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SOURCES OF RISK IN TIMBERLAND RETURNS

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Risk assessment in timberland investment

- Risk assessment in forest economics literature broadly divided into two groups:
  (1) assessment of biophysical or natural hazard risks; and
  (2) economic aspects of risk analysis

- Traditional focus on natural hazards, but data for managed timberland are poor—HTRG example. Often losses do not include value of salvage; prices likely lower if damage is widespread.

Timberland Loss from Biophysical Risks, 1990-2010 (%/year)

	Fire	Storm	Insects
US South	-.02%	-.08%	-.01%
US West	-.01%	0	0
US Northeast	0	-.03%	0
Australia	-.81%	-.10%	-.01%

Source: Hancock Timber Resource Group Research.

- Here we evaluate sources of risk using a framework that integrates biophysical and economic risks.

Outline

i. Background: risk assessment in timberland investment

ii. A real estate model of timberland investment

iii. Assessing timberland investment risk

- Historic returns
- Base case simulations
- A climate change scenario

iv. Concluding remarks

Assessing timberland risks

- Consider a “real estate” model of timberland asset value (vs. Faustmann (1849), Comolli (1981) or DCF model for an actual property—details likely do matter)

- Asset value equals the capitalized value of timber revenues:

$$AV = \frac{p * g}{r} \qquad \text{[Eq. 1]}$$

where AV = asset value
p = stumpage price
g = sustainable growth rate
r = discount rate

Assessing timberland risks

Timberland return (TR) equals the percentage change in asset value plus cash flow expressed as a percentage of opening period asset value (NCREIF).

$$TR_t = \left(\frac{AV_t - AV_{t-1}}{AV_{t-1}}\right) + \frac{p_t \cdot h_t}{AV_{t-1}}$$

$$TR_t = \left(\frac{p_t * g_t * r_{t-1}}{p_{t-1} * g_{t-1} * r_t} - 1\right) + \frac{p_t * g_t * r_{t-1}}{p_{t-1} * g_{t-1}} \qquad \text{[Eq. 2]}$$

where $h(t)$ = harvest level
assume sustainable harvest so that $h_t = g_t$

Note the role of timber **growth**

- Changes, not levels, affect timberland returns
- Likely uncorrelated with prices and discount rate—a structural opportunity for portfolio diversification

Assessing timberland risks

A Simulation Approach

1) Observe historical volatility of factors in [Eq. 2]
    - Price
    - Discount rate
    - Growth

   and fit "appropriate" distributions (e.g., Binkley, Washburn and Aronow, 2001; Mei, Clutter and Harris, 2013).

2) Conduct Monte Carlo simulations of equation [Eq. 2] based on:
    - Fitted distributions of annual change in price, growth, and discount rate
    - Anticipated structural change – climate change

Historical and simulated data

Timber price

- Southern pine stumpage ($/ton)
- Historical data 1987-2009 (Timber-Mart South)
- Stumpage prices follow a random walk with positive drift

$$p_t = p_{t-1} + x_t + c, \quad x_t \sim N(0, \sigma^2)$$

with upper and lower bound on p_t at historical levels

Discount rate

- Annual yield on 10-year constant-maturity Treasuries
- Historical data 1987-2009 (US Federal Reserve System)
- Discount rate follows a random walk with negative drift

$$r_t = r_{t-1} + y_t - k, \quad y_t \sim N(0, \sigma^2)$$

with upper and lower bound on r_t at historical levels

Historical and simulated data

Timber growth

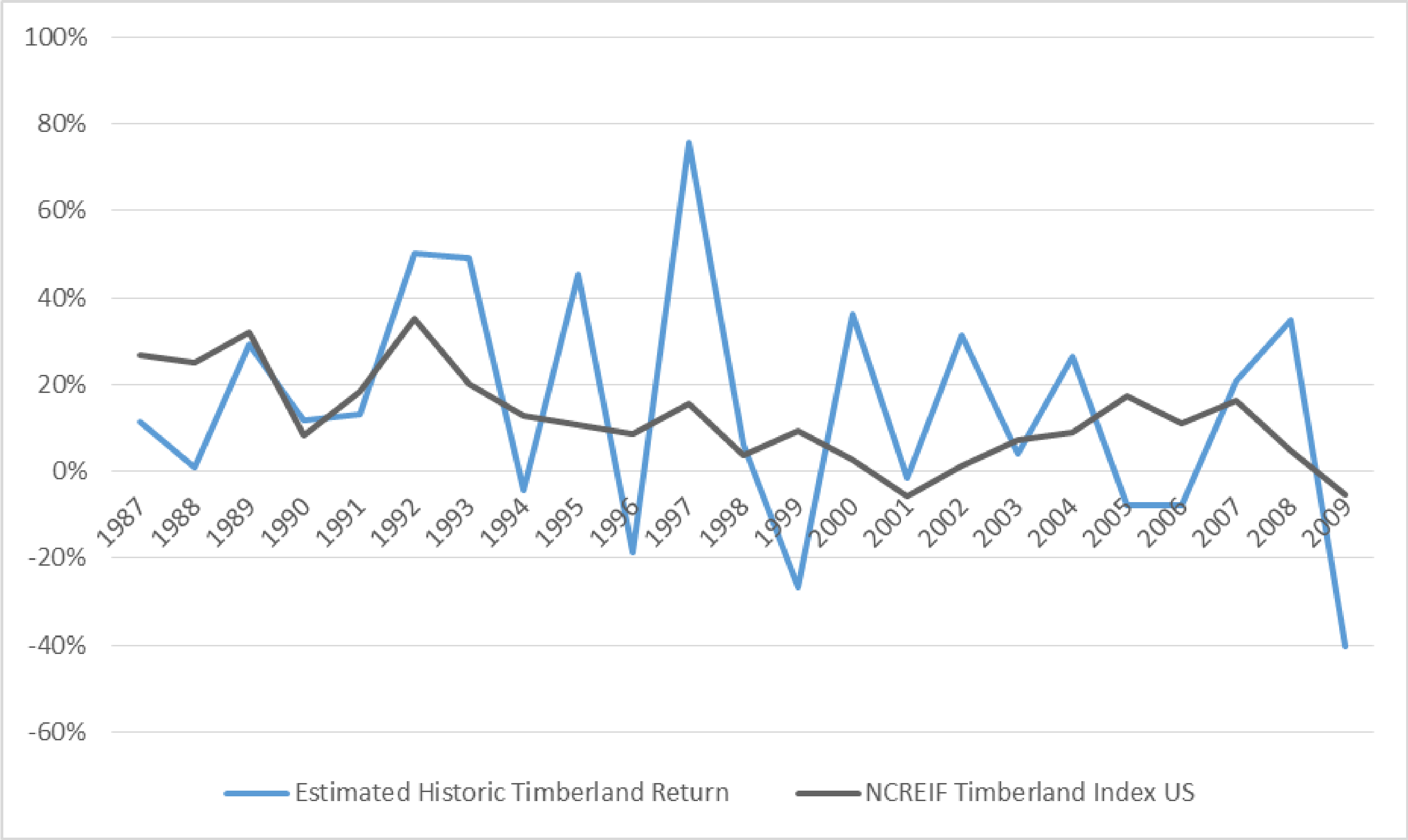
- Employ 3PG, a stand-growth model that is based on physiological processes with weather data as an input (Landsberg and Waring, 1997; Landsberg and Sands, 2010).
- Use historical weather data 1987-2009 at Jefferson, OR study site to generate historical annual growth (Hart/AFRI, 2013).
- For simulations, annual growth $g_t \sim N(\mu, \sigma^2)$ with parameters estimated from 3PG output.

Timber growth with climate change

- Use 3PG to generate annual growth based on predicted weather through 2060 under the UN IPCC A1B, A2, and B1 scenarios (Hart/AFRI, 2013).
- Adjust timber growth parameters based on 3PG outputs from climate change scenarios (μ increases 16.7%; double σ).

Results

NCREIF and estimated historic timberland returns (1987-2009)



Results

Scenario	Stochastic Variables	Mean Return	Standard Deviation of Returns	Risk-adjusted Return (Sharpe Ratio)
NCREIF US (1987-2009)	None	.1234	.1062	.9735
Estimated Historic (1987-2009)	None	.1433	.2482	.4967
Base Case (1987-2009)	p,g,r	.1637	.2506	.5734
Climate Change	p,Δg,r	.1754	.3033	.5124

Data are presented for illustrative purpose only and do not necessarily reflect the performance of investment entities managed by GreenWood Resources, Inc.

Results

Scenario	Source of Volatility	Mean Return	Standard Deviation of Returns
Base Case (1987-2009)	TOTAL	.1637	.2506
	Price constant	.1203	.1729
	Discount rate constant	.1057	.1969
	Growth constant	.1579	.2193
Climate Change	TOTAL	.1754	.3033
	Price constant	.1317	.2369
	Discount rate constant	.1169	.2545
	Growth constant	.1577	.2186

Data are presented for illustrative purpose only and do not necessarily reflect the performance of investment entities managed by GreenWood Resources, Inc.

Concluding Remarks

- Modern risk assessment tools can readily be applied to understand the risks from timberland investments, but some problems remain.

- Compared to the base case the climate change scenario produces higher mean returns from increased growth, but lower risk-adjusted returns due to increased volatility.

- Historically, volatility in economic parameters appears to outweigh biophysical risks—uncertainty in growth rates—with some exceptions. Climate change may alter this general conclusion.

- Correlation between stochastic variables assumed to be zero—in particular changes in growth assumed to be uncorrelated with changes in price. Possible next step.

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