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The role of U.S. timberland assets in a mixed portfolio under the Mean-CVaR Framework

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Outline

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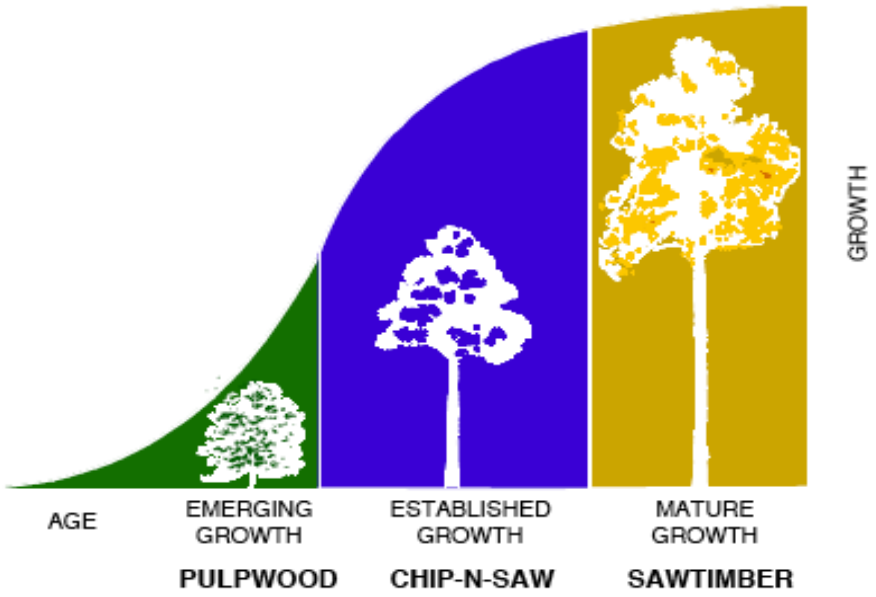
Introduction

BACKGROUND

Timberland assets have several unique features:

- Biological growth
- Land value appreciation
- High risk-adjusted returns
- Hedge against inflation
- Portfolio diversification



Timberland asset as an alternative investment is competitive compared with other assets such as stocks and bonds.

Literature Review

Mills and Hoover (1982):

- Introduced the mean-variance (M-V) approach
- Found that forest investment could provide a diversification benefit

Zinkhan et al. (1992) & Caulfield (1998):

- Demonstrated that adding timberland assets to a portfolio could improve the portfolio performance
- Provided asset allocation suggestions for institutional investors

Newell and Eves (2009):

- Analyzed the risk-adjusted performance in real estate portfolios
- Concluded that the timberland was a strongly performed asset

The mean-variance optimization approach is widely used to examine the relationship between returns and risks in forest investment.

Mean-Variance Optimization

Functions:

- Optimize portfolios
- Generate efficient frontiers
- Formulate asset allocation strategies

Mean-Variance:

- Mean is the expected value of portfolio return
- Variance (Std. Dev.) proxies for the portfolio risk

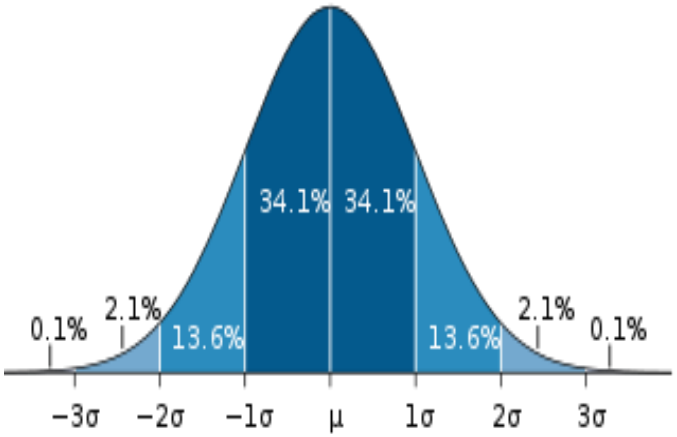
Key assumptions:

- Investors are rational and risk averse
- Asset returns are assumed multivariate normally distributed

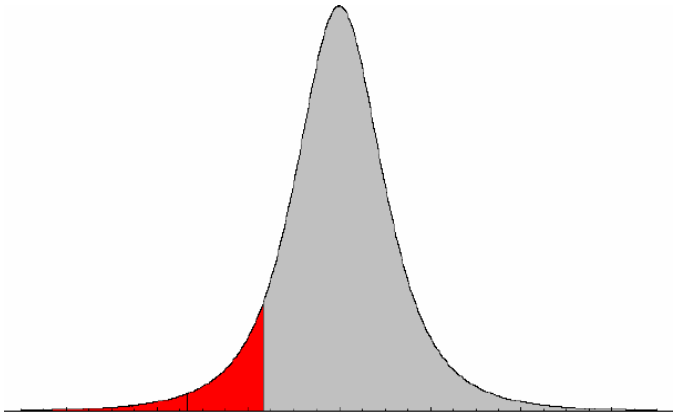
The mean-variance optimization approach uses standard deviation to measure risk and assumes a multivariate normal distribution.

Motivation I: Risk Measure

Standard Deviation



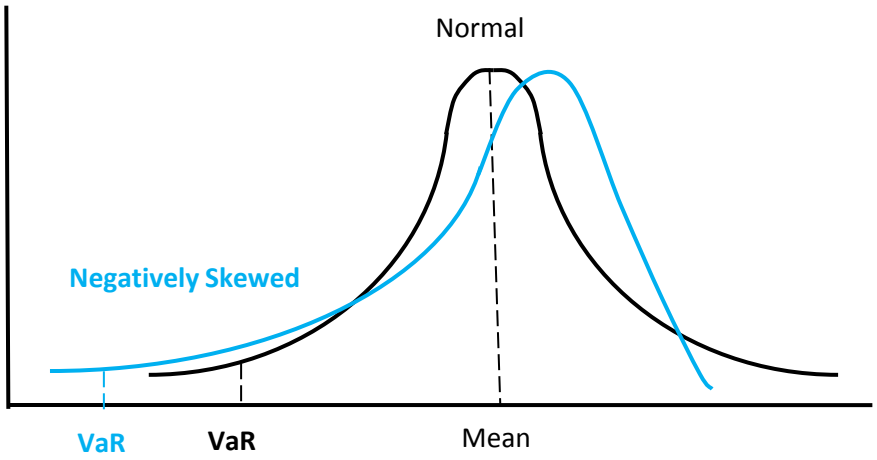
Downside Risk

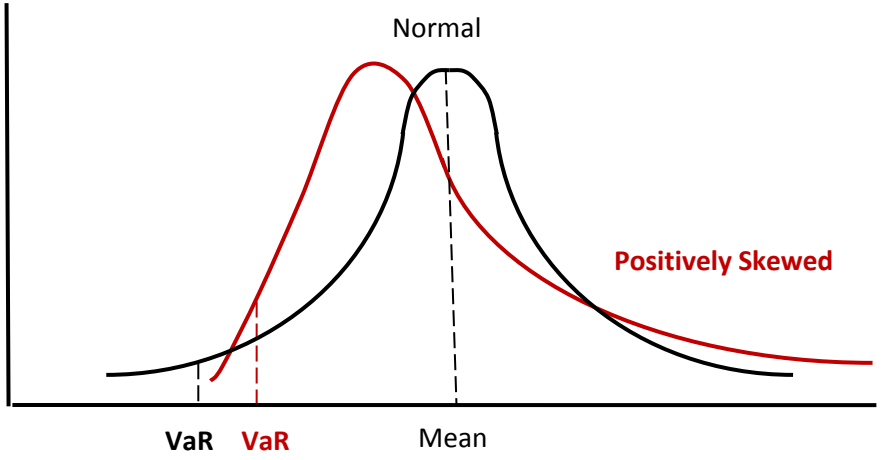


Q: What do investors care about in reality: variation or downside risk?
A: Downside risks such as potential loss and negative returns.

Motivation II: Non-normality

Skewness

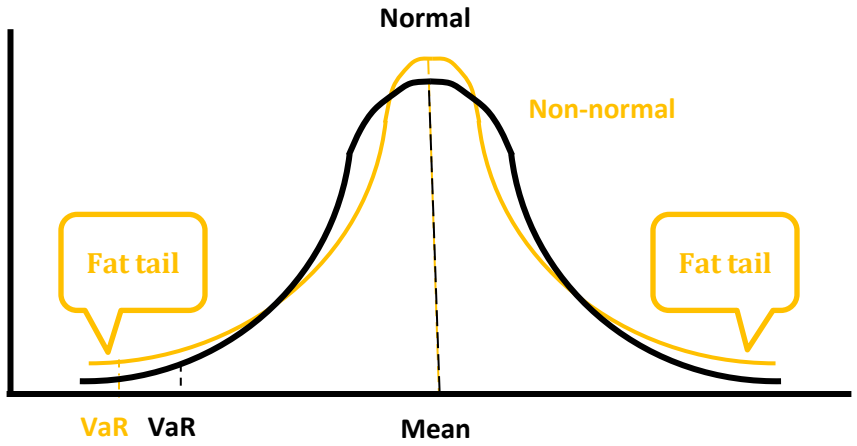




The negatively skewed returns underestimate the VaR, whereas the positively skewed returns overestimate the VaR.

Motivation II: Non-normality

Kurtosis



The VaR of asset returns with fat tails is underestimated.
The skewness and kurtosis should be considered in downside risk measures.

Literature Review Cont.

Caulfield and Meldahl (1994):

- Used the semivariance to measure downside risk of portfolios with timberland assets
- Generated more efficient frontiers by semivariance analysis

Petrasek (2011 SOFEW):

- Discussed the non-normal timberland returns using both univariate and multivariate analysis
- Provided the evidence of non-normality in the NCREIF Timberland Index

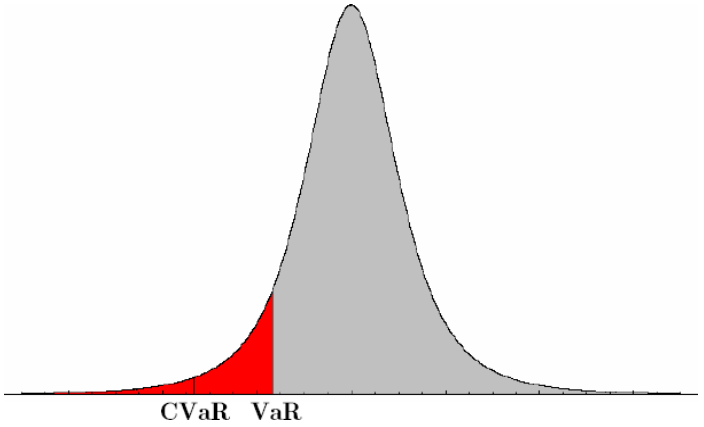
In the financial industry, portfolio managers started paying attention to the downside risk and non-normality in the past decade.

Methodology

SOLUTION: MEAN-CVAR APPROACH

VaR: “How bad can things get?”

CVaR: “If things do get bad, how much is the portfolio expected to lose? ”



Definition: CVaR is the conditional expectation of losses exceeding VaR at a confidence level α.

Formula: $CVaR_{\alpha}(w,r) = -E[R(w,r) \mid R(w,r) \le -VaR_{\alpha}(w,r)]$

The mean-CVaR optimization approach considers the portfolio downside risk and addresses the non-normal distribution issue.

MEAN-CVAR CONT.

The M-CVaR approach does not assume a multivariate normal distribution

$$Min \;\; CVaR_{\alpha}(w, r)$$

$$s.t. \;\; w^T \bar{r} = u \;\; and \;\; \sum_{i=1}^{n} w_i = 1$$

$$\ldots\ldots$$

Where

w is the asset weight

r is the asset return

The M-CVaR approach is to minimize the downside risk CVaR with a given level of return u, subject to the asset allocation constraints.

Risk Decomposition

Risk Contribution:

$$D_i CVaR_\alpha(w,r) = w_i \frac{\partial CVaR_\alpha(w,r)}{\partial w_i}$$

Euler's Theorem: $\sum_{i=1}^{n} D_i CVaR_\alpha(w,r) = 1$

Criteria:

$$D_i CVaR > w_i \Rightarrow \text{Intensifier}$$

$$D_i CVaR < w_i \Rightarrow \text{Diversifier}$$

The risk decomposition can help us identify the sources of portfolio risk and examine the role of individual assets in a mixed portfolio.

DATA & SCENARIOS

Data	Large-cap	Small-cap	T-Bonds	T-Bills	Timberland
Returns	S&P 500	Russell 2000	Gov/Credit	3-month	Timberland
Source	CRSP	Russell	Barclays	CRSP	NCREIF
Time period	1987Q1 – 2011Q4				

Constraints on Individual Assets

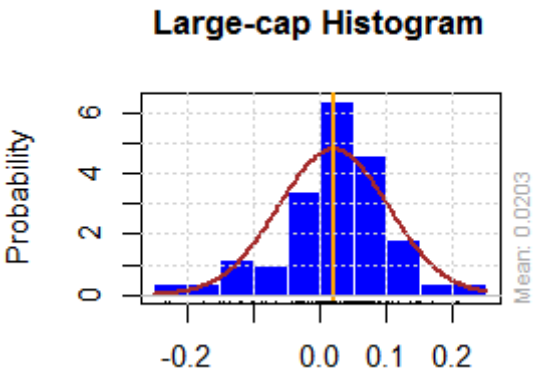
Scenario	Large-cap	Small-cap	T-Bonds	T-Bills	Timberland
Scenario 1	> 20%	> 15%	> 10%	> 5%	—
Scenario 2	> 20%	> 15%	> 10%	> 5%	< 10%

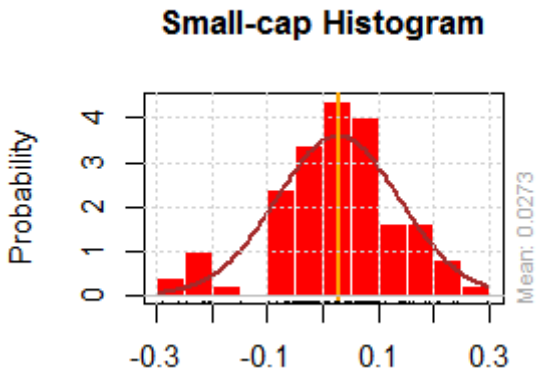
To better understand the role of timberland assets in the mixed portfolio, two different scenarios are proposed in this study.

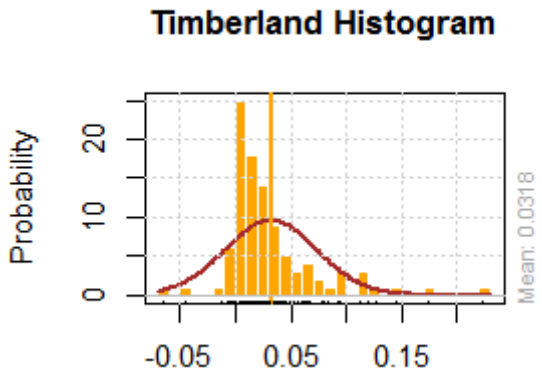
Descriptive Statistics (1987-2011)

Empirical Results

Statistics\Asset	Large-cap	Small-cap	T-Bonds	T-Bills	Timberland
Observation	100	100	100	100	100
Mean	0.020	0.027	0.018	0.010	0.032
Std. Dev.	0.083	0.111	0.024	0.006	0.042
Skewness	-0.609	-0.452	0.081	-0.124	1.797
Excess Kurtosis	0.789	0.565	-0.700	-0.882	4.810
Jarque-Bera Test	0.009	0.074	0.389	0.202	0.000
Shapiro-Wilk Multivariate Normality Test					0.000

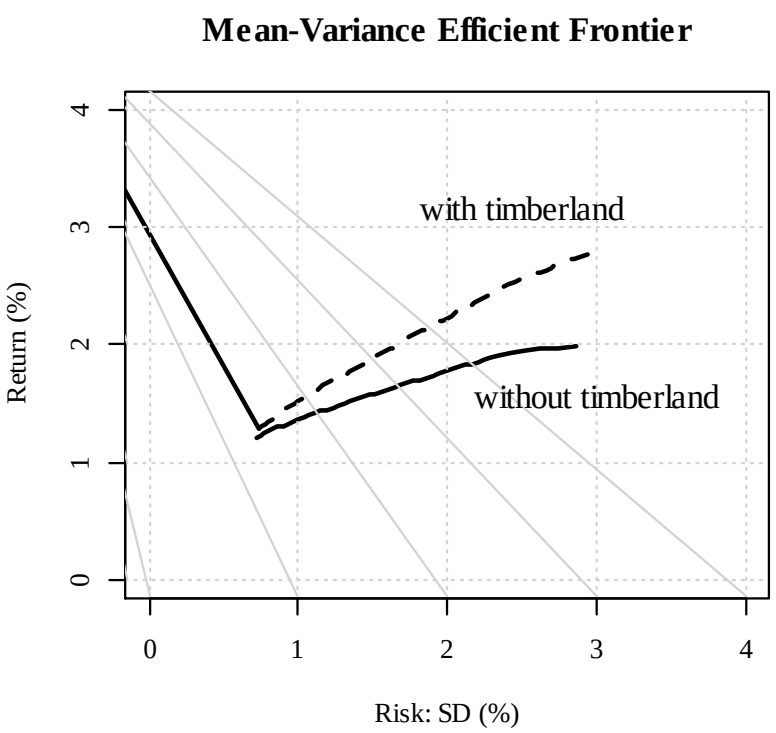


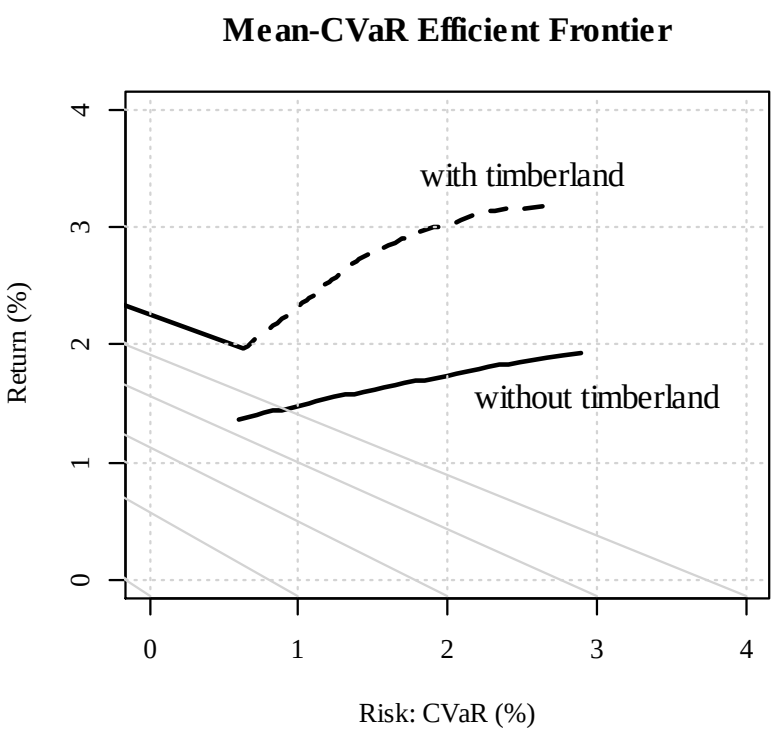




Comparison of Efficient Frontiers

Empirical Results

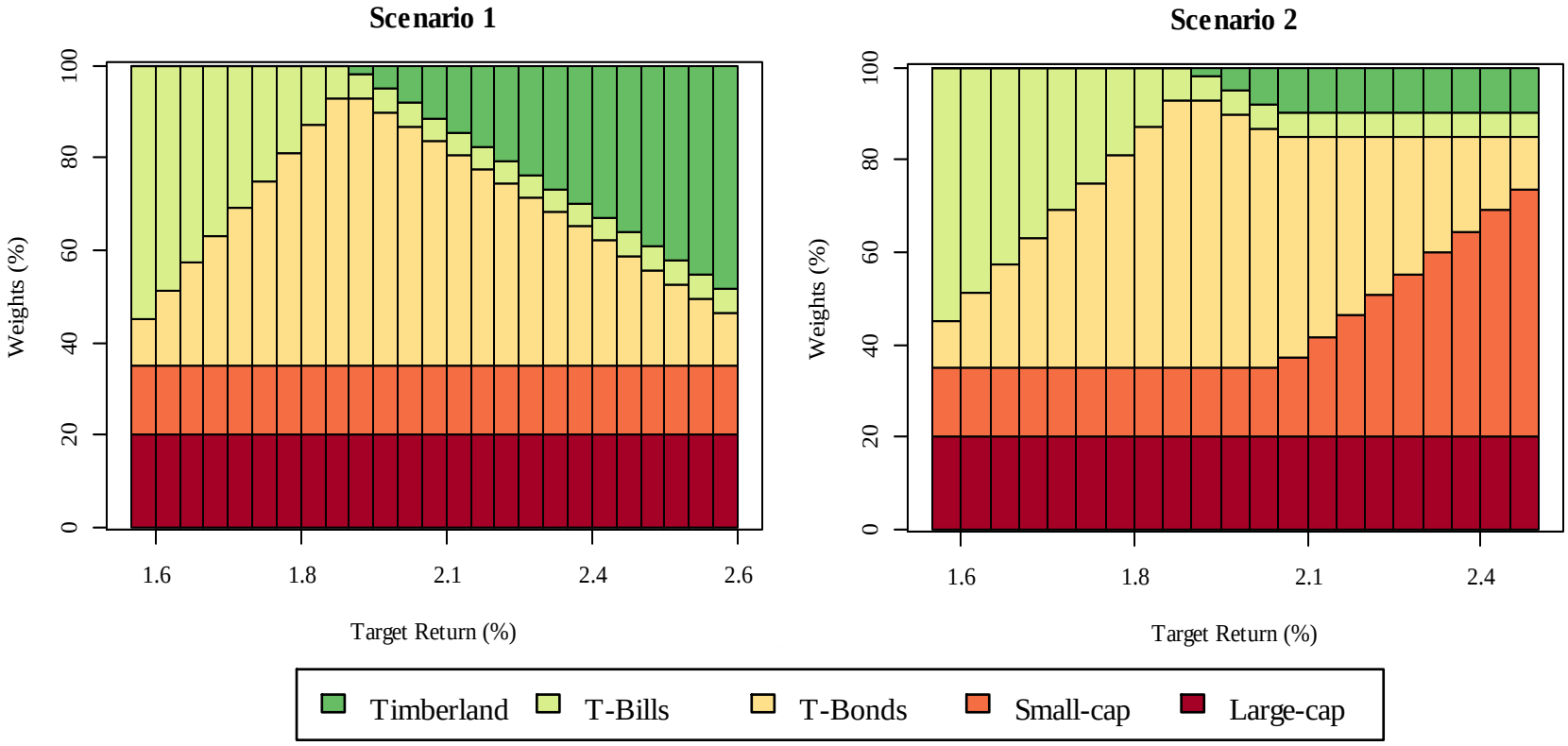




The M-CVaR efficient frontier is dramatically improved after adding timberland assets in comparison of the M-V efficient frontier.

Static Asset Allocations

Empirical Results



The weights on Large-cap and Small-cap stocks are strictly constrained , and the weights on timberland assets increase as investors require higher level returns.

Static Risk Decomposition

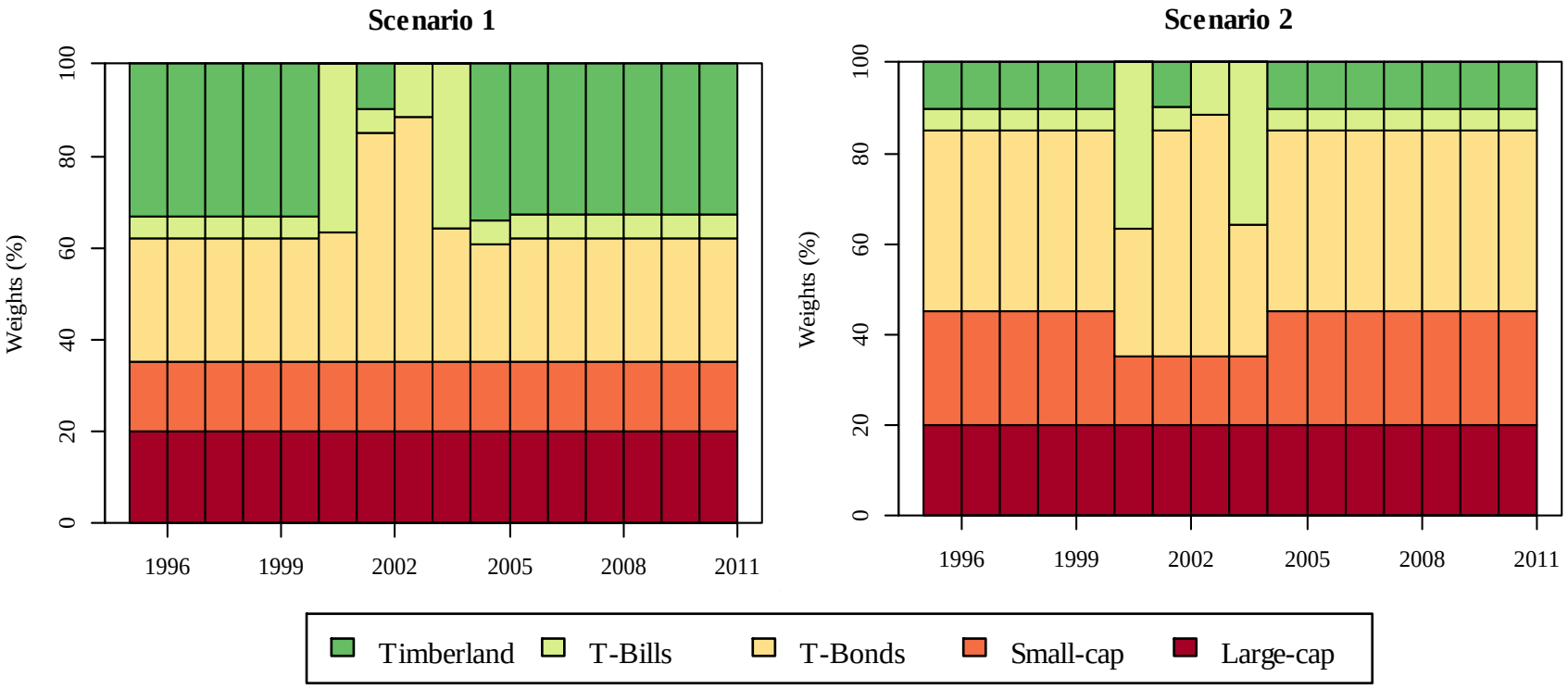
Empirical Results

Target Return	1.6%		2.0%		2.4%	
Asset	Weight	DCVaR	Weight	DCVaR	Weight	DCVaR
Large-cap	20.0	60.7	20.0	65.4	20.0	24.7
Small-cap	15.0	58.5	15.0	63.7	49.2	82.9
T-Bonds	15.0	-11.4	55.1	-26.0	15.8	-5.0
T-Bills	50.0	-7.8	5.0	-1.0	5.0	-0.4
Timberland	0.0	0.0	4.9	-2.1	10.0	-2.2
Sum	**100**	**100**	**100**	**100**	**100**	**100**

Both Large-cap and Small-cap stocks are risk intensifiers, whereas T-Bonds, T-Bills, and timberland assets are risk diversifiers.

Dynamic Asset Allocations

Empirical Results



Timberland assets maintain a significant and persistent allocation over a 10-year rolling portfolio optimization.

Conclusions

- The choice of the risk measure is an important decision for portfolio management.
  - The standard deviation may not fully reflect investors' concern.
  - The downside risk measures such as CVaR may help construct portfolios that better suit investors risk preference.

- The M-CVaR efficient frontier is dramatically improved by adding timberland assets.
  - This method does not assume a multivariate normal distribution.
  - This approach captures the asymmetry and fat tail properties of asset returns.

CONCLUSIONS

Conclusions

- Timberland assets maintain a significant allocation over both static and dynamic optimizations.
  - It was affected around 2001 – 2003, which is probably due to the weak performance of the NCREIF Timberland Index over that period of time.

- Both Large-cap and Small-cap stocks are risk intensifiers, whereas T-Bonds, T-Bills, and timberland assets are risk diversifiers.

- The methodology and findings provide a practical implication for investors with different risk preferences and investment purposes.

THANK YOU!
QUESTIONS?