.16
0.6741	0.0000	0.0000	0.0000	0.0541	0.0000	0.0978	0.1740	0.0000	0.1077	0.17

Unhedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0260	0.0000	0.0000	0.8540	0.0000	0.0001	0.0337	0.0861	0.0000	0.0220	0.07
0.0407	0.0000	0.0000	0.8528	0.0000	0.0001	0.1064	0.0000	0.0000	0.0212	0.08
0.0971	0.0000	0.0000	0.7017	0.0166	0.0352	0.1237	0.0060	0.0197	0.0203	0.09
0.1269	0.0000	0.0442	0.5070	0.0088	0.1196	0.1590	0.0000	0.0345	0.0248	0.10
0.1633	0.0000	0.0849	0.3052	0.0000	0.2061	0.1916	0.0000	0.0490	0.0318	0.11
0.1729	0.0178	0.1301	0.0749	0.0000	0.3116	0.2312	0.0000	0.0613	0.0399	0.12
0.2576	0.0075	0.1314	0.0000	0.0000	0.2812	0.2464	0.0000	0.0759	0.0490	0.13
0.3721	0.0000	0.1058	0.0000	0.0000	0.1815	0.2476	0.0000	0.0929	0.0593	0.14
0.4838	0.0000	0.0776	0.0000	0.0000	0.0801	0.2479	0.0000	0.1106	0.0707	0.15
0.6217	0.0000	0.0157	0.0000	0.0000	0.0000	0.2331	0.0000	0.1295	0.0826	0.16
0.8757	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1243	0.1045	0.17

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0000	0.0088	0.0000	0.7838	0.0072	0.0000	0.0853	-0.0094	0.0420	0.0824	0.0000	0.0203	0.07
0.0000	0.0000	0.0000	0.7522	0.0350	0.0000	0.1359	0.0094	0.0670	0.0000	0.0005	0.0162	0.08
0.0000	0.0091	0.0673	0.5635	0.0457	0.0000	0.2071	0.0110	0.0874	0.0000	0.0088	0.0129	0.09
0.0144	0.0185	0.1184	0.3887	0.0537	0.0000	0.2686	0.0127	0.1059	0.0000	0.0190	0.0169	0.10
0.0485	0.0223	0.1571	0.2196	0.0554	0.0189	0.3187	0.0152	0.1124	0.0000	0.0318	0.0247	0.11
0.0691	0.0323	0.2036	0.0000	0.0517	0.1005	0.3616	0.0231	0.1125	0.0000	0.0455	0.0335	0.12
0.1920	0.0052	0.1853	0.0000	0.0528	0.0002	0.3846	0.0210	0.0977	0.0000	0.0612	0.0435	0.13
0.3547	0.0000	0.1183	0.0000	0.0266	0.0000	0.3103	0.0364	0.0663	0.0000	0.0876	0.0552	0.14
0.5156	0.0000	0.0489	0.0000	0.0000	0.0000	0.2300	0.0522	0.0390	0.0000	0.1143	0.0683	0.15
0.6461	0.0000	0.0000	0.0000	0.0000	0.0000	0.1479	0.0757	0.0000	0.0000	0.1303	0.0824	0.16
0.7472	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.1122	0.0000	0.0000	0.1399	0.0980	0.17

Figure 4 shows where hedged international timberland investments are added to portfolios along two minimum variance frontiers, one with individual U.S. timberland assets and one with HTRG-Market.

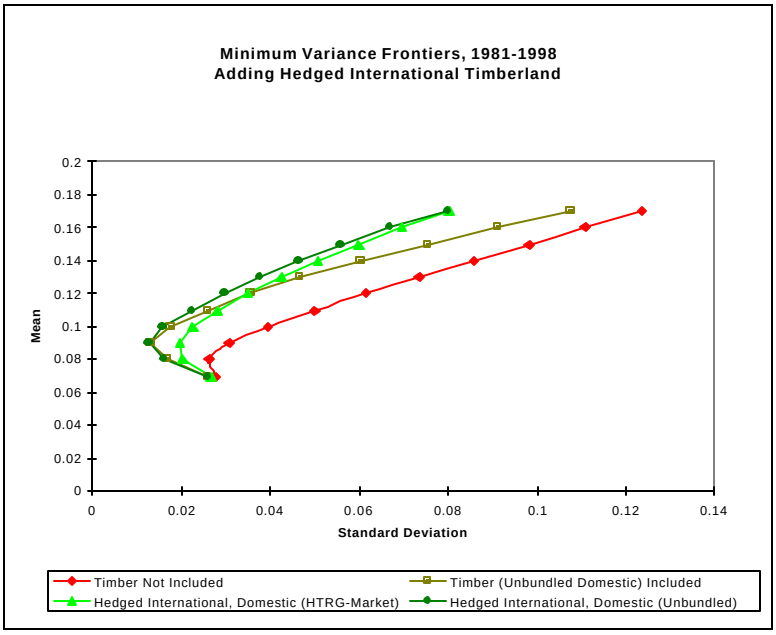


Figure 4. Minimum Variance Frontiers with Domestic and Hedged International.

At all mean portfolio returns the minimum variance frontier with hedged international timberland assets and individual U.S. timberland assets is dominant. Although at the global minimum variance the portfolio was only slightly dominating. At the mean portfolio target return of 9 percent, the portfolio with hedged international timberland assets and individual U.S. timberland assets had a standard deviation of 0.0129 compared to the portfolio with only individual U.S. timberland assets whose standard deviation was 0.0131 (Table 6).

Investors wishing to maximize diversification benefits will be better off allocating capital to hedged international timberland assets. However, at the global minimum variance, 0.8 percent will be allocated to the hedged New Zealand timberland asset and 0 percent will be allocated to the hedged Chilean timberland asset. As target returns increase, asset allocations increase considerably to both hedged international timberland investments.

Table 6. Asset Allocations for Figure 4.

Minimum Variance Frontiers, 1981 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0049	0.0000	0.0000	0.9789	0.0162	0.0000	0.0278	0.07
0.0923	0.0000	0.0000	0.8854	0.0223	0.0000	0.0263	0.08
0.1796	0.0000	0.0000	0.7919	0.0285	0.0000	0.0309	0.09
0.2669	0.0000	0.0000	0.6984	0.0347	0.0000	0.0395	0.10
0.3542	0.0000	0.0000	0.6050	0.0408	0.0000	0.0500	0.11
0.4414	0.0000	0.0000	0.5098	0.0469	0.0020	0.0616	0.12
0.5132	0.0000	0.0225	0.3732	0.0500	0.0411	0.0736	0.13
0.5849	0.0000	0.0451	0.2365	0.0531	0.0803	0.0859	0.14
0.6567	0.0000	0.0678	0.0998	0.0562	0.1195	0.0983	0.15
0.7381	0.0000	0.0787	0.0000	0.0614	0.1218	0.1108	0.16
0.8457	0.0000	0.0577	0.0000	0.0723	0.0243	0.1237	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9506	0.0000	0.0000	0.0086	0.0000	0.0408	0.0261	0.07
0.0000	0.0000	0.0023	0.7599	0.0441	0.0000	0.1873	0.0063	0.0000	0.0170	0.08
0.0000	0.0000	0.0689	0.5670	0.0524	0.0000	0.2212	0.0136	0.0768	0.0131	0.09
0.0000	0.0089	0.1279	0.3829	0.0693	0.0000	0.2978	0.0183	0.0948	0.0177	0.10
0.0058	0.0136	0.1847	0.2030	0.0856	0.0016	0.3749	0.0232	0.1076	0.0261	0.11
0.0188	0.0156	0.2362	0.0000	0.0958	0.0561	0.4403	0.0335	0.1038	0.0356	0.12
0.1410	0.0000	0.1997	0.0000	0.1001	0.0000	0.4318	0.0489	0.0784	0.0468	0.13
0.2791	0.0000	0.1360	0.0000	0.0933	0.0000	0.3689	0.0773	0.0454	0.0605	0.14
0.4172	0.0000	0.0722	0.0000	0.0866	0.0000	0.3059	0.1056	0.0125	0.0755	0.15
0.5565	0.0000	0.0077	0.0000	0.0764	0.0000	0.2240	0.1355	0.0000	0.0913	0.16
0.6741	0.0000	0.0000	0.0000	0.0541	0.0000	0.0978	0.1740	0.0000	0.1077	0.17

Hedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9732	0.0000	0.0000	0.0268	0.0000	0.0000	0.0268	0.07
0.0180	0.0000	0.0000	0.8471	0.0258	0.0000	0.1072	0.0020	0.0000	0.0204	0.08
0.0824	0.0000	0.0000	0.7298	0.0088	0.0287	0.1223	0.0141	0.0140	0.0197	0.09
0.1395	0.0000	0.0000	0.5926	0.0000	0.0748	0.1412	0.0224	0.0295	0.0226	0.10
0.1646	0.0106	0.0234	0.4121	0.0000	0.1470	0.1716	0.0274	0.0433	0.0281	0.11
0.1827	0.0257	0.0504	0.2204	0.0000	0.2278	0.2035	0.0323	0.0571	0.0350	0.12
0.2009	0.0408	0.0773	0.0288	0.0000	0.3085	0.2355	0.0371	0.0710	0.0426	0.13
0.2918	0.0326	0.0533	0.0000	0.0000	0.2501	0.2396	0.0465	0.0862	0.0508	0.14
0.3955	0.0202	0.0203	0.0000	0.0000	0.1671	0.2387	0.0566	0.1017	0.0600	0.15
0.4943	0.0054	0.0000	0.0000	0.0000	0.0782	0.2394	0.0661	0.1167	0.0697	0.16
0.5899	0.0000	0.0000	0.0000	0.0000	0.0000	0.1941	0.0894	0.1267	0.0802	0.17
0.7196	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1639	0.1165	0.0997	0.18
0.5783	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4217	0.0000	0.1452	0.19

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9506	0.0000	0.0000	0.0086	0.0000	0.0408	0.0000	0.0000	0.0261	0.07
0.0000	0.0000	0.0037	0.7521	0.0337	0.0000	0.1343	0.0090	0.0672	0.0000	0.0000	0.0162	0.08
0.0000	0.0079	0.0635	0.5702	0.0461	0.0000	0.2111	0.0119	0.0812	0.0000	0.0082	0.0129	0.09
0.0227	0.0178	0.1016	0.4134	0.0483	0.0000	0.2679	0.0129	0.0906	0.0000	0.0248	0.0159	0.10
0.0728	0.0205	0.1182	0.2816	0.0409	0.0126	0.3074	0.0147	0.0846	0.0043	0.0424	0.0224	0.11
0.1069	0.0323	0.1399	0.0919	0.0228	0.1079	0.3314	0.0236	0.0699	0.0141	0.0593	0.0299	0.12
0.1881	0.0297	0.1277	0.0000	0.0012	0.1350	0.3380	0.0288	0.0463	0.0279	0.0772	0.0377	0.13
0.3013	0.0081	0.0934	0.0000	0.0000	0.0646	0.3643	0.0265	0.0092	0.0391	0.0936	0.0465	0.14
0.4091	0.0000	0.0474	0.0000	0.0000	0.0000	0.3551	0.0279	0.0000	0.0515	0.1090	0.0560	0.15
0.5108	0.0000	0.0000	0.0000	0.0000	0.0000	0.2505	0.0487	0.0000	0.0704	0.1196	0.0669	0.16
0.5889	0.0000	0.0000	0.0000	0.0000	0.0000	0.1171	0.0773	0.0000	0.0900	0.1267	0.0799	0.17
0.6448	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1097	0.0000	0.1334	0.1121	0.0947	0.18
0.4597	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1596	0.0000	0.3807	0.0000	0.1380	0.19

Figures 2-4 illustrate the diversification benefits of adding both U.S. timberland assets and international timberland assets to portfolios of traditional assets. Figure 5 is intended to illustrate the differences between hedged and unhedged international timberland assets.

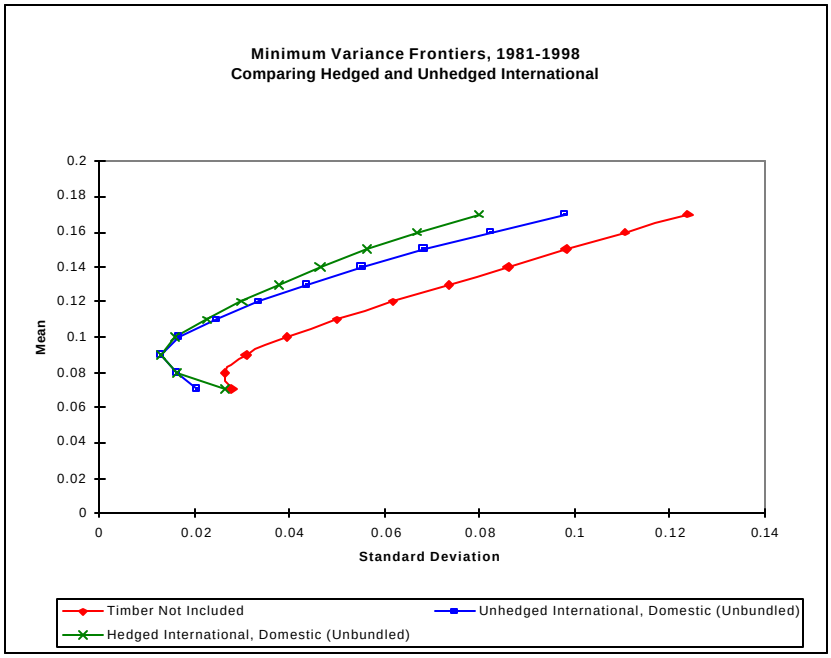


Figure 5. Minimum Variance Frontiers with Hedged and Unhedged International.

Although asset allocations are very similar at the global minimum variance portfolios (Table 7), diversification benefits attributable to hedged international timberland investments begin to surface at target returns greater than 9 percent. The portfolios with hedged international timberland assets dominate the portfolios with unhedged timberland assets and include substantial allocations to both Chile and New Zealand timberland assets (Table 7), meaning investors will receive greater diversification benefits by investing in hedged international investments.

Table 7. Asset Allocations for Figure 5.

Minimum Variance Frontiers, 1981 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0049	0.0000	0.0000	0.9789	0.0162	0.0000	0.0278	0.07
0.0923	0.0000	0.0000	0.8854	0.0223	0.0000	0.0263	0.08
0.1796	0.0000	0.0000	0.7919	0.0285	0.0000	0.0309	0.09
0.2669	0.0000	0.0000	0.6984	0.0347	0.0000	0.0395	0.10
0.3542	0.0000	0.0000	0.6050	0.0408	0.0000	0.0500	0.11
0.4414	0.0000	0.0000	0.5098	0.0469	0.0020	0.0616	0.12
0.5132	0.0000	0.0225	0.3732	0.0500	0.0411	0.0736	0.13
0.5849	0.0000	0.0451	0.2365	0.0531	0.0803	0.0859	0.14
0.6567	0.0000	0.0678	0.0998	0.0562	0.1195	0.0983	0.15
0.7381	0.0000	0.0787	0.0000	0.0614	0.1218	0.1108	0.16
0.8457	0.0000	0.0577	0.0000	0.0723	0.0243	0.1237	0.17

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0000	0.0088	0.0000	0.7838	0.0072	0.0000	0.0853	-0.0094	0.0420	0.0824	0.0000	0.0203	0.07
0.0000	0.0000	0.0000	0.7522	0.0350	0.0000	0.1359	0.0094	0.0670	0.0000	0.0005	0.0162	0.08
0.0000	0.0091	0.0673	0.5635	0.0457	0.0000	0.2071	0.0110	0.0874	0.0000	0.0088	0.0129	0.09
0.0144	0.0185	0.1184	0.3887	0.0537	0.0000	0.2686	0.0127	0.1059	0.0000	0.0190	0.0169	0.10
0.0485	0.0223	0.1571	0.2196	0.0554	0.0189	0.3187	0.0152	0.1124	0.0000	0.0318	0.0247	0.11
0.0691	0.0323	0.2036	0.0000	0.0517	0.1005	0.3616	0.0231	0.1125	0.0000	0.0455	0.0335	0.12
0.1920	0.0052	0.1853	0.0000	0.0528	0.0002	0.3846	0.0210	0.0977	0.0000	0.0612	0.0435	0.13
0.3547	0.0000	0.1183	0.0000	0.0266	0.0000	0.3103	0.0364	0.0663	0.0000	0.0876	0.0552	0.14
0.5156	0.0000	0.0489	0.0000	0.0000	0.0000	0.2300	0.0522	0.0390	0.0000	0.1143	0.0683	0.15
0.6461	0.0000	0.0000	0.0000	0.0000	0.0000	0.1479	0.0757	0.0000	0.0000	0.1303	0.0824	0.16
0.7472	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.1122	0.0000	0.0000	0.1399	0.0980	0.17

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.9506	0.0000	0.0000	0.0086	0.0000	0.0408	0.0000	0.0000	0.0261	0.07
0.0000	0.0000	0.0037	0.7521	0.0337	0.0000	0.1343	0.0090	0.0672	0.0000	0.0000	0.0162	0.08
0.0000	0.0079	0.0635	0.5702	0.0461	0.0000	0.2111	0.0119	0.0812	0.0000	0.0082	0.0129	0.09
0.0227	0.0178	0.1016	0.4134	0.0483	0.0000	0.2679	0.0129	0.0906	0.0000	0.0248	0.0159	0.10
0.0728	0.0205	0.1182	0.2816	0.0409	0.0126	0.3074	0.0147	0.0846	0.0043	0.0424	0.0224	0.11
0.1069	0.0323	0.1399	0.0919	0.0228	0.1079	0.3314	0.0236	0.0699	0.0141	0.0593	0.0299	0.12
0.1881	0.0297	0.1277	0.0000	0.0012	0.1350	0.3380	0.0288	0.0463	0.0279	0.0772	0.0377	0.13
0.3013	0.0081	0.0934	0.0000	0.0000	0.0646	0.3643	0.0265	0.0092	0.0391	0.0936	0.0465	0.14
0.4091	0.0000	0.0474	0.0000	0.0000	0.0000	0.3551	0.0279	0.0000	0.0515	0.1090	0.0560	0.15
0.5108	0.0000	0.0000	0.0000	0.0000	0.0000	0.2505	0.0487	0.0000	0.0704	0.1196	0.0669	0.16
0.5889	0.0000	0.0000	0.0000	0.0000	0.0000	0.1171	0.0773	0.0000	0.0900	0.1267	0.0799	0.17
0.6448	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1097	0.0000	0.1334	0.1121	0.0947	0.18
0.4597	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1596	0.0000	0.3807	0.0000	0.1380	0.19

Since portfolio mangers are often held to minimum asset allocation guidelines constrained minimum variance frontiers were constructed identically to those in Figures 2-5. The constrained portfolios are subject to a minimum of 35 percent U.S. Stocks, 25 percent corporate bonds, and 5 percent U.S. Treasury Bills. A discussion of the constrained model results will immediately follow with additional details to why constrained minimum variances are necessary, included in 6.0 Validity and Reliability of the Study.

At the global minimum variance in Figure 6, individual U.S. assets are still dominant over a preconceived portfolio of U.S. timberland assets.

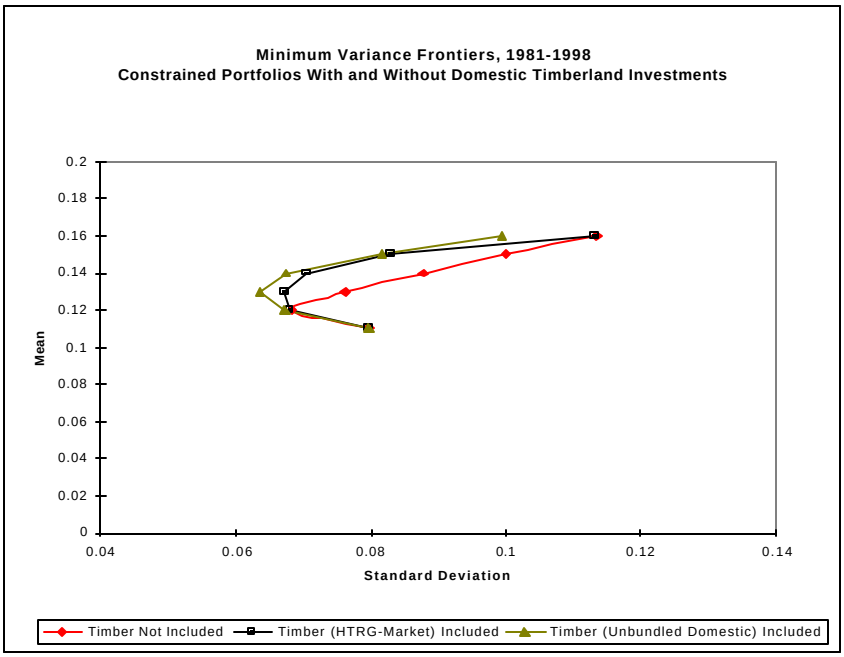


Figure 6. Constrained Minimum Variance Frontiers With and Without Domestic.

In Table 8, the target mean portfolio return of 13 percent, 13.08 percent of capital is allocated to HTRG-Market verses 18.03 percent to HTRG-S and 13.06 percent to HTRG-NE. This equates to a total timberland allocation of 13.08 percent for HTRG-Market and 31.09 percent for the individual timberland assets. The constrained minimum variance frontiers illustrate the same point as the unconstrained minimum variance frontiers in Figure 2. Individual timberland assets offer greater diversification benefits than preconceived portfolios of timberland assets. While the constrained portfolios are intended to illustrate the significance of the results, the constrained portfolios limit the minimum variance frontiers to higher variance portfolios.

Table 8. Asset Allocations for Figure 6.

Constrained Minimum Variance Frontiers, 1981 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0796	0.11
0.2965	0.0535	0.2500	0.4000	0.0000	0.0000	0.0684	0.12
0.3743	0.0000	0.2500	0.1426	0.0330	0.2001	0.0763	0.13
0.4620	0.0000	0.2500	0.0500	0.0388	0.1992	0.0878	0.14
0.5589	0.0000	0.2500	0.0500	0.0492	0.0919	0.0999	0.15
0.6978	0.0000	0.2500	0.0500	0.0022	0.0000	0.1134	0.16

Timber (HTRG-Market) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-M	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0796	0.11
0.2644	0.0856	0.2500	0.3827	0.0000	0.0000	0.0173	0.0682	0.12
0.2990	0.0510	0.2500	0.2118	0.0000	0.0575	0.1308	0.0672	0.13
0.3425	0.0075	0.2500	0.0500	0.0000	0.1096	0.2404	0.0705	0.14
0.4342	0.0000	0.2500	0.0500	0.0165	0.0000	0.2493	0.0829	0.15
0.6985	0.0000	0.2500	0.0500	0.0000	0.0000	0.0015	0.1133	0.16

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1925	0.1575	0.2500	0.2962	0.0000	0.0000	0.0071	0.0000	0.0967	0.0671	0.12
0.2438	0.1062	0.2500	0.0891	0.0000	0.0000	0.1803	0.0000	0.1306	0.0635	0.13
0.3500	0.0000	0.2500	0.0500	0.0052	0.0000	0.2423	0.0530	0.0494	0.0675	0.14
0.3705	0.0000	0.2500	0.0500	0.0434	0.0000	0.1449	0.1412	0.0000	0.0817	0.15
0.4851	0.0000	0.2500	0.0500	0.0198	0.0000	0.0144	0.1807	0.0000	0.0994	0.16

Of the constrained model scenarios, Figure 7 is the one that least substantiates its unconstrained partner (Figure 3). At the global minimum variance (13 percent mean portfolio return) unhedged international assets when combined with the HTRG-Market asset are actually dominant over the portfolio where unhedged international assets are combined with individual U.S. assets (Asset Allocations in Table 9).

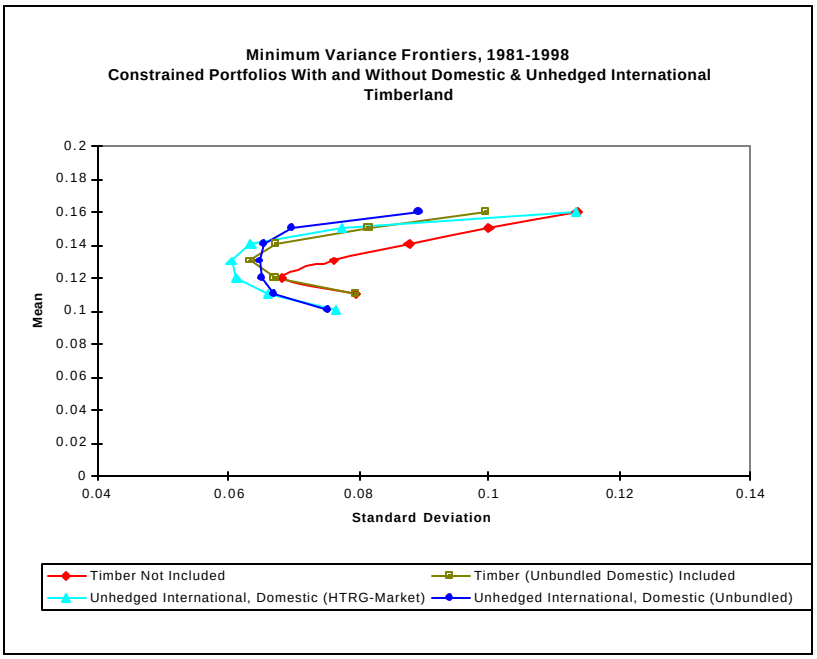


Figure 7. Constrained with Domestic and Unhedged International Timberland.

At higher returns, though, portfolios with individual U.S. timberland assets are dominant. This one inconsistency between the unconstrained and constrained minimum variance frontier scenarios is mitigated by the fact that hedged international assets clearly offer greater diversification benefits to investors than unhedged international timberland assets (Figure 9).

Table 9. Asset Allocations for Figure 7.

Constrained Minimum Variance Frontiers, 1981 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0796	0.11
0.2965	0.0535	0.2500	0.4000	0.0000	0.0000	0.0684	0.12
0.3743	0.0000	0.2500	0.1426	0.0330	0.2001	0.0763	0.13
0.4620	0.0000	0.2500	0.0500	0.0388	0.1992	0.0878	0.14
0.5589	0.0000	0.2500	0.0500	0.0492	0.0919	0.0999	0.15
0.6978	0.0000	0.2500	0.0500	0.0022	0.0000	0.1134	0.16

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1925	0.1575	0.2500	0.2962	0.0000	0.0000	0.0071	0.0000	0.0967	0.0671	0.12
0.2438	0.1062	0.2500	0.0891	0.0000	0.0000	0.1803	0.0000	0.1306	0.0635	0.13
0.3500	0.0000	0.2500	0.0500	0.0052	0.0000	0.2423	0.0530	0.0494	0.0675	0.14
0.3705	0.0000	0.2500	0.0500	0.0434	0.0000	0.1449	0.1412	0.0000	0.0817	0.15
0.4851	0.0000	0.2500	0.0500	0.0198	0.0000	0.0144	0.1807	0.0000	0.0994	0.16

Unhedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0723	0.2777	0.2500	0.1006	0.0000	0.0000	0.0000	0.2994	0.0000	0.0766	0.10
0.1896	0.1604	0.2500	0.1739	0.0000	0.0246	0.0000	0.1856	0.0160	0.0661	0.11
0.2556	0.0944	0.2500	0.1860	0.0000	0.0728	0.0000	0.0760	0.0652	0.0613	0.12
0.2729	0.0771	0.2500	0.1108	0.0000	0.1263	0.0687	0.0070	0.0871	0.0605	0.13
0.3419	0.0081	0.2500	0.0500	0.0000	0.0834	0.1748	0.0000	0.0918	0.0635	0.14
0.4772	0.0000	0.2500	0.0500	0.0000	0.0000	0.1324	0.0000	0.0904	0.0774	0.15
0.6990	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.0000	0.0010	0.1132	0.16

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0833	0.2667	0.2500	0.0500	0.0000	0.2462	0.0000	0.0000	0.0000	0.0000	0.1038	0.0753	0.10
0.2705	0.0795	0.2500	0.1629	0.0000	0.0994	0.0000	0.0000	0.0000	0.0000	0.1377	0.0671	0.11
0.3255	0.0245	0.2500	0.1826	0.0000	0.0000	0.0000	0.0000	0.0777	0.0000	0.1397	0.0652	0.12
0.3295	0.0205	0.2500	0.0824	0.0000	0.0000	0.0892	0.0000	0.0886	0.0000	0.1398	0.0647	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1408	0.0365	0.0825	0.0000	0.0902	0.0655	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1323	0.1070	0.1054	0.0000	0.0053	0.0697	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0000	0.0000	0.0892	0.16

Before investigating the comparison between hedged and unhedged international timberland assets in Figure 9, Figure 8 follows the similar point illustrated by the unconstrained frontier in Figure 4. In Figure 8, at the global minimum variance (14 percent mean portfolio return) hedged international timberland assets combined with individual U.S. assets are dominant over hedged international timberland assets combined with HTRG-Market.

At the global minimum variance in Figure 8 for the frontier including hedged international investments and individual U.S. timberland investments, the total timberland asset allocation is 35 percent, with 9.55 percent going to hedged New Zealand timberland assets and 0.33 percent going to hedged Chilean timberland investments (Table 10).

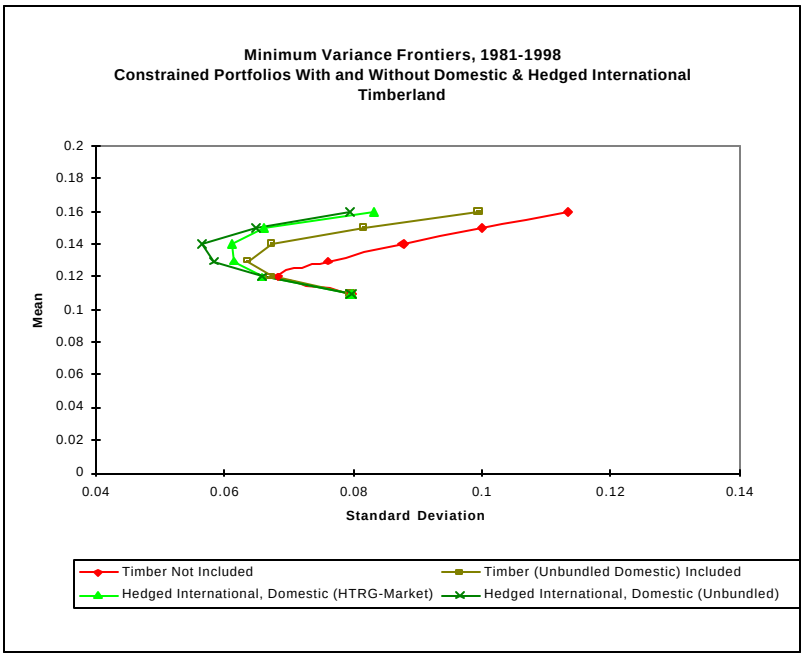


Figure 8. Constrained With Domestic and Hedged International Timberland.

Table 10. Asset Allocations for Figure 8.

Constrained Minimum Variance Frontiers, 1981 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0796	0.11
0.2965	0.0535	0.2500	0.4000	0.0000	0.0000	0.0684	0.12
0.3743	0.0000	0.2500	0.1426	0.0330	0.2001	0.0763	0.13
0.4620	0.0000	0.2500	0.0500	0.0388	0.1992	0.0878	0.14
0.5589	0.0000	0.2500	0.0500	0.0492	0.0919	0.0999	0.15
0.6978	0.0000	0.2500	0.0500	0.0022	0.0000	0.1134	0.16

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1925	0.1575	0.2500	0.2962	0.0000	0.0000	0.0071	0.0000	0.0967	0.0671	0.12
0.2438	0.1062	0.2500	0.0891	0.0000	0.0000	0.1803	0.0000	0.1306	0.0635	0.13
0.3500	0.0000	0.2500	0.0500	0.0052	0.0000	0.2423	0.0530	0.0494	0.0675	0.14
0.3705	0.0000	0.2500	0.0500	0.0434	0.0000	0.1449	0.1412	0.0000	0.0817	0.15
0.4851	0.0000	0.2500	0.0500	0.0198	0.0000	0.0144	0.1807	0.0000	0.0994	0.16

Hedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.2031	0.1469	0.2500	0.3617	0.0000	0.0000	0.0000	0.0000	0.0383	0.0659	0.12
0.2723	0.0777	0.2500	0.2672	0.0000	0.0000	0.0597	0.0000	0.0731	0.0614	0.13
0.2876	0.0624	0.2500	0.0500	0.0000	0.1107	0.1454	0.0013	0.0926	0.0612	0.14
0.3484	0.0016	0.2500	0.0500	0.0000	0.0119	0.2104	0.0289	0.0987	0.0662	0.15
0.4374	0.0000	0.2500	0.0500	0.0000	0.0000	0.0580	0.1164	0.0883	0.0830	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1791	0.1709	0.2500	0.3304	0.0000	0.0000	0.0000	0.0000	0.0363	0.0000	0.0333	0.0657	0.12
0.2122	0.1378	0.2500	0.1456	0.0000	0.0000	0.1204	0.0000	0.0713	0.0000	0.0627	0.0583	0.13
0.3203	0.0297	0.2500	0.0500	0.0000	0.0000	0.2512	0.0000	0.0000	0.0033	0.0955	0.0565	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1502	0.0578	0.0000	0.0475	0.0945	0.0649	0.15
0.3948	0.0000	0.2500	0.0500	0.0000	0.0000	0.0252	0.1024	0.0000	0.0796	0.0980	0.0795	0.16

This shows that when portfolios are subject to minimum asset constraints the allocations to timberland assets are reduced. In Figure 4, the total timberland allocation for the frontier including both hedged international timberland investments and individual U.S. investments at the mean portfolio return of 14 percent, is 53.3 percent, with 3.91 percent allocated to hedged Chilean timberland assets and 9.36 percent allocated to hedged New Zealand assets (Table 6).

Much like in Figure 5, Figure 9 and the asset allocations in Table 11, shows that even when subject to minimum asset allocation constraints, minimum variance frontiers with hedged international timberland assets and individual U.S. timberland assets are dominant. Even at the global minimum variance the best portfolio with hedged international timberland assets clearly offers superior diversification benefits to the best portfolio with unhedged international investments.

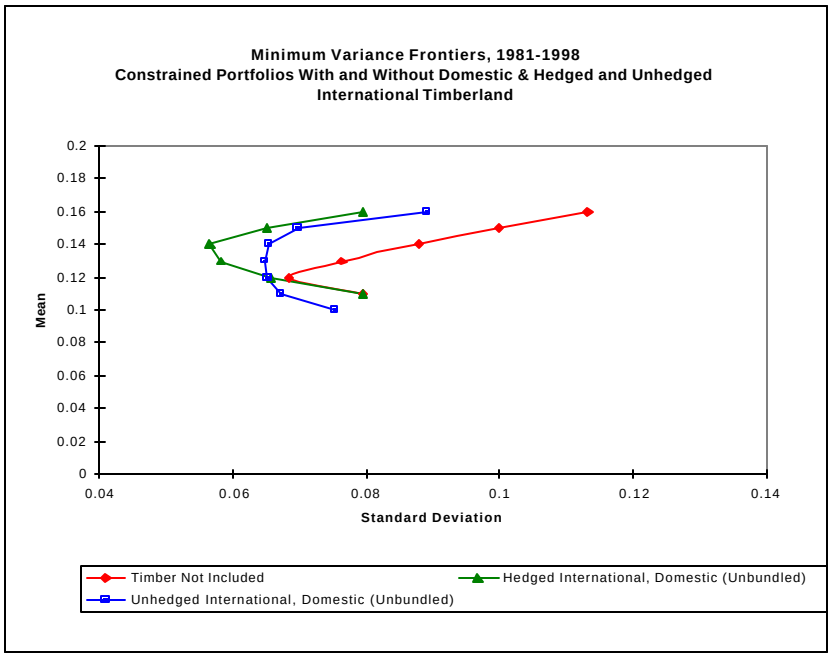


Figure 9. Constrained With Hedged and Unhedged International.

Table 11. Asset Allocations for Figure 9.

Constrained Minimum Variance Frontiers, 1981 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0796	0.11
0.2965	0.0535	0.2500	0.4000	0.0000	0.0000	0.0684	0.12
0.3743	0.0000	0.2500	0.1426	0.0330	0.2001	0.0763	0.13
0.4620	0.0000	0.2500	0.0500	0.0388	0.1992	0.0878	0.14
0.5589	0.0000	0.2500	0.0500	0.0492	0.0919	0.0999	0.15
0.6978	0.0000	0.2500	0.0500	0.0022	0.0000	0.1134	0.16

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0833	0.2667	0.2500	0.0500	0.0000	0.2462	0.0000	0.0000	0.0000	0.0000	0.1038	0.0753	0.10
0.2705	0.0795	0.2500	0.1629	0.0000	0.0994	0.0000	0.0000	0.0000	0.0000	0.1377	0.0671	0.11
0.3255	0.0245	0.2500	0.1826	0.0000	0.0000	0.0000	0.0000	0.0777	0.0000	0.1397	0.0652	0.12
0.3295	0.0205	0.2500	0.0824	0.0000	0.0000	0.0892	0.0000	0.0886	0.0000	0.1398	0.0647	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1408	0.0365	0.0825	0.0000	0.0902	0.0655	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1323	0.1070	0.1054	0.0000	0.0053	0.0697	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0000	0.0000	0.0892	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1791	0.1709	0.2500	0.3304	0.0000	0.0000	0.0000	0.0000	0.0363	0.0000	0.0333	0.0657	0.12
0.2122	0.1378	0.2500	0.1456	0.0000	0.0000	0.1204	0.0000	0.0713	0.0000	0.0627	0.0583	0.13
0.3203	0.0297	0.2500	0.0500	0.0000	0.0000	0.2512	0.0000	0.0000	0.0033	0.0955	0.0565	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1502	0.0578	0.0000	0.0475	0.0945	0.0649	0.15
0.3948	0.0000	0.2500	0.0500	0.0000	0.0000	0.0252	0.1024	0.0000	0.0796	0.0980	0.0795	0.16

Figure 10 and Table 12 have no unconstrained counterpart. Figure 10 is intended to illustrate the negative diversification benefits to preconceived timberland portfolios. Like the previous results in both the constrained and unconstrained portfolios showing the benefits of individual U.S. timberland assets over a preconceived U.S. timberland portfolio, Figure 10 further shows that preconceived a world timberland portfolio including hedged international timberland assets and U.S. timberland assets (40 percent, HTRG-S; 30 percent, HTRG-PNW; 10 percent, HTRG-NE; 10 percent, hedged Chile; 10 percent, hedged New Zealand) is inferior to a portfolio with individual timberland assets. Investors seeking to maximize diversification benefits should thus allow individual timberland assets to interact with the traditional assets and be included with allocations based on the individual timberland assets' own merit.

The reader may note that in Figures 6, 7 and 8, the constrained minimum variance frontiers with HTRG-Market and No Timberland Included begin to converge at the mean portfolio return of 16 percent. This convergence is due to the fact that the asset allocation constraints result in minimum allocations to T-Bills (5 percent) and Corporate Bonds (25 percent). In Figures 5, 6 and 9, which reflect frontiers with HTRG-Market, the only asset class with a high enough mean return after satisfying the minimum constraints is the S&P500, whose mean return is 17.68 percent. Thus, at the mean portfolio return target of 16 percent, the optimal portfolios in different frontiers are comprised of almost identical asset proportions.

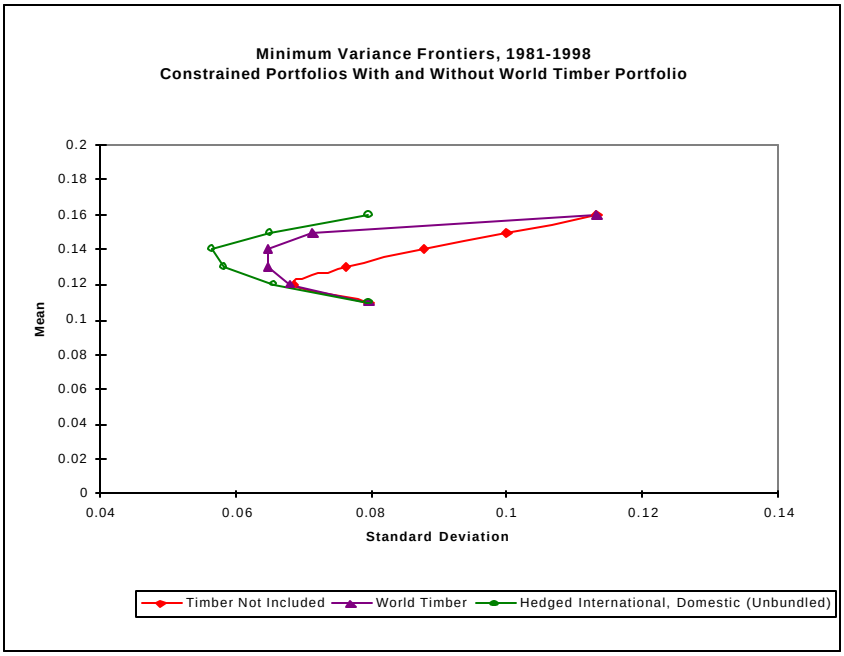


Figure 10. Minimum Variance Frontier with World Timber Portfolio.

Table 12. Asset Allocations for Figure 10.

Constrained Minimum Variance Frontiers, 1981 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0796	0.11
0.2965	0.0535	0.2500	0.4000	0.0000	0.0000	0.0684	0.12
0.3743	0.0000	0.2500	0.1426	0.0330	0.2001	0.0763	0.13
0.4620	0.0000	0.2500	0.0500	0.0388	0.1992	0.0878	0.14
0.5589	0.0000	0.2500	0.0500	0.0492	0.0919	0.0999	0.15
0.6978	0.0000	0.2500	0.0500	0.0022	0.0000	0.1134	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0796	0.11
0.1791	0.1709	0.2500	0.3304	0.0000	0.0000	0.0000	0.0000	0.0363	0.0000	0.0333	0.0657	0.12
0.2122	0.1378	0.2500	0.1456	0.0000	0.0000	0.1204	0.0000	0.0713	0.0000	0.0627	0.0583	0.13
0.3203	0.0297	0.2500	0.0500	0.0000	0.0000	0.2512	0.0000	0.0000	0.0033	0.0955	0.0565	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1502	0.0578	0.0000	0.0475	0.0945	0.0649	0.15
0.3948	0.0000	0.2500	0.0500	0.0000	0.0000	0.0252	0.1024	0.0000	0.0796	0.0980	0.0795	0.16

World Timberland Portfolio Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	World Timber	Std. Dev.	Mean(rp)
0.0319	0.3181	0.2500	0.4000	0.0000	0.0000	0.0000	0.0796	0.11
0.2472	0.1028	0.2500	0.3760	0.0000	0.0000	0.0240	0.0680	0.12
0.2715	0.0785	0.2500	0.2464	0.0000	0.0152	0.1384	0.0649	0.13
0.2831	0.0669	0.2500	0.0500	0.0000	0.1032	0.2468	0.0649	0.14
0.3757	0.0000	0.2500	0.0500	0.0000	0.0000	0.3243	0.0712	0.15
0.6982	0.0000	0.2500	0.0500	0.0000	0.0000	0.0018	0.1132	0.16

CHAPTER 4: DISCUSSION OF COUNTRY ASSESSMENT RESULTS

When investing in international timberland there are several country-specific characteristics and issues that need to be addressed. Will the timber species grow as expected? How secure is the land base? Is the inventory all there as claimed? These types of questions are those that are of concern to international timberland investors. Several published studies (see 3.3 Country Risk Assessments and Analysis) are adapted and standardized into scales of relevance to the international timberland investor[19]. For example, Transparency International reports that country corruption can be characterized by the following factors.

Are payments easily quantified and consistent?

Are payments institutionalized by contracts that can be enforced by law?

Are conditions agreed with governments likely to be changed after investment capital is spent?

It is under this developed framework of corruption and data previously reported that this research relies upon. In addition to corruption, the following is a complete list of the categories considered in the qualitative assessment of international timberland investments: policy consistency, debt/GDP, inflation, exchange rate stability, ideological differences, strength of judiciary, corruption, population pressure, indigenous land claims, foreign ownership provisions, transport infrastructure, ports, labor cost and quality, land tenure laws, land availability, distance to major markets, domestic market, biological and physical risks, and species domestication. Each category is then assigned an importance rank of one to three[20], as they are perceived to relate to timberland investments (Table 13).

[19] In a similar fashion to The Tree Farm and Managed Forest Industry, the study assigns a ranking through seven to each identified category.

[20] Three being most important and one being of least importance.

Table 13. Category Importance Ranking.

No.	Category	Importance
1	Policy Consistency	2
2	Debt/GDP	1
3	Inflation	1
4	Economic Climate	2
5	Exchange Rate Stability	2
6	Ideological Differences	2
7	Strength of Judiciary	3
8	Corruption	3
9	Population Pressure	2
10	Indigenous Land Claims	3
11	Foreign Ownership Provisions	2
12	Transport Infrastructure	1
13	Ports	1
14	Labor Cost/Quality	2
15	Land Tenure	3
16	Land Availability	3
17	Distance to Major Markets	1
18	Domestic Market	2
19	Biological & Physical Risks	3
20	Species Domestication	2

Data was collected from sources listed in Chapter 3 and normalized to a consistent scale in order to make country to country comparisons and for computation of a final assessment. Tables 26 through 46 show the selected categories and normalized rankings for each country and can be found in Appendix A.

Category rankings are then compiled into a weighted-average score for each country and listed in (Table 14).

Table 14 shows the total qualitative country risk assessment score for each country. Australia and New Zealand are first and second with total scores of 5.71 and 5.56 respectively. Although dealing with ordinal data, which limits analysis, on category-by-category basis, the similarities between Australia and New Zealand are apparent in terms similar scores by category of country risk.

Table 14. Total Country Risk Assessment Score.

Country	Total Score	Category																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Australia	5.71	6	1	5	6	7	7	6	7	5	4	6	7	7	6	7	4	2	6	6	6
New Zealand	5.56	7	1	6	7	7	7	7	7	4	3	6	7	7	6	7	3	1	1	7	7
Argentina	5.51	6	2	7	6	7	7	2	4	7	7	6	4	2	6	7	7	7	3	5	6
Chile	5.20	7	3	4	6	5	7	3	6	5	7	2	6	7	6	7	5	2	2	5	6
Brazil	4.59	4	3	4	5	1	7	1	3	4	7	4	6	4	6	7	6	2	4	5	6
South Africa	4.49	2	3	3	4	4	1	3	5	7	3	5	7	7	5	7	6	1	3	5	7
China	3.93	3	7	1	2	5	5	2	2	4	7	6	3	3	7	4	3	5	4	2	5
Russia	3.22	2	1	1	2	1	1	1	3	7	1	4	2	7	5	4	7	4	4	1	7

Argentina, Chile and Brazil are third, fourth, and fifth with total scores of 5.51, 5.20, 4.59. Much like Australia and New Zealand only with a few exceptions, similarities on a category-by-category basis are also evident for Argentina, Chile, and Brazil.

Considering South Africa, Russia, and China who are sixth, seventh, and eighth, is a much more daunting task. On a category-by-category basis these countries have the least similarities to each other and may be more appropriately considered as individual or stand-alone cases.

It is important to note that the scores for each country are inherently subjective in nature. While it is true that measures such as debt/GDP and inflation quantitatively factual other measures such as ideological difference are more subjectively measured and may be very time-sensitive. The importance rank is also subjective and may need to be adjusted to reflect specific international timberland investors' goals. This information would be beneficial to an investor faced with an investment opportunity similar to that of one in either Chile or New Zealand. Because diversification results are evident from the MV analysis for Chile and New Zealand, investors could gauge other similar investment opportunities to those of Chile and New Zealand.

CHAPTER 5: VALIDITY AND RELIABILITY OF THE STUDY

5.1. CONSTRAINED MINIMUM VARIANCE FRONTIERS

Even though for over 45 years, the MV framework has defined the standard approach to asset allocation decision making, various advances in the literature in formulating alternative decisions have been proposed (Samuleson, 1969; Ziemba and Vickson, 1975; Arzac and Bawa, 1977). There has also been significant improvements in the algorithms for solving large-scale programming problems (Perold, 1984). However, these proposals have been largely ignored due to the fact that they have not led to a significant practical reformulation of the investor's decision problem away from the MV framework. With the applied nature of this study, staying within the MV framework is not only practical but also expected. As mentioned previously in the Literature Review, no body of literature is without its problems. From the work of Kallberg and Ziemba (1984) and Chapra and Ziemba (1993) we know that MV allocations are very sensitive to small variations in the means and covariances. These authors also found this sensitivity to be especially pronounced in variations in means. Michaud (1989) describes this sensitivity as "error maximization". For example, assets with high expected returns are more likely to have positive estimation errors[21], inducing MV optimization to hold too much of them. In the subsequent period, the MV-efficient portfolio is likely to perform poorly because the realized returns on these assets are likely to be lower than previously predicted and too many of those assets were held.

One way to control this sensitivity to forecast errors, is to constrain the MV solution. For example, Frost and Savarino (1988) force the solutions to be more highly diversified than unconstrained solutions. Using a three-asset framework it has been shown that portfolios with sensible constraints outperform an unconstrained portfolio over time (Chapra 1993). Constraints prevent the model from inappropriately magnifying the influence of forecast errors. For this reason constrained models are included along with the realistic fact that pension fund managers are often subject to asset class guidelines.

5.2. SENSITIVITY ANALYSIS

In order to conduct a sensitivity analysis, correlation coefficients are computed for subsets of the data and the minimum variance frontiers are re-ran for a shorter, more recent time period.

5.2.1. Correlation Coefficients

Specifically with regard to Chile, the question has been raised as to whether the Chilean timberland asset may be structurally different from one subset of time to another due to the fact of a major change in government rule. In 1990, General Pinochet was no longer the dictator of Chile and a democratic government took control of Chile.

[21] Assets with similar risk characteristics are expected to have similar returns. If the estimated return for an asset is high relative to those of similar assets, the probability that the estimate is high due to measurement error increases.

Tables 15 and 16 highlight the correlation coefficients of the different timberland assets and reveals that from 1991-1998 the unhedged Chilean timberland assets are generally less positively correlated to U.S. timberland investments than from 1981-1990. It can also be said that from 1991-1998 the hedged Chilean timberland assets go from being slightly negatively correlated to U.S. timberland assets form 1981-1990 to being slightly positively correlated. This difference can be interpreted in two different ways. First, when working with a limited data set such as with this study, subsets of the data may be more subject to differences. Second, even though there are slight changes, the 1991-1998 correlation coefficients for between both unhedged and hedged Chilean and New Zealand timberland assets and U.S. timberland assets do not substantially shift to either very strong positive or negative correlation coefficients.

Table 15. Correlation Coefficients 1981-1990.

					Unhedged		Hedged		
	HTRG-S	HTRG-PNW	HTRG-NE	HTRG-Market	Chile	NZ	Chile	NZ	World Timber
HTRG-S	1.0000	0.4110	0.4403	0.6160	0.2554	0.0806	-0.3667	-0.1046	0.5233
HTRG-PNW	0.4110	1.0000	0.7219	0.9712	0.6510	0.1498	-0.0283	-0.0636	0.9203
HTRG-NE	0.4403	0.7219	1.0000	0.7482	0.8035	0.3647	-0.2111	0.2329	0.7810
HTRG-Market	0.6160	0.9712	0.7482	1.0000	0.6362	0.1558	-0.1229	-0.0760	0.9336
Chile-U	0.2554	0.6510	0.8035	0.6362	1.0000	0.6335	0.2232	0.5031	0.8231
NZ-U	0.0806	0.1498	0.3647	0.1558	0.6335	1.0000	-0.0863	0.9531	0.4610
Chile-H	-0.3667	-0.0283	-0.2111	-0.1229	0.2232	-0.0863	1.0000	-0.0299	0.0104
NZ-H	-0.1046	-0.0636	0.2329	-0.0760	0.5031	0.9531	-0.0299	1.0000	0.2580
World Timber	0.5233	0.9203	0.7810	0.9336	0.8231	0.4610	0.0104	0.2580	1.0000

Table 16. Correlation Coefficients 1991-1998.

					Unhedged		Hedged		
	HTRG-S	HTRG-PNW	HTRG-NE	HTRG-Market	Chile	NZ	Chile	NZ	World Timber
HTRG-S	1.0000	-0.1524	0.0143	0.1752	-0.0482	0.0089	0.2281	-0.0804	0.1916
HTRG-PNW	-0.1524	1.0000	-0.5441	0.9388	0.2148	0.4983	0.1545	0.4501	0.6626
HTRG-NE	0.0143	-0.5441	1.0000	-0.4310	0.1241	-0.0853	0.2820	0.1981	-0.0311
HTRG-Market	0.1752	0.9388	-0.4310	1.0000	0.2316	0.5235	0.2831	0.4833	0.7685
Chile-U	-0.0482	0.2148	0.1241	0.2316	1.0000	0.9396	0.9260	0.9010	0.7567
NZ-U	0.0089	0.4983	-0.0853	0.5235	0.9396	1.0000	0.8794	0.9272	0.8936
Chile-H	0.2281	0.1545	0.2820	0.2831	0.9260	0.8794	1.0000	0.9054	0.8265
NZ-H	-0.0804	0.4501	0.1981	0.4833	0.9010	0.9272	0.9054	1.0000	0.9069
World Timber	0.1916	0.6626	-0.0311	0.7685	0.7567	0.8936	0.8265	0.9069	1.0000

5.2.2. Minimum Variance Frontiers for 1990-1998

Figures 11-19 depict the same minimum variance frontiers as those in Figures 2-10, with the difference being the time span of data utilized. In an effort to see any substantial changes due to time periods Figures 11-19 are analyzed with associated Tables 17-25, which reflect the actual asset allocations of different minimum variance portfolios on each frontier.

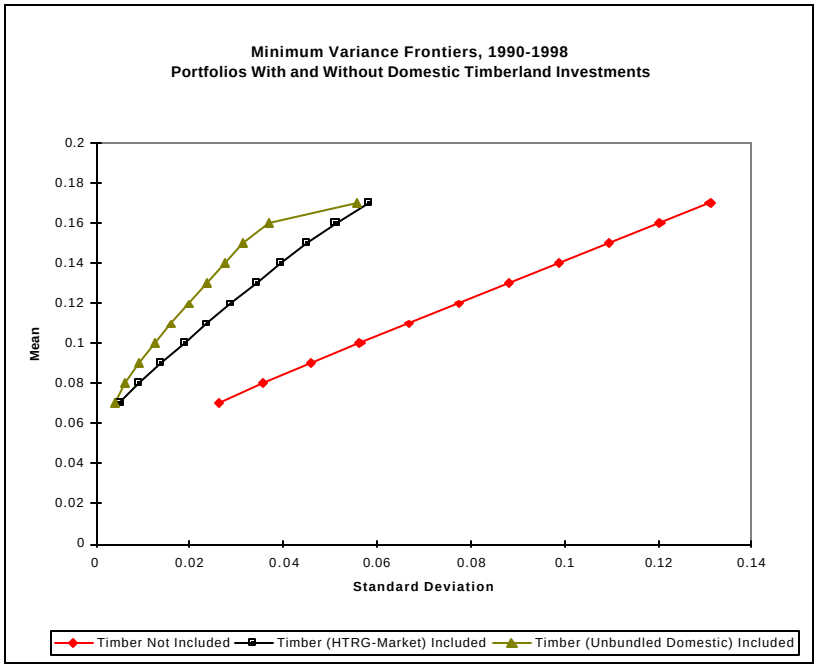


Figure 11. Constrained Period With and Without Domestic Timberland.

Figure 11 and Table 17 again illustrate that even when only considering data from 1990-1998, individual U.S. timberland assets provide greater diversification benefits than a preconceived U.S. timberland portfolio.

Table 17. Asset Allocations for Figure 11.

Minimum Variance Frontiers, 1990 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFI	NCREIEF	Std. Dev.	Mean(rp)
0.1474	0.0000	0.0000	0.8479	0.0048	0.0000	0.0262	0.07
0.2203	0.0000	0.0000	0.7797	0.0000	0.0000	0.0358	0.08
0.2928	0.0000	0.0000	0.7072	0.0000	0.0000	0.0459	0.09
0.3653	0.0000	0.0000	0.6347	0.0000	0.0000	0.0563	0.10
0.4378	0.0000	0.0000	0.5622	0.0000	0.0000	0.0668	0.11
0.5103	0.0000	0.0000	0.4897	0.0000	0.0000	0.0775	0.12
0.5828	0.0000	0.0000	0.4172	0.0000	0.0000	0.0881	0.13
0.6553	0.0000	0.0000	0.3447	0.0000	0.0000	0.0989	0.14
0.7278	0.0000	0.0000	0.2722	0.0000	0.0000	0.1096	0.15
0.8003	0.0000	0.0000	0.1997	0.0000	0.0000	0.1204	0.16
0.8728	0.0000	0.0000	0.1272	0.0000	0.0000	0.1311	0.17

Timber (HTRG-Market) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFI	NCREIEF	HTRG-M	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7202	0.0405	0.0673	0.1721	0.0050	0.07
0.0000	0.0000	0.0000	0.5918	0.0339	0.1155	0.2588	0.0093	0.08
0.0325	0.0000	0.0000	0.5135	0.0199	0.1257	0.3083	0.0140	0.09
0.0546	0.0000	0.0000	0.4191	0.0083	0.1481	0.3699	0.0190	0.10
0.0758	0.0000	0.0000	0.3230	0.0000	0.1691	0.4321	0.0239	0.11
0.0950	0.0000	0.0000	0.2226	0.0000	0.1865	0.4959	0.0290	0.12
0.1142	0.0000	0.0000	0.1222	0.0000	0.2038	0.5598	0.0342	0.13
0.1334	0.0000	0.0000	0.0218	0.0000	0.2211	0.6236	0.0394	0.14
0.1716	0.0000	0.0000	0.0000	0.0000	0.1611	0.6672	0.0450	0.15
0.2150	0.0000	0.0000	0.0000	0.0000	0.0797	0.7052	0.0512	0.16
0.2663	0.0000	0.0000	0.0000	0.0000	0.0000	0.7337	0.0580	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFI	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7651	0.0361	0.0175	0.0789	0.0549	0.0475	0.0043	0.07
0.0068	0.0000	0.0000	0.6930	0.0257	0.0000	0.1394	0.0601	0.0750	0.0062	0.08
0.0227	0.0000	0.0000	0.6128	0.0118	0.0000	0.1864	0.0691	0.0972	0.0092	0.09
0.0320	0.0000	0.0123	0.5219	0.0000	0.0000	0.2377	0.0762	0.1199	0.0125	0.10
0.0396	0.0000	0.0211	0.4221	0.0000	0.0000	0.2990	0.0840	0.1343	0.0160	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0274	0.14
0.0699	0.0000	0.0561	0.0229	0.0000	0.0000	0.5443	0.1151	0.1916	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4932	0.1644	0.1868	0.0369	0.16
0.3042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2592	0.2636	0.1730	0.0558	0.17

Figures 12 and 13 with Tables 18 and 19 do not follow the same illustration set forth in Figures 3 and 4 with Tables 5 and 6. In both Figures 12 and 13, unhedged and hedged international timberland assets do not offer any diversification benefits over a portfolio having only individual U.S. timberland assets. This is not only evident in the Figures but also in Tables 18 and 19 where the minimum variance frontiers with international timberland assets and individual U.S. timberland assets have essentially zero capital allocated to the international timberland assets.

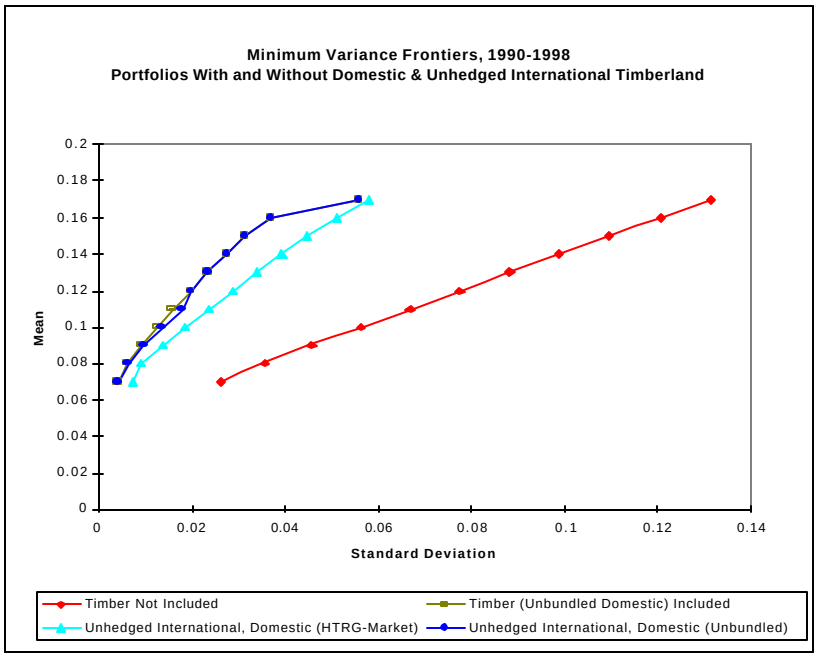


Figure 12. Constrained Period with Domestic and Unhedged International Timberland.

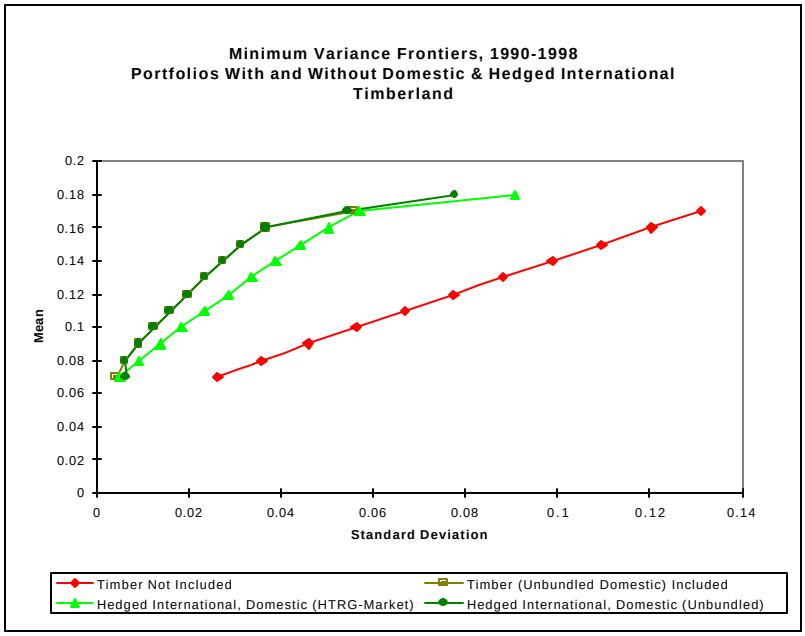


Figure 13. Constrained Period with Domestic and Hedged International Timberland.

Table 18. Asset Allocations for Figure 12.

Minimum Variance Frontiers, 1990 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.1474	0.0000	0.0000	0.8479	0.0048	0.0000	0.0262	0.07
0.2203	0.0000	0.0000	0.7797	0.0000	0.0000	0.0358	0.08
0.2928	0.0000	0.0000	0.7072	0.0000	0.0000	0.0459	0.09
0.3653	0.0000	0.0000	0.6347	0.0000	0.0000	0.0563	0.10
0.4378	0.0000	0.0000	0.5622	0.0000	0.0000	0.0668	0.11
0.5103	0.0000	0.0000	0.4897	0.0000	0.0000	0.0775	0.12
0.5828	0.0000	0.0000	0.4172	0.0000	0.0000	0.0881	0.13
0.6553	0.0000	0.0000	0.3447	0.0000	0.0000	0.0989	0.14
0.7278	0.0000	0.0000	0.2722	0.0000	0.0000	0.1096	0.15
0.8003	0.0000	0.0000	0.1997	0.0000	0.0000	0.1204	0.16
0.8728	0.0000	0.0000	0.1272	0.0000	0.0000	0.1311	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7651	0.0361	0.0175	0.0789	0.0549	0.0475	0.0043	0.07
0.0068	0.0000	0.0000	0.6930	0.0257	0.0000	0.1394	0.0601	0.0750	0.0062	0.08
0.0227	0.0000	0.0000	0.6128	0.0118	0.0000	0.1864	0.0691	0.0972	0.0092	0.09
0.0320	0.0000	0.0123	0.5219	0.0000	0.0000	0.2377	0.0762	0.1199	0.0125	0.10
0.0396	0.0000	0.0211	0.4221	0.0000	0.0000	0.2990	0.0840	0.1343	0.0160	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0274	0.14
0.0699	0.0000	0.0561	0.0229	0.0000	0.0000	0.5443	0.1151	0.1916	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4932	0.1644	0.1868	0.0369	0.16
0.3042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2592	0.2636	0.1730	0.0558	0.17

Unhedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.6914	0.0000	0.1139	0.1740	0.0207	0.0000	0.0073	0.07
0.0115	0.0000	0.0000	0.6060	0.0296	0.1050	0.2456	0.0022	0.0000	0.0092	0.08
0.0388	0.0000	0.0000	0.5020	0.0084	0.1362	0.3011	0.0135	0.0000	0.0139	0.09
0.0665	0.0000	0.0000	0.3889	0.0000	0.1692	0.3530	0.0000	0.0224	0.0187	0.10
0.0858	0.0000	0.0000	0.2882	0.0000	0.1866	0.4167	0.0000	0.0226	0.0237	0.11
0.1051	0.0000	0.0000	0.1876	0.0000	0.2041	0.4805	0.0000	0.0228	0.0288	0.12
0.1244	0.0000	0.0000	0.0869	0.0000	0.2215	0.5442	0.0000	0.0229	0.0340	0.13
0.1448	0.0000	0.0000	0.0000	0.0000	0.2275	0.6073	0.0000	0.0204	0.0393	0.14
0.1722	0.0000	0.0000	0.0000	0.0000	0.1606	0.6664	0.0000	0.0007	0.0450	0.15
0.2150	0.0000	0.0000	0.0000	0.0000	0.0797	0.7052	0.0000	0.0000	0.0512	0.16
0.2663	0.0000	0.0000	0.0000	0.0000	0.0000	0.7337	0.0000	0.0000	0.0580	0.17

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7796	0.0366	0.0000	0.0812	0.0506	0.0520	0.0000	0.0000	0.0043	0.07
0.0000	0.0000	0.0000	0.6884	0.0280	0.0000	0.1477	0.0604	0.0755	0.0000	0.0000	0.0063	0.08
0.0000	0.0000	0.0000	0.5972	0.0195	0.0000	0.2141	0.0703	0.0989	0.0000	0.0000	0.0098	0.09
0.0000	0.0000	0.0000	0.5061	0.0109	0.0000	0.2806	0.0801	0.1224	0.0000	0.0000	0.0138	0.10
0.0000	0.0000	0.0000	0.4149	0.0024	0.0000	0.3470	0.0899	0.1458	0.0000	0.0000	0.0180	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0000	0.0000	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0000	0.0000	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0000	0.0000	0.0274	0.14
0.0699	0.0000	0.0561	0.0230	0.0000	0.0000	0.5443	0.1151	0.1916	0.0000	0.0000	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4932	0.1644	0.1868	0.0000	0.0000	0.0369	0.16
0.3042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2592	0.2637	0.1730	0.0000	0.0000	0.0558	0.17

Table 19. Asset Allocations for Figure 13.

Minimum Variance Frontiers, 1990 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	Std. Dev.	Mean(rp)
0.1474	0.0000	0.0000	0.8479	0.0048	0.0000	0.0262	0.07
0.2203	0.0000	0.0000	0.7797	0.0000	0.0000	0.0358	0.08
0.2928	0.0000	0.0000	0.7072	0.0000	0.0000	0.0459	0.09
0.3653	0.0000	0.0000	0.6347	0.0000	0.0000	0.0563	0.10
0.4378	0.0000	0.0000	0.5622	0.0000	0.0000	0.0668	0.11
0.5103	0.0000	0.0000	0.4897	0.0000	0.0000	0.0775	0.12
0.5828	0.0000	0.0000	0.4172	0.0000	0.0000	0.0881	0.13
0.6553	0.0000	0.0000	0.3447	0.0000	0.0000	0.0989	0.14
0.7278	0.0000	0.0000	0.2722	0.0000	0.0000	0.1096	0.15
0.8003	0.0000	0.0000	0.1997	0.0000	0.0000	0.1204	0.16
0.8728	0.0000	0.0000	0.1272	0.0000	0.0000	0.1311	0.17

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7651	0.0361	0.0175	0.0789	0.0549	0.0475	0.0043	0.07
0.0068	0.0000	0.0000	0.6930	0.0257	0.0000	0.1394	0.0601	0.0750	0.0062	0.08
0.0227	0.0000	0.0000	0.6128	0.0118	0.0000	0.1864	0.0691	0.0972	0.0092	0.09
0.0320	0.0000	0.0123	0.5219	0.0000	0.0000	0.2377	0.0762	0.1199	0.0125	0.10
0.0396	0.0000	0.0211	0.4221	0.0000	0.0000	0.2990	0.0840	0.1343	0.0160	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0274	0.14
0.0699	0.0000	0.0561	0.0229	0.0000	0.0000	0.5443	0.1151	0.1916	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4932	0.1644	0.1868	0.0369	0.16
0.3042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2592	0.2636	0.1730	0.0558	0.17

Hedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-MKT	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7188	0.0402	0.0684	0.1718	0.0000	0.0007	0.0050	0.07
0.0105	0.0000	0.0000	0.6079	0.0315	0.1032	0.2468	0.0000	0.0000	0.0092	0.08
0.0418	0.0000	0.0000	0.5112	0.0103	0.1328	0.2919	0.0033	0.0087	0.0138	0.09
0.0658	0.0000	0.0000	0.4198	0.0000	0.1526	0.3468	0.0074	0.0076	0.0185	0.10
0.0850	0.0000	0.0000	0.3264	0.0000	0.1663	0.4083	0.0110	0.0031	0.0234	0.11
0.1046	0.0000	0.0000	0.2310	0.0000	0.1810	0.4695	0.0139	0.0000	0.0285	0.12
0.1249	0.0000	0.0000	0.1316	0.0000	0.1977	0.5302	0.0155	0.0000	0.0336	0.13
0.1453	0.0000	0.0000	0.0322	0.0000	0.2144	0.5910	0.0172	0.0000	0.0388	0.14
0.1824	0.0000	0.0000	0.0000	0.0000	0.1652	0.6327	0.0198	0.0000	0.0442	0.15
0.2275	0.0000	0.0000	0.0000	0.0000	0.0844	0.6653	0.0228	0.0000	0.0504	0.16
0.2725	0.0000	0.0000	0.0000	0.0000	0.0036	0.6979	0.0259	0.0000	0.0570	0.17
0.6470	0.0000	0.0000	0.0000	0.0000	0.0000	0.2588	0.0942	0.0000	0.0908	0.18

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7659	0.0516	0.0000	0.1372	0.0454	0.0000	0.0000	0.0000	0.0065	0.07
0.0068	0.0000	0.0000	0.6930	0.0257	0.0000	0.1394	0.0601	0.0750	0.0000	0.0000	0.0062	0.08
0.0227	0.0000	0.0000	0.6128	0.0118	0.0000	0.1864	0.0691	0.0972	0.0000	0.0000	0.0092	0.09
0.0320	0.0000	0.0123	0.5219	0.0000	0.0000	0.2377	0.0762	0.1199	0.0000	0.0000	0.0125	0.10
0.0396	0.0000	0.0211	0.4221	0.0000	0.0000	0.2990	0.0840	0.1343	0.0000	0.0000	0.0160	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0000	0.0000	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0000	0.0000	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0000	0.0000	0.0274	0.14
0.0699	0.0000	0.0561	0.0229	0.0000	0.0000	0.5443	0.1151	0.1916	0.0000	0.0000	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4933	0.1643	0.1866	0.0002	0.0000	0.0369	0.16
0.3100	0.0000	0.0000	0.0000	0.0000	0.0000	0.2807	0.2372	0.1426	0.0295	0.0000	0.0544	0.17
0.4643	0.0000	0.0000	0.0000	0.0000	0.0000	0.0680	0.3102	0.0986	0.0588	0.0000	0.0777	0.18

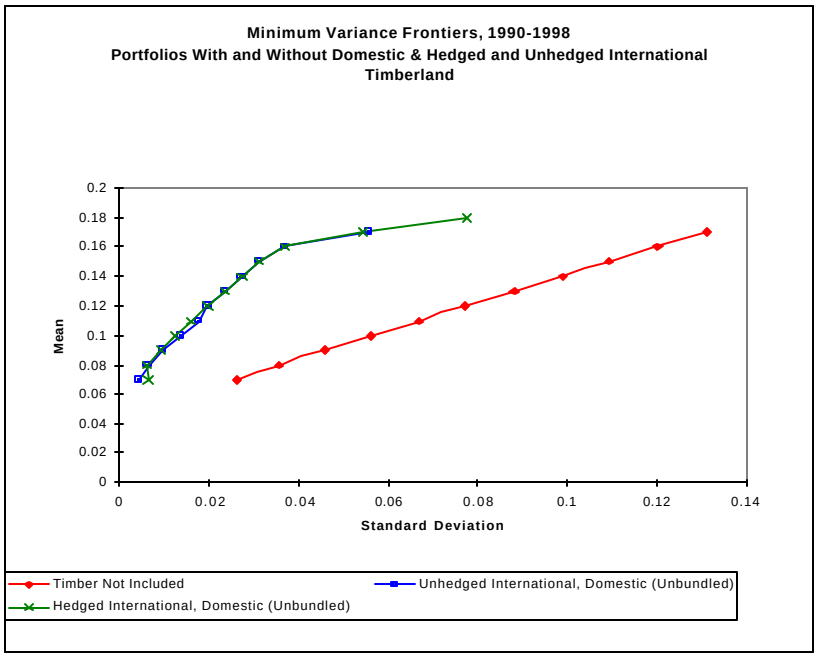


Figure 14. Minimum Variance Frontiers.

Figure 14 and Table 20 merely compare, the two frontiers with international timberland assets and individual U.S. timberland assets depicted in Figures 12 and 13. Since Table 20 reveals that the minimum variance portfolios with international timberland assets have essentially zero allocations, it is foolhardy to try and compare hedged and unhedged international assets.

Table 20. Asset Allocations for Figure 14.

Minimum Variance Frontiers, 1990 - 1998

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	Std. Dev.	Mean(rp)
0.1474	0.0000	0.0000	0.8479	0.0048	0.0000	0.0262	0.07
0.2203	0.0000	0.0000	0.7797	0.0000	0.0000	0.0358	0.08
0.2928	0.0000	0.0000	0.7072	0.0000	0.0000	0.0459	0.09
0.3653	0.0000	0.0000	0.6347	0.0000	0.0000	0.0563	0.10
0.4378	0.0000	0.0000	0.5622	0.0000	0.0000	0.0668	0.11
0.5103	0.0000	0.0000	0.4897	0.0000	0.0000	0.0775	0.12
0.5828	0.0000	0.0000	0.4172	0.0000	0.0000	0.0881	0.13
0.6553	0.0000	0.0000	0.3447	0.0000	0.0000	0.0989	0.14
0.7278	0.0000	0.0000	0.2722	0.0000	0.0000	0.1096	0.15
0.8003	0.0000	0.0000	0.1997	0.0000	0.0000	0.1204	0.16
0.8728	0.0000	0.0000	0.1272	0.0000	0.0000	0.1311	0.17

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7796	0.0366	0.0000	0.0812	0.0506	0.0520	0.0000	0.0000	0.0043	0.07
0.0000	0.0000	0.0000	0.6884	0.0280	0.0000	0.1477	0.0604	0.0755	0.0000	0.0000	0.0063	0.08
0.0000	0.0000	0.0000	0.5972	0.0195	0.0000	0.2141	0.0703	0.0989	0.0000	0.0000	0.0098	0.09
0.0000	0.0000	0.0000	0.5061	0.0109	0.0000	0.2806	0.0801	0.1224	0.0000	0.0000	0.0138	0.10
0.0000	0.0000	0.0000	0.4149	0.0024	0.0000	0.3470	0.0899	0.1458	0.0000	0.0000	0.0180	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0000	0.0000	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0000	0.0000	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0000	0.0000	0.0274	0.14
0.0699	0.0000	0.0561	0.0230	0.0000	0.0000	0.5443	0.1151	0.1916	0.0000	0.0000	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4932	0.1644	0.1868	0.0000	0.0000	0.0369	0.16
0.3042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2592	0.2637	0.1730	0.0000	0.0000	0.0558	0.17

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.0000	0.0000	0.0000	0.7659	0.0516	0.0000	0.1372	0.0454	0.0000	0.0000	0.0000	0.0065	0.07
0.0068	0.0000	0.0000	0.6930	0.0257	0.0000	0.1394	0.0601	0.0750	0.0000	0.0000	0.0062	0.08
0.0227	0.0000	0.0000	0.6128	0.0118	0.0000	0.1864	0.0691	0.0972	0.0000	0.0000	0.0092	0.09
0.0320	0.0000	0.0123	0.5219	0.0000	0.0000	0.2377	0.0762	0.1199	0.0000	0.0000	0.0125	0.10
0.0396	0.0000	0.0211	0.4221	0.0000	0.0000	0.2990	0.0840	0.1343	0.0000	0.0000	0.0160	0.11
0.0472	0.0000	0.0298	0.3223	0.0000	0.0000	0.3603	0.0918	0.1486	0.0000	0.0000	0.0197	0.12
0.0548	0.0000	0.0386	0.2225	0.0000	0.0000	0.4217	0.0996	0.1629	0.0000	0.0000	0.0235	0.13
0.0623	0.0000	0.0473	0.1227	0.0000	0.0000	0.4830	0.1073	0.1773	0.0000	0.0000	0.0274	0.14
0.0699	0.0000	0.0561	0.0229	0.0000	0.0000	0.5443	0.1151	0.1916	0.0000	0.0000	0.0313	0.15
0.1557	0.0000	0.0000	0.0000	0.0000	0.0000	0.4933	0.1643	0.1866	0.0002	0.0000	0.0369	0.16
0.3100	0.0000	0.0000	0.0000	0.0000	0.0000	0.2807	0.2372	0.1426	0.0295	0.0000	0.0544	0.17
0.4643	0.0000	0.0000	0.0000	0.0000	0.0000	0.0680	0.3102	0.0986	0.0588	0.0000	0.0777	0.18

Figures 15-19 utilize the shortened time period from 1990-1998 and are also subject to the same minimum asset allocations as those in Figures 5-9.

Like Figure 11 and Table 17, Figure 15 and Table 21 illustrate that even when only considering data from 1990-1998 and constraining assets to minimum allocations, individual U.S. timberland assets provide greater diversification benefits than a preconceived U.S. timberland portfolio.

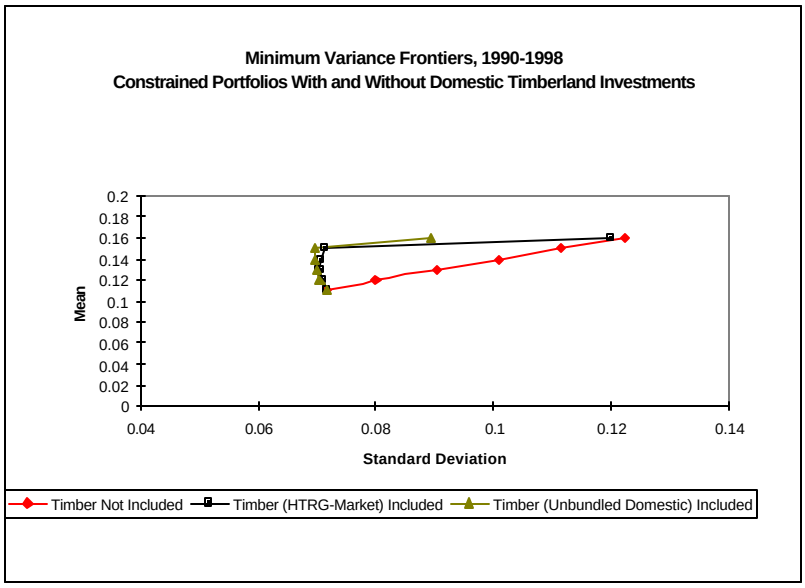


Figure 15. Constrained Period and Minimum Asset Allocations.

Table 21. Asset Allocations for Figure 15.

Constrained Minimum Variance Frontiers, 1990 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.3113	0.0387	0.2500	0.4000	0.0000	0.0000	0.0718	0.11
0.4073	0.0000	0.2500	0.3427	0.0000	0.0000	0.0800	0.12
0.4798	0.0000	0.2500	0.2702	0.0000	0.0000	0.0904	0.13
0.5523	0.0000	0.2500	0.1977	0.0000	0.0000	0.1010	0.14
0.6248	0.0000	0.2500	0.1252	0.0000	0.0000	0.1115	0.15
0.6973	0.0000	0.2500	0.0527	0.0000	0.0000	0.1222	0.16

Timber (HTRG-Market) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-M	Std. Dev.	Mean(rp)
0.3098	0.0402	0.2500	0.3993	0.0000	0.0000	0.0007	0.0718	0.11
0.3396	0.0104	0.2500	0.3257	0.0000	0.0000	0.0743	0.0709	0.1200001
0.3500	0.0000	0.2500	0.2430	0.0000	0.0000	0.1570	0.0705	0.13
0.3500	0.0000	0.2500	0.1553	0.0000	0.0000	0.2447	0.0707	0.1400001
0.3500	0.0000	0.2500	0.0676	0.0000	0.0000	0.3324	0.0715	0.15
0.6844	0.0000	0.2500	0.0500	0.0000	0.0000	0.0156	0.1201	0.1600002

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.2858	0.0642	0.2500	0.3855	0.0000	0.0000	0.0000	0.0000	0.0145	0.0717	0.11
0.2567	0.0933	0.2500	0.2638	0.0000	0.0000	0.0045	0.0000	0.1317	0.0704	0.12
0.2840	0.0660	0.2500	0.1850	0.0000	0.0000	0.0732	0.0188	0.1230	0.0699	0.13
0.3154	0.0346	0.2500	0.1100	0.0000	0.0000	0.1376	0.0411	0.1114	0.0696	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1514	0.0957	0.1029	0.0698	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0892	0.16

Figures 16 and 17 and Tables 22 and 23 provide more favorable results in terms of international timberland offering diversification benefits, than Figures 12 and 13, where international timberland assets did not provide any diversification benefits. At mean portfolio return target of 14 percent both frontiers with unhedged and hedged international timberland assets when combined with individual U.S. timberland assets were dominant and consisted of significant capital allocations to New Zealand timberland assets (Tables 22 and 23). In Table 22, a mean return of 14 percent resulted in a 9.02 percent allocation to unhedged New Zealand timberland assets and in Table 21, a mean return of 14 percent resulted in a 10.5 percent allocation to New Zealand timberland assets.

Figure 18 and Table 24 like previous model results for 1981-1998 reveal that hedged international timberland assets offer more diversification benefits than unhedged international timberland assets.

Figure 19 and Table 25 also like previous the model results for 1981-1998 reveal that individual international and U.S. timberland investments offer diversification benefits over a preconceived world timber portfolio.

This sensitivity analysis shows that even while working with limited data from 1981-1998, model results from a more recent period (1990-1998) still provide results depicting the same general relationships illustrated with models utilizing the entire data set. With the exception of the frontiers without unconstrained minimum asset allocations international timberland assets offered diversification over simply adding individual U.S. timberland assets to portfolios of traditional assets.

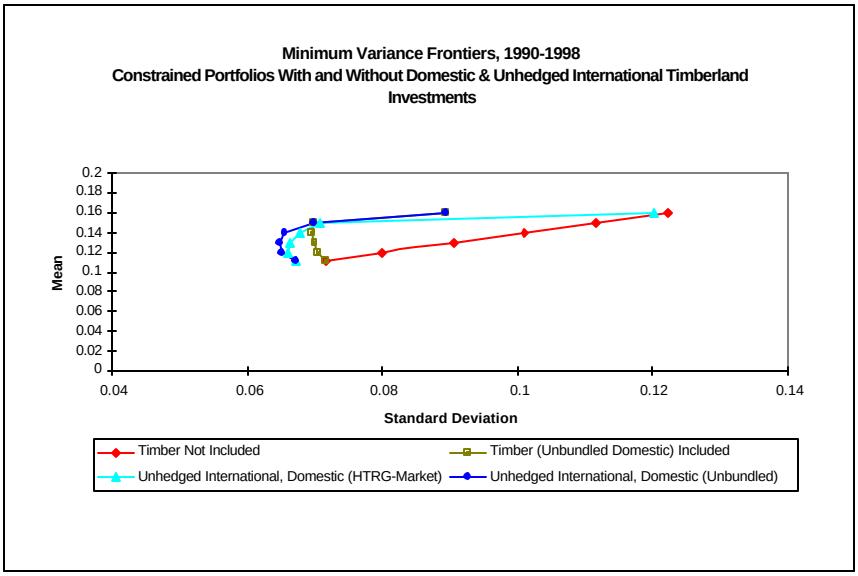


Figure 16. Double Constraints with Unhedged International Timberland.

Table 22. Asset Allocations for Figure 16.

Constrained Minimum Variance Frontiers, 1990 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.3113	0.0387	0.2500	0.4000	0.0000	0.0000	0.0718	0.11
0.4073	0.0000	0.2500	0.3427	0.0000	0.0000	0.0800	0.12
0.4798	0.0000	0.2500	0.2702	0.0000	0.0000	0.0904	0.13
0.5523	0.0000	0.2500	0.1977	0.0000	0.0000	0.1010	0.14
0.6248	0.0000	0.2500	0.1252	0.0000	0.0000	0.1115	0.15
0.6973	0.0000	0.2500	0.0527	0.0000	0.0000	0.1222	0.16

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.2858	0.0642	0.2500	0.3855	0.0000	0.0000	0.0000	0.0000	0.0145	0.0717	0.11
0.2567	0.0933	0.2500	0.2638	0.0000	0.0000	0.0045	0.0000	0.1317	0.0704	0.12
0.2840	0.0660	0.2500	0.1850	0.0000	0.0000	0.0732	0.0188	0.1230	0.0699	0.13
0.3154	0.0346	0.2500	0.1100	0.0000	0.0000	0.1376	0.0411	0.1114	0.0696	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1514	0.0957	0.1029	0.0698	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0892	0.16

Unhedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0833	0.2667	0.2500	0.0500	0.0000	0.2462	0.0000	0.0000	0.1038	0.0753	0.10
0.2705	0.0795	0.2500	0.1629	0.0000	0.0994	0.0000	0.0000	0.1377	0.0671	0.11
0.3500	0.0000	0.2500	0.1736	0.0000	0.0331	0.0518	0.0000	0.1416	0.0659	0.12
0.3500	0.0000	0.2500	0.0615	0.0000	0.0655	0.1393	0.0000	0.1338	0.0663	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0160	0.2324	0.0000	0.1016	0.0675	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.3301	0.0000	0.0199	0.0707	0.15
0.6844	0.0000	0.2500	0.0500	0.0000	0.0000	0.0156	0.0000	0.0000	0.1201	0.16

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0833	0.2667	0.2500	0.0500	0.0000	0.2462	0.0000	0.0000	0.0000	0.0000	0.1038	0.0753	0.10
0.2705	0.0795	0.2500	0.1629	0.0000	0.0994	0.0000	0.0000	0.0000	0.0000	0.1377	0.0671	0.11
0.3255	0.0245	0.2500	0.1826	0.0000	0.0000	0.0000	0.0000	0.0777	0.0000	0.1397	0.0652	0.12
0.3295	0.0205	0.2500	0.0824	0.0000	0.0000	0.0892	0.0000	0.0886	0.0000	0.1398	0.0647	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1408	0.0365	0.0825	0.0000	0.0902	0.0655	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1323	0.1070	0.1054	0.0000	0.0053	0.0697	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0000	0.0000	0.0892	0.16

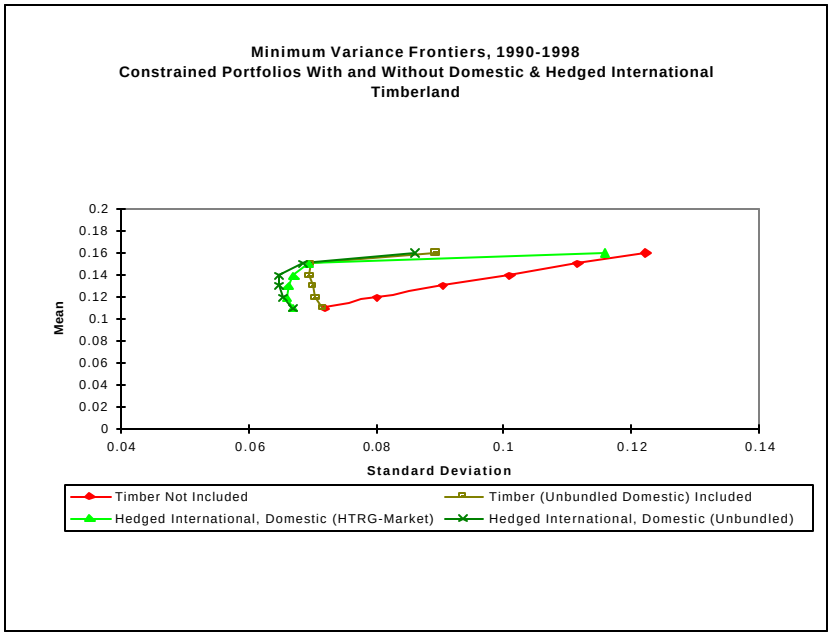


Figure 17. Double Constraints with Hedged International Timberland.

Table 23. Asset Allocations for Figure 17.

Constrained Minimum Variance Frontiers, 1990 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.3113	0.0387	0.2500	0.4000	0.0000	0.0000	0.0718	0.11
0.4073	0.0000	0.2500	0.3427	0.0000	0.0000	0.0800	0.12
0.4798	0.0000	0.2500	0.2702	0.0000	0.0000	0.0904	0.13
0.5523	0.0000	0.2500	0.1977	0.0000	0.0000	0.1010	0.14
0.6248	0.0000	0.2500	0.1252	0.0000	0.0000	0.1115	0.15
0.6973	0.0000	0.2500	0.0527	0.0000	0.0000	0.1222	0.16

Timber (Unbundled Domestic) Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Std. Dev.	Mean(rp)
0.2858	0.0642	0.2500	0.3855	0.0000	0.0000	0.0000	0.0000	0.0145	0.0717	0.11
0.2567	0.0933	0.2500	0.2638	0.0000	0.0000	0.0045	0.0000	0.1317	0.0704	0.12
0.2840	0.0660	0.2500	0.1850	0.0000	0.0000	0.0732	0.0188	0.1230	0.0699	0.13
0.3154	0.0346	0.2500	0.1100	0.0000	0.0000	0.1376	0.0411	0.1114	0.0696	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1514	0.0957	0.1029	0.0698	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0892	0.16

Hedged International, Domestic (HTRG-Market)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-MKT	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.2238	0.1262	0.2500	0.1313	0.0000	0.1433	0.0000	0.0000	0.1254	0.0668	0.11
0.3423	0.0077	0.2500	0.2435	0.0000	0.0000	0.0386	0.0000	0.1180	0.0658	0.12
0.3500	0.0000	0.2500	0.1491	0.0000	0.0158	0.1241	0.0000	0.1110	0.0661	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0336	0.2136	0.0000	0.1028	0.0669	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.2973	0.0250	0.0278	0.0693	0.15
0.6741	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.0259	0.0000	0.1159	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.2238	0.1262	0.2500	0.1313	0.0000	0.1433	0.0000	0.0000	0.0000	0.0000	0.1254	0.0668	0.11
0.3027	0.0473	0.2500	0.2152	0.0000	0.0000	0.0321	0.0000	0.0362	0.0000	0.1166	0.0653	0.12
0.3083	0.0417	0.2500	0.1154	0.0000	0.0000	0.1247	0.0000	0.0423	0.0000	0.1176	0.0648	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.2175	0.0108	0.0167	0.0000	0.1050	0.0648	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1594	0.0814	0.0723	0.0319	0.0050	0.0683	0.15
0.3753	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.2833	0.0000	0.0414	0.0000	0.0861	0.16

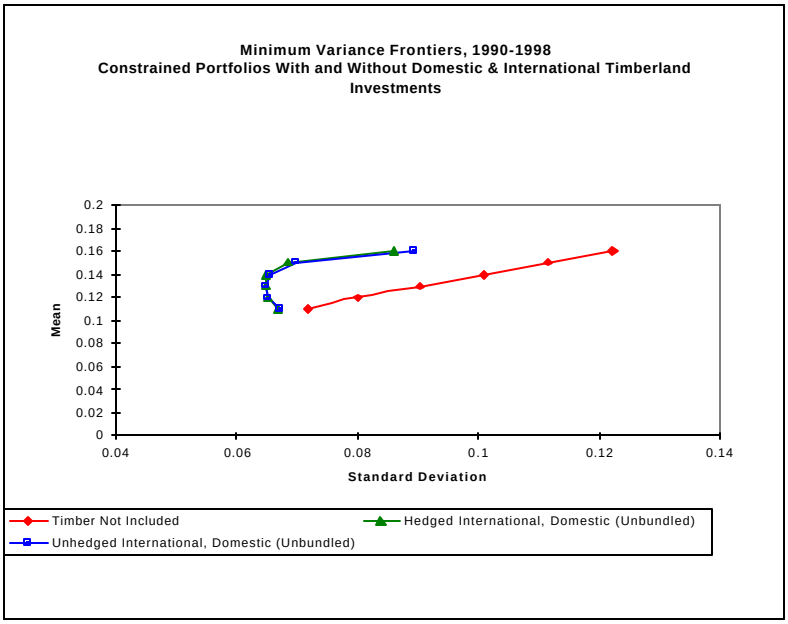


Figure 18. Double Constraints with Hedged and Unhedged International Timberland.

Table 24. Asset Allocations for Figure 18.

Constrained Minimum Variance Frontiers, 1990 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	Std. Dev.	Mean(rp)
0.3113	0.0387	0.2500	0.4000	0.0000	0.0000	0.0718	0.11
0.4073	0.0000	0.2500	0.3427	0.0000	0.0000	0.0800	0.12
0.4798	0.0000	0.2500	0.2702	0.0000	0.0000	0.0904	0.13
0.5523	0.0000	0.2500	0.1977	0.0000	0.0000	0.1010	0.14
0.6248	0.0000	0.2500	0.1252	0.0000	0.0000	0.1115	0.15
0.6973	0.0000	0.2500	0.0527	0.0000	0.0000	0.1222	0.16

Unhedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-U	NZ-U	Std. Dev.	Mean(rp)
0.0833	0.2667	0.2500	0.0500	0.0000	0.2462	0.0000	0.0000	0.0000	0.0000	0.1038	0.0753	0.10
0.2705	0.0795	0.2500	0.1629	0.0000	0.0994	0.0000	0.0000	0.0000	0.0000	0.1377	0.0671	0.11
0.3255	0.0245	0.2500	0.1826	0.0000	0.0000	0.0000	0.0000	0.0777	0.0000	0.1397	0.0652	0.12
0.3295	0.0205	0.2500	0.0824	0.0000	0.0000	0.0892	0.0000	0.0886	0.0000	0.1398	0.0647	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1408	0.0365	0.0825	0.0000	0.0902	0.0655	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1323	0.1070	0.1054	0.0000	0.0053	0.0697	0.15
0.3718	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.3137	0.0145	0.0000	0.0000	0.0892	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCRIEF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.2238	0.1262	0.2500	0.1313	0.0000	0.1433	0.0000	0.0000	0.0000	0.0000	0.1254	0.0668	0.11
0.3027	0.0473	0.2500	0.2152	0.0000	0.0000	0.0321	0.0000	0.0362	0.0000	0.1166	0.0653	0.12
0.3083	0.0417	0.2500	0.1154	0.0000	0.0000	0.1247	0.0000	0.0423	0.0000	0.1176	0.0648	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.2175	0.0108	0.0167	0.0000	0.1050	0.0648	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1594	0.0814	0.0723	0.0319	0.0050	0.0683	0.15
0.3753	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.2833	0.0000	0.0414	0.0000	0.0861	0.16

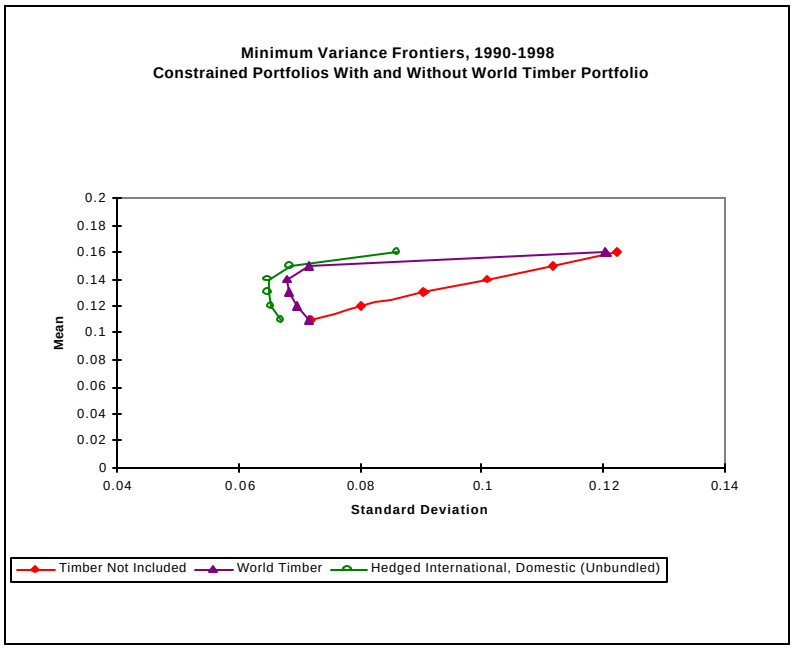


Figure 19. Double Constraints with World Timber Portfolio.

Table 25. Asset Allocations for Figure 19.

Constrained Minimum Variance Frontiers, 1990 - 1998

(Minimum Asset Class Proportions: 0.35 Domestic Stocks, 0.25 Corporate Bonds, 0.05 T-Bills)

Asset Class Proportions

Timber Not Included

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	Std. Dev.	Mean(rp)
0.3113	0.0387	0.2500	0.4000	0.0000	0.0000	0.0718	0.11
0.4073	0.0000	0.2500	0.3427	0.0000	0.0000	0.0800	0.12
0.4798	0.0000	0.2500	0.2702	0.0000	0.0000	0.0904	0.13
0.5523	0.0000	0.2500	0.1977	0.0000	0.0000	0.1010	0.14
0.6248	0.0000	0.2500	0.1252	0.0000	0.0000	0.1115	0.15
0.6973	0.0000	0.2500	0.0527	0.0000	0.0000	0.1222	0.16

Hedged International, Domestic (Unbundled)

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	HTRG-S	HTRG-PNW	HTRG-NE	Chile-H	NZ-H	Std. Dev.	Mean(rp)
0.2238	0.1262	0.2500	0.1313	0.0000	0.1433	0.0000	0.0000	0.0000	0.0000	0.1254	0.0668	0.11
0.3027	0.0473	0.2500	0.2152	0.0000	0.0000	0.0321	0.0000	0.0362	0.0000	0.1166	0.0653	0.12
0.3083	0.0417	0.2500	0.1154	0.0000	0.0000	0.1247	0.0000	0.0423	0.0000	0.1176	0.0648	0.13
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.2175	0.0108	0.0167	0.0000	0.1050	0.0648	0.14
0.3500	0.0000	0.2500	0.0500	0.0000	0.0000	0.1594	0.0814	0.0723	0.0319	0.0050	0.0683	0.15
0.3753	0.0000	0.2500	0.0500	0.0000	0.0000	0.0000	0.2833	0.0000	0.0414	0.0000	0.0861	0.16

World Timber Portfolio

S&P500	Small Caps	Corp. Bonds	T-bills	MSCIEAFE	NCREIF	World Timber	Std. Dev.	Mean(rp)
0.2878	0.0622	0.2500	0.3880	0.0000	0.0000	0.0120	0.0716	0.11
0.3190	0.0310	0.2500	0.3096	0.0000	0.0000	0.0904	0.0695	0.12
0.3500	0.0000	0.2500	0.2311	0.0000	0.0000	0.1689	0.0682	0.13
0.3500	0.0000	0.2500	0.1368	0.0000	0.0000	0.2632	0.0680	0.14
0.3750	0.0000	0.2500	0.0500	0.0000	0.0000	0.3250	0.0717	0.15
0.6883	0.0000	0.2500	0.0500	0.0000	0.0000	0.0117	0.1205	0.16

CHAPTER 6: CONCLUSION

In the traditional MV framework utilized in modern day financial management international timberland investments in Chile and New Zealand appear to provide diversification benefits over the study horizon. Investors wishing to maximize diversification benefits will be better off by allocating capital to hedged international timberland assets. However, at the global minimum variance mean portfolio return, only 0.8 percent will be allocated to the hedged New Zealand timberland asset and 0 percent will be allocated to the hedged Chilean timberland asset. As target returns increase, asset allocations increase considerably to both hedged international timberland investments. For example, at a mean portfolio return of 14 percent, 9.36 percent of portfolio capital will be allocated to hedged New Zealand timberland assets and 3.91 percent of portfolio capital will be allocated to hedged Chilean timberland assets.

However, not all countries have as developed a timber industry as Chile and New Zealand and the time horizon of historical timber prices and other general forestry data is either of limited value, not publicly available, or even simply nonexistent.

Where data is unavailable for inclusion into the MV framework the qualitative assessment developed in this study is useful in relating MV framework results to countries with similar rankings and who serve similar markets. For example, both Argentina and Brazil, given their geographic proximity to Chile would seem to be likely candidates for investment grade timberland. The qualitative assessment shows that Argentina has a higher ranking than Brazil. If an investor is faced with an investment opportunity similar to that of in Chile, appropriate adjustments may be made in their analysis when weighing a choice between an investment in Argentina or in Brazil. Knowing that 3.91 percent of portfolio assets will be allocated to hedged Chilean timberland assets with a target mean portfolio return of 14 percent may be of benefit to investors when considering hedged investments in Argentina and Brazil. It is also a benefit to those (considering) having timberland investment-specific country assessments that illustrate similarities in total assessment and on a category-by-category basis.

Further, Australia is a relatively new source of investment grade timberland. While historical data is not publicly available for forestry operations in Australia, a timberland investment in this region can be gauged by both the results of the MV framework in which a New Zealand timberland investment is included and the qualitative assessment of Australia, which happens to have a higher total score than New Zealand. This study quantitatively conveys the diversification benefits to international timberland investments in Chile and New Zealand. The study also develops a qualitative framework in which to analyze countries that are unable to pass the data requirements necessary to fit into MV analysis.

Additional development of reliable asset return data is one particular area of further research potential. Also, as more and more international investment grade timberland is developed market transaction data and asset characteristics will be better documented for countries beyond Chile and New Zealand. Future research in this area is currently on going and will continue to develop as capital deployment seeks out diversification opportunities.

Diversification benefits from investing in international timberland investments have been shown to exist yet relatively few institutional investors are venturing into the international arena. This is not sign of market inefficiency. It merely identifies the lack of information and asymmetric information available to institutional investors. Domestic timberland investments have grown in demand among institutional investors with the increasing expertise of Timber Investment Management Organizations International timberland investments currently are experiencing some interest and will continue to be in increasing demand along with Timber Investment Management Organizations increasing there own knowledge of international timberland investments and their unique characteristics and diversification benefits.

With institutional investment in international timberland in the early stages and predicted to grow in the future, this study will be helpful to practitioners by providing a link on a comparison basis, between the data demanding MV framework and the developed qualitative country assessment.

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Appendix

APPENDIX A: COUNTRY ASSESSMENT CATEGORY SCORES

Table 26. Category Score: Policy Consistency.

(Importance = 2)

Country	Policies Inconsistent or Destabilizing	Policies Inconsistent Due to Conflicting Policies	Adopted a Consistent View in Past, Now Wavering	Inconsistent in the Past, Now Adopting Some Consistency	Policies Have Been Consistent for Past Five Years	Policies Have Been Consistent for Seven Years	Policies Have Been Consistent for Over Twelve Years
Argentina						6	
Australia						6	
Brazil				4			
Chile							7
China			3				
New Zealand							7
Russia		2					
South Africa		2					

Table 27. Category Score: Debt/GDP.

(Importance = 1)

Country	>30	25-30	20-25	15-20	11-15	8-11	<8
Argentina		2.25					
Australia	1						
Brazil			3				
Chile			3				
China							7
New Zealand	1						
Russia	1						
South Africa			3				

Table 28. Category Score: Inflation.

(Importance = 1)

Country	>12	10.1-12	8.1-10	6.1-8	4.1-6	2-4	<2
Argentina					5		
Australia					5		
Brazil				4			
Chile				4			
China	1						
New Zealand						6	
Russia	1						
South Africa			3				

Table 29. Category Score: Economic Climate.

(Importance = 2)

Country	Extensive Regulations, Restrictive Environment	Regulations, Government Interaction, and Black Market	Regulated, Significant Tax or Black Market	Regulated Environment	Low Regulation, but Difficult Business Environment	Low Regulation	Open & Transparent Environment
Argentina							7
Australia						6	
Brazil					5		
Chile						6	
China		2					
New Zealand							7
Russia		2					
South Africa				4			

Table 30. Category Score: Exchange Rate Stability.

(Importance = 2)

Country	50%	0-50%	0-40%	20%	15%	10%	table
Argentina						6	
Australia							7
Brazil	1						
Chile					5		
China					5		
New Zealand							7
Russia	1						
South Africa				4			

Table 31. Category Score: Ideological Differences.

(Importance = 2)

Country	Differences Marked and Well Entrenched	Differences Marked and Evolving	Significant Differences Occur	Significant Differences Occur but Able to be Accommodated	Ideological Differences are Present	Ideological Differences are Incorporated into Decision Making Processes	No Significant Ideological Differences
Argentina							7
Australia							7
Brazil							7
Chile							7
China					5		
Russia	1						
South Africa	1						

Table 32. Category Score: Strength of Judiciary System.

(Importance = 3)

Country	<2.5	>2.5	>5	>6	>7	>8	>9
Argentina							7
Australia					5.5		
Brazil	1						
Chile			3				
China		2					
New Zealand							7
Russia	1						
South Africa			3				

Table 33. Category Score: Corruption.

(Importance = 3)

Country	<1	<2.5	>2.5	>4	>6	>7	>8
Argentina		2					
Australia							7
Brazil			3				
Chile					5.8		
China	1.8						
New Zealand							7
Russia		2					
South Africa				4.5			

Table 34. Category Score: Population Pressure.

(Importance = 2)

Country	Typical Land Use <50 ha	Typical Land Use <100 ha	Typical Land Use <150 ha	Typical Land Use <300 ha	Large Scale Land Use Subject to Strict Controls	Large Scale Land Use Subject to Controls	No Pressure
Argentina			3.5				
Australia				4.5			7
Brazil				4			
Chile					5		
China				4			
New Zealand				4			
Russia							7
South Africa							7

Table 35. Category Score: Indigenous Land Claims.

(Importance = 3)

Country	Violent Disagreements Over Land Claims	Areas in Dispute, No Judicial System, No Probability of Repriation	Areas in Dispute, Judicial System, Will Repriate State Land	Small Scale Claims Likely to be Repriated	Small Scale Claims	Remote Possibility, Insignificant	No Likelihood of Claims
Argentina							7
Australia			3.5				
Brazil							7
Chile							7
China							7
New Zealand			3				
Russia	1						
South Africa			3				

Table 36. Category Score: Foreign Ownership Provisions.

(Importance = 2)

Country	No Foreign Ownership of Assets	Requires Significant Approved Local Partner	Requires Significant Local Partner	Requires Minor Approved Local Partner	Requires Minor Local Partner	Foreign Ownership Subject to Conditions	No Restrictions on Foreign Ownership
Argentina						6	
Australia						6	
Brazil				4			
Chile		2					
China					5.5		
New Zealand						6	
Russia				4			
South Africa					5		

Table 37. Category Score: Transportation Infrastructure.

(Importance = 1)

Country	None	Marginal	Marginal, Upgrade Program in Place	Adequate, No Upgrade Program	Acceptable, Needs Repair & Maintenance	Acceptable, Upgrade Program in Place	Meets all Requirements
Argentina				4		6	
Australia							7
Brazil						6	
Chile						6	
China			3				
New Zealand							7
Russia		2					
South Africa							7

Table 38. Category Score: Ports.

(Importance = 1)

Country	None	Shallow Water	Poor Port & Infrastructure	Poor Port, Good Infrastructure	Good Port, Poor Infrastructure	Port & Infrastructure in Place	Good Port & Infrastructure
Argentina		2					
Australia							7
Brazil				4			
Chile							7
China			3				
New Zealand							7
Russia							7
South Africa							7

Table 39. Category Score: Labor Cost/Quality.

(Importance = 2)

Country	None	Limited	Adequate but Unreliable, Unskilled	Adequate but Unskilled	Abundant but Unreliable, Unskilled	Abundant but Unskilled	Abundant & Skilled
Argentina						6	
Australia						6	
Brazil						6	
Chile						6	
China							7
New Zealand						6	
Russia					5		
South Africa					5		

Table 40. Category Score: Land Tenure.

(Importance = 3)

Country	Customary Land, Indistinct Claimants	Customary Land, No Title System	Customary Land with Title System	Lease, No Legal Precedent	Freehold, No Legal System	Leasehold, Legal Precedent	Freehold, Legal Precedent
Argentina							7
Australia							7
Brazil							7
Chile							7
China				4			
New Zealand							7
Russia				4			
South Africa							7

Table 41. Category Score: Land Availability.

(Importance = 3)

Country	<50ha Discrete Parcels, Restrictions on Amalgamation	<100ha Discrete Parcels, Restrictions on Amalgamation	<<100ha Discrete Parcels, No Restriction on Amalgamation	10-20,00 ha Available, Not Contiguous	10-20,00 ha Available, Contiguous	>20.000 ha Available, Not Contiguous	>20,000 ha Available, Contiguous
Argentina							7
Australia				4			
Brazil						6	
Chile					5		
China			3				
New Zealand			3				
Russia							7
South Africa						6	

Table 42. Category Score: Distance to Major markets.

(Importance = 1)

Country	>10,000 km	>7,500 km	>5,000 km	>2,500 km	>1000 km	<1000 km	Is a Major Market
Argentina							7
Australia		2					
Brazil		2.3					
Chile		2					
China				4.8			
New Zealand	1						
Russia				4			
South Africa	1						

Table 43. Category Score: Domestic Market.

(Importance = 2)

Country	Minor Population of Wood Consumers, Net Exporter	Minor Population of Nonwood Consumers, Net Exporter	Major Population, but Not Significant Wood Consumers	Large Population, but Not Large Wood Consumers	Small but Significant Wood Consumption, Net Importer	Major Wood Using Population	Significant Population & Wood Consumption
Argentina			3				
Australia						6	
Brazil				4			
Chile		2					
China				4			
New Zealand	1						
Russia				4			
South Africa			3				

Table 44. Category Score: Biological & Physical Risks.

(Importance = 3)

Country	Liklihood of Significant Annual Loss	Liklihood of Small Annual Loss	Chance of Loss on a One Rotation Return	Small Loss May Occur per Rotation	Significant Rist but Have Well Organized Counter Measure	Opportunity for Loss Reduced by Well Proven Counter Measures	Little Chance of Significant Loss
Argentina					5		
Australia						6	
Brazil					5		
Chile					5		
China		2					
New Zealand							7
Russia	1						
South Africa					5		

Table 45. Category Score: Species Domestication.

(Importance = 2)

Country	No Previous History	Limited Scale Trial <One Rotation	Large Scale Trial <One Rotation	Trial Plantings, One Rotation, Range of Sites	At Least One Commercial	At Least Two Commercial	At Least Three Commercial
Argentina						6	
Australia						6	
Brazil						6	
Chile						6	
China					5		
New Zealand							7
Russia							7
South Africa							7