Liability-Relative Optimization: Begin with the End in Mind

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Agenda

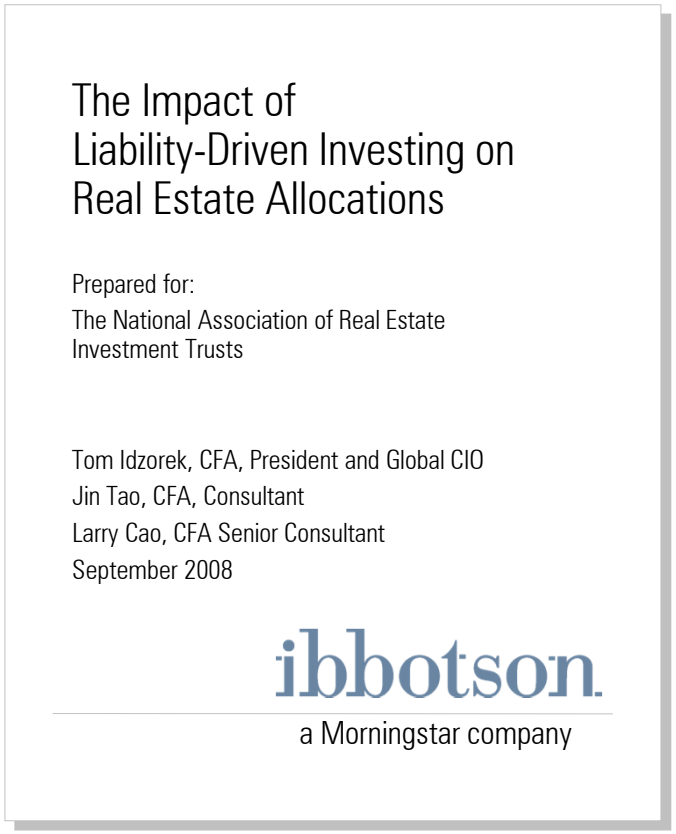
- Introduce Liability-Relative/Surplus Optimization
- Portfolio Implications
- Retiree Portfolio Implications
- Estimating the Liability for a DB Plan
- Our Approach
- Dynamic Considerations

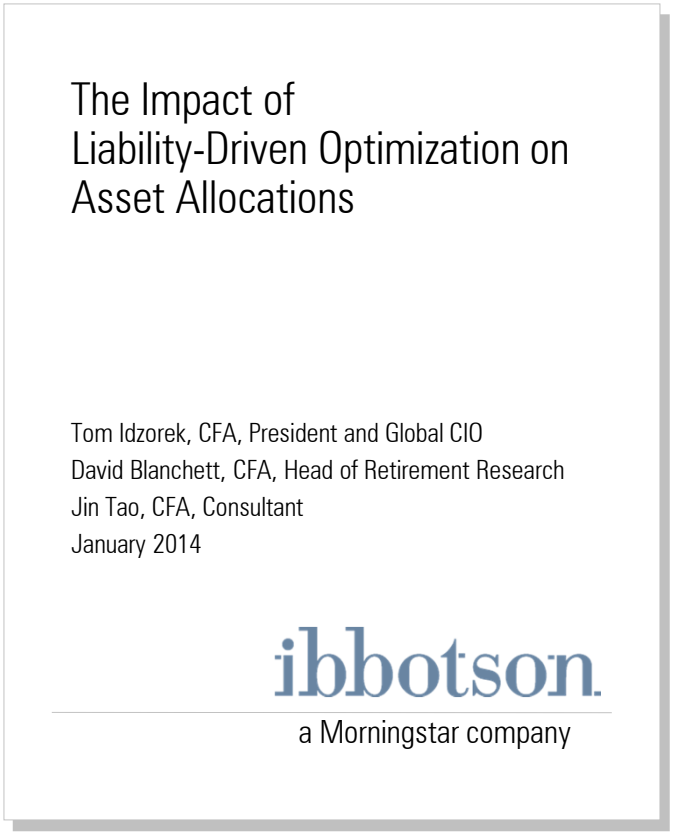
No Portfolio is an Island…

No man is an island,
Entire of itself,
Every man is a piece of the continent,
A part of the main

John Donne, 1624

Morningstar/Ibbotson Surplus (Liability-Relative) Optimization





Liability-Relative Investing Overview

Techniques

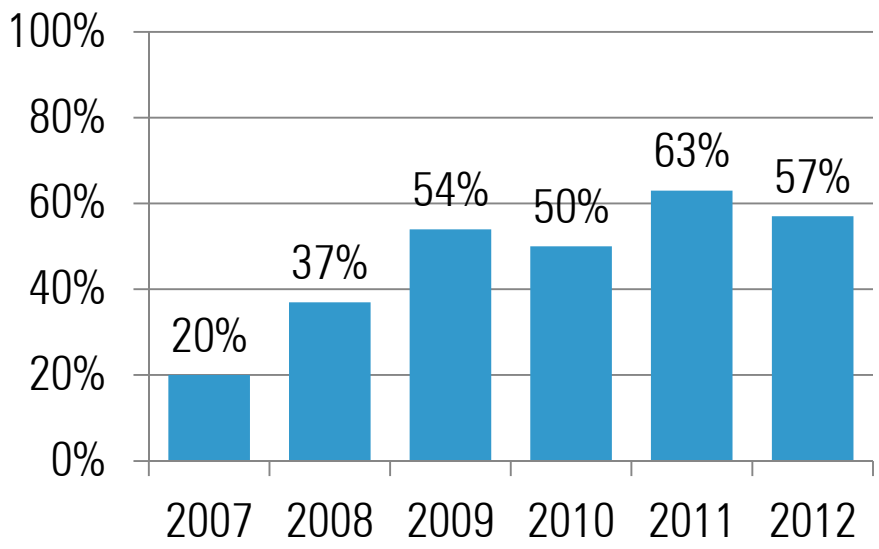
- Cash Flow Matching
- Duration (Interest Rate Sensitivity) Matching
- Liability-Relative Optimization (Surplus Optimization)

What is Liability-Relative Investing?

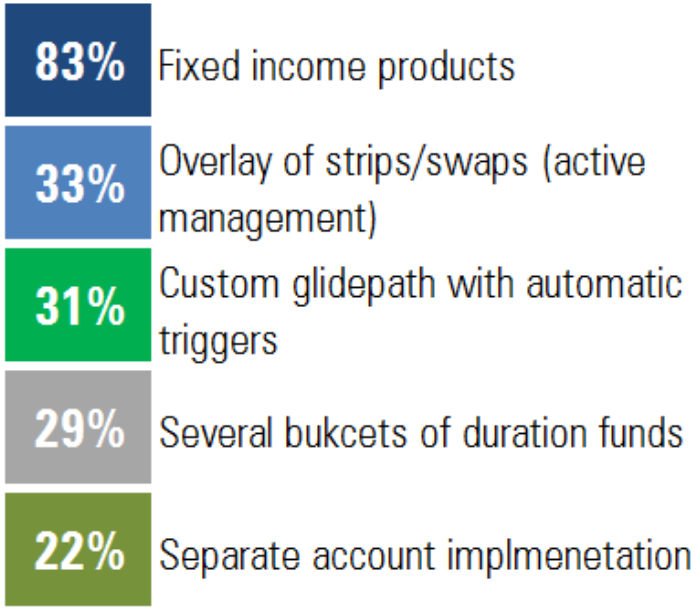
- An extension of traditional mean-variance optimization in which the optimizer is constrained to hold a combination of assets representing the liability short
- Focuses on the entire portfolio–assets and liabilities– not just the assets

Growth of Liability Driven Investing in the DB Space

% of DB Plans Employing LDI



LDI Implementation Methods



Source: SEI's 6th Annual Global Liability Driven Investing Poll

Example of Liability Matching

Hypothetical Example

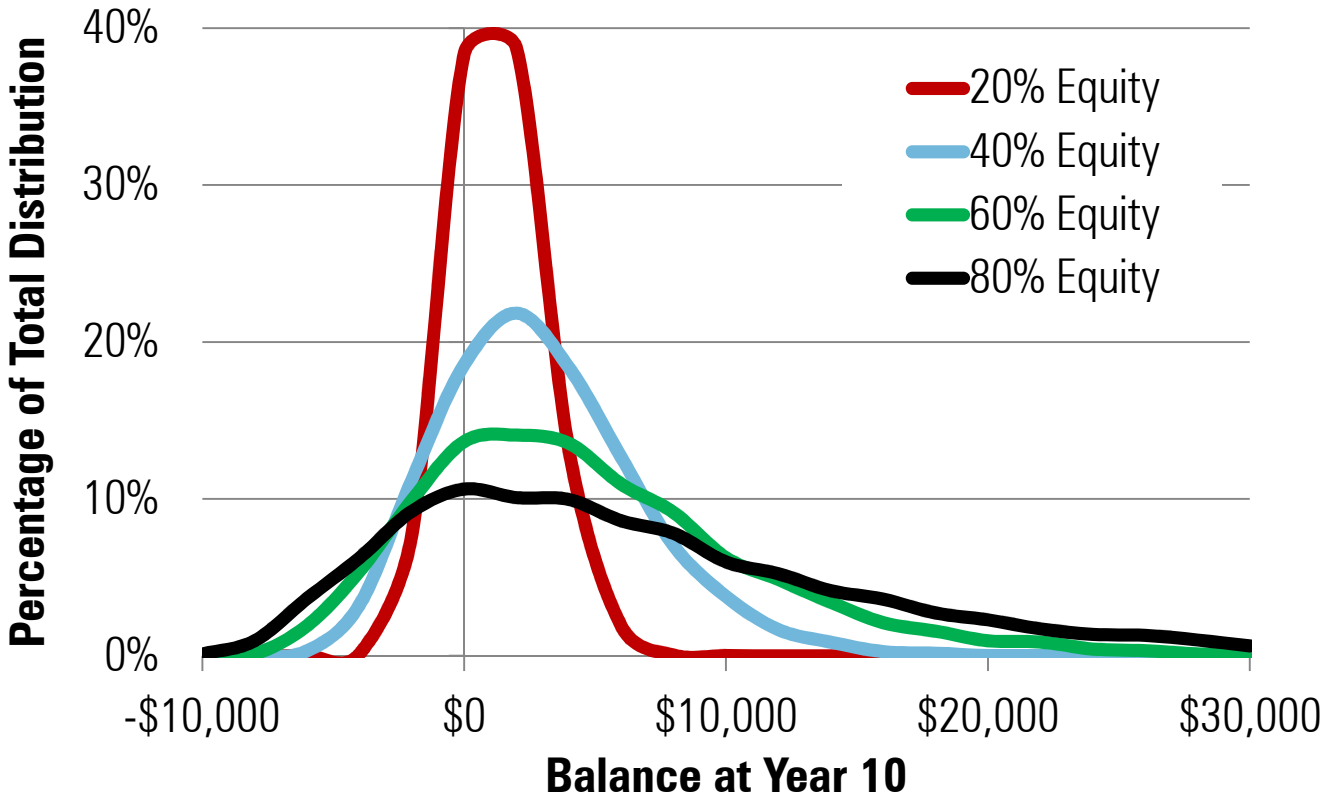
- Required Payments

Year	Need
1	$400
2	$400
3	$400
4	$400
5	$400
6	$400
7	$400
8	$400
9	$400
10	$10,400

- Assets = $10,000
- Investment Choices

  Cash (2% yield)
  10 Year Govt Bond (4% yield)
  Large Cap US Stocks

Different Equity Allocations



How Do You Manage the Portfolio?

The Perfect Hedge

- Buy the Government Bond with the 4% Coupon

Year	Need	Cash Flow	Remain
1	$400	$400	$0
2	$400	$400	$0
3	$400	$400	$0
4	$400	$400	$0
5	$400	$400	$0
6	$400	$400	$0
7	$400	$400	$0
8	$400	$400	$0
9	$400	$400	$0
10	$10,400	$10,400	$0

Estimating the Liability

Estimating the Liability of a Defined Benefit Plan

- Current and future defined benefit payments are “certain”
- Payments should be discounted at a rate that reflects their risk (Modigliani and Miller (1958), independent of the rate of return of assets.
- The only way to remove the risk of having to make (or being able to make) future benefit payments would be to either:

    1. transfer the liability to a third party (e.g., an insurance company)

    2. retain the liability and purchase risk-free securities that match future benefit payments (e.g., US Treasuries/STRIPs)

Why Not Corporate Bonds?

- While corporate bonds/yields are used to estimate the total liability (per PPA), corporate bonds are not “riskless” and therefore cannot be used to guarantee the liability is perfectly offset
- This does not mean investing corporate bonds is not prudent, though, since corporate bonds may offer a more attractive risk/return tradeoff for a plan sponsor unable or unwilling to perfectly fund the liability
- Corporate bond yields must also be considered when considering things like funding liability

A Liability Perspective…

- Think of the IRS mandated liability calculation (using corporate yields) as the tax-assessed value of your home. This valuation perspective is important for funding purposes, but does not accurately reflect the true "market" value
- The true market value of the liability, which could be estimated by discounting future cash flows by the yield on Treasuries, is important when understanding what it would "cost" to eliminate the liability

Different Liability Estimates

- Segment Rates = $84 million
- Corporate Yield Curve = $128 million
- Ibbotson Government CMAs = $139 million
- Current Government Yield Curve = $165 million

Segment Rate Calculation

- Yields on investment grade corporate bonds with varying maturities that are in the top 3 quality levels available
- The segment rate is adjusted if it is outside a specified range of the average of the segment rates for the preceding 25-year period
- For 2014 it is 80% of the minimum or 120% of the maximum
- The 24-month average segment rates were: 4.43% for the first segment, 5.62% for the second segment, and 6.22% for the third segment versus, 1.22%, 4.06%, and 5.09%, respectively, for the 24-month rolling average

Estimating Retirement Readiness

- A common metric used to estimate the "health" of a defined benefit plan is the "funded ratio"
- Funded Ratio describes the
  - Underfunded if Funded Ratio > 1
  - Adequately funded if Funded Ratio = 1
  - Overfunded if Funded Ratio < 1

$$\textbf{Funded Ratio} = \frac{\textbf{Assets}}{\textbf{Liability}}$$

Common Liability Metrics

- Accumulated Benefit Obligation (ABO) = accrued service * current salary (value if plan were terminated)
- Projected Benefit Obligation (PBO) = accrued service * projected termination salary (incorporates future benefit obligations)
- ABO always ≤ PBO, therefore funding will always look better with ABO
- Pension Protection Act (PPA) of 2006 specifes evaluating beneft costs based on workers' current earnings, i.e, the ABO
- ABO vs PBO does not change promised benefits, and funding to an ABO target ignores eventual costs

ABO vs PBO

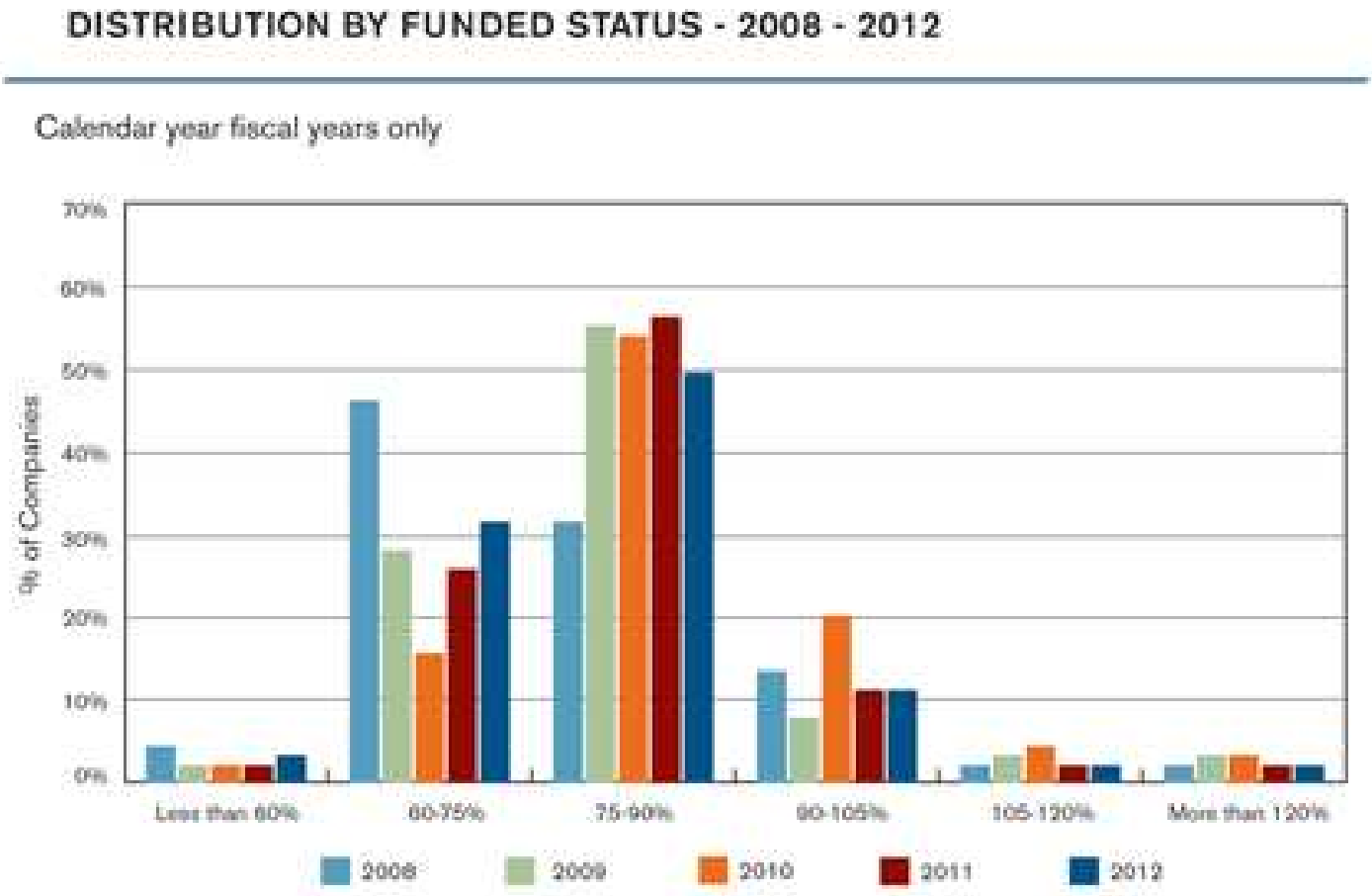
- Black (1989) argues that since benefits in a DB plan are linked to final salary, PBO should be the target
- Bodie (1990) suggests that PBO is misleading and that ABO should be used
- Under FASB accounting protocols, pension charges against operating earnings come from interest and service costs, not from contributions. Therefore, for any plan less than 150% funded, cash contributions lower tax liabilities without lowering reported earnings, thus raising both after-tax earnings and shareholders' equity.

"The ABO, the PBO and Pension Investment Policy" by Zvi Bodie, Financial Analysts Journal, September/October 1990, Vol. 46, No. 5: 27-34.

Funded Ratio of Typical DB Plan

Source: https://www2.blackrock.com/webcore/litService/search/getDocument.seam?venue=PUB_IND&source=GLOBAL&contentId=1111171414

Distribution of Funded Status



Source: http://us.milliman.com/Solutions/Products/Corporate-Pension-Funding-Study/

Surplus Optimization

Optimal Asset Allocation

When assets exist to fund a liability, how should the asset allocation policy be determined?

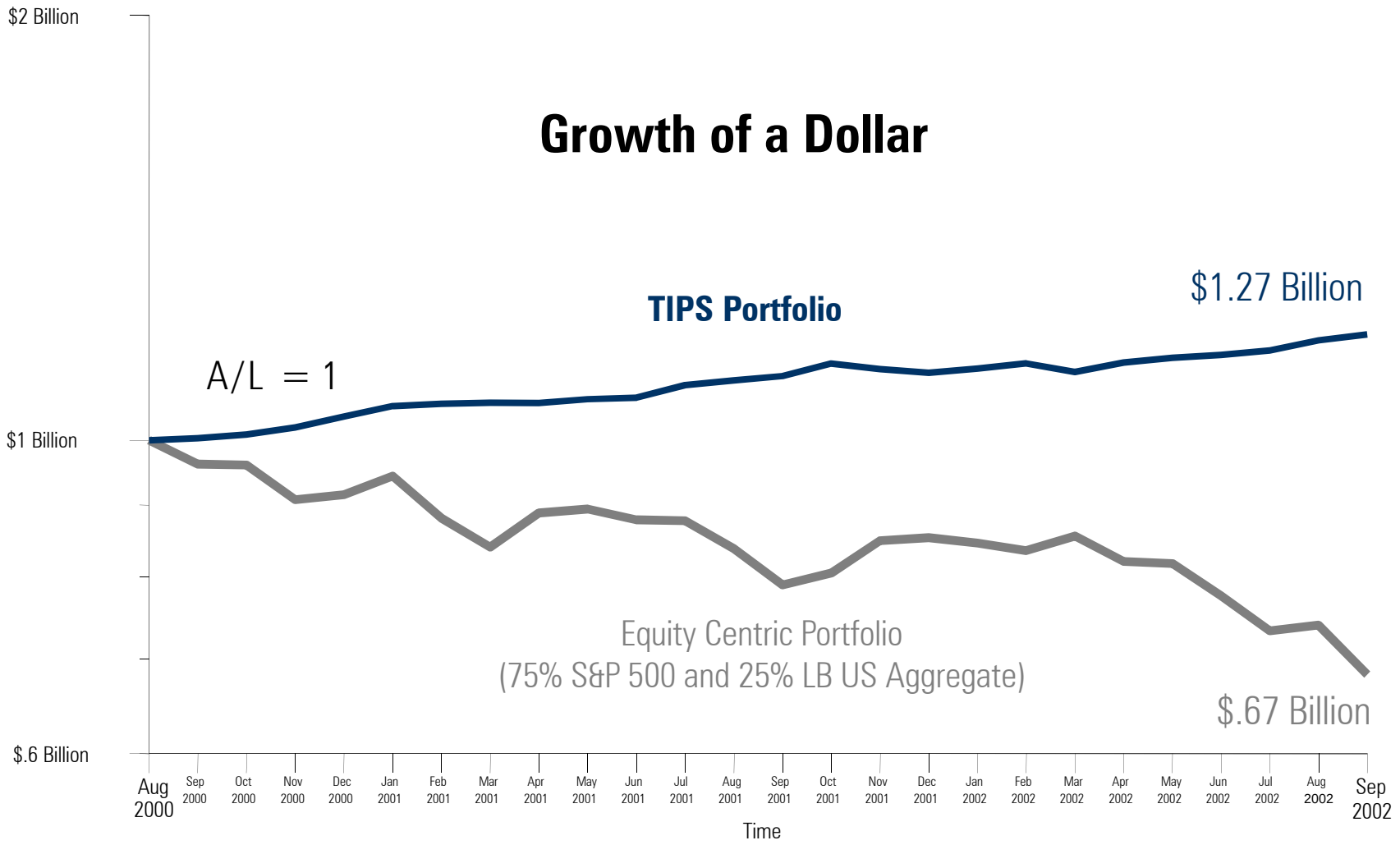
- The Traditional Approach – asset-only mean-variance optimization followed perhaps by a Monte Carlo Simulation
- Surplus optimization (a.k.a. asset-liability optimization approach)

True Risk

What is the TRUE risk for a portfolio that exists to fund (pay for) a liability?

- It is NOT the standard deviation of the asset portfolio
- It is NOT the performance of your asset portfolio relative to the asset portfolios of your peers
- The TRUE risk is that it won't be able to pay for the liability!

Matching the Liability



What is Surplus Optimization?

- Surplus optimization is a special case (or extension) of traditional mean-variance optimization in which the optimizer is *constrained* to hold a combination of assets representing the liability short
- Surplus optimization is one element of a broader approach called liability-relative investing or asset-liability management (ALM), which can include 1) duration matching (a.k.a. immunization), 2) convexity matching, and 3) cash flow matching
- Surplus optimization focuses on the entire portfolio – assets and liabilities – not just the assets of a portfolio

Surplus Optimization Advocates

"Plan sponsors should do away with an asset-centric approach and establish a liability-relative approach, controlling what really matters to the health of the plan (i.e. the net of the assets and the liabilities, the deficit or surplus)."

- M. Barton Waring [2004]

"Individual investors, in fact, probably stand to reap the largest benefit from an asset liability view of the problem they are facing…"

- Larry Siegel [2004]

"The goal of asset allocation analysis should be stated in terms of surplus. The objective is to maximize the risk-adjusted future value of the surplus."

- Bill Sharpe

Asset-only Optimization vs. Surplus Optimization

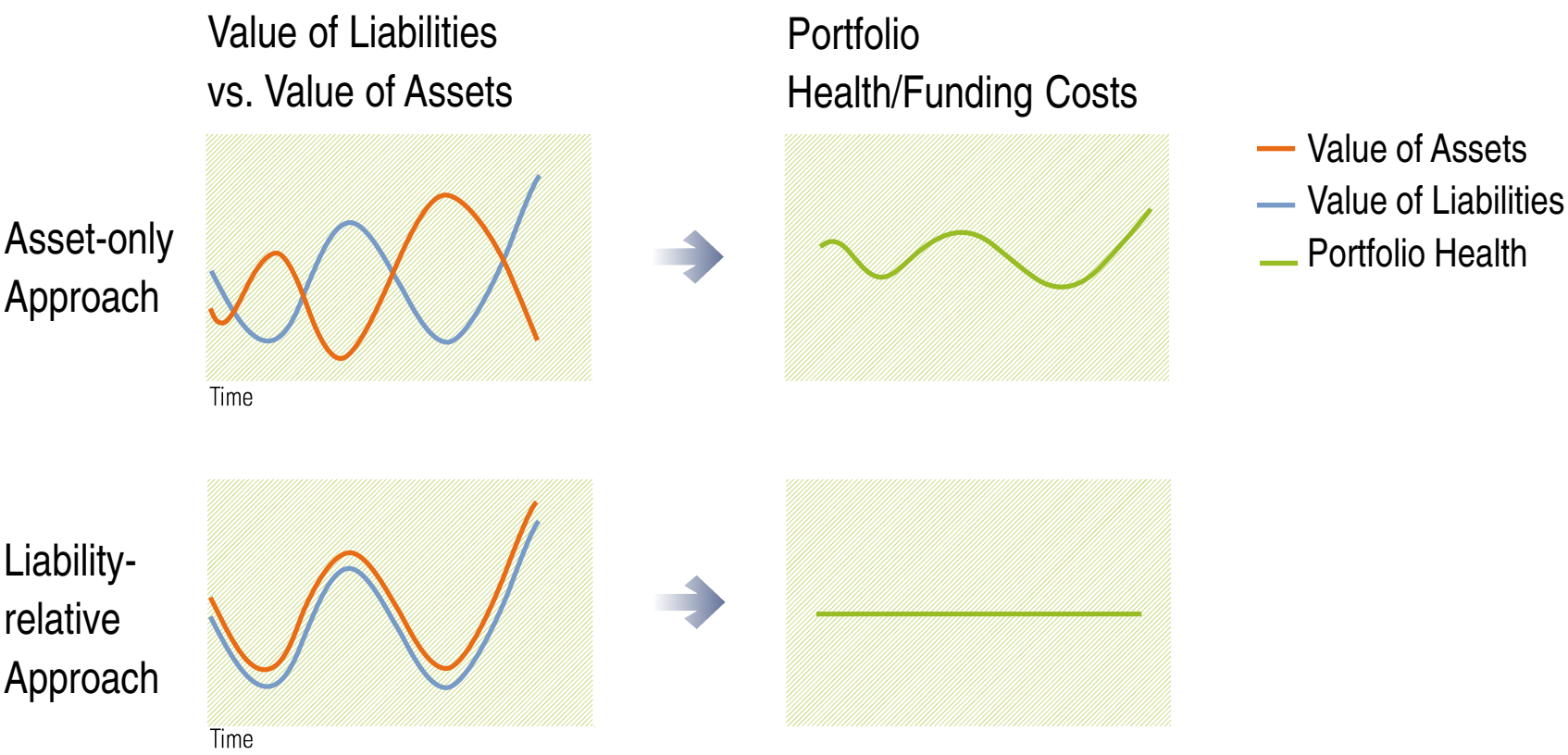
- Asset-only optimization: Maximizes the asset return per unit of asset risk (variability)

$$\max(U_A) = R_A - \lambda\sigma_A$$

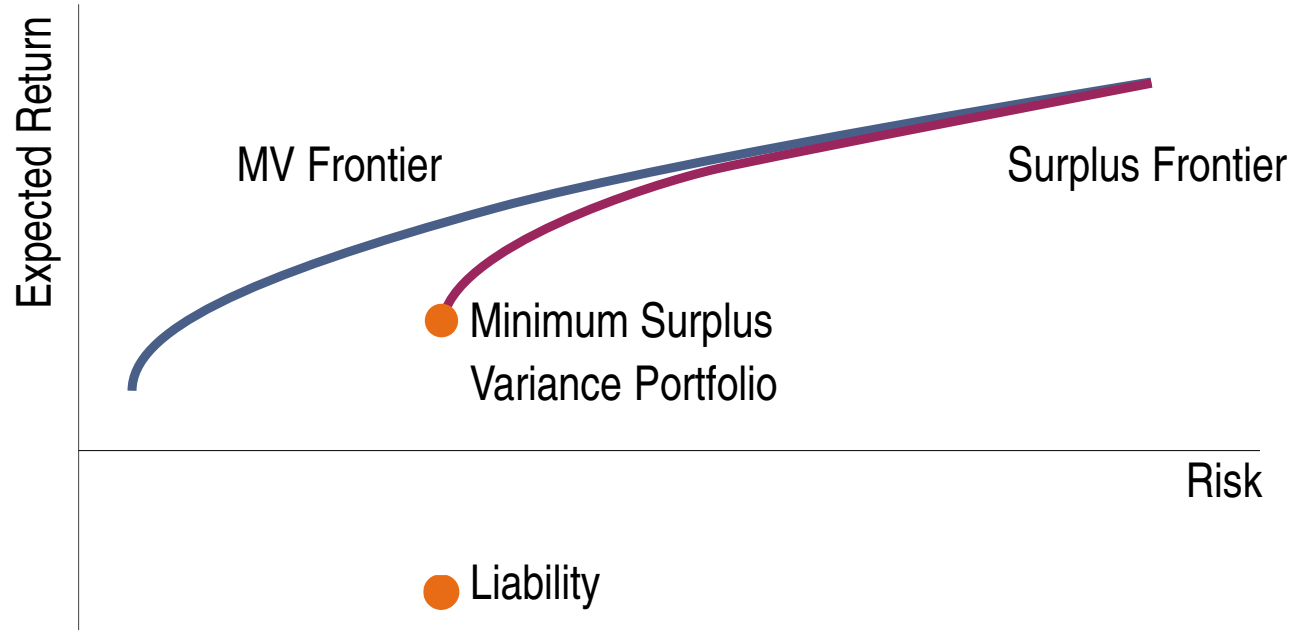
- Surplus optimization: Maximizes the surplus return per unit of surplus risk (variability)

$$\max(U_S) = R_S - \lambda\sigma_S$$

Asset-only versus Liability-relative



Different Efficient Frontiers



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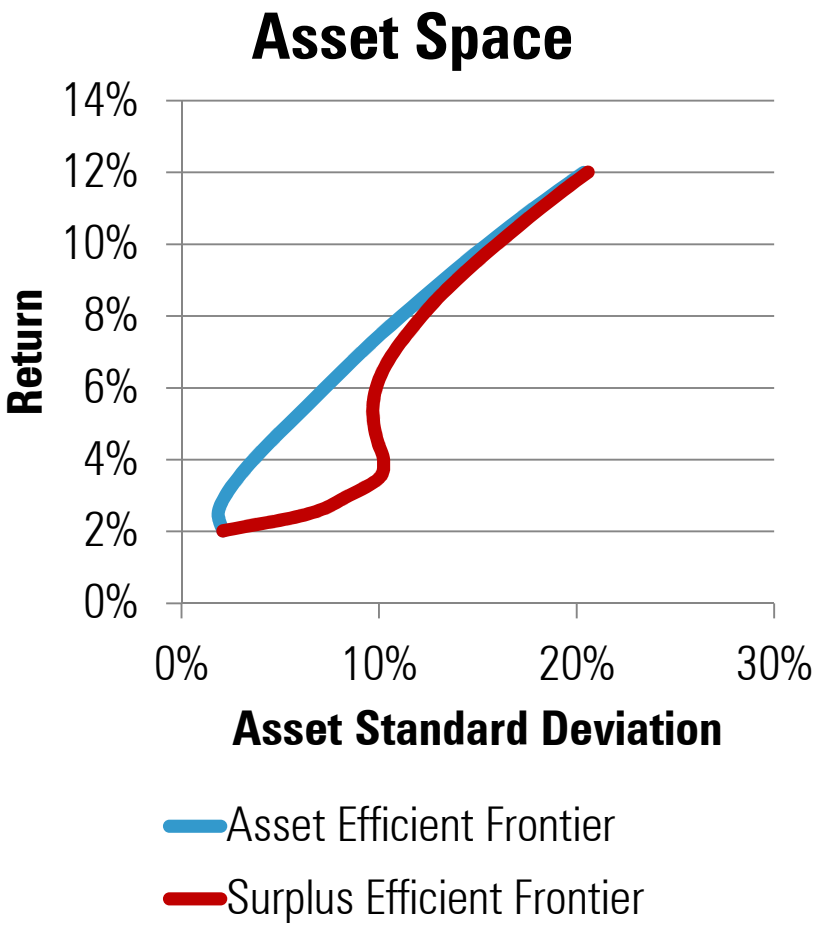
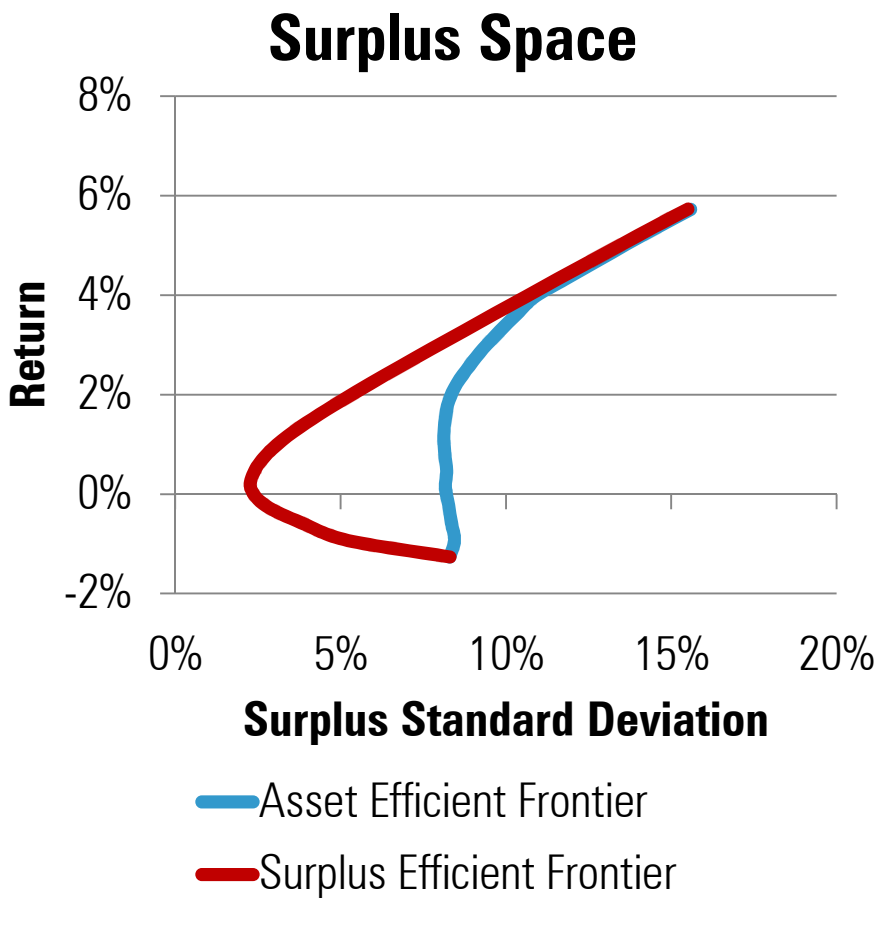
Portfolio Implications

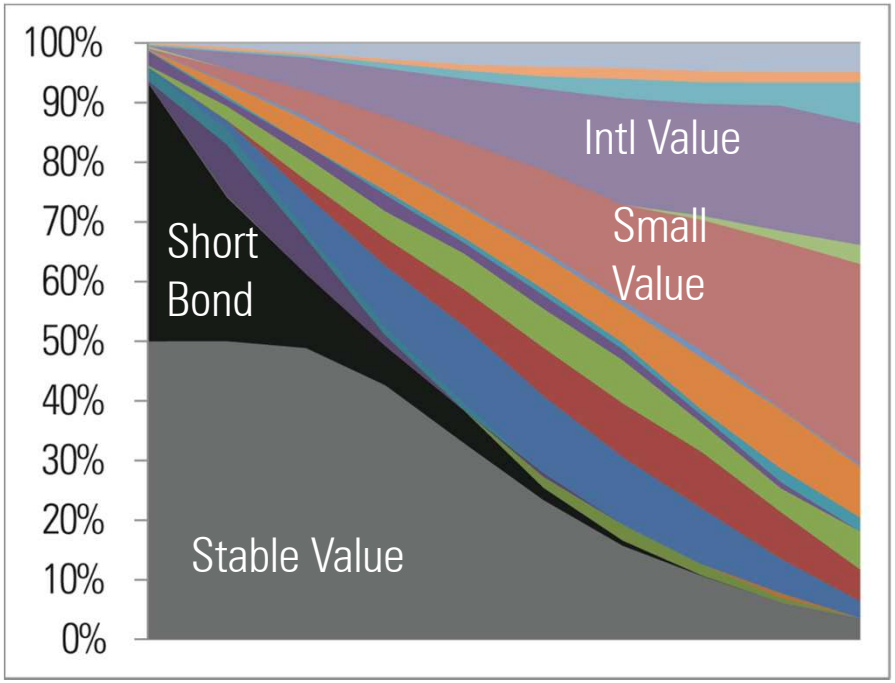
Optimization Differences



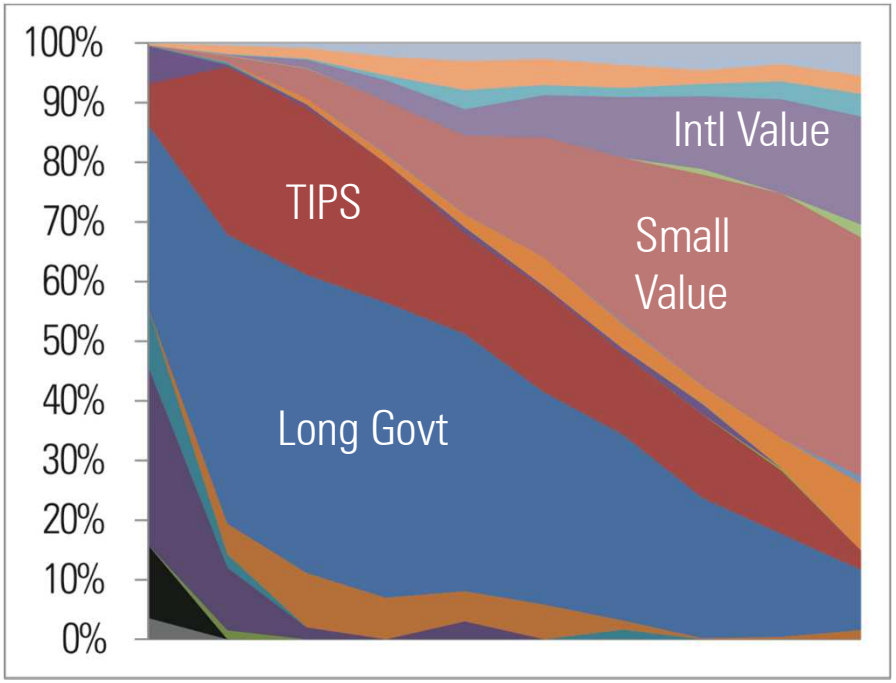


Optimization Differences

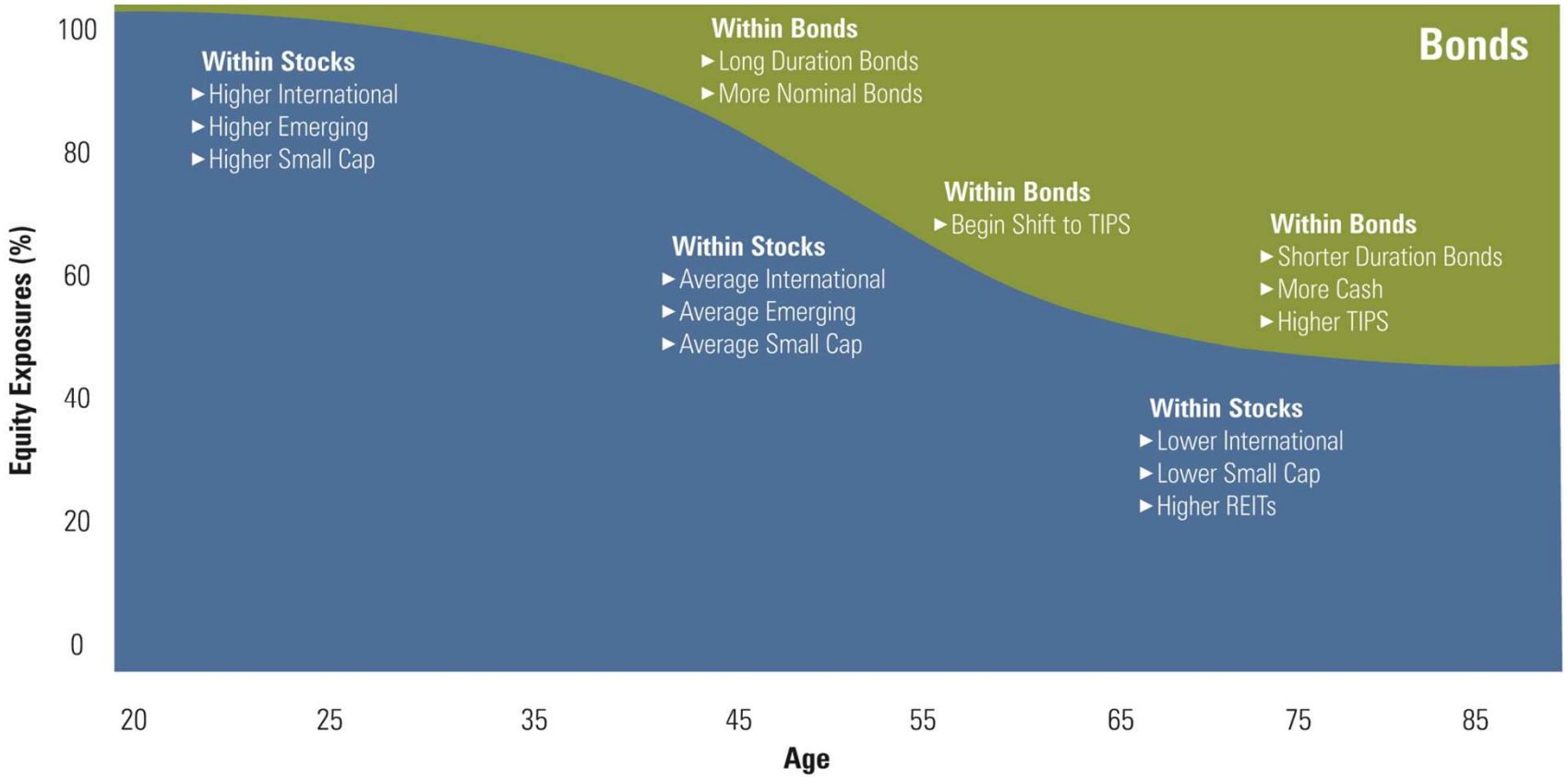
Asset Only Optimization



Liability Relative Only Optimization



Generalized Ibbotson Target Maturity Glide Path



Portfolio Impact Summary

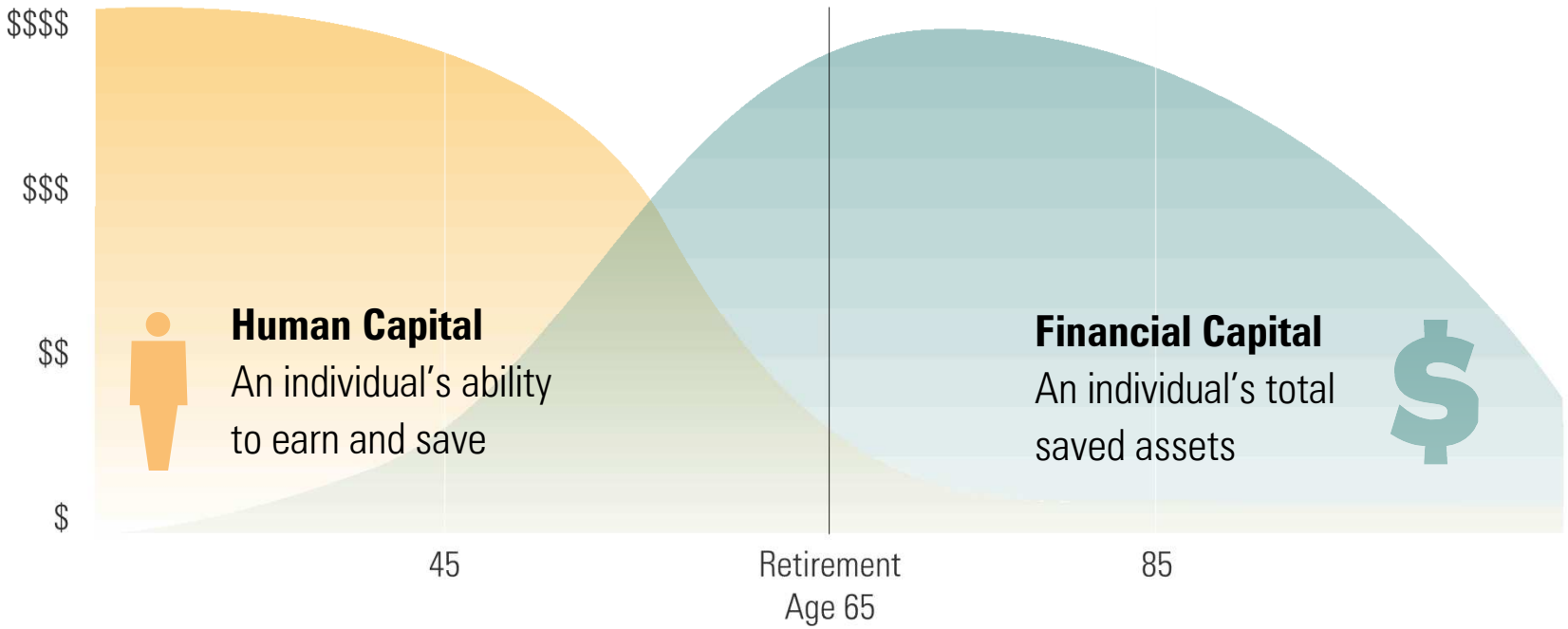
- The differences between liability-relative optimization based asset allocations and asset-only optimization based asset allocation are most significant in conservative, bond-centric portfolios
- Historical & Forward-Looking Optimization Results
  - LRO lead to higher allocations to TIPS and Real Estate
  - LRO lead to mixed evidence of a great home-bias

Retiree Portfolio Implications

Individual Balance Sheet

Assets	Liabilities
Financial Capital	**Future Expenses**
Human Capital	PV of Pre-Retirement Expenses
PV of Earnings used for Pre-Retirement Expenses	PV of Post-Retirement Expenses
PV of Earnings directed toward Savings	PV of Bequest
PV of future Social Security and Pensions	
Surplus (Deficit)	

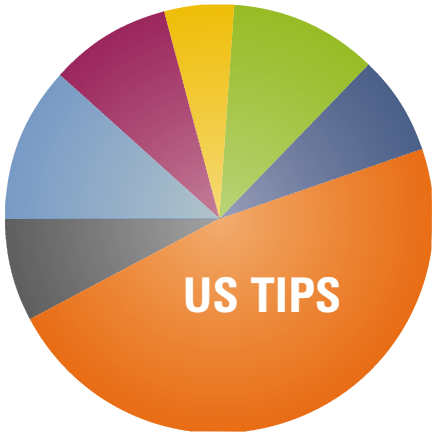
Life Cycle of Human Capital and Financial Capital



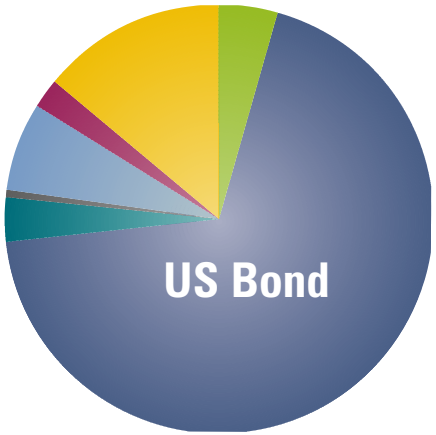
For illustration purposes only

Different Portfolios

Liability Relative Optimization



Asset-Only Optimization



- Cash
- US Bond
- Non US Bond
- US TIPS
- US Large Cap Stock
- US Small Cap Stock
- Non US Large Cap Stock
- Emerging Markets Stock

For illustration purposes only

Average Historical Return When Inflation Exceeds 3%

	Inflation	US Large Stocks	US Small Stocks	Non-US Dev Stocks	US Agg Bonds	TIPS	US Real Estate	Commodities
Dec 07	4.1%	5.5%	-1.6%	11.6%	7.0%	11.6%	-15.7%	16.2%
Dec 05	3.4%	4.9%	4.6%	14.0%	2.4%	2.8%	12.2%	21.4%
Dec 00	3.4%	-9.1%	-3.0%	-14.0%	11.6%	13.2%	26.4%	31.8%
Dec 04	3.3%	10.9%	18.3%	20.7%	4.3%	8.5%	31.6%	9.1%
Dec 11	3.0%	2.1%	-4.2%	-11.7%	7.8%	13.6%	8.3%	-13.3%
Inflation over 3%		**2.9%**	**2.8%**	**4.1%**	**6.6%**	**9.9%**	**12.5%**	**13.1%**
Dec 09	2.7%	26.5%	27.2%	32.5%	5.9%	11.4%	28.0%	18.9%
Dec 99	2.7%	21.0%	21.3%	27.3%	-0.8%	2.4%	-4.6%	24.3%
Dec 06	2.5%	15.8%	18.4%	26.9%	4.3%	0.4%	35.1%	2.1%
Dec 02	2.4%	-22.1%	-20.5%	-15.7%	10.3%	16.6%	3.8%	25.9%
Dec 12	2.3%	16.0%	16.4%	17.9%	4.2%	7.0%	19.7%	-1.1%
Dec 03	1.9%	28.7%	47.3%	39.2%	4.1%	8.4%	37.1%	23.9%
Dec 97	1.7%	33.4%	22.4%	2.1%	9.7%	-1.4%	20.3%	-3.4%
Dec 98	1.6%	28.6%	-2.5%	20.3%	8.7%	4.0%	-17.5%	-27.0%
Dec 01	1.6%	-11.9%	2.5%	-21.2%	8.4%	7.9%	13.9%	-19.5%
Dec 10	1.5%	15.1%	26.9%	8.2%	6.5%	6.3%	27.9%	16.8%
Dec 08	0.1%	-37.0%	-33.8%	-43.1%	5.2%	-2.4%	-37.7%	-35.6%
Inflation under 3%		**10.4%**	**11.4%**	**8.6%**	**6.1%**	**5.5%**	**11.5%**	**2.3%**

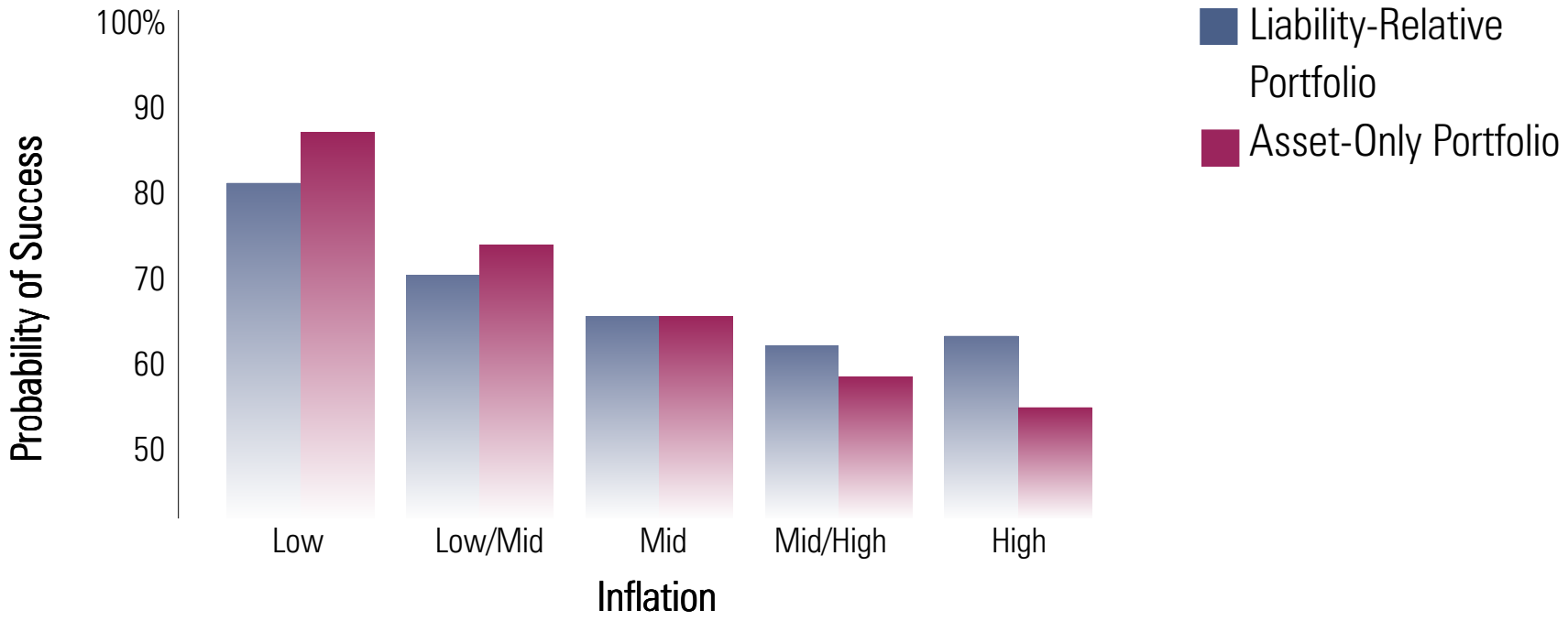
Past performance does not guarantee future results. While obtained from reliable sources, Ibbotson Associates can not guarantee the accuracy or completeness of the information presented." The columns are representative of the returns associated with the indices for each particular asset class. Indexes are unmanaged and cannot be invested in directly. Please see the following slide for additional disclosures on the indices used and how the return information was calculated..

Return and Risk Impact

	Scenario One: Return	Standard Risk	Scenario Two: Return	Surplus Risk
Liability-Relative Optimization	6.00	7.45	3.74	6.79
Asset-Only Optimization	6.00	6.71	3.66	7.38

For illustration only. Source: "Alpha, Beta, … and Now Gamma" by David Blanchett and Paul D. Kaplan, Morningstar White Paper

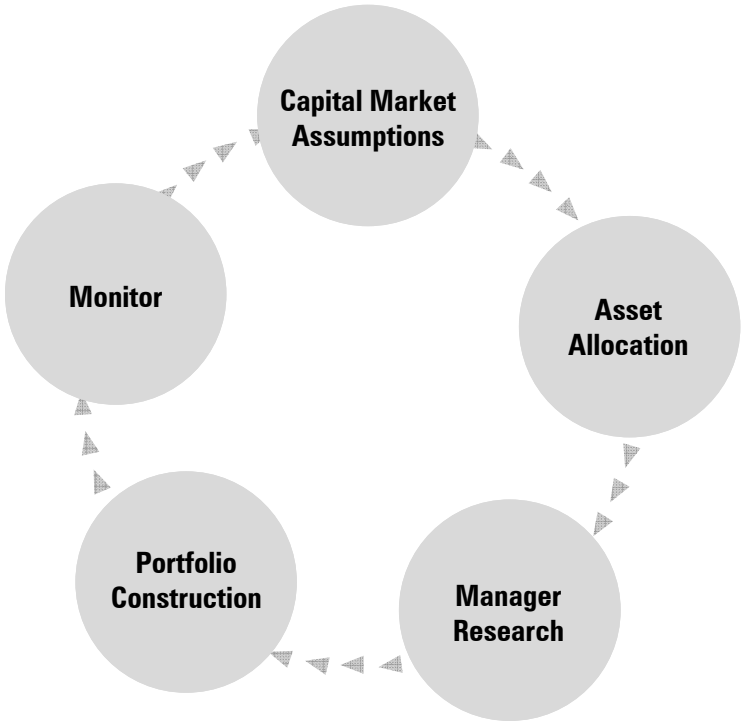
More Consistent Success Rates



For illustration only. Source: "Alpha, Beta, … and Now Gamma" by David Blanchett and Paul D. Kaplan, Morningstar White Paper

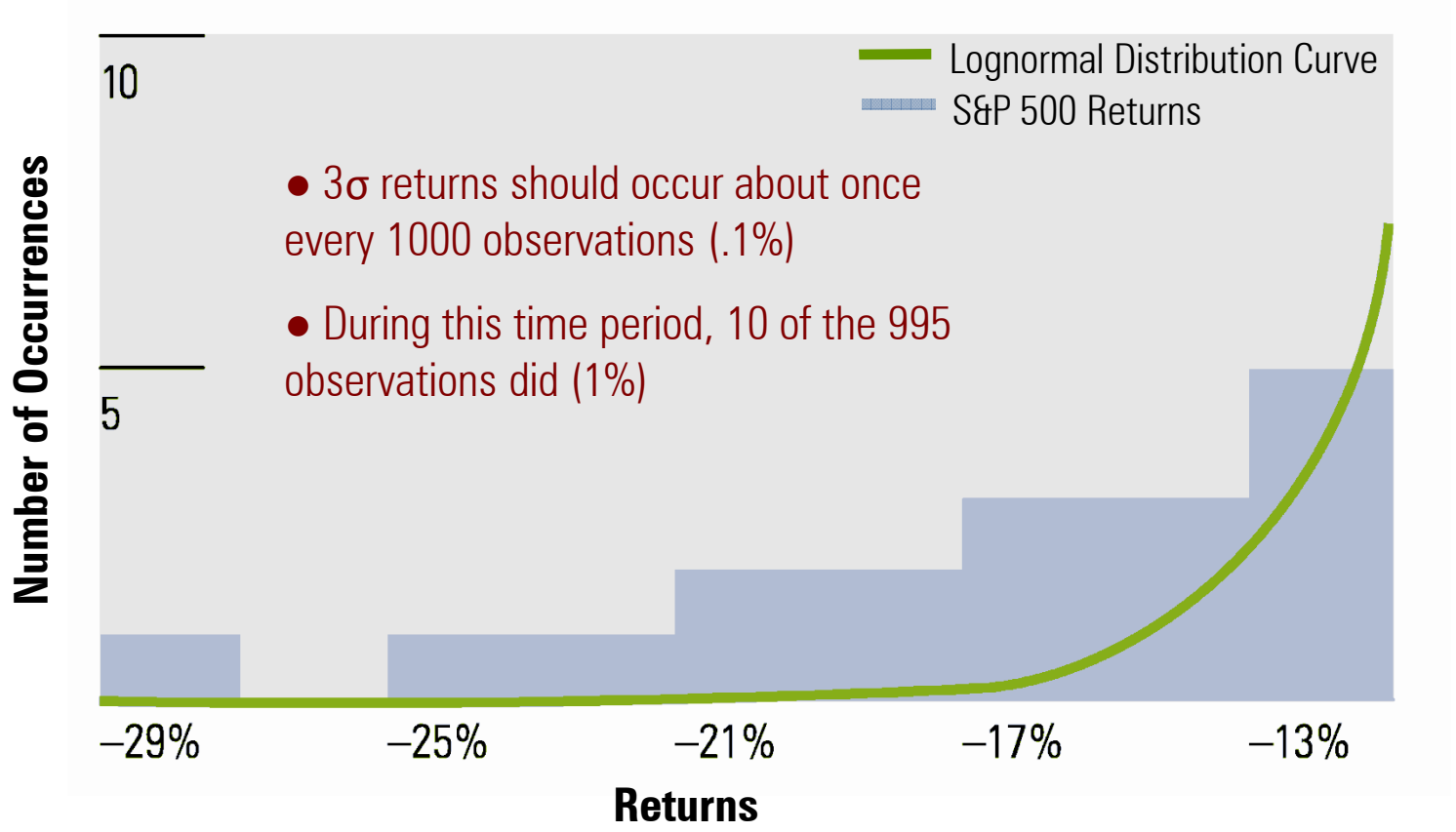
Thoughts on Implementing a Surplus Optimization Approach

The Investment Management Process



The Flaw of the Bell Shaped Curve

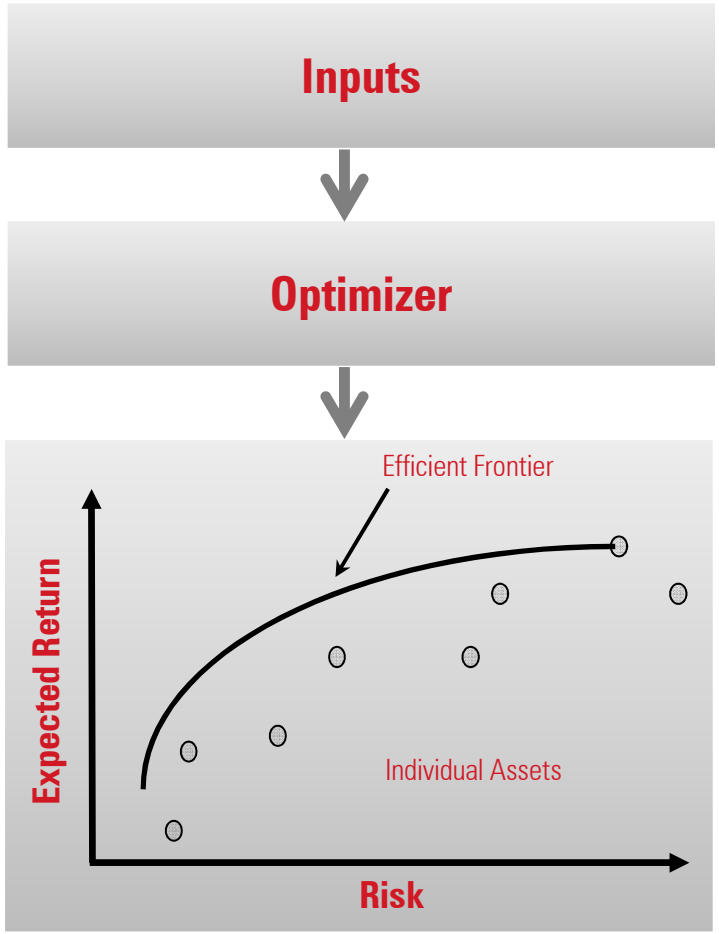
Histogram of S&P 500 Monthly Returns – January 1926 to November 2008



Source: Paul D. Kaplan, "Déja Vu All Over Again," in Morningstar Advisor Magazine, February/March 2009

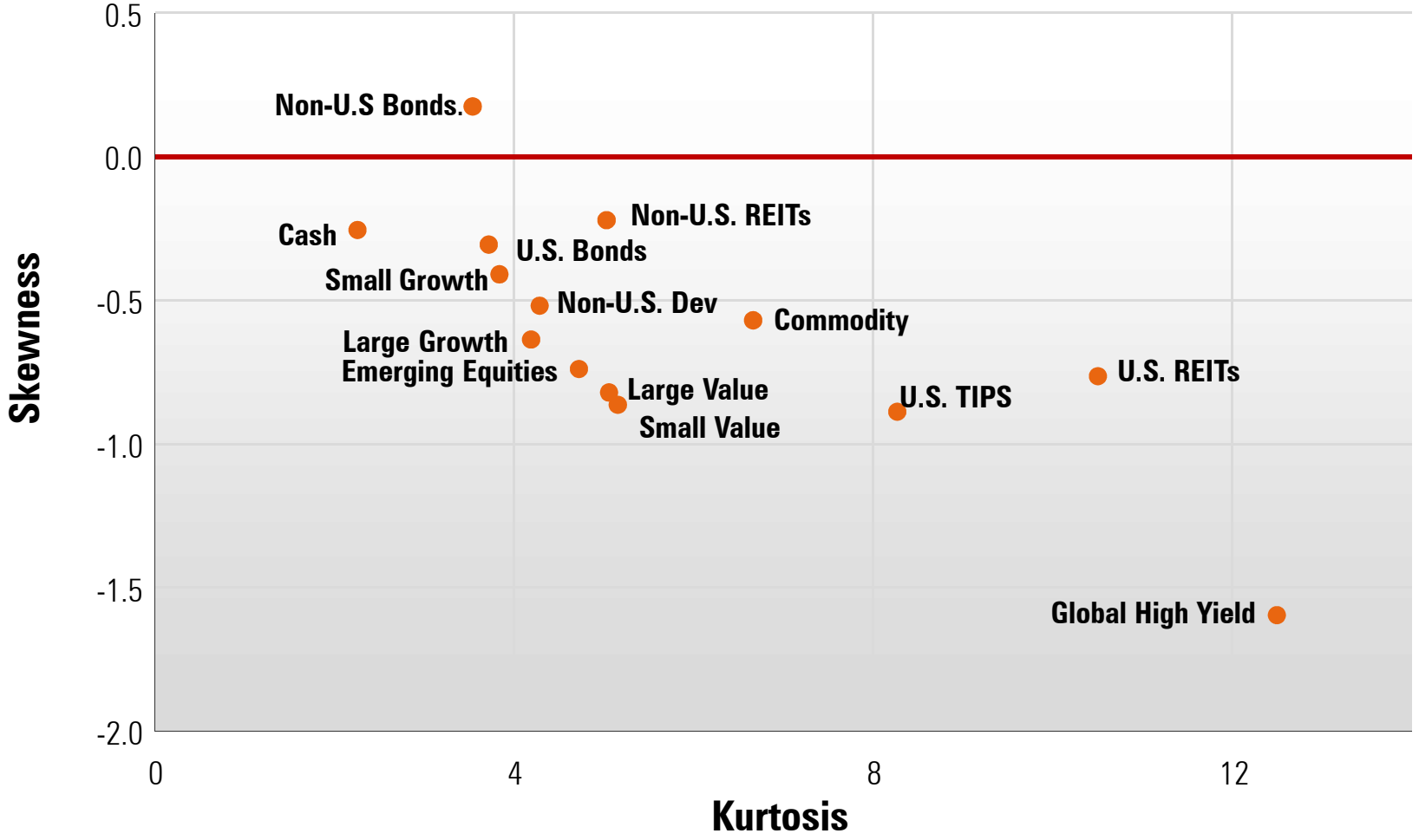
Performance data shown represents past performance. Past performance is not indicative and not a guarantee of future results. Indices shown are unmanaged and not available for direct investment. Performance data does not factor in transaction costs or taxes.

Portfolio Optimization



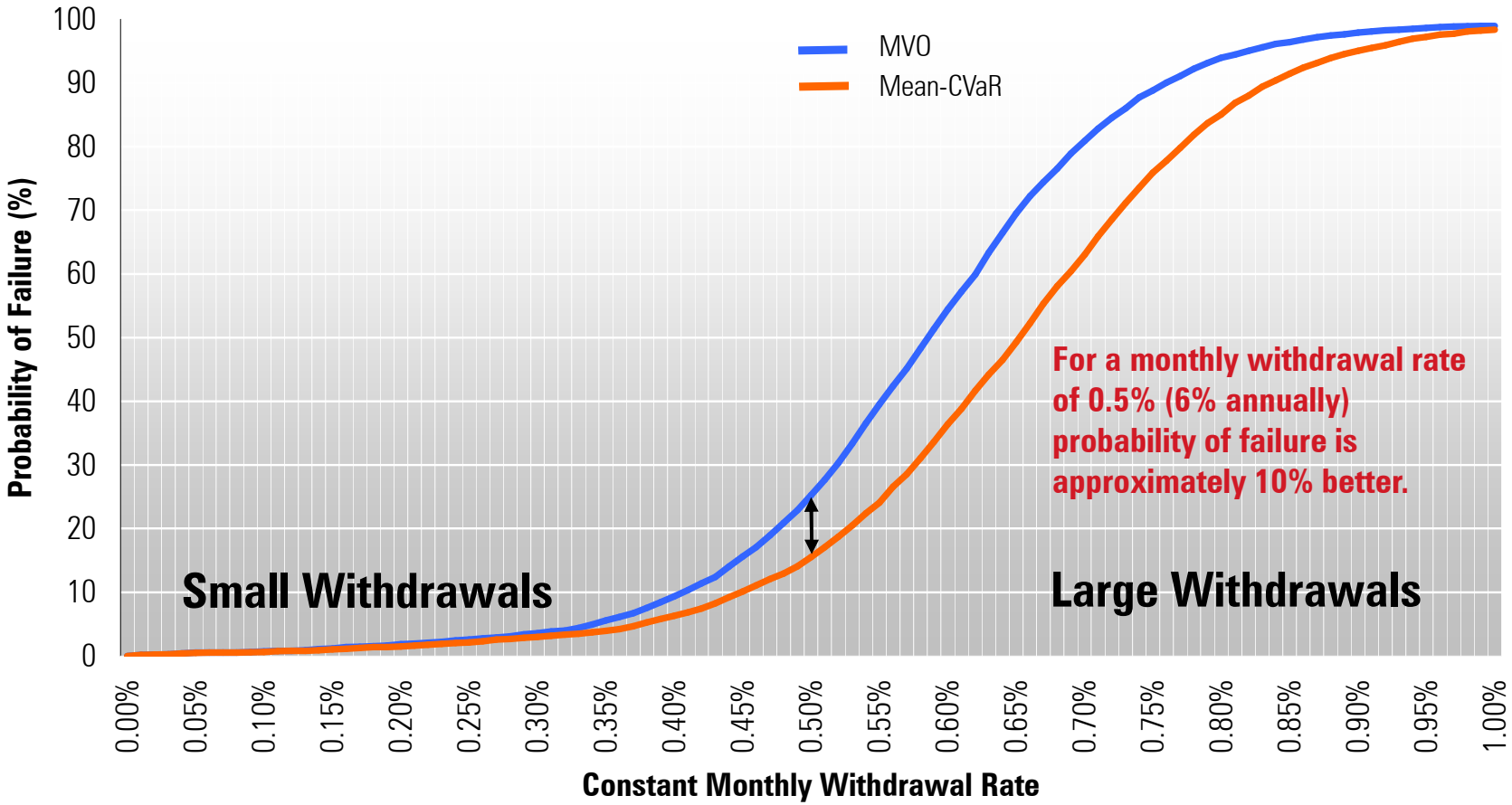
- Mean-conditional value-of-risk (improving on Markowitz [1952, 1959])
- Capital Market Assumption
  - Expected Returns
  - Standard Deviations (Risks)
  - Correlations
  - **Skewness**
  - **Kurtosis**
- Surplus Optimization

Non-Normal Asset Class Returns



Source: "The Impact of Skewness and Fat Tails On the Asset Allocation Decision" by James Xiong and Thomas Idzorek (2011).

Improved Income Sustainability of Mean-CVaR



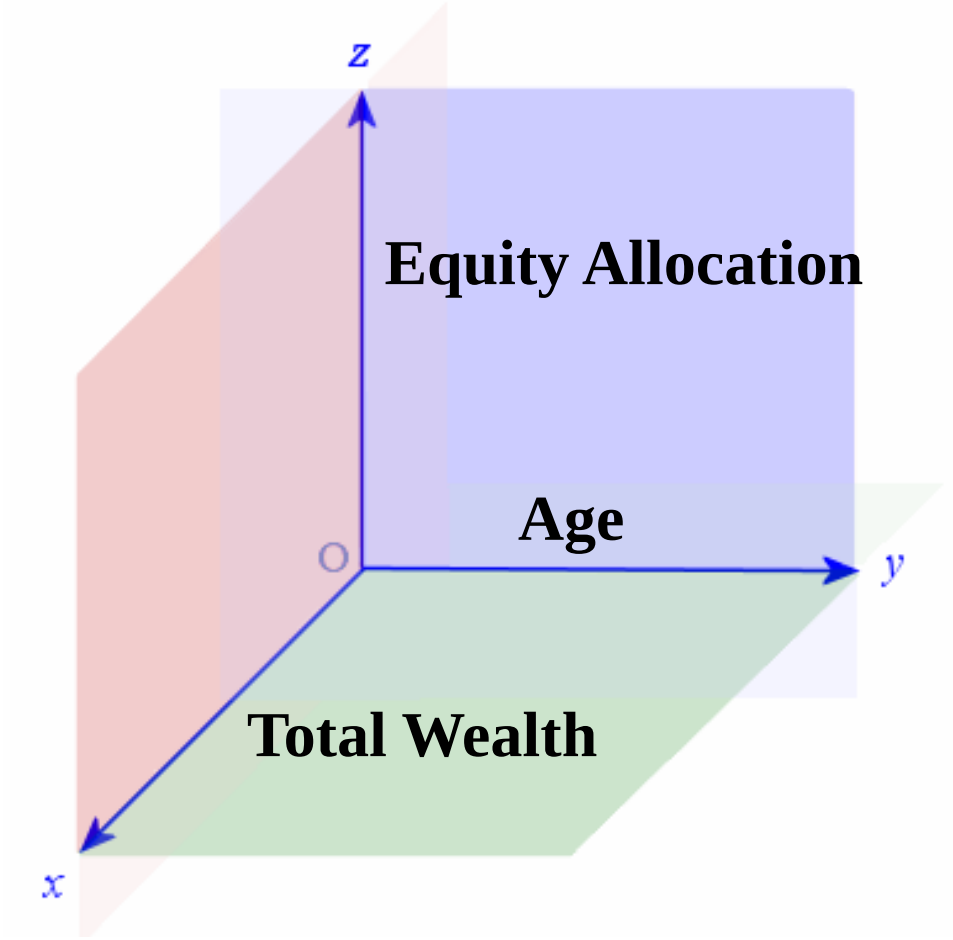
Source: Internal Ibbotson analysis. Monte Carlo simulation is an analytical method used to simulate random returns of uncertain variables to obtain a range of possible outcomes. Such probabilistic simulation does not analyze specific security holdings, but instead analyzes the identified asset classes within the strategy and identified cash flows. The simulation presented is not a guarantee or projection of future results, but rather, an analysis of the likelihood that you may be able to achieve the stated goal and a tool to identify a range of potential outcomes that could potentially be realized. The Monte Carlo simulation is hypothetical in nature and for illustrative purposes only. Results noted may vary with each use and over time.

Morningstar's Current Managed Account Approach (Phase 1, 2D)

	Early Career	Mid Career	Late Career
Age	30	47	65
Equity Percent	60%	60%	60%
Recommendations			
US Large Cap Equity	20%	22%	24%
US Mid Cap Equity	10%	10%	11%
US Small Cap Equity	6%	5%	4%
International Equity	**17%**	**14%**	**12%**
Real Estate (REITs)	**7%**	**9%**	**10%**
Long Term Bonds	**12%**	**9%**	**6%**
Short Term Bonds	22%	20%	17%
TIPS	**4%**	**7%**	**10%**
Cash	2%	4%	6%

For illustrative purposes only.

Morningstar's Managed Accounts Longer-term Goal (Phase 2, 3D)



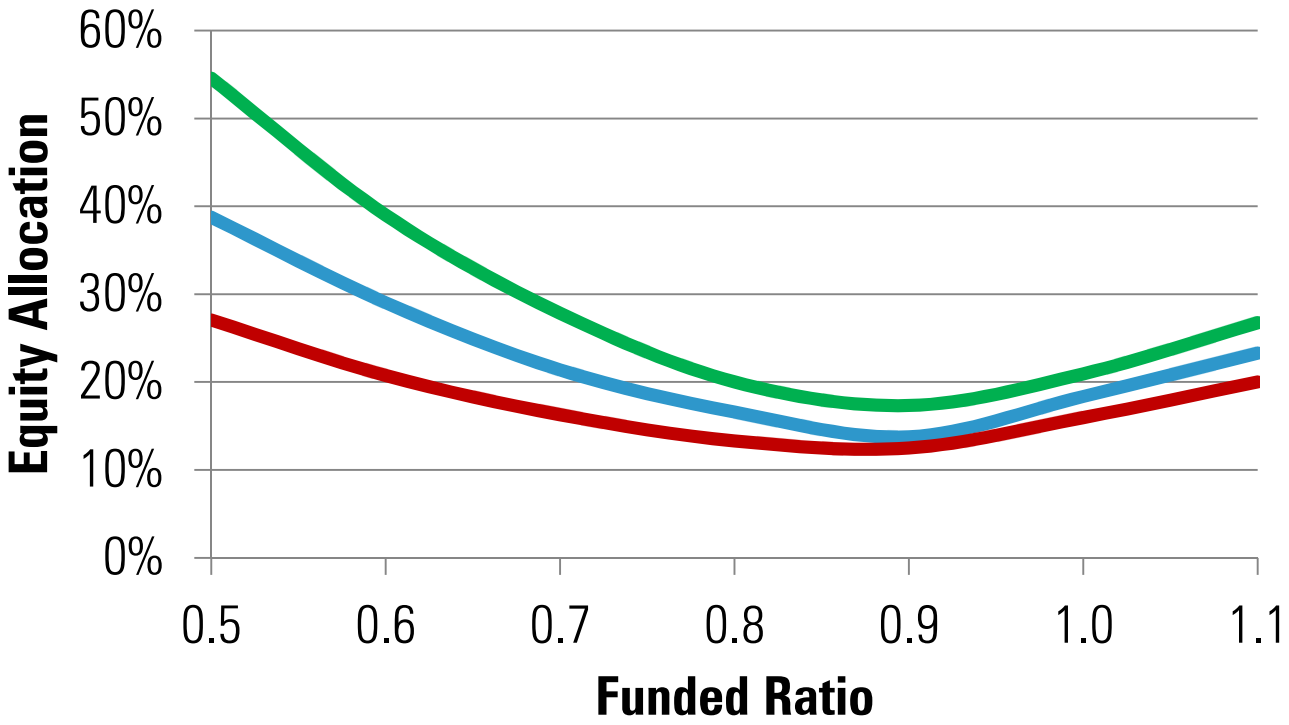
Dynamic Considerations

Investment Considerations

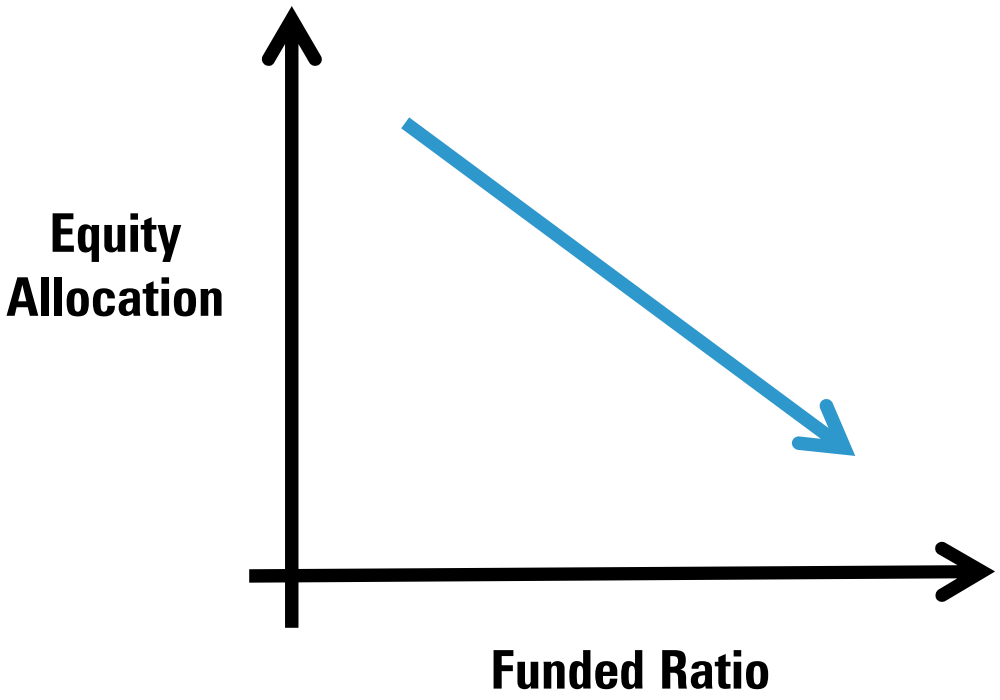
- The incentive to immunize is strongest when the plan is fully funded.
- If overfunded, then a 100% fixed-income portfolio is no longer required to minimize the cost of the corporate pension guarantee. Management can invest surplus pension assets in equities
  - This is a type of portfolio insurance known as contingent immunization
- If the plan is very underfunded, it may be optimal to exploit the put provided by PBGC insurance through a high-risk investment strategy.

"The ABO, the PBO and Pension Investment Policy" by Zvi Bodie, Financial Analysts Journal, September/October 1990, Vol. 46, No. 5: 27-34.

Optimal Allocation for Various Risk Levels



Updating the Portfolio Allocation



Risk Matrix

Risk Score	Funded Ratio						
	0.5	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.1**
High	75%	70%	65%	60%	55%	50%	45%
Mid/High	65%	60%	55%	50%	45%	40%	35%
Mid	50%	45%	40%	40%	35%	30%	30%
Low/Mid	35%	30%	25%	25%	20%	20%	20%
Low	20%	20%	20%	15%	15%	15%	15%

Conclusions

- The Liability-Relative Optimization (LRO) framework is arguably a more appropriate than the traditional asset-only optimization framework
- The differences between liability-relative optimization based asset allocations and asset-only optimization based asset allocation vary depending on the liability
- There is not one optimal 60% equity portfolio, rather, a range of potential portfolios based on the unique risks associated with the client and the client's goals