Assessing Risk and Asset Prominence within a Portfolio of Timberland Investments

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We Employ Portfolio Optimization & Simulation Techniques To:

- Explore the prominence, or persistence of U.S. South timberland regions within a portfolio, as a function of:
  - portfolio risk,
  - security allocation constraints
- Estimate the value at risk (VAR) of a timberland portfolio utilizing Monte Carlo simulation.
  - Value at risk (VAR) is a measure of the financial risk of an investment over some specified period of time.
Analysis Framework: The Portfolio Security-Selection Decision

- Several analyses have identified the role that timberland can play in a diversified portfolio of investments.
  - The Asset-Allocation Decision
  - Utilize modern portfolio theory (MPT), developed by Markowitz.

- Once a decision is made to invest in timberland, what is the next step?
  - The Security-Selection Decision
  - Identify timberland with specific attributes consistent with those of the asset class in general, and that best fit the investor’s objectives.
  - Can we use MPT to help us here?
Analyze Timberland Regions Using Portfolio Theory

- Focus on the US South
- We would like to have historical return data for the universe of timberland investments in the South – impossible!
- NCREIF return data for the South is all we’ve got (aside from individual fund data).
- We need time series of return data at a finer level of resolution.
  - Can we synthesize this?
  - At what level?
Requirements For A Synthetic Timberland Return

- A timberland return model
- Data for the model components at an appropriate geographic level of interest, and with a significant history. Such as:
  - timber prices
  - consumption levels
  - etc.
John Hancock Timberland Index (JHTI) (HTRG 2003)

- Calculates a quarterly, composite pine stumpage price, based upon published prices:
  \[ P_t = 0.5 \times ppwd \$ + 0.5 \times pst \$ \]

- Develops a quarterly return series, reflecting income and capital appreciation components:
  \[ Return_t = [(Net \text{ Income}_t + Capital \text{ Value}_t)/Capital \text{ Value}_{t-1}] - 1 \]

- Net Income = \( P_t \times \text{Income Rate} \)

- Capital Value = \( (8P_t + 7P_{t-1} + 6P_{t-2} + 5P_{t-3} + 4P_{t-4} + 3P_{t-5} + 2P_{t-6} + P_{t-7})/36 \)
A Good Start, But We Would Like To Have:

- Finer geographic resolution:
  - TMS divides the US South into 22 areas.
  - [TMS Map](#)

- Finer product resolution:
  - Pine chip-n-saw should be included. TMS has this.

- Region-specific product harvest weights for developing a region-specific composite stumpage price:
  - $P_t = W_1 * \text{ppwd $} + W_2 * \text{cns $} + W_3 * \text{pst $}$
  - Not so easy.
Region-Specific Product Harvest Data

- USFS Timber Product Output (TPO) data
  - Surveys mills to determine usage by product.
  - Matches this consumption to USFS Forest Inventory and Analysis (FIA) origination data.

- The result is volume harvested by:
  - Species Group,
  - Product,
  - County,
  - Ownership class – we are most interested in the Forest Industry class.

- With a catch…
A Helpful Workaround

- Legalities prevent the USFS from publishing forest ownership data at the county level.
- A special request to the USFS resulted in us getting Forest Industry data at the TMS area level, without the FS having to reveal county-level ownership data.
- A big THANKS to Tony Johnson at the Southern Research Station!
Almost There

- USFS TPO data includes pine pulpwood and sawtimber harvest data – not pine chip-n-saw.
- We needed a way to apportion the sawtimber removals to cns and pst for the 22 TMS areas.
- Utilized the Southern Forest Products Association Mill Survey…
- …with a special request
- ..And another big thanks!
Almost There

- **Net Income** = \( P_t \times \text{Income Rate} \),
  - where *Income Rate* represents ratio of Income to Capital Value
  - Adjust *Income Rate* to minimize sum of squared differences between annual returns of synthetic & NCREIF South series.

- **Capital Value:**
  - Use 12 previous qtrs. composite stumpage prices, rather than 8.
Comparing Our South-wide, Synthetic Return Series to NCREIF

Annual Southwide Returns

Correlation

0.710  -  19 years
0.936  -  9 years
## Historic Annual Returns of our Synthetic Regional Series (1987-2005)

<table>
<thead>
<tr>
<th>TMS Area</th>
<th>AL</th>
<th>ARK</th>
<th>FLA</th>
<th>GA</th>
<th>LA</th>
<th>MS</th>
<th>NC</th>
<th>SC</th>
<th>TN</th>
<th>TX</th>
<th>VA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Avg. Ret.</td>
<td>10.8</td>
<td>11.2</td>
<td>9.4</td>
<td>8.9</td>
<td>11.5</td>
<td>13.0</td>
<td>10.4</td>
<td>8.5</td>
<td>13.3</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>8.0</td>
<td>10.4</td>
<td>8.6</td>
<td>10.7</td>
<td>8.0</td>
<td>11.2</td>
<td>9.6</td>
<td>7.5</td>
<td>13.8</td>
<td>10.2</td>
</tr>
<tr>
<td>2</td>
<td>Avg. Ret.</td>
<td>10.4</td>
<td>7.0</td>
<td>8.3</td>
<td>8.0</td>
<td>11.5</td>
<td>11.8</td>
<td>10.5</td>
<td>8.9</td>
<td>12.4</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>9.4</td>
<td>18.0</td>
<td>9.1</td>
<td>7.7</td>
<td>9.7</td>
<td>9.7</td>
<td>4.8</td>
<td>6.6</td>
<td>13.9</td>
<td>11.7</td>
</tr>
</tbody>
</table>
Efficient Frontier – No Constraints

![Graph showing the Efficient Frontier with no constraints, illustrating the trade-off between portfolio risk and expected return. The graph displays a curve that moves upward and to the right, indicating increasing returns with higher risk.](image-url)
Efficient Frontier – No Constraints
Efficient Frontiers: With Constraints

Portfolio Expected Return vs Portfolio Risk

- Pink line: All Areas
- Blue line: IP - 1 mil
- Yellow line: IP - 2 mil
- Light blue line: IP - 3 mil

Portfolio Risk:
- 0%
- 1%
- 2%
- 3%
- 4%
- 5%
- 6%
- 7%
- 8%
- 9%
- 10%
- 11%
- 12%
- 13%
- 14%
- 15%
- 16%
1 mil acre excursion
2 mil acre excursion

![Graph showing regional portfolio allocation and portfolio expected return against desired portfolio risk. The graph includes lines for AL1, AL2, AR1, FL1, FL2, GA2, LA1, MS1, MS2, NC2, SC2, TN1, TN2, TX2, and VA2, with Portfolio Expected Return and Regional Portfolio Allocation on the y-axis and Desired Portfolio Risk on the x-axis.]

18
3 mil acre excursion

Regional Portfolio Allocation vs. Desired Portfolio Risk

- AL1
- AL2
- AR1
- FL1
- FL2
- GA2
- LA1
- MS1
- MS2
- NC2
- SC2
- TN1
- TN2
- TX2
- VA2

Portfolio Expected Return
## Asset Selections:
1 mil acre Excursion

<table>
<thead>
<tr>
<th>Asset</th>
<th>Maximum Allowable Allocation</th>
<th>Optimal Allocation</th>
<th>Asset Prominence</th>
<th>Constrained Allocations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL 1</td>
<td>51%</td>
<td>1.1%</td>
<td>0.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>AL 2</td>
<td>51%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>AR 1</td>
<td>59%</td>
<td>0.0%</td>
<td>19.4%</td>
<td>34.5%</td>
</tr>
<tr>
<td>FL 1</td>
<td>5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>FL 2</td>
<td>3%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>GA 2</td>
<td>44%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>LA 1</td>
<td>62%</td>
<td>28.4%</td>
<td>22.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>MS 1</td>
<td>12%</td>
<td>0.0%</td>
<td>10.8%</td>
<td>96.6%</td>
</tr>
<tr>
<td>MS 2</td>
<td>20%</td>
<td>5.2%</td>
<td>10.9%</td>
<td>41.7%</td>
</tr>
<tr>
<td>NC 2</td>
<td>47%</td>
<td>47.0%</td>
<td>15.7%</td>
<td>20.6%</td>
</tr>
<tr>
<td>SC 2</td>
<td>34%</td>
<td>0.0%</td>
<td>0.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>TN 1</td>
<td>13%</td>
<td>8.4%</td>
<td>11.1%</td>
<td>78.0%</td>
</tr>
<tr>
<td>TN 2</td>
<td>4%</td>
<td>0.0%</td>
<td>2.6%</td>
<td>87.8%</td>
</tr>
<tr>
<td>TX 2</td>
<td>52%</td>
<td>0.0%</td>
<td>4.8%</td>
<td>7.7%</td>
</tr>
<tr>
<td>VA 2</td>
<td>9%</td>
<td>9.5%</td>
<td>1.4%</td>
<td>50.0%</td>
</tr>
</tbody>
</table>
Value at risk (VAR) is a method of measuring the financial risk of a portfolio over some specified period of time.

VAR estimates the maximum reasonable loss that could be expected.
- ‘reasonable’ is usually defined as the portfolio value at the 5% probability level of a distribution of possible returns.

If a normal distribution of returns is assumed, the 5% VAR will equal the expected portfolio value - 1.645 * std. dev. of expected return.

We can use Monte Carlo simulation to estimate the distribution of returns for a timberland portfolio after each year of a 10 year horizon.
- With this distribution, we will know the 5% VAR, or worst-case scenario.
## Value At Risk (VAR)

### Expected Portfolio Value Over Time

<table>
<thead>
<tr>
<th>Investment Year</th>
<th>Mean</th>
<th>Std Dev</th>
<th>5% VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$891,255,260</td>
<td>$46,195,151</td>
<td>$827,947,840</td>
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<tr>
<td>2</td>
<td>$992,828,990</td>
<td>$71,463,959</td>
<td>$887,470,784</td>
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<tr>
<td>3</td>
<td>$1,106,013,102</td>
<td>$99,973,715</td>
<td>$963,367,616</td>
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<tr>
<td>4</td>
<td>$1,232,321,540</td>
<td>$31,713,289</td>
<td>$1,042,946,304</td>
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<tr>
<td>5</td>
<td>$1,372,921,782</td>
<td>$163,123,876</td>
<td>$1,131,435,136</td>
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<tr>
<td>6</td>
<td>$1,529,656,267</td>
<td>$200,875,865</td>
<td>$1,244,753,536</td>
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<tr>
<td>7</td>
<td>$1,703,956,519</td>
<td>$239,462,905</td>
<td>$1,380,284,800</td>
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<tr>
<td>8</td>
<td>$1,899,486,588</td>
<td>$296,818,518</td>
<td>$1,490,860,288</td>
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<tr>
<td>9</td>
<td>$2,116,522,319</td>
<td>$350,543,612</td>
<td>$1,633,660,672</td>
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<tr>
<td>10</td>
<td>$2,357,176,537</td>
<td>$405,656,102</td>
<td>$1,792,319,360</td>
</tr>
</tbody>
</table>
Conclusion

- Analyzing sub-regional asset return series within a portfolio optimization context, and utilizing Monte Carlo simulation for a longer term perspective, can assist in the construction of optimal timberland investment portfolios, and help to characterize risk levels through time.
- Neither of these techniques should be used to dictate investment strategies.
- There are many facets of a potential timberland investment that cannot be sufficiently quantified or qualified to allow comprehensive, automated analysis and subsequent recommendations.
Timber Mart-South Areas

http://www.tmart-south.com/tmart/