

# Tax-Cognizant Portfolio Analysis: *A Methodology for Maximizing After-Tax Wealth*

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# Tax-Aware Investing

## *Current Practices*

- Preliminary Adjustment of Asset Allocation Inputs
- Post-Optimization Application of Asset Location Heuristics

**A 2008 survey of CFA Institute members showed that while most investment managers preferred to place taxable bonds in tax-deferred retirement accounts, more than a quarter of those surveyed preferred to place taxable bonds in taxable accounts.<sup>1</sup>**

<sup>1</sup>Horan, S.M., and Adler, D. "Tax Aware Investment Management Practice."  
*The Journal of Wealth Management*. Fall 2009: pp. 71-88.

# Taxes and Portfolio Analysis

## *Taxation Dynamics and Illiquidities*

Taxation is a dynamic process dependent upon:

- Tax rates
- Account characteristics
- Sequence of returns
- Timing of taxation events
  - Asset management/investing decisions
  - Wealth consumption decisions

# Taxes and Portfolio Analysis

## *Wealth and Risk*

- **Wealth:**

*The cumulative value of after-tax cash flows that an investment can provide over an investor's lifetime based on specific investing and consumption decisions.*

- **Risk:**

*Not achieving the appropriate amount of wealth.*

# Tax-Cognizant Portfolio Analysis (TCPA)

## *Overview*

- Seeks to maximize the present value of after-tax cash flows
- Simulation of after-tax cash flows provided by investments
- Provides a comprehensive approach to tax-cognizant investing
  - Asset allocation
  - Asset location
  - Consumption guidance

# Deriving Tax-Cognizant Inputs

## *Simulating After-Tax Cash Flows*

- Investor Lifecycle Model
  - Accumulation period
  - Consumption period
- Consumption Model
- Taxation Model

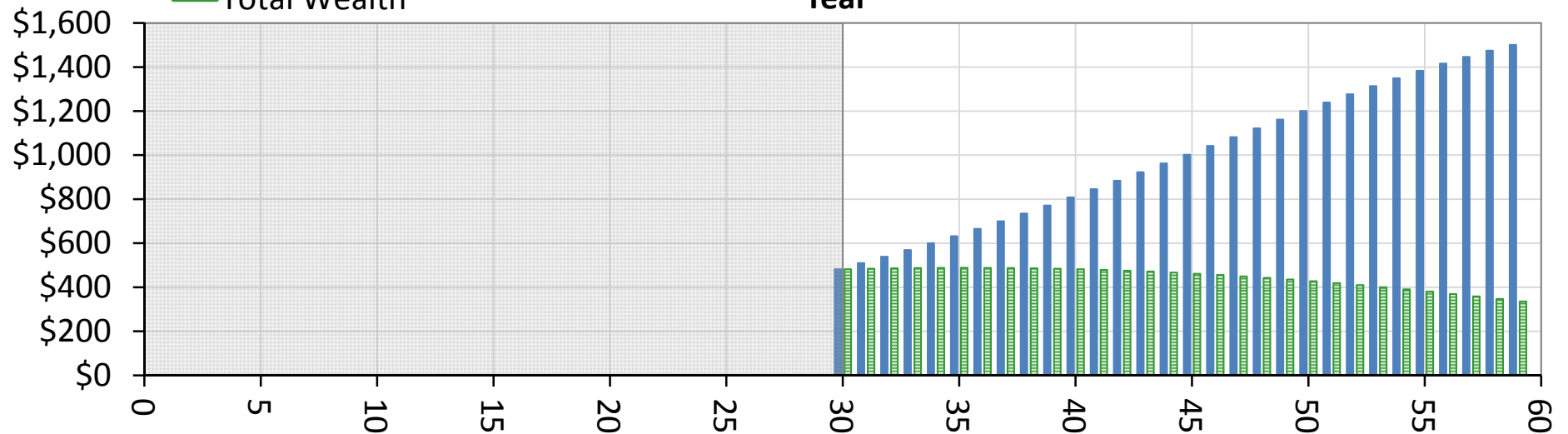
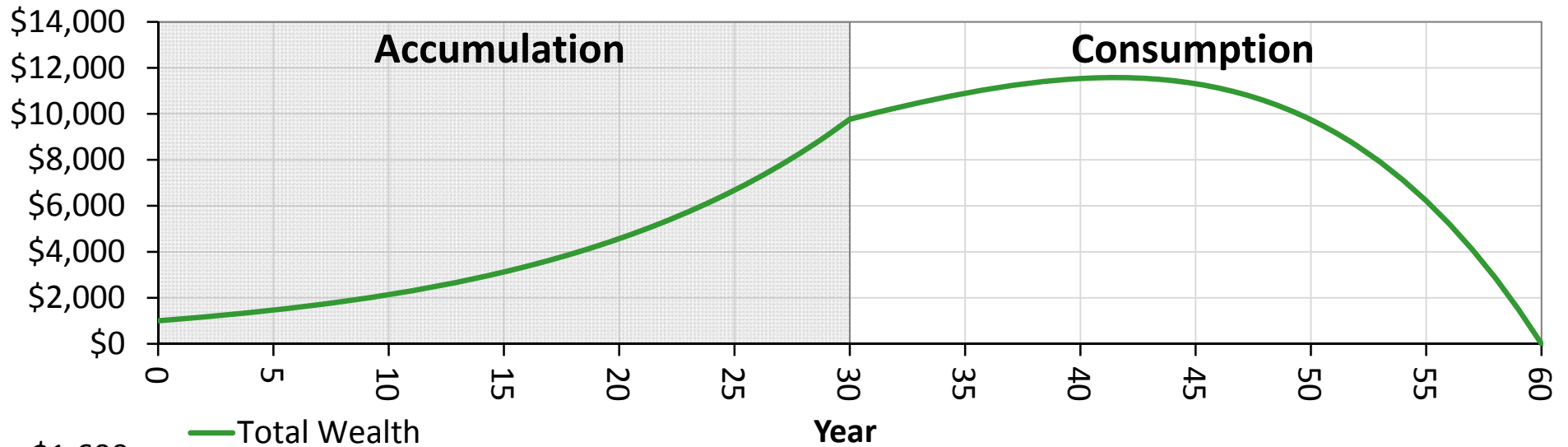
# Deriving Tax-Cognizant Inputs

## *Specifications*

- Standard tax-exempted inputs (*Simulation parameters*)
- Account types
- Investment horizon
  - Example: 30 years Accumulation / 30 years Consumption*
- Asset class/investment return characteristics
  - % Income (*Additional simulation parameters*)
  - % Capital appreciation
  - Turnover (*Short-term and Long-term*)
- Expected tax rates (*Accumulation and Consumption*)
- Discount rate (*rate of intertemporal substitution*)

# Deriving Tax-Cognizant Inputs

## *Investor Lifecycle Model*



■ After-Tax Cash Flow

■ Present Value of Cash Flow at Retirement

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# Deriving Tax-Cognizant Inputs

## *Wealth Consumption Model*

- Modified fractional consumption

$$\text{Total Wealth} \times \frac{1}{n_c} \times cmf$$

*$n_c$  = Years remaining in consumption*

*cmf = consumption modification factor*

- Modification necessary to achieve Required Minimum Distributions in consumption
- Alternative consumption methods can be used but implications should be carefully considered

# Deriving Tax-Cognizant Inputs

## *Blay-Markowitz Taxation Model*

A general model of investment taxation

- Income - I
- Short-term turnover -  $TO_S$
- Long-term turnover -  $TO_L$
- Capital loss carry forward - L

$$W_T = W_A + W_U$$

$W_T$  = Total Wealth

$W_A$  = After-tax Wealth

$W_U$  = Untaxed Wealth

# Deriving Tax-Cognizant Inputs

## *Simulation of Present Values*

### Asset Classes

**Fixed Income - FI**

**Municipal Fixed Income - MFI**

**Large Company Equities - LC**

**Small Company Equities - SC**

**Developed Market Equities - DM**

**Emerging Market Equities - EM**

**Real Estate - RE**

**Commodities - C**

Inputs must include simulations for each asset class held in every account type

### Asset Class

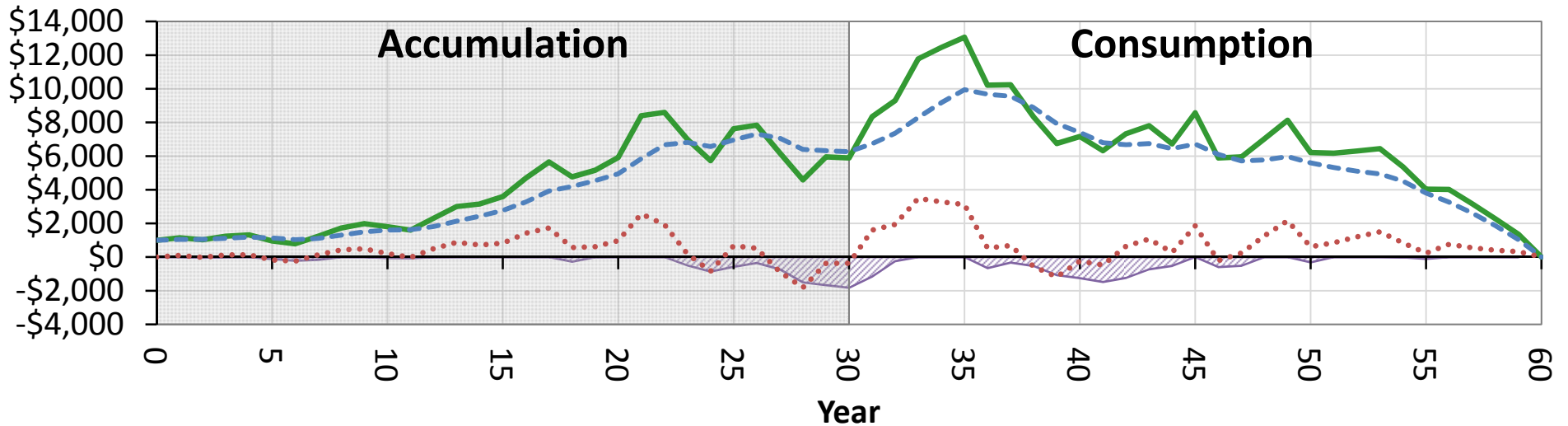
Taxable

Tax-Deferred

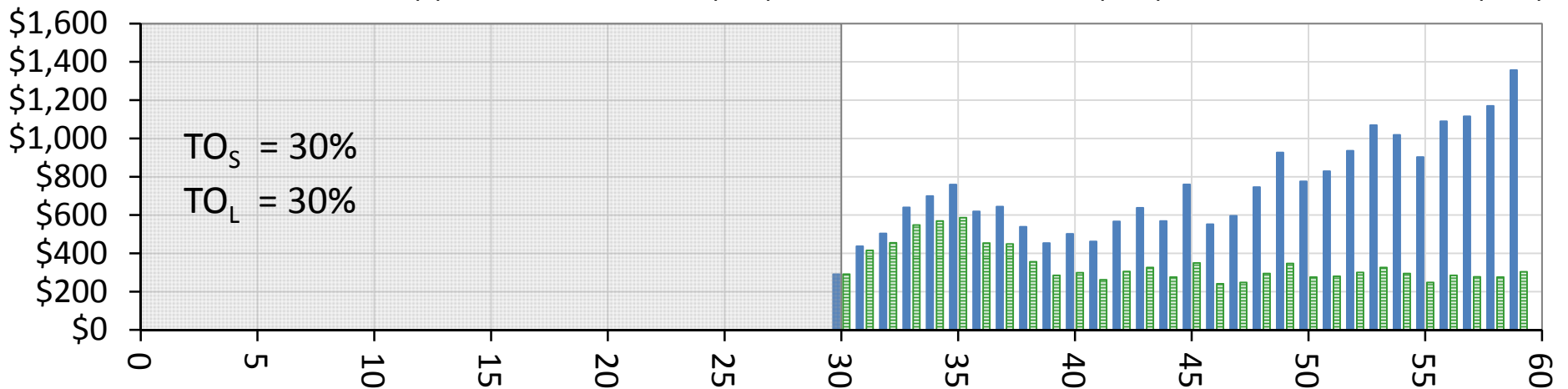
Tax-Exempt

# Deriving Tax-Cognizant Inputs

## Simulation of Present Values



Losses Carried Forward (L)
  Total Wealth (WT)
  After-Tax Wealth (WA)
  Untaxed Wealth (WU)



■ After-Tax Cash Flow

▨ Present Value of Cash Flow at Beginning of Consumption Period

# Deriving Tax-Cognizant Inputs

## *Simulation of Present Values*

- Assume \$1 starting values for asset class investments (*allows for scaling*)
- Simulate present values concurrently (*Example: 25,000 iterations*)
- Determine tax-cognizant optimization inputs
  - Average of simulated present values
  - Standard deviation of simulated present values
  - Correlation of simulated present values

# Deriving Tax-Cognizant Inputs

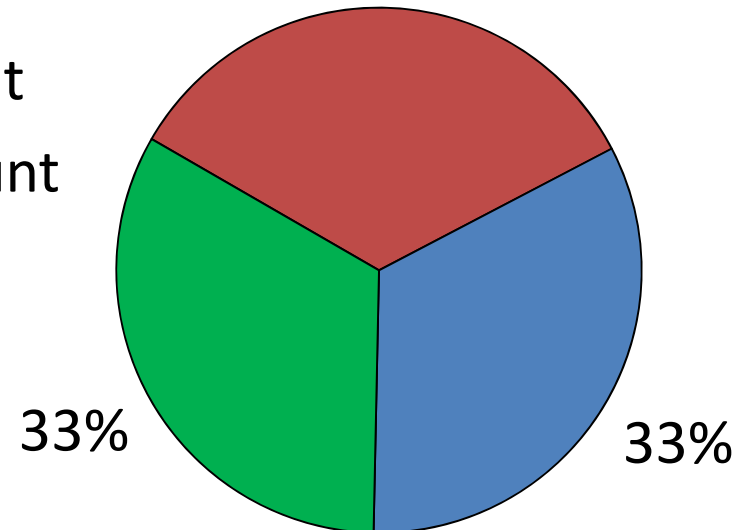
## *Estimation Error*

Emerging Market Stocks Held in a Tax-Exempt Account		Simulation Run (25,000 iterations per run)				
		1	2	3	4	5
Simulated Present Values	Arithmetic Mean	<b>\$10.12</b>	<b>\$9.26</b>	<b>\$9.62</b>	<b>\$10.00</b>	<b>\$9.25</b>
	Standard Deviation	<b>\$72.00</b>	<b>\$38.76</b>	<b>\$39.90</b>	<b>\$49.41</b>	<b>\$45.05</b>
Logs of Simulated Present Values	Arithmetic Mean	0.60	0.58	0.60	0.61	0.59
	Standard Deviation	1.80	1.80	1.80	1.80	1.78
	Skewness	0.06	0.04	0.07	0.06	0.04
	Excess Kurtosis	0.00	0.02	0.00	0.05	0.05
Present Value Estimates Based on Logs of Simulated Present Values	Arithmetic Mean	<b>\$9.21</b>	<b>\$9.04</b>	<b>\$9.21</b>	<b>\$9.34</b>	<b>\$8.73</b>
	Standard Deviation	<b>\$45.71</b>	<b>\$44.87</b>	<b>\$45.57</b>	<b>\$46.44</b>	<b>\$41.37</b>

# Optimization *Constraints*

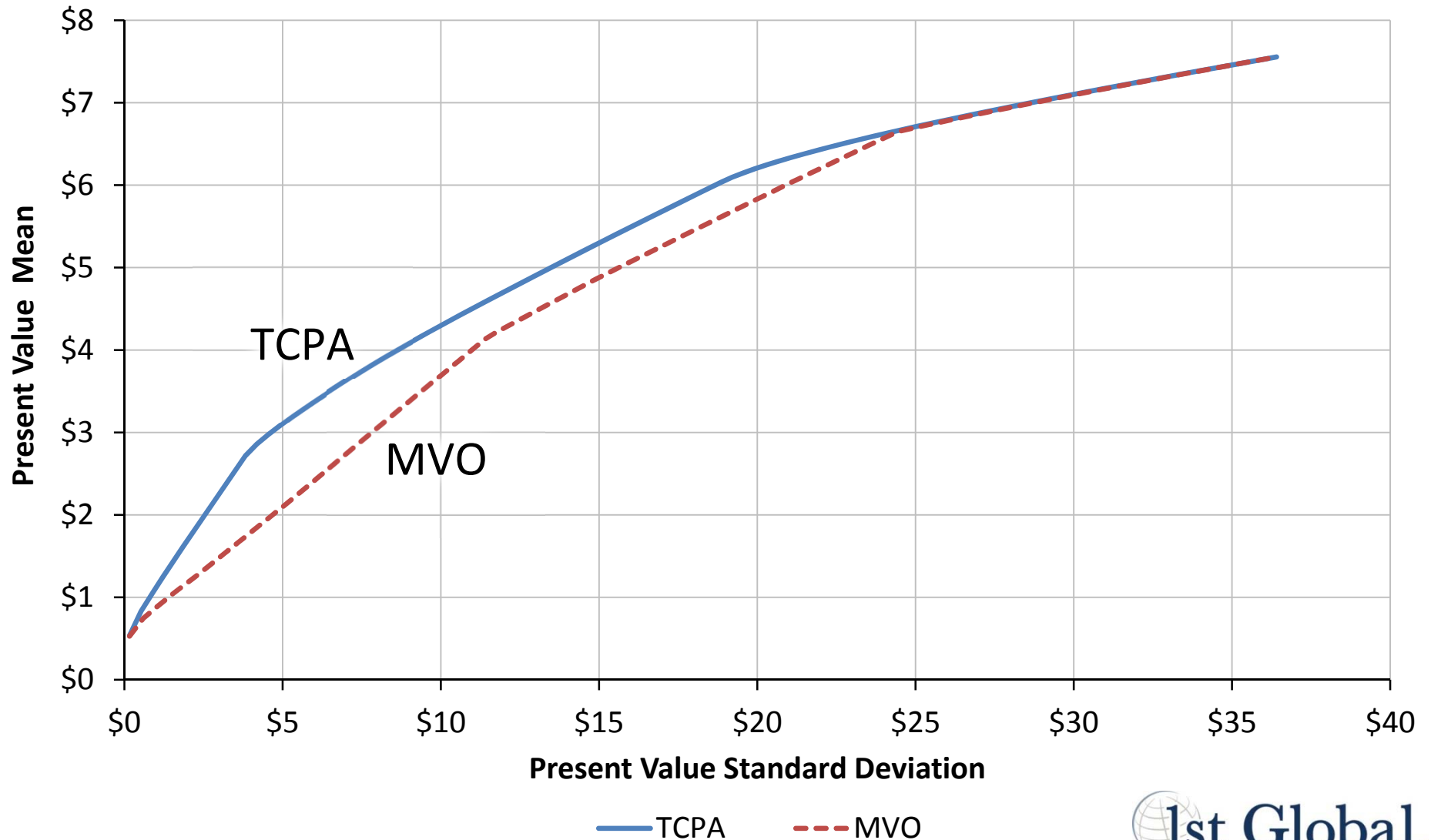
- **Account type constraints**
  - % of assets in Taxable account
  - % of assets in Tax-Exempt account
  - % of assets in Tax-Deferred account
- **Other constraints**

Example Account Type  
Constraints  
34%



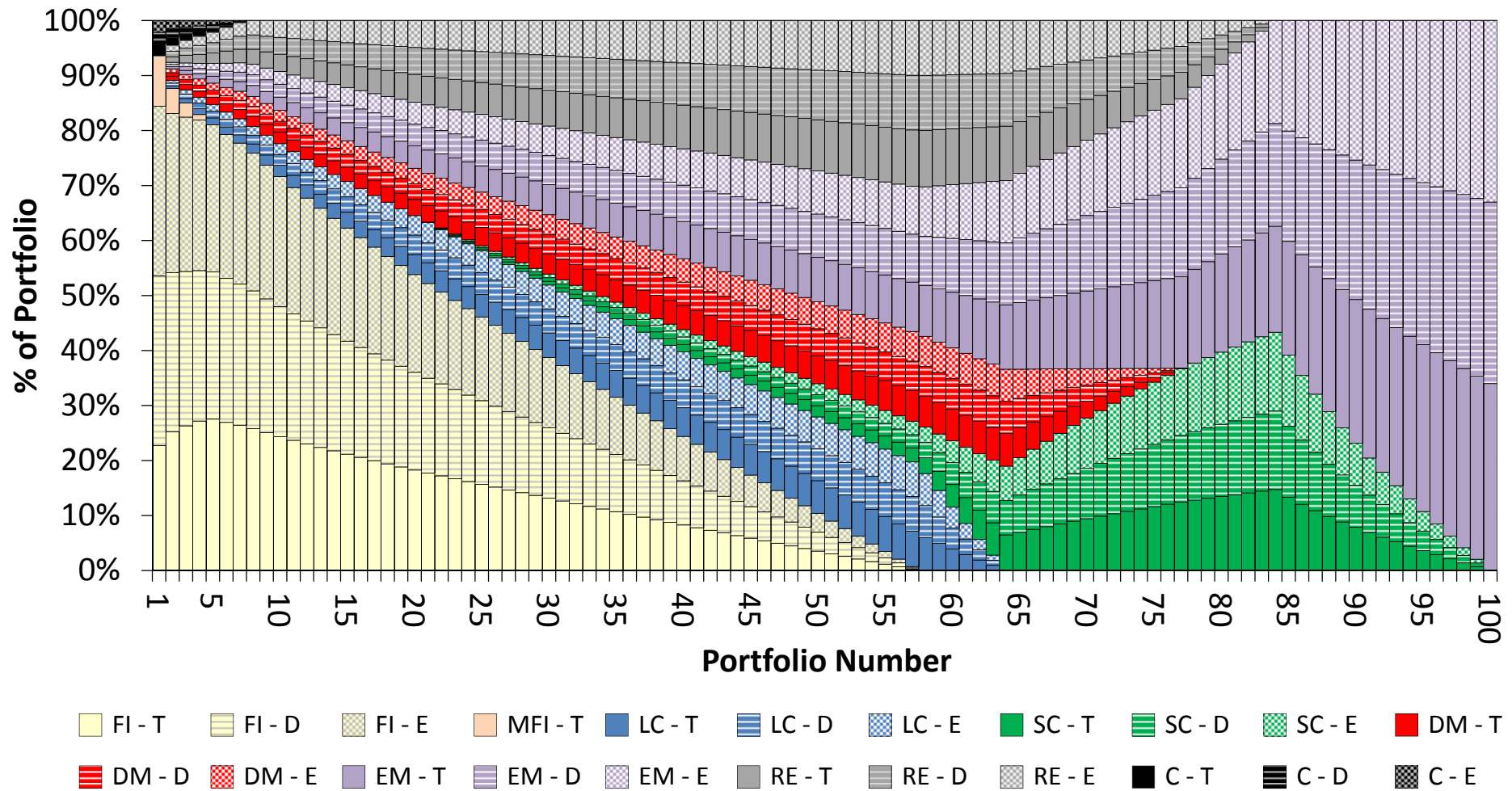
■ Taxable ■ Tax-Deferred ■ Tax-Exempt

# The Tax-Cognizant Efficient Frontier *Comparison*

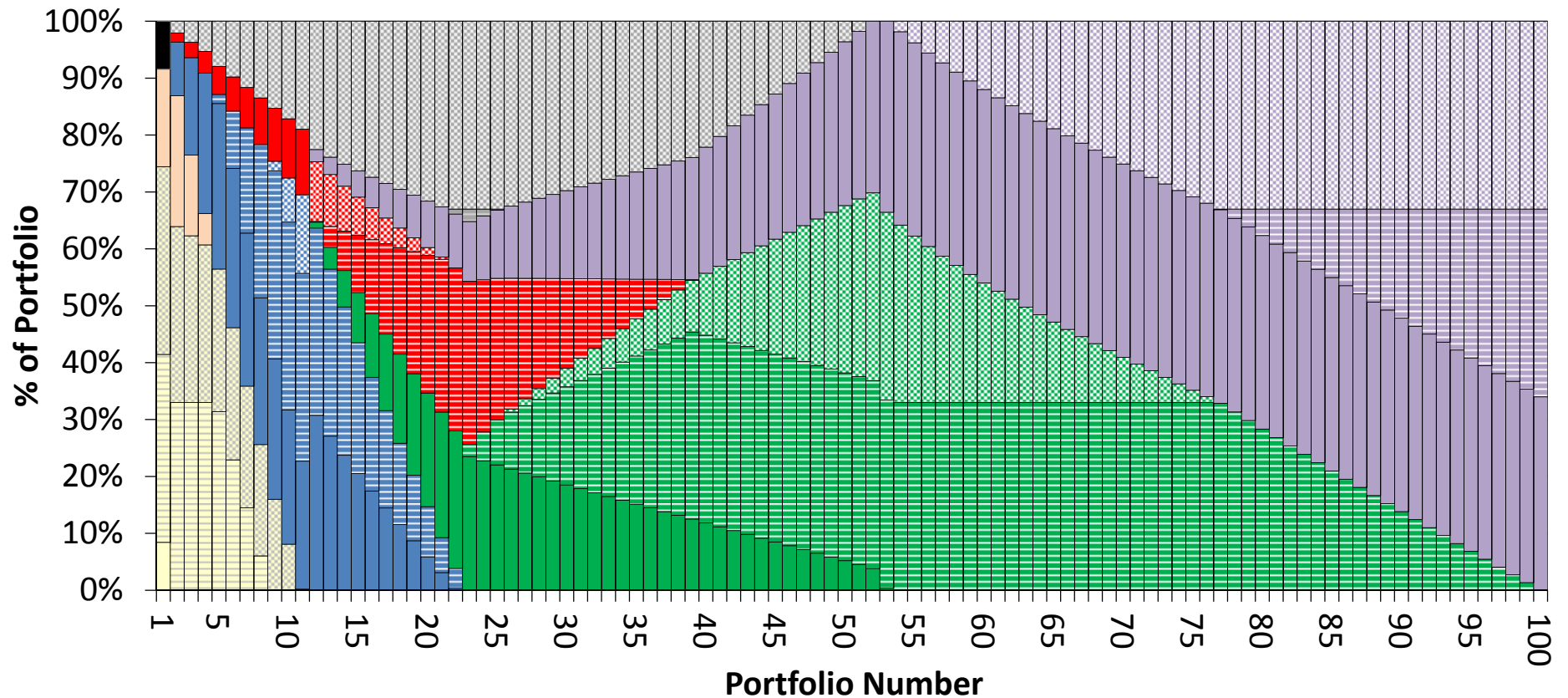




# Mean Variance Frontier (MVO) Composition



# Present Value Frontier (TCPA) Composition



# Present Value Frontier

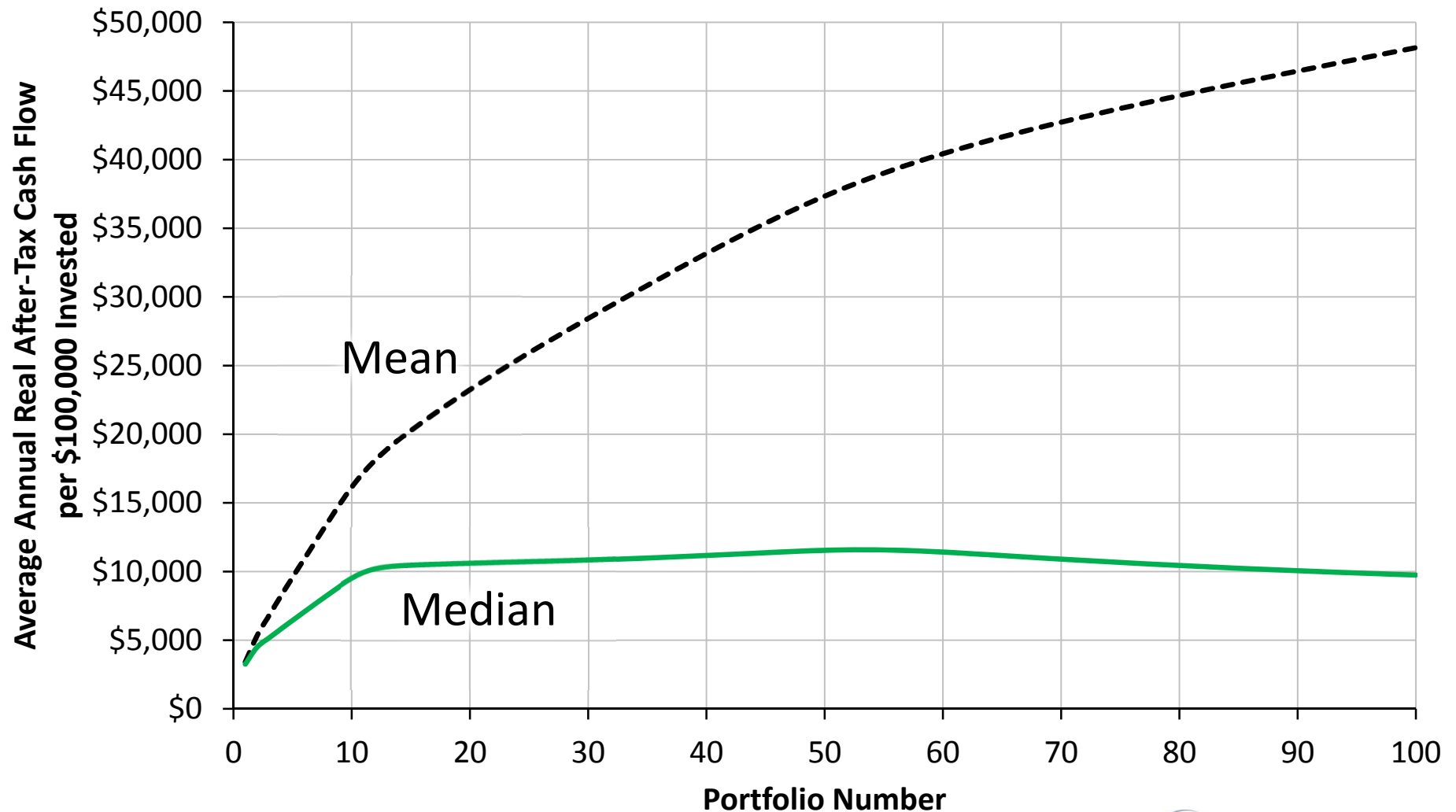
## *Portfolio Selection Impracticalities*

- Present value mean
  - Not a good measure of central tendency
  - Sum of a series of cash flows
- Present value standard deviation

Lognormally distributed present values makes conceptualizing risk with standard deviation a difficult, if not nebulous, proposition
- Instability of present value frontiers

# Present Value Frontier

## *Portfolio Selection Impracticalities*



--- Mean    — 50% Confidence (Median)

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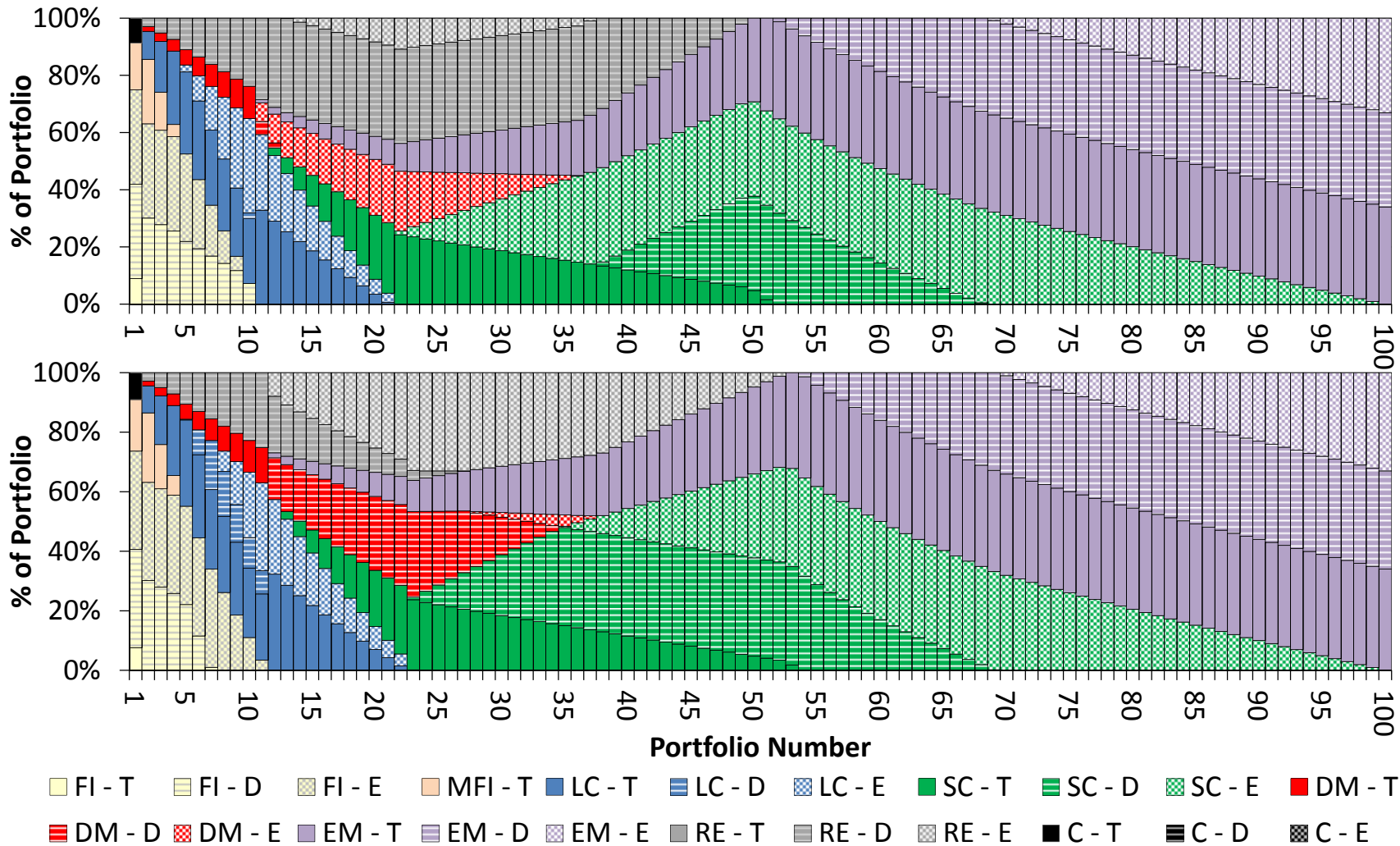
# Transform the Present Value Frontier

## *Intuitive Measures for Portfolio Selection*

- Convert present values to average annual real after-tax cash flows
- Use confidence levels instead of standard deviation
  - Use Value-at-Risk (VaR) approach with log present value distribution
  - Identify the average annual real after-tax cash flow provided by frontier portfolios at specific confidence levels

# Present Value Frontier

## Composition Instability



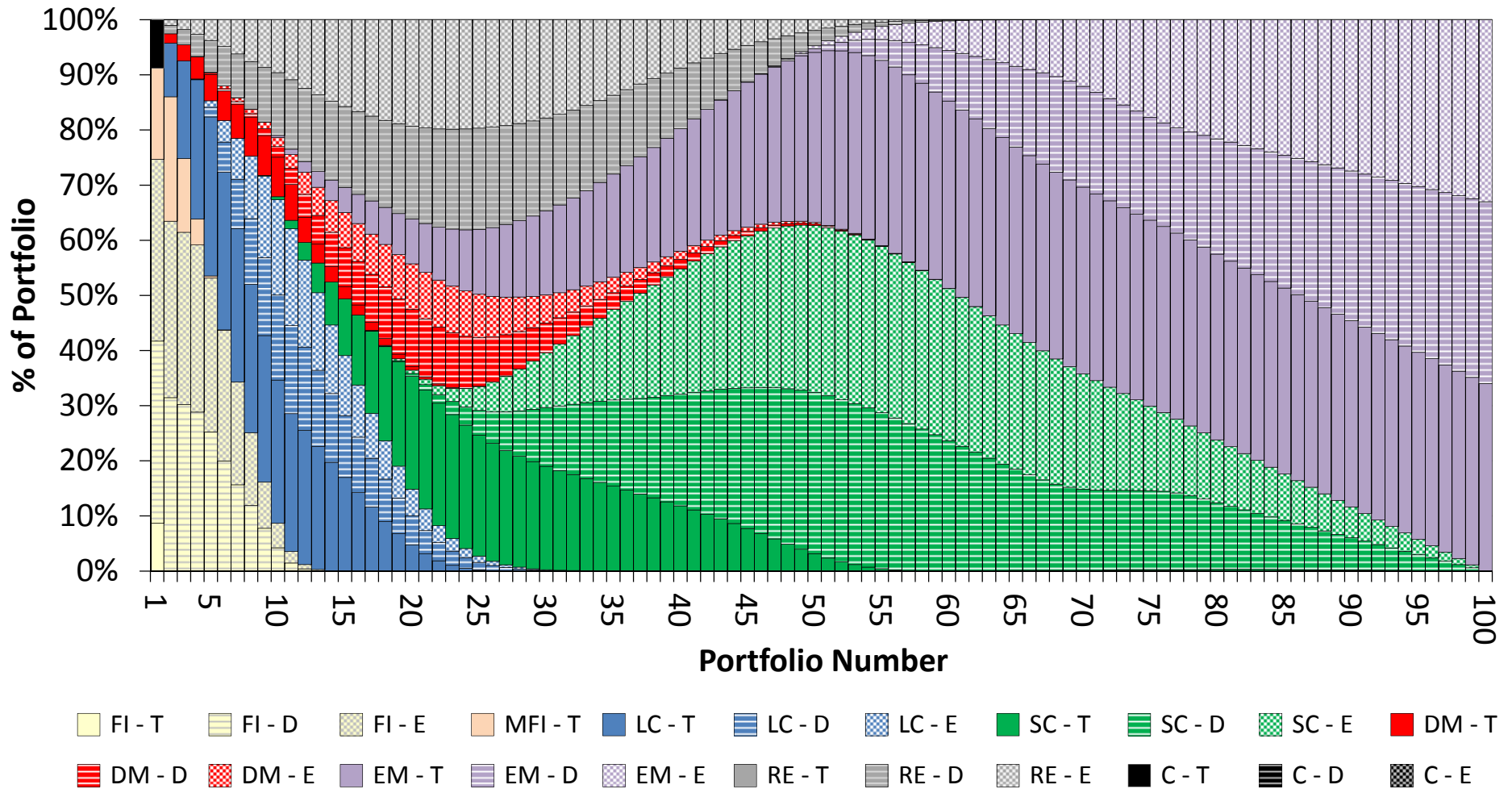
# Present Value Frontier

## *Frontier Resampling*

- Resampling provides a solution to instability
- The resampling process used depends on the portfolio selection approach chosen
  - Cash Flow-Confidence Level
  - Maximum Cash Flow-Confidence Level

# Cash Flow-Confidence Level Frontier

## Composition



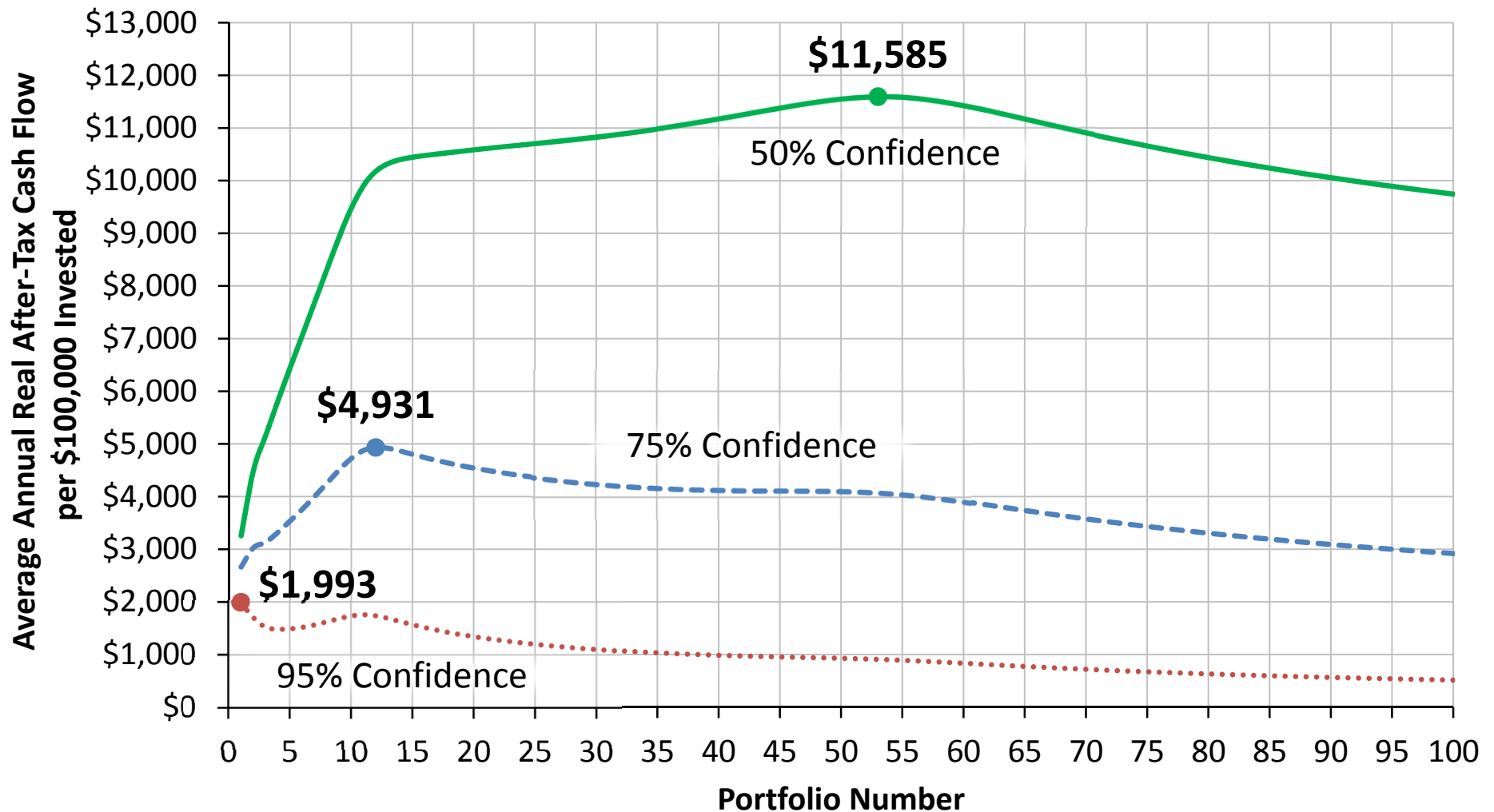
*Frontier created by averaging 250 present value frontiers developed with inputs derived from simulation runs with 1,000 iterations each.*

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# Cash Flow-Confidence Level Frontier

## Portfolio Selection

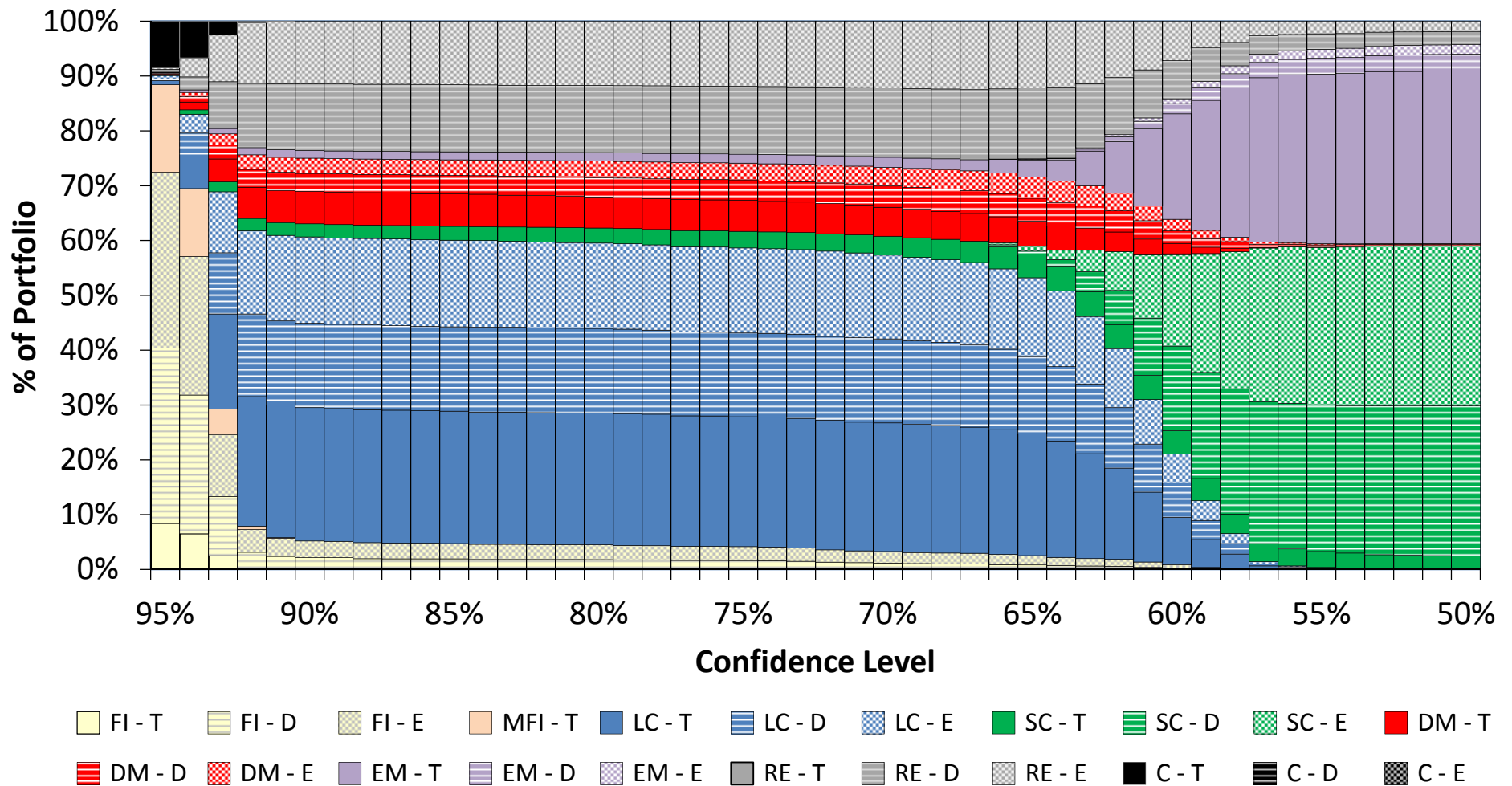


— 50% Confidence (Median)    - - - 75% Confidence    ..... 95% Confidence

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# Max Cash Flow-Confidence Level Frontier

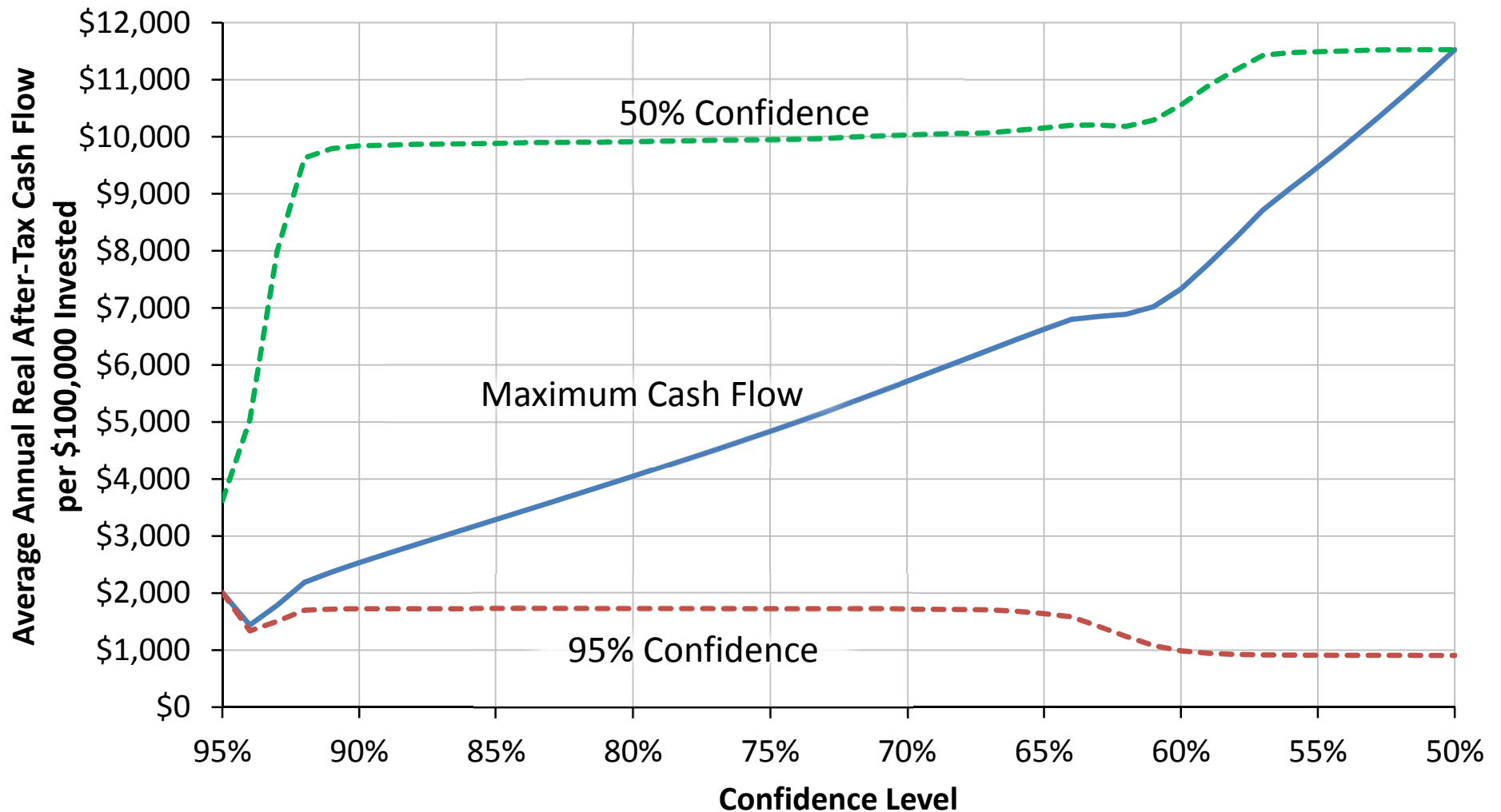
## Composition



Frontier created by averaging 250 maximum cash flow–confidence level frontiers developed with inputs derived from simulation runs with 1,000 iterations each.

# Max Cash Flow-Confidence Level Frontier

## Portfolio Selection

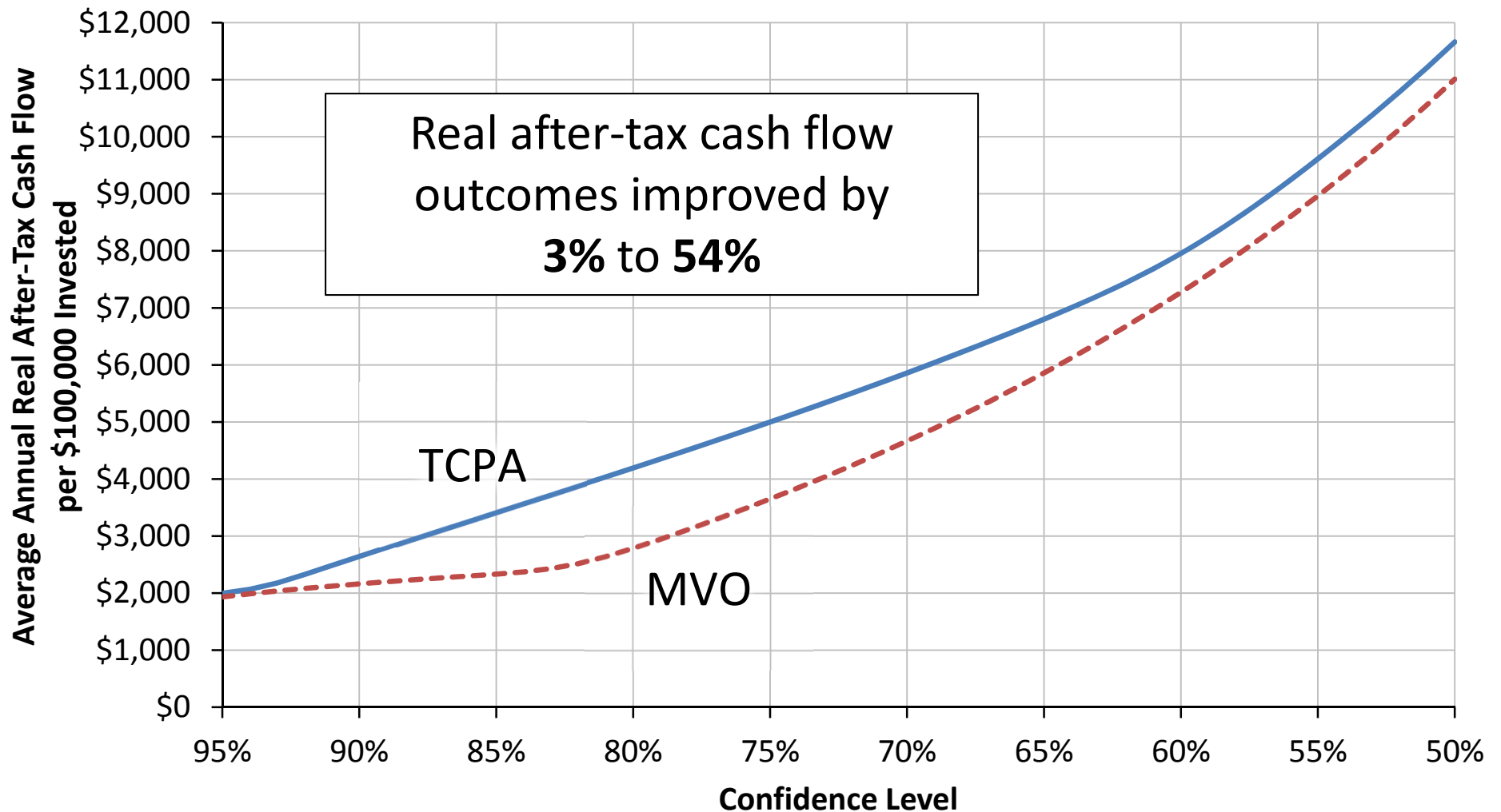


— TCPA Maximum Cash Flow Frontier — 50% Confidence (Median) - - - 95% Confidence

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# Max Cash Flow-Confidence Level Frontier

## *Benefits of TCPA – Average of Outcomes*



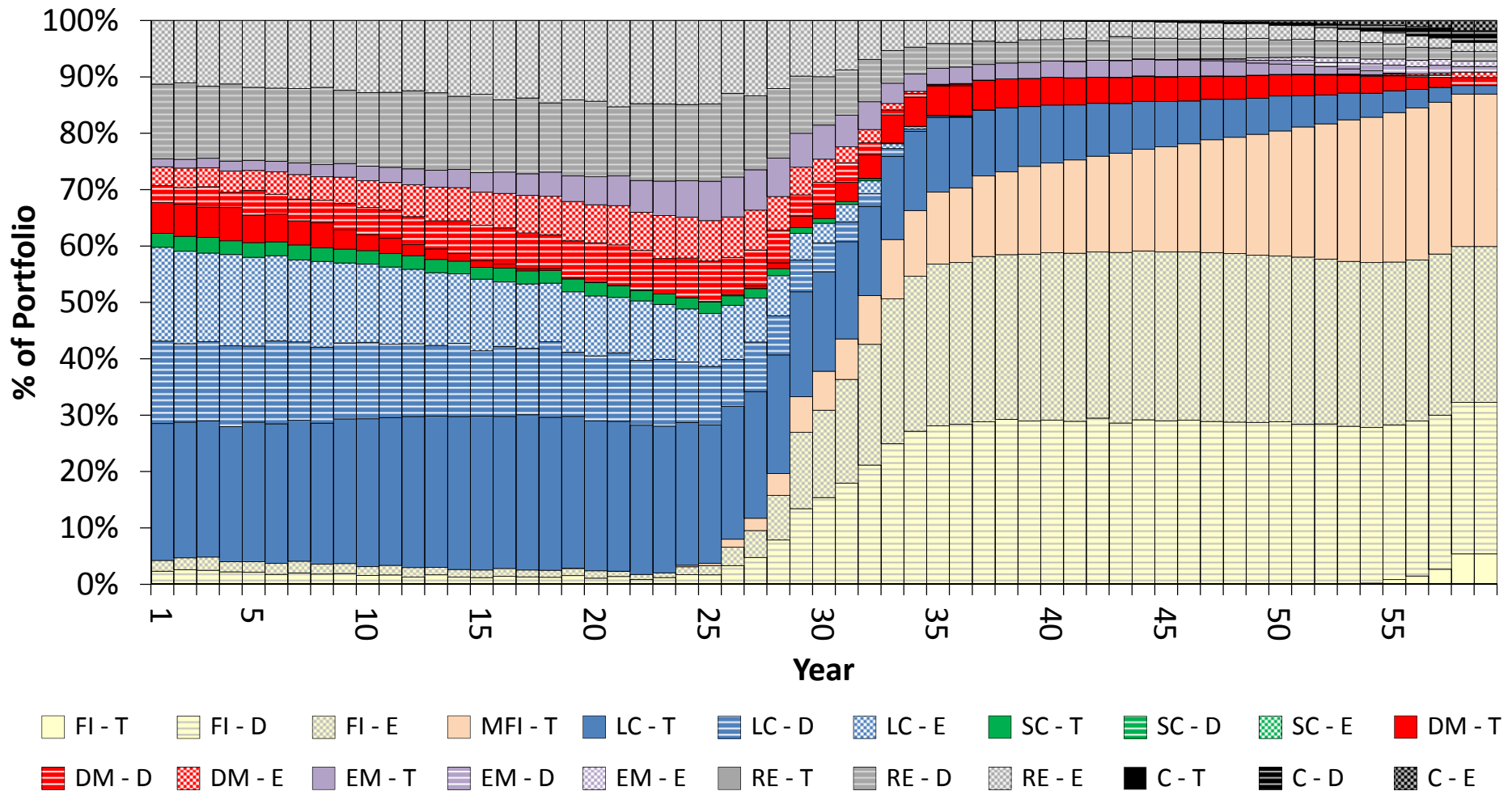
— TCPA Confidence Level Maximizing Frontier

- - - MVO

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# TCPA and Time-Dependence

## 82% Confidence Level Portfolios



Portfolios created by averaging 500 maximum cash flow–confidence level portfolios developed with inputs derived from simulation runs with 1,000 iterations each.

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# Tax-Cognizant Investing

## *Time Dependence and Client Engagement Level*

- Target/Opportunistic
- Dynamic Glide-paths
  - Constant Confidence Level
  - Increasing Confidence Level

# Conclusion

- Tax-Cognizant Portfolio Analysis
  - Maximizes after-tax wealth for given levels of risk
  - Addresses taxation dynamics and illiquidities
  - Optimizes present values
- Two approaches to tax-cognizant portfolio selection:
  - Cash Flow–Confidence Level
  - Maximum Cash Flow–Confidence Level
- Tax-Cognizant Investing

# Appendix

## Portfolio Analysis Variables - Example

### Correlation Matrix

Asset Class		FI	MFI	LC	SC	DM	EM	RE	C
Investment Grade Bonds	FI	1.00	0.47	0.22	0.21	0.14	0.12	0.17	0.00
Municipal Bonds	MFI	0.47	1.00	0.27	0.25	0.18	0.16	0.19	0.00
U.S. Large Company Stocks	LC	0.22	0.27	1.00	0.84	0.75	0.70	0.62	0.16
U.S. Small Company Stocks	SC	0.21	0.25	0.84	1.00	0.64	0.67	0.66	0.18
Developed Market Stocks	DM	0.14	0.18	0.75	0.64	1.00	0.52	0.46	0.25
Emerging Market Stocks	EM	0.12	0.16	0.70	0.67	0.52	1.00	0.47	0.26
Real Estate	RE	0.17	0.19	0.62	0.66	0.46	0.47	1.00	0.14
Commodities	C	0.00	0.00	0.16	0.18	0.25	0.26	0.14	1.00

### Asset Class Risk and Return Characteristics

Asset Class		A	B	C	A × B	A × C			
Asset Class		Expected Standard Deviation %	Expected Return %	% of Return Gain	% of Return Income	Gain Return	Income Return	Income Standard Deviation %	Correl. Income, Total Return
Investment Grade Bonds	FI	5.6	4.3	10	90	0.40	3.60	1.26	0.40
Municipal Bonds	MFI	7.1	3.6	10	90	0.36	3.24	0.95	0.24
U.S. Large Company Stocks	LC	19.2	8.2	75	25	6.08	2.03	0.84	0.09
U.S. Small Company Stocks	SC	28.5	10.0	85	15	8.25	1.46	0.71	0.53
Developed Market Stocks	DM	23.5	8.3	75	25	6.15	2.05	0.79	0.45
Emerging Market Stocks	EM	33.0	10.9	85	15	9.35	1.65	0.67	0.79
Real Estate	RE	22.9	8.4	45	55	3.42	4.18	1.26	0.42
Commodities	C	20.0	4.0	100	0	4.30	0	-	-

Inputs were derived using common input estimation methods and are for illustrative purposes only.



# Appendix

## Portfolio Analysis Variables - Example

Taxation Characteristics		Income		Capital Gains			
		Income Type	Income Tax Rate % (T <sub>I</sub> ) A/C <sup>†</sup>	Short-Term Turnover TO <sub>S</sub>	Short-Term Gain Tax Rate % (T <sub>S</sub> ) A/C <sup>†</sup>	Long-Term Turnover TO <sub>L</sub>	Long-Term Gain Tax Rate % (T <sub>L</sub> ) A/C <sup>†</sup>
<b>Investment Grade Bonds</b>	FI	<i>Taxable</i>	33 / 28*	0%	33 / 28	0%	15 / 15
<b>Municipal Bonds</b>	MFI	<i>Tax-Exempt</i>	0 / 0	0%	0 / 0	0%	15 / 15
<b>U.S. Large Company Stocks</b>	LC	<i>Qualified</i>	15 / 15	0%	33 / 28	0%	15 / 15
<b>U.S. Small Company Stocks</b>	SC	<i>Qualified</i>	15 / 15	0%	33 / 28	0%	15 / 15
<b>Developed Market Stocks</b>	DM	<i>Qualified</i>	15 / 15	0%	33 / 28	0%	15 / 15
<b>Emerging Market Stocks</b>	EM	<i>Qualified</i>	15 / 15	0%	33 / 28	0%	15 / 15
<b>Real Estate</b>	RE	<i>Taxable</i>	33 / 28	0%	33 / 28	0%	15 / 15
<b>Commodities</b>	C	-	-	100%	22.2 / 20.2	0%	15 / 15

<sup>†</sup>A/C = Rate in Accumulation Period / Rate in Consumption Period

\*The ordinary income tax rate is equal to the marginal tax rate.

### Investor Details

<b>Years in Accumulation</b>	30
<b>Years in Consumption</b>	30
<b>Intertemporal Substitution Rate %</b>	5.3
<b>Forward Consumption Rate %</b>	3.0

<b>% of Total Assets in Taxable Accounts</b>	34
<b>% of Total Assets in Tax-Deferred Accounts</b>	33
<b>% of Total Assets in Tax-Exempt Accounts</b>	33
<b>Forward Consumption Dampening Rate %</b>	2.75

The tax rates used are for illustrative purposes and may not coincide with the current U.S. Federal Tax Code.

Our analysis assumes an asset class implementation using ETF index investments. The turnover rates applied assume that the ETFs are expected to incur negligible capital gain distributions.

A futures-based commodity implementation is assumed in our analysis. Gains for these types of investments are taxed annually at a blended rate comprised of 60% long-term capital gains tax rate and 40% short-term capital gains rate regardless of whether the investment was sold or not.

# Disclosures

Material in this presentation was derived from:

Blay, K.A., and Markowitz, H.M. "Tax-Cognizant Portfolio Analysis: A Methodology for Maximizing After-Tax Wealth".  
Forthcoming in the Journal of Investment Management

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