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TIR

DIVERSIFICATION OF TIMBERLAND INVESTMENTS

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Economic Research and Analysis

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Executive Summary

Investors understand the value of diversification in timberland investing. However, little is known about building an effective diversification strategy within the asset class because of a general lack of comparative performance data. In fact, for timberland investments made outside of the United States, benchmark indices and performance statistics are nonexistent. In preparing this paper, TIR Research worked around this limitation by using timber prices as a proxy for timberland returns.

Achieving diversification within a timberland portfolio is a multi-faceted and multi-dimensional exercise. Spreading investments across countries is not enough. By using timber prices as a return proxy, our work and analysis indicates that diversifying within a county –by end-use log product, by local market and by physiographic region – can provide an investor with the same level of risk reduction as diversifying investments by country (Table 1). In fact, after one adds timberland holdings in a third or fourth country, the overall risk-to-return contribution of adding another country to the portfolio is marginal. In certain cases, a more effective approach to achieving optimal diversification is to first ensure that one's portfolio contains investments that are characterized by different tree species, forest maturities, timber types and local wood markets.

Table 1. Summary results of the analysis that estimates the potential reduction of risk – as measured by the standard deviation of annual return – of a timberland portfolio when it is diversified across various means.

Diversification	Expected Risk Reduction for a Timberland Portfolio					
By Country	**1 Country**	**2 Countries**	**3 Countries**	**4 Countries**	**5 Countries**	**6 Countries**
	Baseline	8.9%	12.1%	13.3%	14.2%	15.7%
By Region	**1 Region**	**2 Regions**	**3 Regions**			
	Baseline	14.2%	19.6%			
By Timber Product	**Pulpwood Only**	**Large Log Focus**	**Small Log Focus**	**Balanced Products**		
	Baseline	8.6%	13.5%	13.6%		
By Micro-Market	**1 Sub-Market**	**2 Sub-Markets**	**3 Sub-Markets**	**4 Sub-Markets**	**5 Sub-Markets**	**6 Sub-Markets**
	Baseline	8.3%	10.5%	12.1%	12.8%	14.5%

Introduction

Diversification is among the core fundamental tenets of investing. This well-established approach to reducing investment risk applies not only across asset classes, but also within asset classes – and timberland is no exception.

Investors have long recognized timberland as a potential diversification tool within a broader investment portfolio. However, diversification within one's timberland portfolio is also necessary. Just as it is unwise to exclusively hold high-yield bonds in one's fixed income portfolio, or to focus solely on bio-tech venture capital in one's private equity portfolio, it is equally inadvisable to invest one's timberland allocation only in Latin American eucalyptus plantations.

Understanding the dynamics of diversification within a timberland portfolio can be challenging because credible background and literature on the subject is sparse. This is because for much of its history as an asset class, the timberland investment universe was very limited. In fact, most timberland investments made from the time of the asset class's inception in the mid-1980s until the mid-1990s were implemented in the United States. The first non-U.S. timberland investments made by sophisticated institutional investors were not initiated until 1992, when a small handful of U.S. pension funds began placing capital in New Zealand. Through the early 2000s, the universe of countries in which timberland investments were made was small and select – consisting of the United States, Canada, Uruguay, Brazil, Chile, New Zealand and Australia. Since then, placement of institutional capital in the timberland asset class has expanded rapidly beyond these six countries. Today, investors see timberland as an increasingly global asset class and are aggressively sourcing and analyzing opportunities around the world – including the boreal forests of Eastern Europe and the tropical forests of East Africa. In most cases, interest in these global opportunities is being driven by a desire to achieve additional diversification.

Despite the perception that cross-border activity improves the overall risk dynamics of a timberland portfolio, investors should not blindly pursue such diversification without properly weighing the benefits and costs. The goal of this paper is to provide insight on how to manage risk within a timberland investment portfolio by employing deliberate diversification strategies. We

begin by explaining the various ways effective diversification can be achieved and then follow with an analysis of how one can improve the risk-to-return fundamentals of one's timberland portfolio by carefully selecting the geographic regions in which one will hold land and the log markets in which one will participate. Finally, we will demonstrate that one's approach to diversification should have a quantitative, analytical basis that supports the overarching investment strategy.

Fundamentals of Timber Diversification

In investment parlance, *risk* is anything that can affect investment performance, but that cannot be predicted with full confidence. In that regard, there are a variety of risk factors that can affect timberland investment returns and these risk factors fall into three major categories:

1. Price or value of timber and land

2. Costs of forest operations and management

3. Biological growth and inventory

Diversification can help reduce or manage all three risk factors with the sole caveat being that the first – timber and land prices – is subject to systemic risk. As is the case with equities and fixed income investments, no amount of diversification can eliminate a timberland portfolio's systemic risk from the prevailing dynamics of timber markets and the wood products sector. Wood pulp is globally priced in U.S. dollars in the same fashion as crude oil and gold. Lumber is shipped across borders. The United States receives wood moldings from Chile, pulp from Brazil, framing lumber from Canada and furniture from China. As a result, the relative performance of the forest sector and timberland investments are closely tied to global economic activity spawned by the actions and behaviors of an intricate web of producers and consumers.

Given that land and timber prices are core drivers of timberland investment returns, it is important for investors to recognize that all timberland portfolios are subject to a measure of systemic risk regardless how scattered their forest holdings may be across the globe. Nevertheless, broad diversification can substantially control the volatility of timberland returns if it is planned and executed in a disciplined fashion.

Two Levels of Timberland Diversification

To effectively implement a strategy of diversification, investors or their timberland investment management organizations (TIMOs) must make decisions on two levels. First, at a "macro" level, they must determine what countries or major regions they will target. And second, at a "micro" level, they must identify the other dimensions of diversification that should be considered within a targeted country or geographic region. These "macro" and "micro" level diversification options are outlined below.

Macro-Level (Country and Regional) Diversification

The macro level decision is important because, although the forest sector is interconnected globally, there are still significant variations between countries. Each targeted country has its own set of (1) foreign exchange currency risks, (2) political, legal, and regulatory risks, (3) economic and demographic growth patterns; (4) general species composition and productivity characteristics; and (4) wood processing, manufacturing and export infrastructure.

Macro level diversification decisions are important because risks occur on the country level. For instance, Russia's implementation of major export tariffs on logs from €4.00/m^3 to €15.00/m^3 on April 1, 2008 has pushed up wood prices in China, resulting in Chinese manufacturers seeking to meet their growing appetite for wood from domestic and non-Russian sources. In another case, the earthquake that occurred in Chile in February of 2010 caused widespread infrastructure damage and the temporary shutdown of a large segment of that country's wood products industry. As would be expected, this had a decidedly negative impact on Chile's timber growers because it caused demand for wood products to become significantly constrained for several months.

Macro-level diversification does not necessarily stop at the country level. In some cases, a country may offer investment opportunities within its borders that are broad and varied enough to provide macro-level diversity. A prime example is the United States, where major timberland regions include (a) the hardwood forests of the Northeast, (b) the Southern pine forests of the Southeast, and (c) the boreal forests of the Pacific Northwest. When a country offers such geographic,

market, species and end-product diversity, macro-level risk management can take the form of cross-regional diversification.

Micro-Level (Property) Diversification

There are four dimensions of diversification that can be achieved at the "micro" or property level:

1. **Species**

   Each forest region offers a range of commercially valuable species in which to invest and each species has its own product and pricing profile. For instance, the leading species in the U.S. Pacific Northwest are Douglas Fir, Western Hemlock, True Fir and Ponderosa Pine. In Brazil, there are a variety of Eucalyptus species that are grown for commercial production, including *E. grandis*, *E. dunnii*, and *E. urograndis.* In addition, a variety of southern yellow pines species grow in Brazil. They include *Pinus taeda* (Loblolly pine) and *Pinus eliiottii* (Slash Pine). The more tree species a timberland portfolio has, the less its risk profile will be influenced by price volatility.

2. **Timber Products**

   Forests produce a variety of wood products for a multitude of end-uses. Large logs from mature trees can be processed into dimensional lumber, plywood or poles. Smaller logs can be used in the production of paper, board, and reconstituted wood panels. Logging residuals can sometimes be collected and sold as bio-energy feedstock. It is not uncommon for a particular region or "wood-basket" to produce end-use products in all three of these markets, as well as others. New Zealand's timber markets, for example, offer at least five export log grades and seven domestic log grade markets, each with their own pricing dynamics. Having the capacity to offer a range of wood products to different markets provides a timberland investor with the ability to archive broad income diversification.

3. **Age of Timber**

   Timber takes a number of years to reach economic maturity. When a stand of trees is ready to be harvested and sold, there is no guarantee that the market will be strong. Consequently, it can be very

advantageous for an investor to own timberland properties that are stocked with a broad spectrum of timber age classes. This gives the investor the flexibility and latitude to sell timber across a broader range of market conditions compared to timberland that is heavily concentrated in a given maturity of timber.

4. **Property Size and Distribution**

The size and distribution characteristics of a timberland investment can influence on investment risk in four ways:

BIOLOGICAL RISK. A portfolio that consists of smaller and/or widely dispersed timberland tracts normally has greater biological variation due to differences in climate, soil conditions and forest management.

CATASTROPHIC RISK. Property dispersion can help insulate a portfolio against catastrophic loss from major events, like severe weather, wildfire, disease, pest outbreaks, or theft.

LOCAL MARKET RISK. A portfolio of well distributed forest properties is positioned to bring more timber to a greater variety of local micro markets. Timber is a bulky product that is typically transported fewer than 100 miles (160 kilometers) from its source to the mill or manufacturing facility where it will be processed. A micro market is defined as a local cluster of nearby mills that serve as outlets for timber in a particular region. The larger and more diverse a portfolio's geographic footprint, the more micro market mill clusters it can access for purposes of merchandizing wood. Furthermore, the more mills to which a portfolio can sell wood, the less impact a mill curtailment or closure will have on its capacity to generate revenue.

LOCAL LAND MARKET RISK. A portfolio characterized by smaller and broadly distributed timberland also can benefit from broader exposure to different rural real estate markets. Land markets are highly impacted by demographics and competing land uses, including agriculture, conservation, recreation and development. As a result, a portfolio that has a diverse and expansive footprint of timberland assets may experience less

volatility because of land value fluctuations than might a portfolio whose holdings are concentrated in a single location.

Applying the Principles of Diversification

We have seen that there are two levels of diversification to consider when investing in timberland: macro/country level diversification and micro/property level diversification. Hence, there are two consecutive decisions associated with managing risk through diversification. This leads one to the issue of balance – how does one combine the two levels of diversification to create a portfolio that has an optimal risk and return profile? Given one's objectives, is it more important to focus one's diversification at the macro level (country or global allocation) or at the micro level (property selection)? The following next sections of this paper provide analysis of and insight into these questions.

Measuring the Benefits of Diversification

Quantitatively assessing the benefits of diversification as a risk reduction measure would ideally entail establishing benchmark indices for all countries or regions where timberland investments are made. Unfortunately, this objective is unachievable at present due to the lack of data. Currently, only one return index exists for institutional timberland investments – the National Council of Real Estate Investment Fiduciaries (NCREIF) Timberland Index, and it only tracks investments made in the United States.

Given the lack of global benchmarks, the next best option for assessing the impact of diversification is to use a proxy. An effective proxy is one where there is both a theoretical and empirical association between the proxy and the desired benchmark. It is also important that data for the proxy is available in all of the markets to be targeted for investment. With the aforementioned as context, the natural proxy benchmark for global timberland investment performance is timber prices.

Statistically Establishing Timber Prices as a Proxy for Return

The role of timber prices in calculating timberland investment performance has is well known and has been well documented since the mid-80s. Among others, supporting studies include Milliken & Cubbage (1985), Redmond & Cubbage (1988), Washburn (1990) and

NCREIF Timberland Index Returns for U.S. South Region Against Annual Timber Price Changes, 1987–2014

Figure 1.

NCREIF Timberland Index Returns for U.S. Northwest Region Against Annual Timber Price Changes, 1987–2014

Figure 2.

Zinkhan (1988). The natural association between timber prices and timber return applies to both the income and appreciation components of timberland returns. Income from timberland relies heavily on harvest revenue, which is a function of timber prices. Capital theory dictates that the value of an asset is the net present value (NPV) of future expected cash flows. In the case of a timberland asset, future timber prices will have a direct bearing on many of those future cash flows. Insomuch as current prices help shape a market's expectations of future prices, capital gains – like income – are also subject to spot pricing dynamics.

One way to establish the effectiveness of a return proxy is to determine if timber prices have, through time, tracked timberland returns. A simple chart of timber price changes against timberland returns (Figure 1) suggests such a relationship exists. The year-over-year changes between the NCREIF Timberland Index's numbers for the U.S. Southeast shows a 65 percent statistical correlation with a timber price index consisting of a 25/30/45 weighted blend of the three leading Southern pine log products: pulpwood, chip-n-saw and sawtimber. The strong relationships also hold for the U.S. West. The annual rates of return reflected in the NCREIF Timberland Index's Pacific Northwest component reflects a 58 percent statistical correlation with log prices consisting of a 55/15/15/15 blend of Douglas Fir, Hemlock, True Firs and Ponderosa pine. Both correlations are tested to be statistically significant on the 99 percent level (Figure 2).

Translating Timber Prices into Timberland Investment Performance

For this analysis, TIR took an empirical approach that relied on the observed statistical relationship between timber prices and timberland returns. For a detailed explanation of why this method was chosen over a more theoretical or engineered approach, please refer to the section of the Appendix entitled: "Two Methods to Generate Timberland Returns from Other Variables."

Methodology in Assessing Macro Level Diversification by Country

Measuring the benefits of diversification across countries begins with an understanding of how timber prices relate to timberland returns. In other words, we require a formula to convert the proxy (i.e., timber prices) to

investment performance. A regression analysis of the NCREIF Timberland Index against U.S. timber prices can be used to create that formula – assuming that the relationship between timber markets and timberland return in offshore markets behaves in a similar fashion to the U.S.

Price series were collected from 1999 through 2014 and represent a total of nine regions: Austria/Germany, Brazil, Canada, Chile, Finland, Japan, New Zealand, Sweden, and the United States.

By knowing the statistical correlation and standard deviations of prices between the nine regions, one can estimate the overall price volatility (i.e., standard deviation) of a timberland portfolio constructed of properties located in any of those nine regions. Using Monte Carlo simulation to select different regions, TIR measured the average price volatility of a portfolio that was composed of a single (1) region, two (2) regions, three (3) regions, and so forth up to a highly diversified portfolio that included timberland in all nine (9) regions. Naturally, one would assume that the more countries in which a portfolio has exposure, the less price risk it would have.

This portfolio-level estimate of price volatility can be converted into an estimate of return volatility (i.e., investment risk). To accomplish this, TIR relied on the regression equation that was calculated earlier and combined it with the Monte Carlo simulation. This analysis makes it possible to establish how much a portfolio's risk level is reduced as it becomes more geographically diversified with the addition of new countries.

An in-depth description on how the macro-level diversification analysis was performed can be found in the Appendix.

Methodology in Assessing Macro Level Diversification by Region

As was referenced earlier in this paper, a few select countries, such as the United States, offer investors an opportunity to achieve considerable regional diversification if the regions in which they hold forestland exhibit separate and distinct market dynamics and biological performance characteristics. Fortunately, the NCREIF Timberland Index – along with U.S. wide coverage – does separate investment returns in the

United State into three regions: the U.S. South, the U.S. Northeast, and the U.S. Pacific Northwest.

Given the coverage of the NCREIF Timberland Index (1994-2014), we can skip the use of a timber price proxy. Like the country-level analysis, TIR used Monte Carlo simulations to create sample portfolios made up of investments in the South, the Northeast and the Pacific Northwest. TIR then estimated what kind of risk an investor might expect if there was (1) no diversification (all of the investments were concentrated in just one region); (2) diversification across two regions: and (3) diversification across all three regions.

Methodology in Assessing Micro Level Diversification

The same methods used to assess macro or country-level diversification also were used to test micro (property-level) diversification. As was discussed earlier in this paper, there are many ways to diversify on a micro level. TIR chose two for analysis: (1) diversification across various log products; and, (2) diversification across sub-markets within a given country.

For log products, TIR focused on the U.S. South with its three primary softwood log products: the *pine sawlog* grade, meaning logs 12 inches or greater in diameter; the *pine chip-n-saw* grade meaning logs between 8 and 12 inches in diameter; and the *pine pulpwood* grade consisting of logs 8 inches or smaller in diameter. The impact of product diversification on risk is calculated based on the overall mix of log products a timber portfolio may have.

In the case of diversification across sub-markets in a given region, TIR chose the U.S. South. Historic timber prices are available in the region across 22 defined micro-markets, which cover 11 states in the Southeast. One region, western Tennessee, was omitted, however, due to data limitations, which culled the data set down to 21 sub-markets. Otherwise, we employed the same methods to assess diversification across sub-markets as was employed for the macro/country-level.

Results of the Analysis

Average Reductions in Risk for a Timberland Portfolio through Country Diversification

Baseline = 1 Country

2 Countries: 8.9%
3 Countries: 12.1%
4 Countries: 13.3%
5 Countries: 14.2%
6 Countries: 15.7%
7 Countries: 15.8%
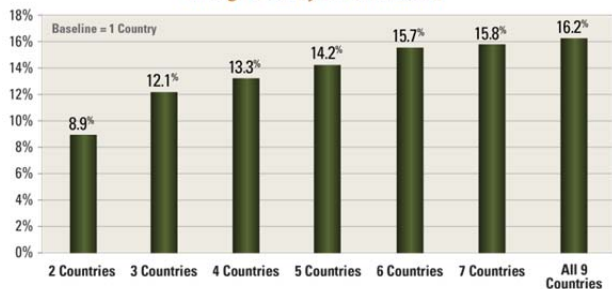All 9 Countries: 16.2%

Figure 3. Average reductions in risk, as measured by standard deviation of annual investment return, for a timberland portfolio that is diversified beyond a single country. In this example, capital is evenly distributed across all countries represented in the portfolio.

Table 2. The impact of risk on a timberland portfolio concentrated in the United States, as measured by the standard deviation of annual returns, when investments are diversified evenly across 1, 2 or 3 regions. The regions represented are the South, the Northeast and the Pacific Northwest.

Regions Represented in Portfolio	Average Risk (Std. Dev.)	Redution in Risk from Diversification
1 Region	8.83%	
2 Regions	7.58%	14.2%
3 Regions	7.10%	19.6%

Average Reductions in Risk for a Timberland Portfolio through Multi-Region Diversification

Baseline = 1 Country
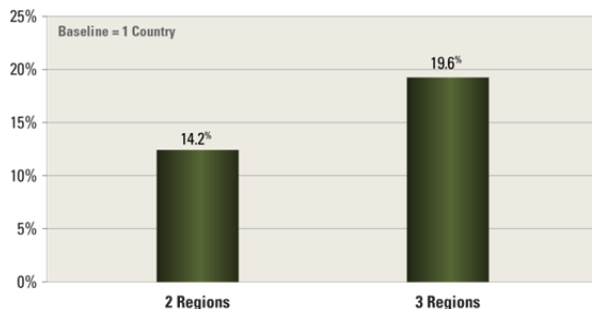
2 Regions: 14.2%
3 Regions: 19.6%

Figure 4. Average reductions in risk, as measured by standard deviation of annual investment return for a timberland portfolio in the United States that is diversified beyond a single region. Three U.S. regions available for investment are the South, the Northeast and the Pacific Northwest. Performance is based on historic NCREIF Timberland Index regional returns from 1994 through 2014. 1994 is the earliest year in which all three regions had performance numbers in the Index.

Because TIR was translating the proxy of price risk into investment risk in the process of conducting this assessment, it was not a simple matter to calculate the precise risk level of a timberland portfolio. Nevertheless, useful observations can be made about the relative increases or decreases in risk when measured against a chosen baseline.

Measuring the Benefits of Diversification on a Macro / Country Level

The results of TIR's analysis suggest that diversifying on a macro level could offer significant benefits, which are demonstrated in Figure 3. The risk level can drop, on average, by 9 percent simply by adding a second country to a timberland portfolio. The benefits, however, are rapidly marginalized after the fourth or fifth country is added to the portfolio. A fully global timberland investment program should experience, on average, roughly one-quarter less volatility than one that is concentrated in a single country. Investors, however, do not need to go to such extremes because exposure in three or four countries provides most of the diversification benefits needed create a risk-managed global portfolio.

Measuring the Benefits of Diversification on a Macro / Regional Level

As explained earlier, macro level diversification can also extend into a given country if its timber markets are broad and varied enough. This approach applies to countries with large, diverse timberland investment areas like the United States, Canada, Brazil, China and Russia. For purposes of this analysis, TIR focused on quantifying the benefits of pursuing diversification in the United States. Since such an analysis does not require a regression analysis with a timber price proxy, direct estimates of the portfolio risk can be made and the results are shown in Table 2 and illustrated in Figure 4.

As is observed in the table and figure above, diversification beyond a single region can reduce portfolio risk by about 14 percent. Again, it is important to emphasize that the United States is one of a few countries capable of providing these benefits because its timber and timberland markets are broad and varied enough to have macro level diversification attributes. However, TIR's analysis of the U.S. market

Average Reductions in Risk for a Timberland Portfolio through Sub-Market Diversification in the U.S. South
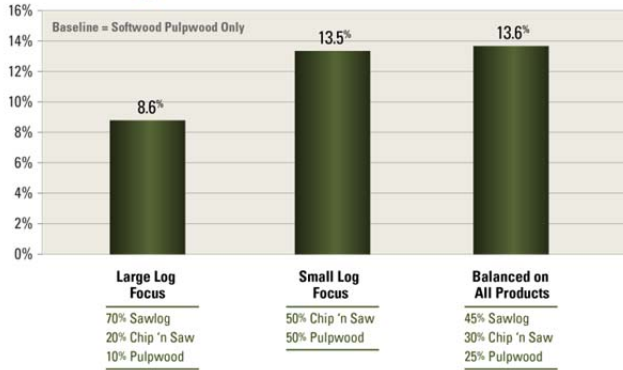
Figure 5. Average reductions in risk, as measured by standard deviation of annual investment return for a timberland portfolio in the U.S. South that is diversified beyond the pine pulpwood log product (logs 8 inches or smaller in diameter). The pine chip-n-saw log grade consists of 8 and 12 inches in diameter. Pine sawlogs are logs 12 inches or larger in diameter.

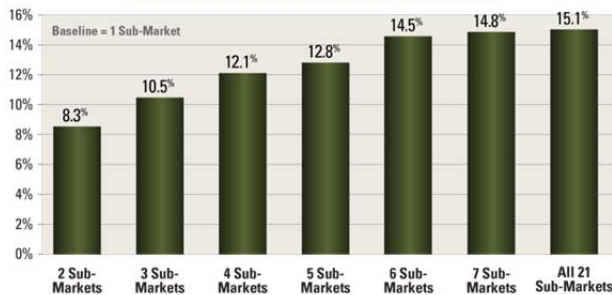Average Reductions in Risk for a Timberland Portfolio through Sub-Market Diversification in the U.S. South

Figure 6. Average reductions in risk, as measured by standard deviation of annual investment return, for a timberland portfolio in the U.S. South that is diversified beyond a single sub-market. There are 22 total sub-markets in the U.S. South as classified by the timber price reporting service, *Timber Mart-South*. All but one – western Tennessee – were included in the analysis.

demonstrates that in those countries that have multiple investment regions and diverse markets, the potential to reduce risk can be significant, and potentially on par with the benefits associated with country-level diversification.

Measuring the Benefits of Diversification on a Micro / Property Level

In the case of micro level diversification, the benefits can be comparable with those generated by macro-level diversification. In the case of diversifying by log-products, having a balance of different timber products in a timberland investment portfolio, rather than focusing on producing a single log product for a particular market also may reduce the annual volatility of a portfolio's returns by close to 14 percent (see Figure 5).

As was outlined earlier, another way to diversify on a micro-level is to spread the footprint of one's timberland investments in a country or region across a broad swath of semi-independent sub-markets. As Figure 5 demonstrates, broadening the regional coverage beyond a single sub-market could significantly cut risk levels by an average by 15 percent. The marginal gains drop appreciably, though, after the fourth sub-market is added to the portfolio. As with macro level country diversification, micro level sub-market diversification eventually reaches a point of diminishing benefits with regard to reducing systemic risk after a fourth or fifth investment region is added to a portfolio.

In interpreting these results, one should recognize that TIR's analysis was based on one specific region: the U.S. South. The degree of which the analysis' conclusions can be applied to other global regions depends, in large part, upon how analogous a particular timberland market's behavior is with the U.S. South. While associations will vary across countries, TIR believes the U.S. South is a good indicator as to the general magnitude of risk reduction available from micro level diversification.

Conclusions and Recommendations

The results of the analyses profiles in this paper suggest that achieving diversification within a timberland investment portfolio in not a one-dimensional exercise. Investors should not select a global allocation and consider their work done. At the very least, micro-level risks – such as species, age, product types, and distribution patterns – should be given equal consideration.

Striking a Balance and Understanding Tradeoffs

When building a timberland portfolio, investors should weigh the benefits and drawbacks of adding diversification between countries and regions (macro diversification) and within a region (micro diversification). For instance, one may think one's portfolio is well diversified because it includes timberland holdings across New Zealand and Chile. However, if these investments in are all stocked with Radiata Pine as the primary species, then one may not have achieved cross country diversification because both New Zealand and Chile are heavily dependent upon the Asian Radiata export market.

The factor that must be weighed when considering approaches to timberland diversification is the tradeoff between risk and cost. There are economies of scale in forestry. Small properties, especially in emerging markets where support services and infrastructure may be limited, can have very high fixed costs. This means investors must achieve a critical ownership and operating mass to be cost competitive. Consequently, the benefits of global diversification may be largely offset by the higher costs associated with achieving it. When capital is limited, an investor may be better advised to concentrate on a few select countries or regions and to work at achieving micro level diversification within them, rather than attempting to spread one's investments across a multitude of regions and markets in the pursuit of a perceived higher level of diversification.

In addition, it is important to recognize that many global timberland markets are thin. They lack the depth, the deal flow, and the inventories of attractive, investment-grade properties to facilitate one's efforts to achieve an ideal level of global diversification. When global opportunities are limited, investors should consider focusing their efforts on achieving diversification within more easily accessible markets – and specifically those

that have depth, complexity and strong investment fundamentals.

Weighting Macro and Micro Level Diversification on a Holistic Level

In considering the balance required between macro and micro level diversification, it is important to remember that one's ability to implement micro-level diversification varies by country or region. Some regions have significant levels of heterogeneity. North America is a case in point. It provides several dozen commercially viable hardwood and softwood species, along with a varied network of mills that produce a wide range of wood products – from lumber and building panels to paper products and furniture. Some countries, by comparison, are largely homogenous. In Uruguay, for instance, 70 percent of the country's intensively managed plantations are stocked with *Eucalyptus* and almost all of its wood products are designed for export and sale to a limited number of major forest product companies.

The key to achieving success with a diversification strategy is to employ a holistic approach. As was demonstrated in TIR's earlier analysis, timberland can be achieved across numerous dimensions. What separates a proactive investor from a passive investor is that the former understands that timberland investment risks cannot be handled simply by a country or regional allocation. It is multivariate and complex undertaking.

When building a portfolio, an investor should consider how each addition or removal of a forest asset will alter its overall risk profile. That means understanding (1) the sources of one's cash flow; (2) the maturity structure of the timber one owns over the investment horizon; (3) the local land market dynamics that affect one's timber and land merchandizing options; and (4) the biological growth variability of the tree species one holds. How these considerations integrate with each other requires careful consideration.

Summary and Application

To conclude, a single-minded focus on one type of diversification can be self-defeating if the other components and dimensions of one's timberland portfolio are all alike. In TIR's analysis, which utilizes timber prices as a surrogate for investment return, expanding a timberland portfolio across more than four

countries produces minimal risk reduction benefit. The gains top out at around a one-quarter risk reduction regardless of how many countries are represented in a portfolio. This is likely due to the systemic market risk resident in the global forest products sector. In contrast, the same level of risk reduction can be achieved by diversifying within a country, provided its markets are deep and diverse enough. Risk can be lowered by roughly 20 percent consecutively by carefully acquiring forest assets that (a) produce a broad range of timber products, (b) have a large footprint covering many local markets, and (c) are characterized by different physiographic regions that exhibit a spectrum of species, management types and biological growth characteristics. When these three are combined together, a portfolio of well diversified forests assets within a single country could product risk reduction benefits that match or exceed those generated by investing across multiple countries. An investor should consider these tradeoffs when building a balanced timberland portfolio that is designed to meet his or her tolerance for volatility.

Appendix

Two Methods to Generate Timberland Returns from Other Variables

There are two ways to use timber prices to derive timberland return: one is an engineered approach; the other is the empirical approach. For the engineered method, a mathematical model is constructed based on theory that translates timber prices into investment performance. This engineered model – in the form of a series of mathematical formulas – requires assumptions from the modeler over a wide variety of variables affecting timberland investment, among them: (1) the biology of the forest, (2) the forest management regime in place, (3) the cost structure, (3) and, the mechanism employed to decide how forest owners adjust their economic behaviors to changing prices. The downside of the engineered approach is that it assumes the chosen model is a fitting representation of the timberland market as a whole. In contrast, the empirical approach simply relies on the statistical association between prices and timber. How prices work in affecting investment return is not considered in the empirical approach – the process is a black box. The limitation with empirical modeling is that there is a greater range of uncertainty as compared to the engineered model and it may not be useful in testing new scenarios outside of historical norms.

Previous research that relied on timber prices and other observable variables as a proxy for return has typically relied on the engineered approach. They included Redmond and Cubbage (1988), Washburn and Binkley (1990, 1993), Conroy and Miles (1989) and Mills (1988). For this paper, TIR relied on the empirical method. TIR avoided the engineered approach due to the large differences between countries. Each timberland investment region requires its own unique engineered model to convert regional prices into return. Assuming a whole country or region relies on that singular engineered model to project timberland returns is unlikely to be any more accurate than utilizing the empirical approach.

Methodology of Modeling Macro/Country Level Diversification

Here are the steps used in this paper to measure the effect country diversification may have on a timberland investment portfolio.

1. **Perform a Regression of Timberland Returns Against Timber Prices.** A regression analysis can be performed between the NCREIF Timberland Index Southeast (dependent variable) and annual changes in pine timber prices (independent variable). This allows one to estimate timberland returns with a given confidence interval based on timber prices.

2. **Get Correlations of Timber Prices Between Countries.** Standard deviations and statistical correlations were calculated between the year-over-year changes in timber prices representing nine different countries or regions: Austria/Germany, Brazil, Canada, Chile, Finland, Japan, New Zealand, Sweden, and the United States. The price series covered the period between 1999 and 2014. Knowing the standard deviation and correlation values for each country is important for understanding the standard deviation of a portfolio of different countries.

3. **Record the Standard Deviation of Portfolios of Different Countries.** After an iterative model is developed, one can randomly select a portfolio of a given number of countries from the available set of nine. The resulting standard deviation of timber prices for the chosen portfolio can then be calculated and recorded. In the case of TIR"s work, a high sample run of 5,000 iterations was used to calculate the average variability of timberland portfolios composed of as few as one country and as many as seven countries. All countries are equally weighted. The purpose of this exercise was

to observe how total price volatility falls as a portfolio becomes more and more diversified.

4. **Convert Timber Price Variability to Timberland Investment Return Variability.** The timber price variability for the portfolio can be extrapolated to an estimation of the potential range (i.e., confidence interval) of timberland investment returns, based on the regression analysis in Step #1. The process was performed with Monte Carlo simulation. While the calculated variability is likely an overestimation of the true variability of a timberland portfolio, the relative differences between portfolios are meaningful and can provide insight on the impact of return-to-return performance of diversification.

For Additional Information

Further information and details on the calculations, data and models used in this paper are available upon request.

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