
Real Estate Investment In Liability-Driven Portfolios

July 2011

Analysis Overview

- ▶ Commercial real estate is widely recognized as one of the four primary core assets: stocks, bonds, real estate and cash.
- ▶ Liability-driven investing (LDI) has received renewed attention, particularly in the aftermath of the global financial crisis.
- ▶ Although liabilities often have been modeled using long-term government or corporate bond returns, most liabilities are linked in some way to inflation.
- ▶ Liability-driven investing need not restrict the opportunity set only to fixed income assets, which remain exposed to
 - ▶ Credit risk
 - ▶ Inflation risk
 - ▶ Political risk
 - ▶ Currency risk
- ▶ This analysis examines strategic allocations to U.S. and international real estate as determined using liability-relative optimization.

Analysis Overview

- ▶ The opportunity set includes 14 asset classes and subclasses.
- ▶ The analysis is conducted from both historical and forward-looking perspectives.
- ▶ Four different liability proxies are used:
 - ▶ Treasury inflation-protected securities (TIPS)
 - ▶ Long-term government bonds
 - ▶ Combination of 50% TIPS, 30% nominal U.S. bonds, 10% U.S. equities and 10% U.S. commercial real estate
 - ▶ Bureau of Labor Statistics “Experimental CPI” (experimental price index for Americans 62 years of age and older)

Major Conclusions

- ▶ Over the period 1990-2009, U.S. commercial real estate had the strongest investment performance among all assets in the opportunity set.
- ▶ Using LDI and historical returns:
 - ▶ Allocations to real return assets were higher in nearly all portfolios.
 - ▶ Allocations to commercial real estate were higher in most portfolios.
 - ▶ The real estate allocation was invested entirely in U.S. real estate.
 - ▶ The average increase in real estate allocations was 2 percentage points.
- ▶ Using LDI and forward-looking returns:
 - ▶ Portfolio allocations were tilted more toward real return assets in moderate risk and risk-averse portfolios.
 - ▶ Allocations to commercial real estate are again higher in most portfolios.
 - ▶ The average increase in real estate allocations was 2 percentage points.
 - ▶ Real estate allocations were invested in both U.S. and non-U.S. real estate.

Part I: Overview of Liability-Driven Investing

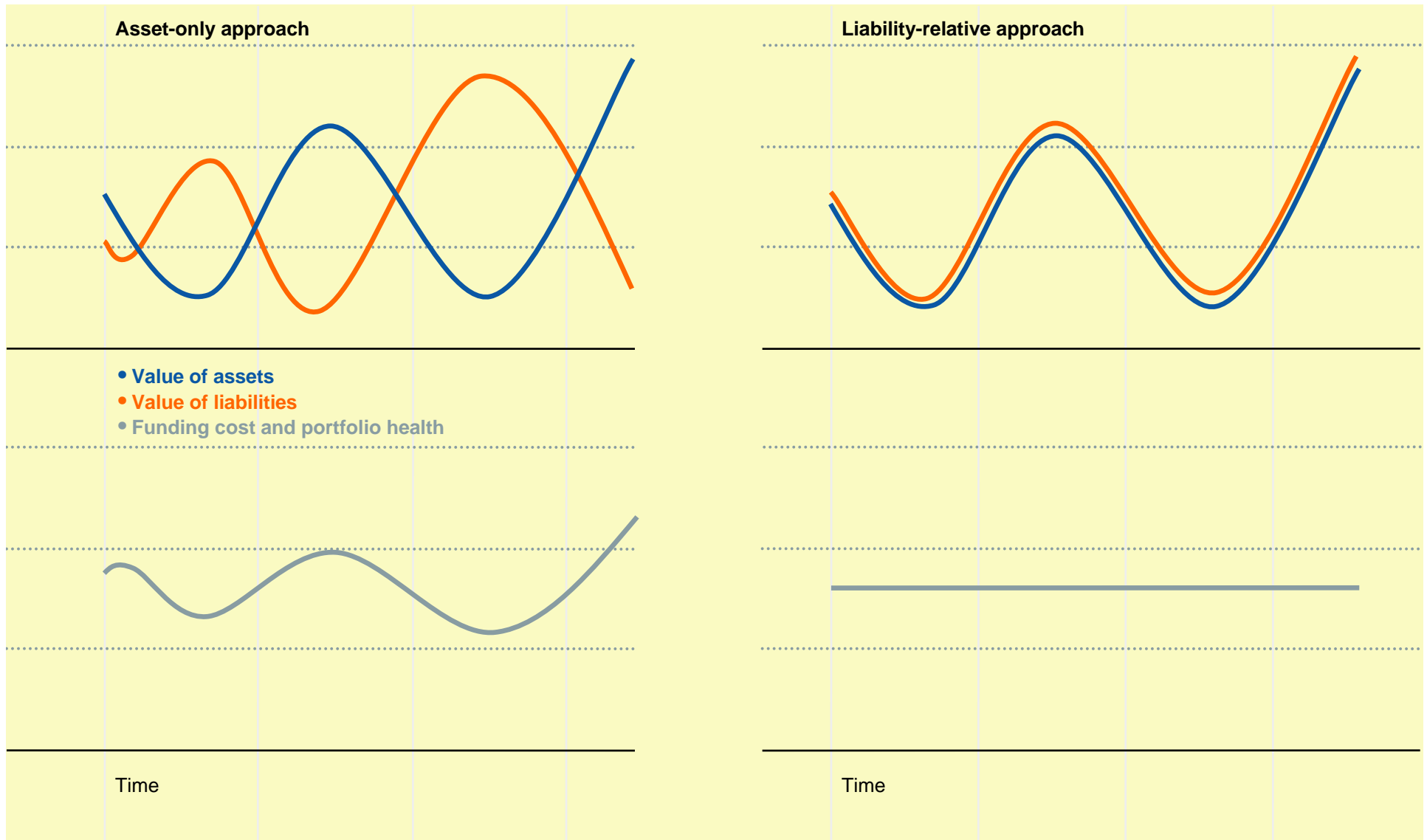
Liability-Driven Investing

- ▶ Growing popularity of liability-driven investing, in particular, the use of liability-relative optimization to set asset allocation policy.
- ▶ Liability-relative optimization commonly used in defined-benefit pensions, endowments, foundations and now target-maturity and retirement-income funds.
- ▶ Liability-focused approaches are typically applied within a defined-benefit pension plan where there is a legal liability, but are also relevant for other portfolios that exist to fund a liability, including:
 - ▶ Individual investors funding their future retirement income
 - ▶ Foundations and endowments seeking to preserve purchasing power of their portfolios
 - ▶ Insurance companies managing payouts in conjunction with a pool of assets

Asset-Only Versus Liability-Relative Optimization

- ▶ Asset-only approach to portfolio optimization identifies allocations across the opportunity set that maximize expected portfolio return subject to risk constraints based on the variability of asset values.
- ▶ Variability of asset values is only a partial measure of risk.
- ▶ Maximum returns to portfolio assets may not be well aligned with future payout obligations of portfolio liabilities.
- ▶ Asset-only approach ignores the natural, albeit incomplete, hedge between the assets and the liabilities that form the investor's total portfolio.
- ▶ In the presence of liabilities, variance of the surplus (assets less liabilities) is a more appropriate and useful measure of risk.
- ▶ Liability-relative optimization maximizes expected portfolio return subject to risk constraints based on the variability of the funding surplus.
- ▶ Liability-relative optimization often leads to more stable and predictable funding costs.

Advantages of Liability-Relative Models Over Asset-Only Optimization



Part II: Historical Analysis

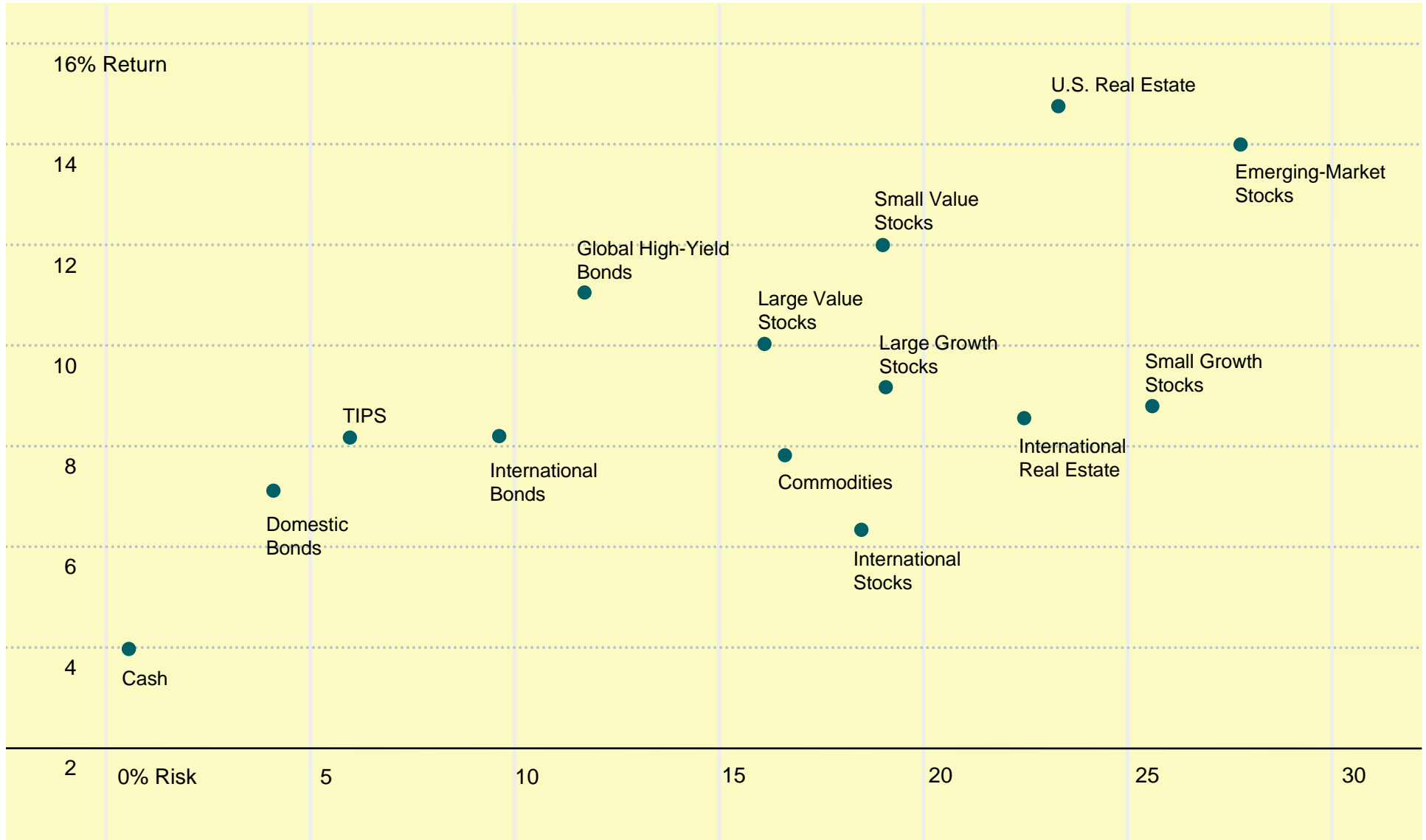
Asset Class Selection

Opportunity set

Asset Classes	Asset Class Proxies
U.S. Large-Cap Value Stocks	Russell 1000 Value
U.S. Large-Cap Growth Stocks	Russell 1000 Growth
U.S. Small-Cap Value Stocks	Russell 2000 Value
U.S. Small-Cap Growth Stocks	Russell 2000 Growth
International Stocks	MSCI World ex U.S.
Emerging-Market Stocks	MSCI Emerging Markets
Commodities	Ibbotson Associates Commodity Composite
International Real Estate	FTSE EPRA/NAREIT Global Developed ex U.S.
U.S. Real Estate	FTSE EPRA/NAREIT United States
Domestic Bonds	Barclays Capital U.S. Aggregate Bonds
International Bonds	Citigroup World BIG ex U.S. Index (1999 – 2009) Citigroup Non-U.S. Dollar World Government Bond Index (1990 – 1998)
TIPS	Barclays Capital Global Inflation Linked U.S. TIPS
Global High-Yield Bonds	Barclays Capital Global High Yield
Cash	Citigroup U.S. Domestic 3-Month Treasury Bill

The Opportunity Set

Risk versus return: 1990–2009



Asset Class Characteristics of the Opportunity Set 1990–2009

Asset Classes	Arithmetic Annual Return	Compounded Annual Return	Standard Deviation	Sharpe Ratio
U.S. Large-Cap Value	10.02%	8.82%	16.13%	0.38
U.S. Large-Cap Growth	9.15%	7.48%	19.10%	0.27
U.S. Small-Cap Value	11.97%	10.34%	19.02%	0.42
U.S. Small-Cap Growth	8.78%	5.81%	25.63%	0.19
International Stocks	6.31%	4.70%	18.51%	0.13
Emerging-Market Stocks	13.97%	10.58%	27.79%	0.36
Commodities	7.80%	6.51%	16.64%	0.23
International Real Estate	8.53%	6.24%	22.49%	0.20
U.S. Real Estate	14.74%	12.33%	23.33%	0.46
Domestic Bonds	7.09%	7.01%	4.12%	0.76
International Bonds	8.17%	7.75%	9.64%	0.44
Global High-Yield Bonds	11.04%	10.40%	11.73%	0.60
TIPS	8.15%	7.98%	5.99%	0.70
Cash	3.94%	3.94%	0.58%	0.00

Asset Class Correlations

1990–2009

Asset Classes	U.S. Large-Cap Value	U.S. Large-Cap Growth	U.S. Small-Cap Value	U.S. Small-Cap Growth	Int'l. Stocks	Emerg. Market Stocks	Commodities	Int'l. Real Estate	U.S. Real Estate	Domestic Bonds	Int'l. Bonds	Global High-Yield Bonds	TIPS	Cash
U.S. Large-Cap Value	1.00													
U.S. Large-Cap Growth	0.78	1.00												
U.S. Small-Cap Value	0.81	0.67	1.00											
U.S. Small-Cap Growth	0.65	0.82	0.83	1.00										
International Stocks	0.69	0.68	0.61	0.63	1.00									
Emerging-Market Stocks	0.63	0.66	0.63	0.67	0.72	1.00								
Commodities	0.18	0.15	0.15	0.18	0.27	0.29	1.00							
International Real Estate	0.63	0.54	0.58	0.52	0.79	0.72	0.27	1.00						
U.S. Real Estate	0.64	0.45	0.76	0.51	0.47	0.43	0.14	0.51	1.00					
Domestic Bonds	0.20	0.14	0.11	0.03	0.14	0.02	0.01	0.21	0.19	1.00				
International Bonds	0.12	0.06	0.05	0.02	0.36	0.09	0.16	0.36	0.18	0.49	1.00			
Global High-Yield Bonds	0.63	0.59	0.65	0.61	0.59	0.70	0.25	0.60	0.56	0.27	0.10	1.00		
TIPS	0.18	0.12	0.13	0.06	0.18	0.11	0.24	0.25	0.25	0.75	0.45	0.34	1.00	
Cash	0.05	0.06	-0.03	-0.02	-0.07	-0.10	0.02	-0.10	-0.03	0.11	-0.03	-0.08	0.02	1.00

Efficient Portfolios

An introduction into the models and details

- ▶ **Traditional Markowitz optimization**
 - ▶ Treats capital market assumptions as certain
 - ▶ Is very sensitive to small changes and errors

- ▶ **Resampled optimization**
 - ▶ Recognizes capital market assumptions are not certain
 - ▶ Combines traditional optimization and Monte Carlo simulation to develop more robust asset allocation estimates
 - ▶ Considers alternative investment scenarios with different asset returns, volatilities, and correlations

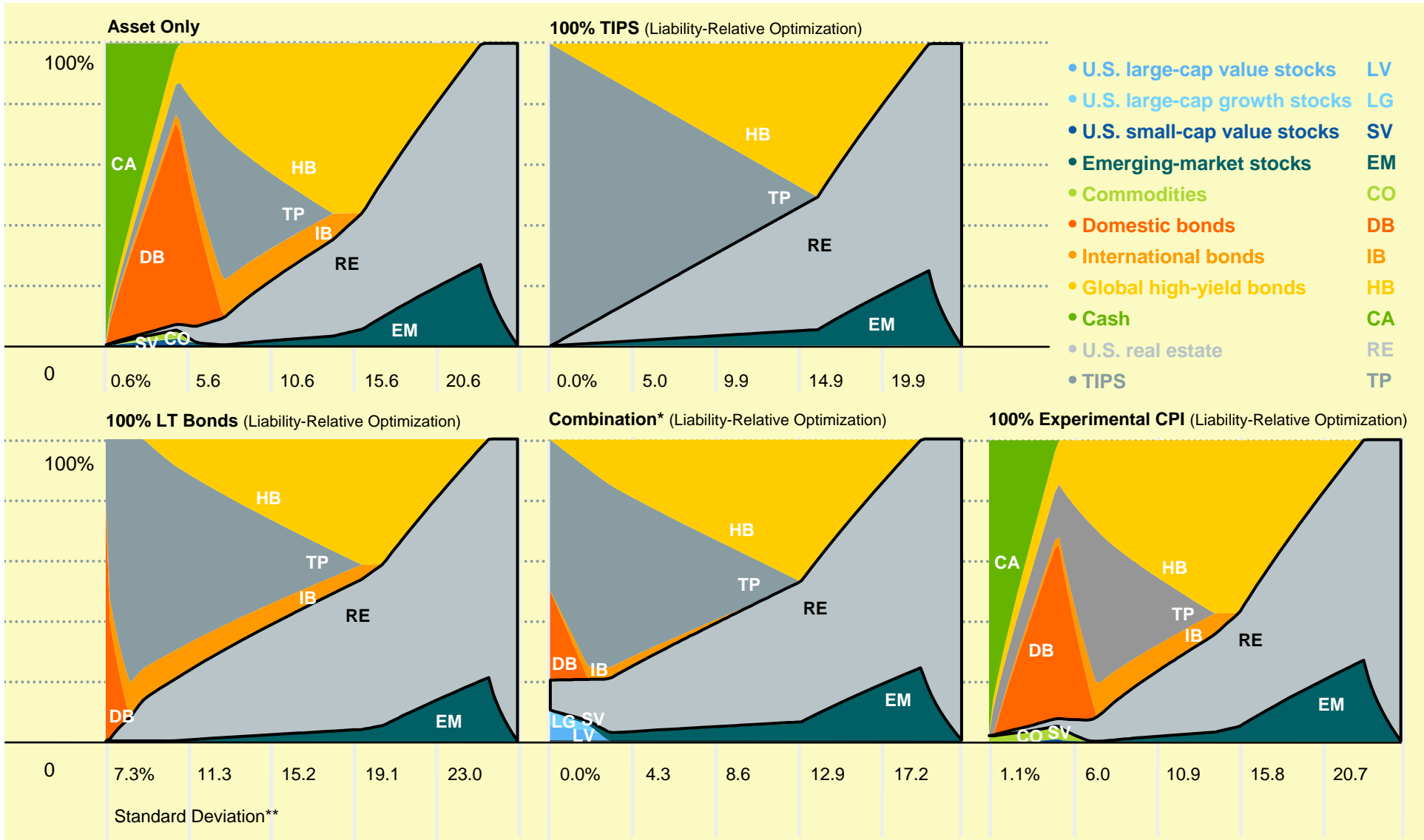
- ▶ **Efficient portfolio is identified for each scenario**

- ▶ **Scenarios are grouped within specific ranges of risk**

- ▶ **Allocations are averaged for all scenarios in each risk range to construct the “most efficient” portfolio**

Historical Results

Asset allocation area graphs



*50% TIPS, 30% nominal U.S. bonds, 10% U.S. equities & 10% U.S. real estate ** First graph is standard deviation while other four are surplus standard deviation. © 2011 Morningstar. Analysis conducted by Ibbotson Associates. Ibbotson Associates is a registered investment advisor, and wholly owned subsidiary of Morningstar. All Rights Reserved. 7/1/2011

Portfolio Allocations

% of total assets allocated to TIPS, U.S. real estate and commodities

Asset Mixes	Asset-Only Optimization	Liability-Relative Optimization (TIPS)	Liability-Relative Optimization (Long-Term Bonds)	Liability-Relative Optimization (Combination)	Liability-Relative Optimization (Experimental CPI)
20% Stocks / 80% Bonds	47%	77%	82%	60%	47%
30% Stocks / 70% Bonds	37%	66%	73%	70%	37%
40% Stocks / 60% Bonds	36%	55%	63%	59%	36%
50% Stocks / 50% Bonds	42%	45%	53%	50%	43%
60% Stocks / 40% Bonds	48%	51%	54%	51%	48%
70% Stocks / 30% Bonds	54%	57%	60%	57%	55%
80% Stocks / 20% Bonds	60%	63%	66%	64%	61%
90% Stocks / 10% Bonds	67%	69%	73%	70%	67%

Portfolio Allocations

% of total assets allocated to U.S. real estate

Asset Mixes	Asset-Only Optimization	Liability-Relative Optimization (TIPS)	Liability-Relative Optimization (Long-Term Bonds)	Liability-Relative Optimization (Combination)	Liability-Relative Optimization (Experimental CPI)
20% Stocks / 80% Bonds	18%	18%	20%	10%	19%
30% Stocks / 70% Bonds	28%	27%	29%	26%	28%
40% Stocks / 60% Bonds	36%	35%	38%	36%	36%
50% Stocks / 50% Bonds	42%	45%	47%	44%	43%
60% Stocks / 40% Bonds	48%	51%	54%	51%	48%
70% Stocks / 30% Bonds	54%	57%	60%	57%	55%
80% Stocks / 20% Bonds	60%	63%	66%	64%	61%
90% Stocks / 10% Bonds	67%	69%	73%	70%	67%

Overall Conclusions From Historical Analysis

- ▶ Asset allocations derived from all five optimizations converge for more risk-tolerant portfolios (right-hand side).
- ▶ In contrast, asset allocations derived from each of the five optimizations diverge for more risk-averse portfolios (left-hand side) because liability-relative optimization matches more precisely the systemic characteristics of the liability proxy with the natural hedges available in the opportunity set.
- ▶ Using either asset-only or liability-relative optimization, TIPS, global high-yield bonds and U.S. commercial real estate received large allocations over the past 20 years because of their high risk-adjusted returns.
- ▶ In all cases, U.S. commercial real estate received larger allocations in moderate risk to risk-tolerant portfolios, whereas TIPS received larger allocations in moderate risk to risk-averse portfolios.
- ▶ Allocations to U.S. commercial real estate are relatively stable across the different optimizations. The average increase in U.S. real estate allocations using liability-relative optimization compared with asset-only optimization was 2 percentage points.

Conclusions From Historical Analysis

Assets allocated to TIPS, real estate and commodities

- ▶ Liability-relative optimization leads to a larger role for real return assets in a strategic asset allocation, illustrating how LDI takes advantage of the natural, albeit incomplete, hedges that exist between the assets in the portfolio and the systemic risk factors affecting the value of the liabilities.
- ▶ Liability-relative optimization results in higher allocations to the real return assets of TIPS, real estate and commodities in nearly all portfolios.
- ▶ The increase in portfolio allocations to real return assets using liability-relative optimization compared with asset-only optimization is greater in moderate risk and more risk-averse (or bond-centric) portfolios.
- ▶ The average increase in allocations to TIPS, real estate and commodities using liability-relative optimization compared with asset-only optimization was 10 percentage points.

Conclusions From Historical Analysis

Assets allocated to real estate

- ▶ Allocations to real estate are higher in almost all portfolios using liability-relative optimization compared with asset-only optimization.
- ▶ Allocations to real estate increase uniformly as stock-bond split becomes more equity-centric.
- ▶ Both asset-only and liability-relative optimization invest the entire real estate allocation in U.S. real estate because of high risk-adjusted returns compared with non-U.S. real estate.
- ▶ Liability-relative optimization using 100 percent long-term bonds as the liability proxy results in the highest allocations to real estate across all portfolios.
- ▶ Allocations to U.S. commercial real estate are relatively stable across the different optimizations. The average increase in real estate allocations using liability-relative optimization compared with asset-only optimization was 2 percentage points.

Part III: Forward-Looking Analysis

Forward-Looking Analysis

- ▶ Historical returns are not necessarily a reliable guide to future performance
- ▶ The optimal strategy in the past may not be optimal in the future
- ▶ Disciplined methods are available for developing robust forward-looking allocations
- ▶ Asset allocations are more robust and more evenly distributed across all assets in the opportunity set

CAPM Model of Forward-Looking Analysis

- ▶ Capital Asset Pricing Model (CAPM)
 - ▶ Investors demand above average returns for assets that contribute above average risk to the market portfolio
 - ▶ Requires estimate of the unobservable market portfolio
 - ▶ Returns developed using risk-free rate and large-cap equity risk premium
 - Long-term risk-free rate: 4.58%
 - Equity risk premium: 5.08%
 - ▶ Historical volatilities and correlations

Market Capitalization Estimates

Asset Class	Market Capitalization (in billions)	Weight in Market Portfolio
U.S. Large-Cap Value	\$5,448	8.00%
U.S. Large-Cap Growth	\$5,595	8.21%
U.S. Small-Cap Value	\$482	0.71%
U.S. Small-Cap Growth	\$456	0.67%
International Stocks	\$11,258	16.53%
Emerging-Market Stocks	\$3,247	4.77%
Commodities	\$8,527	12.52%
International Real Estate	\$4,999	7.34%
U.S. Real Estate	\$2,200	3.23%
Domestic Bonds	\$13,577	19.94%
International Bonds	\$10,042	14.74%
Global High-Yield Bonds	\$1,146	1.68%
TIPS	\$514	0.75%
Cash	\$616	0.90%
Total	\$68,106	100.00%

CAPM Expected Returns

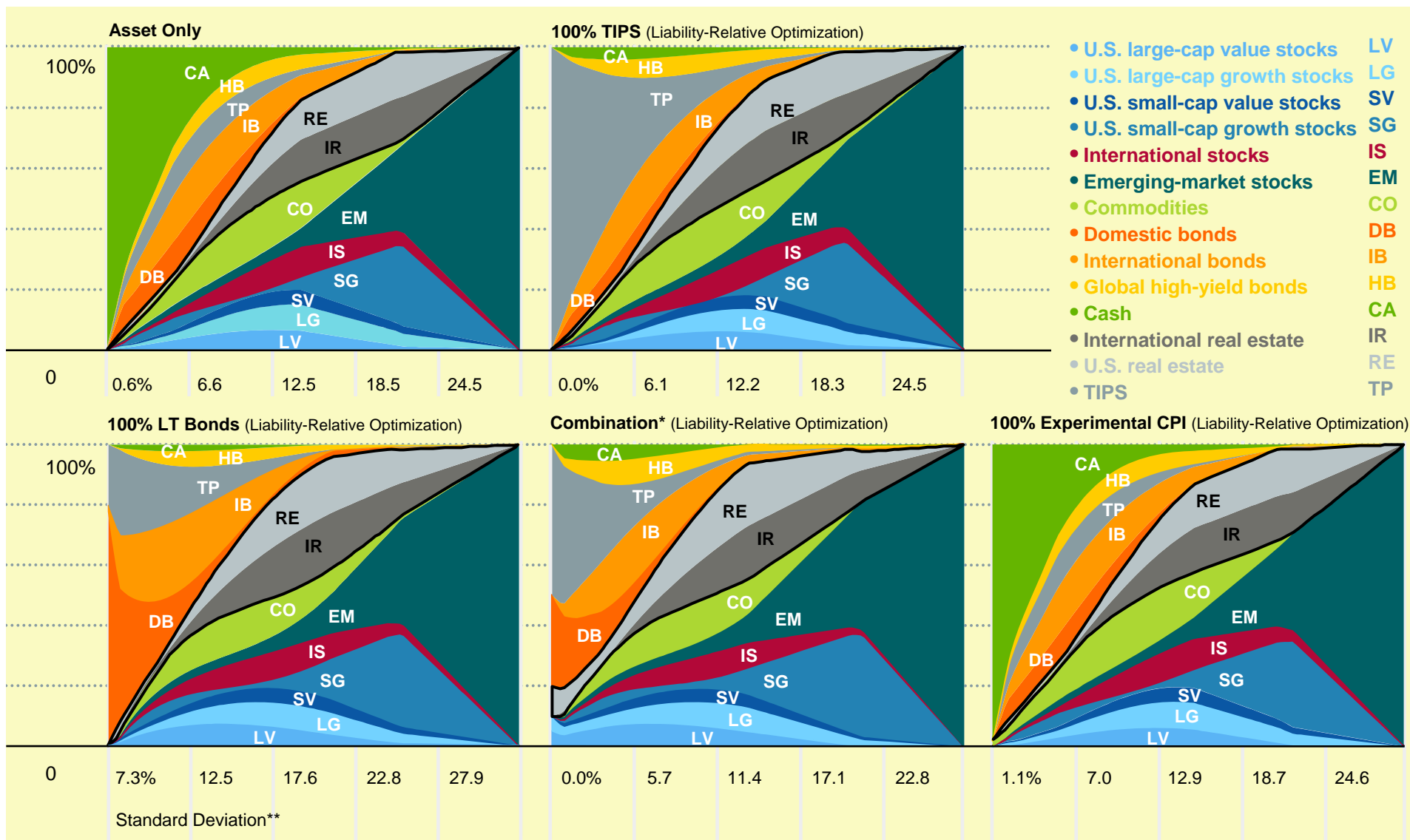
Asset Class	CAPM Expected Returns
U.S. Large-Cap Value	8.80%
U.S. Large-Cap Growth	9.32%
U.S. Small-Cap Value	9.03%
U.S. Small-Cap Growth	10.42%
International Stocks	10.08%
Emerging-Market Stocks	11.77%
Commodities	7.09%
International Real Estate	10.86%
U.S. Real Estate	9.24%
Domestic Bonds	4.99%
International Bonds	5.95%
Global High-Yield Bonds	7.31%
TIPS	5.28%
Cash	4.57%

Long-term risk-free rate: 4.58%

Equity risk premium: 5.08%

Forward-Looking Results

Asset allocation area graphs



*50% TIPS, 30% nominal U.S. bonds, 10% U.S. equities & 10% U.S. real estate ** First graph is standard deviation while other four are surplus standard deviation. © 2011 Morningstar. Analysis conducted by Ibbotson Associates. Ibbotson Associates is a registered investment advisor, and wholly owned subsidiary of Morningstar. All Rights Reserved. 7/1/2011

Portfolio Allocations

% of total assets allocated to TIPS, real estate and commodities

Asset Mixes	Asset-Only Optimization	Liability-Relative Optimization (TIPS)	Liability-Relative Optimization (Long-Term Bonds)	Liability-Relative Optimization (Combination)	Liability-Relative Optimization (Experimental CPI)
20% Stocks / 80% Bonds	18%	55%	31%	52%	20%
30% Stocks / 70% Bonds	25%	50%	32%	38%	26%
40% Stocks / 60% Bonds	30%	48%	34%	35%	31%
50% Stocks / 50% Bonds	35%	48%	38%	37%	36%
60% Stocks / 40% Bonds	39%	49%	42%	40%	41%
70% Stocks / 30% Bonds	43%	50%	47%	44%	43%
80% Stocks / 20% Bonds	44%	50%	49%	49%	45%
90% Stocks / 10% Bonds	38%	44%	48%	51%	40%

Portfolio Allocations

% of total assets allocated to real estate

Asset Mixes	Asset-Only Optimization	Liability-Relative Optimization (TIPS)	Liability-Relative Optimization (Long-Term Bonds)	Liability-Relative Optimization (Combination)	Liability-Relative Optimization (Experimental CPI)
20% Stocks / 80% Bonds	1%	1%	2%	8%	1%
30% Stocks / 70% Bonds	3%	5%	4%	5%	2%
40% Stocks / 60% Bonds	7%	10%	7%	8%	6%
50% Stocks / 50% Bonds	12%	14%	13%	13%	11%
60% Stocks / 40% Bonds	17%	21%	19%	20%	17%
70% Stocks / 30% Bonds	22%	26%	27%	26%	22%
80% Stocks / 20% Bonds	27%	31%	33%	32%	28%
90% Stocks / 10% Bonds	29%	32%	37%	38%	30%

Portfolio Allocations

% of total real estate allocated to non-U.S. real estate

Asset Mixes	Asset-Only Optimization	Liability-Relative Optimization (TIPS)	Liability-Relative Optimization (Long-Term Bonds)	Liability-Relative Optimization (Combination)	Liability-Relative Optimization (Experimental CPI)
20% Stocks / 80% Bonds	0%	26%	54%	10%	2%
30% Stocks / 70% Bonds	41%	44%	56%	1%	33%
40% Stocks / 60% Bonds	48%	48%	54%	21%	46%
50% Stocks / 50% Bonds	50%	49%	53%	33%	49%
60% Stocks / 40% Bonds	51%	50%	52%	38%	50%
70% Stocks / 30% Bonds	51%	50%	52%	41%	51%
80% Stocks / 20% Bonds	51%	50%	51%	43%	51%
90% Stocks / 10% Bonds	49%	50%	51%	46%	50%

Overall Conclusions From Forward-Looking Analysis

- ▶ Not surprisingly, overall asset allocations are more robust, taking full advantage of the complete opportunity set.
- ▶ For risk-tolerant portfolios (right-hand side), asset allocations derived from all five optimizations tend to converge.
- ▶ For more risk-averse portfolios (left-hand side), asset allocations derived from each of the five optimizations tend to diverge because liability-relative optimization matches more precisely the systemic characteristics of the liability proxy with the natural hedges available in the opportunity set.
- ▶ Even with more robust and evenly distributed allocations using forward-looking returns, both asset-only and liability-relative optimization include appreciable allocations to real return assets, including U.S. and non-U.S. commercial real estate.
- ▶ The average increase in real estate allocations using liability-relative optimization compared with asset-only optimization was approximately 2 percentage points.
- ▶ The proportion of the total real estate allocation invested in U.S. real estate (the home bias) using liability-relative optimization compared with asset-only optimization was on average unchanged.

Conclusions From Forward-Looking Analysis

Assets allocated to TIPS, real estate and commodities

- ▶ Allocations to all three real return assets combined are lower using forward-looking expected returns compared with historical returns because forward-looking returns lead to more robust and evenly-distributed allocations across the opportunity set.
- ▶ However, portfolio allocations remain tilted more toward the real return assets of TIPS, real estate and commodities when using liability-relative optimization compared with asset-only optimization for both historical and forward-looking returns.
- ▶ The increase in portfolio allocations to real return assets when using liability-relative optimization compared with asset-only optimization is most pronounced when the liability proxy is TIPS.
- ▶ The average increase in allocations to TIPS, real estate and commodities using liability-relative optimization compared with asset-only optimization was 8 percentage points.

Conclusions From Forward-Looking Analysis

Assets allocated to real estate

- ▶ Allocations to real estate also are lower using forward-looking expected returns compared with historical returns because forward-looking returns lead to more robust and evenly-distributed allocations across the opportunity set.
- ▶ However, allocations to real estate are higher in most portfolios using liability-relative optimization compared with asset-only optimization.
- ▶ Allocations to real estate increase uniformly as stock-bond split becomes more risk tolerant and equity-centric.
- ▶ The average increase in real estate allocations using liability-relative optimization compared with asset-only optimization was more than 2 percentage points.

Conclusions From Forward-Looking Analysis

Assets allocated to non-U.S. real estate

- ▶ Both asset-only and liability-relative optimization using historical returns allocated no assets to non-U.S. real estate because of low risk-adjusted returns when compared with U.S. real estate.
- ▶ Both asset-only and liability-relative optimization using forward-looking returns allocated assets to both U.S. real estate and non-U.S. real estate across most, though not all, portfolios.
- ▶ Using forward-looking returns, liability-relative optimization with “combination” or experimental inflation as the liability proxy tilts the total real estate allocation towards an appreciable U.S. home bias in some balanced and more risk-averse portfolios.
- ▶ Using forward-looking returns, both asset-only optimization and liability-relative optimization with long-term bonds as the liability proxy leads to real estate allocations more evenly balanced between U.S. and non-U.S. real estate across risk-averse and risk-tolerant portfolios.