



Building Bridges

Liability Driven Investment (W8)

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TOWERS WATSON 

Agenda

- I. Driving the Change: Traditional Liabilities versus Mark-to-Market Liabilities
- II. Asset Liability Modeling
- III. Sample Case
- IV. Other Cases
- v. Tools for Managing Risk

Driving the Change: Traditional Liabilities versus Mark-to-Market Liabilities

Understanding of Liabilities is Changing

- Old approach
 - Traditional liability
 - Future payments discounted based on expected rate of return
 - Gave advance credit for future equity risk premium (Current economic value is zero: \$100 worth of bonds is as valuable as \$100 worth of stocks)
- New approach
 - Move towards mark-to-market liability
 - Future payments discounted based on bond rates
 - Promise to participant is like a bond

Funding Policy

- Traditional liability uses expected rate of return
 - Chance of not needing more generally 50%.
- U.S. Corporate plans forced to mark-to-market approach
 - Funding target is to have enough to immunize mark-to-market liability with virtually 100% chance of success
 - They can still invest in equities. Excess returns must actually materialize before being used to offset accruing benefit cost.

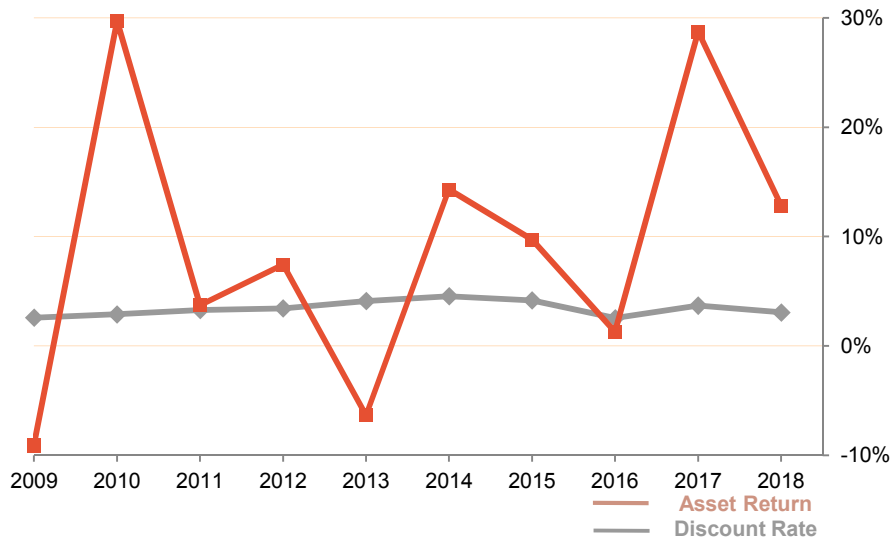
Liability Duration

- Traditional liability calculated at $x\%$ expect return each year
- Market interest rates move
- What is duration of traditional liability?
- What is mark-to-market liability duration?
- What is low risk investment based on duration?
- What is low risk investment based on funding method?

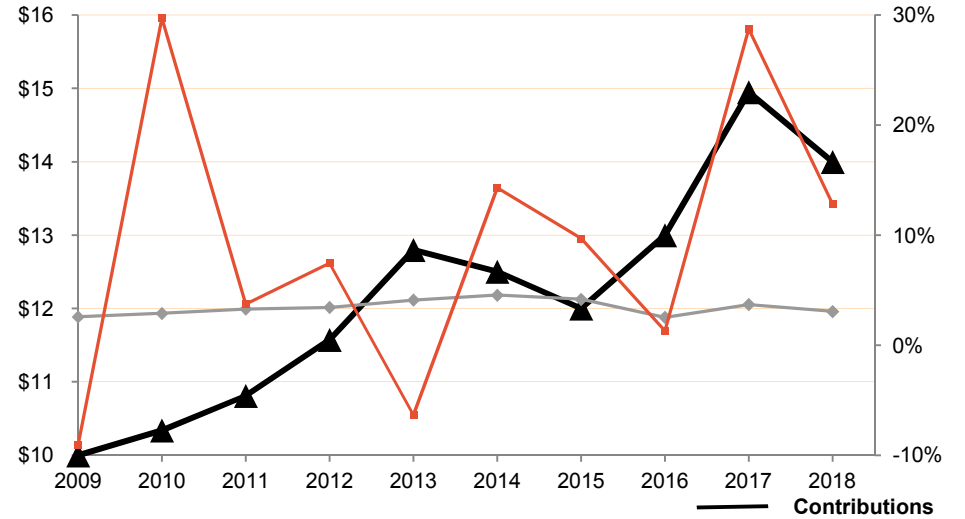
Asset/Liability Modeling

How Does ALM Work?

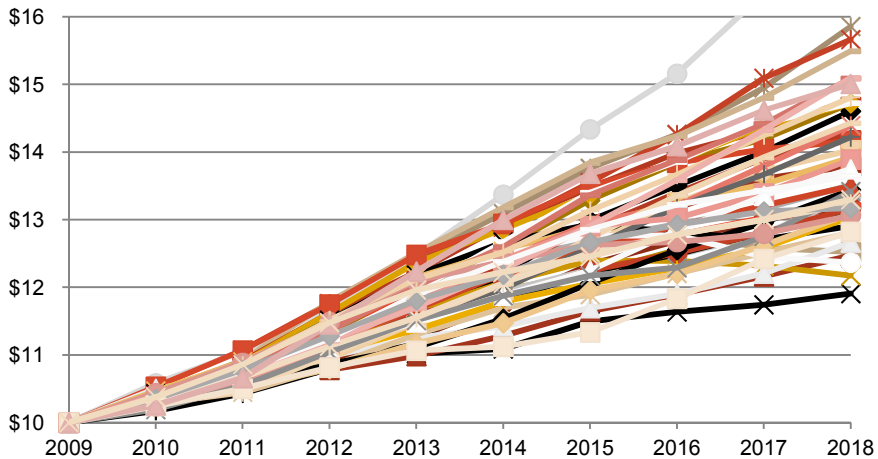
1. Project Future Economic Environments



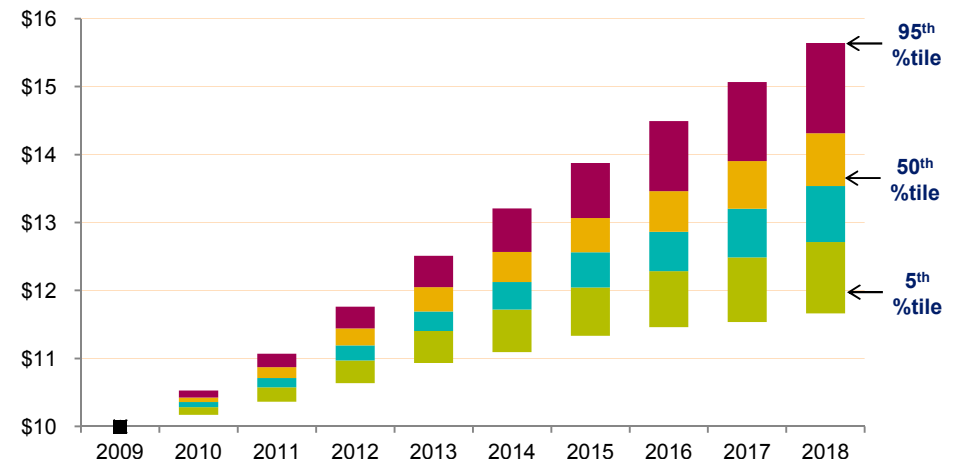
2. Perform a Valuation at Each Future Year



3. Repeat 5,000 Times



4. Rank Results



Capital Market Assumptions

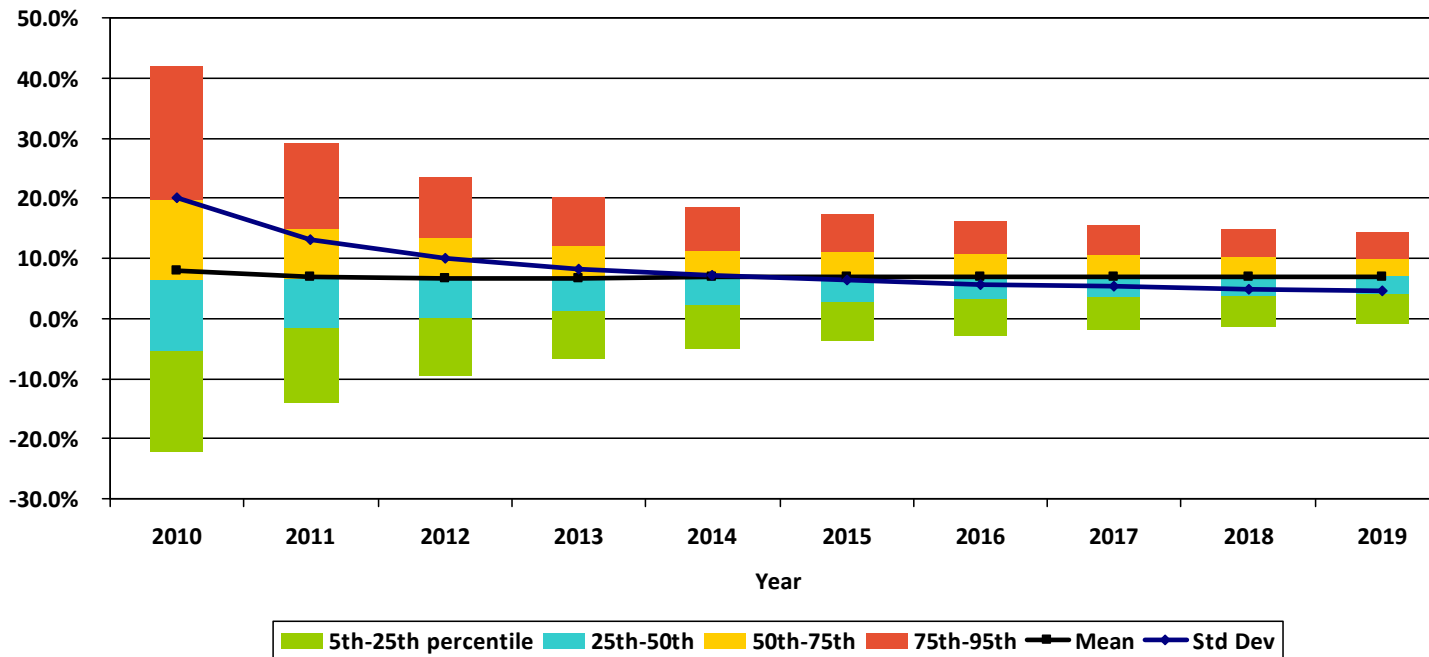
- Asset classes are described by their returns, volatility, and correlation with other asset classes
- Expectations for individual asset classes were developed by the Towers Watson Investment Model as of January 2012
- Return assumptions are net of fees assuming passive management (or minimum risk)
- Return distributions incorporate fat tails
- Correlations between return-seeking asset classes increase when fat-tail events occur
- Simulated government yield curves and simulated corporate spreads are used in developing liability discount rates and returns on fixed income

Summary assumptions for January 1, 2012 Towers Watson Investment Services						
	1st Year Returns		10th Year Returns		10 Year Returns	
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation	Geometric Mean	Standard Deviation
Equity Investments						
Global (unhedged)	9.6%	20.9%	8.9%	16.0%	7.7%	17.5%
Global (hedged)	9.2%	20.1%	8.7%	15.0%	7.5%	16.6%
US Equity	9.3%	21.8%	8.7%	16.2%	7.4%	17.9%
US Large Cap	9.2%	22.0%	8.6%	16.2%	7.3%	18.0%
US Small Cap	10.1%	27.1%	9.3%	21.1%	7.2%	23.0%
International (unhedged)	9.8%	24.5%	9.1%	18.7%	7.4%	20.5%
International (hedged)	9.2%	21.4%	8.6%	15.8%	7.3%	17.6%
International Developed	9.8%	24.6%	9.1%	18.8%	7.4%	20.5%
International Developed (hedged)	9.0%	21.4%	8.5%	15.8%	7.2%	17.5%
Emerging Market Equity	10.6%	30.6%	9.4%	23.0%	6.8%	25.4%
Private Equity	10.0%	29.2%	8.8%	21.5%	6.5%	23.9%
REITs	7.7%	17.0%	7.7%	14.0%	6.7%	14.9%
Infrastructure	8.4%	23.5%	7.4%	15.0%	6.4%	17.8%
Fixed Income						
US Investment Grade	3.2%	5.9%	4.8%	5.3%	2.9%	5.9%
High Yield	4.0%	13.1%	7.1%	10.1%	5.7%	11.1%
Inflation-Indexed	3.2%	6.3%	4.2%	6.0%	2.9%	6.1%
Long Government	0.8%	14.4%	4.0%	10.0%	1.3%	11.9%
Long Credit	3.7%	16.6%	6.0%	13.0%	3.6%	14.8%
Long Government/Credit	2.3%	14.9%	5.0%	10.4%	2.6%	12.3%
Emerging Market Debt	1.9%	11.0%	6.6%	9.0%	4.8%	9.8%
Cash	0.6%	0.8%	3.6%	2.5%	2.3%	2.3%
Alternatives						
Real Estate	6.9%	12.0%	7.1%	10.0%	6.6%	10.6%
Hedge Fund-of-Funds	4.5%	7.5%	6.6%	7.2%	5.4%	7.3%
Commodities	3.0%	14.0%	5.6%	10.3%	3.9%	11.5%
Inflation	2.0%	1.5%	2.4%	2.5%	2.3%	2.3%

Forecast of Current Target Allocation

Annualized Compound Return

Annualized Compound Return - Target Policy



Percentile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	7.9%	6.9%	6.7%	6.7%	6.8%	6.8%	6.9%	6.9%	6.9%	6.9%
Std Dev	20.0%	13.2%	10.0%	8.2%	7.1%	6.3%	5.7%	5.3%	4.9%	4.6%
5th	-22.4%	-13.9%	-9.6%	-6.7%	-5.0%	-3.8%	-2.8%	-1.9%	-1.3%	-0.8%
25th	-5.4%	-1.7%	0.1%	1.3%	2.3%	2.8%	3.2%	3.4%	3.7%	3.9%
50th	6.3%	6.6%	6.4%	6.8%	6.8%	6.9%	6.8%	6.9%	7.0%	7.1%
75th	19.8%	15.0%	13.3%	12.1%	11.4%	11.0%	10.7%	10.4%	10.2%	10.0%
95th	41.9%	29.0%	23.5%	20.1%	18.6%	17.2%	16.3%	15.5%	14.9%	14.3%

- The median annualized compound return for 10 years is 7.1%
- Under 5th percentile economic conditions, asset returns can be as low as -22.4% for 2010
- The mean 10-year annualized compound return is 6.9%

Opportunities to Manage Risk

Benefit Strategy

Effective at managing active liability risk profile and long-term plan cost

Funding Strategy

Effective at managing short-term plan cost and volatility

Pension Risk

Investment Strategy

Effective at managing long-term plan cost and volatility

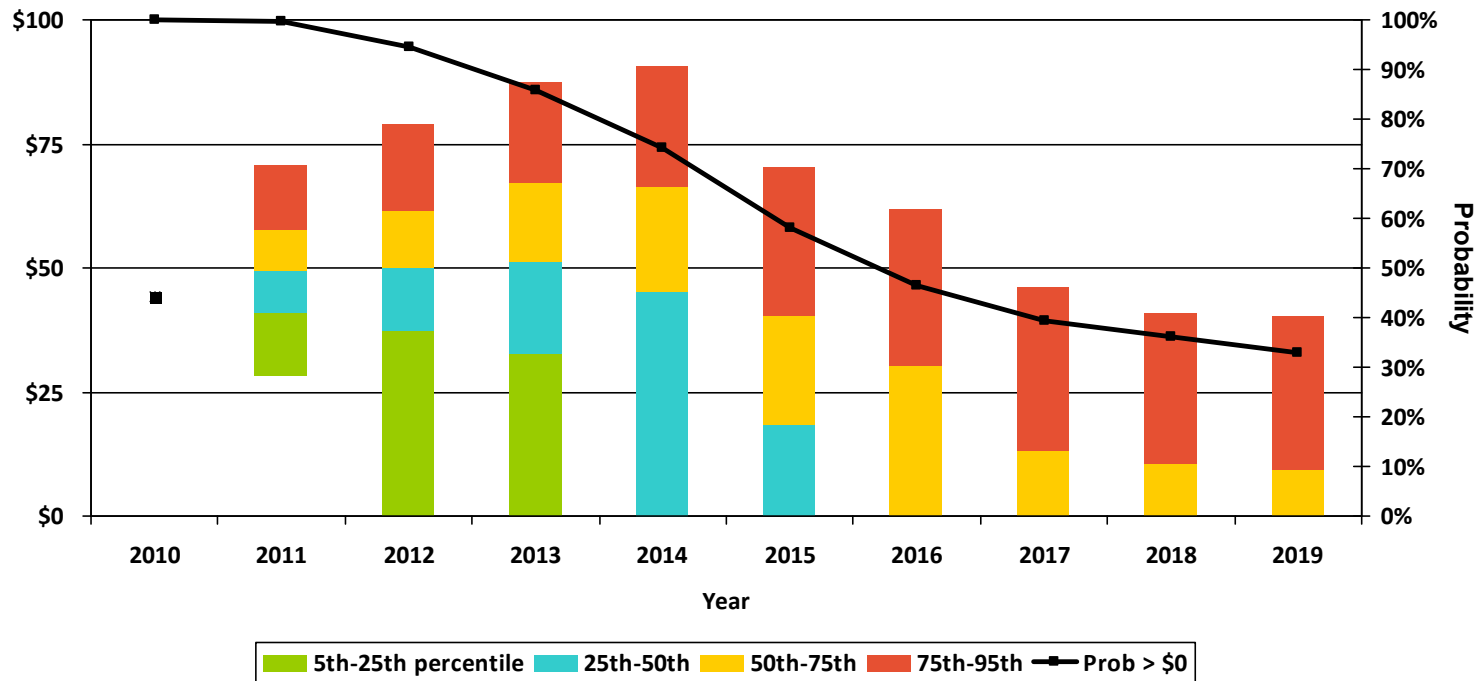
Assumptions and Methods

Effective only for short-term issues

Sample Case

Forecast of Current Target Allocation Contributions

Actual Contribution (Plan Year) (\$M) - Target Policy

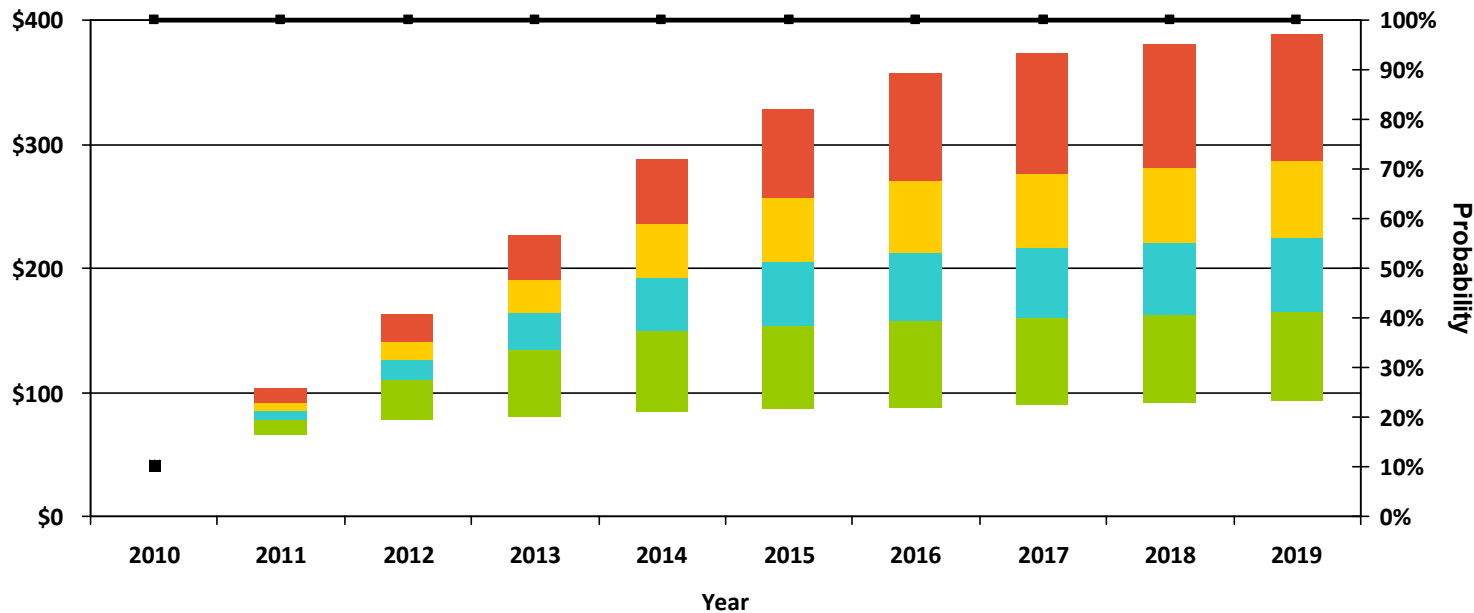


Percentile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
5th	\$44	\$29	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
25th	\$44	\$41	\$38	\$33	\$0	\$0	\$0	\$0	\$0	\$0
50th	\$44	\$49	\$50	\$51	\$45	\$18	\$0	\$0	\$0	\$0
75th	\$44	\$58	\$62	\$67	\$67	\$40	\$30	\$13	\$11	\$9
95th	\$44	\$71	\$79	\$87	\$91	\$70	\$62	\$46	\$41	\$40
Prob > \$0	100.00%	99.58%	94.60%	85.88%	74.06%	57.92%	46.50%	39.36%	36.08%	33.04%

- Contributions are expected (at median level) to be \$40-\$50M through 2014, then drop to ~\$0
- Under 95th percentile conditions, annual contributions can exceed \$70M over the near term
- The probability of an annual contribution being required slowly decreases to 33% by 2019

Forecast of Current Target Allocation Cumulative Contributions

Cumulative PV of Plan Year Contributions (\$M) - Target Policy

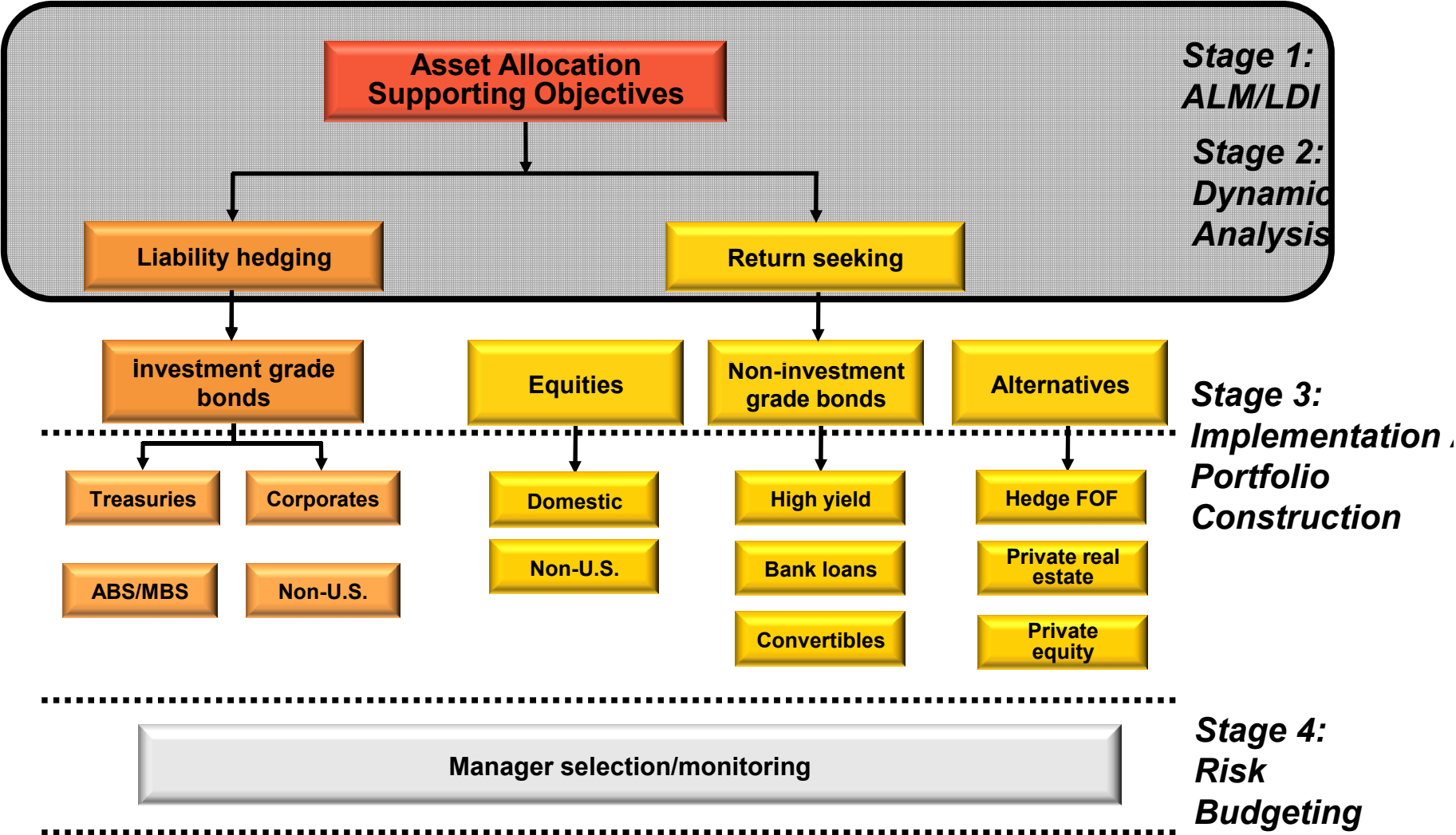


- Over the ten-year period, median cumulative contributions total \$225M
- Under worst-case (i.e. 95th percentile) conditions, cumulative contributions can exceed \$380M

■ 5th-25th percentile
 ■ 25th-50th
 ■ 50th-75th
 ■ 75th-95th
 —■ Prob > \$0

Percentile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
5th	\$41	\$66	\$77	\$81	\$84	\$87	\$87	\$90	\$92	\$93
25th	\$41	\$77	\$109	\$134	\$149	\$154	\$158	\$160	\$163	\$165
50th	\$41	\$85	\$126	\$164	\$192	\$205	\$212	\$216	\$221	\$225
75th	\$41	\$92	\$141	\$190	\$236	\$257	\$271	\$276	\$281	\$286
95th	\$41	\$103	\$163	\$227	\$288	\$328	\$357	\$372	\$381	\$388
Prob > \$0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Building a Pension Portfolio in Four Stages



Pension Risk Budgeting

Framework for Investment Decisions

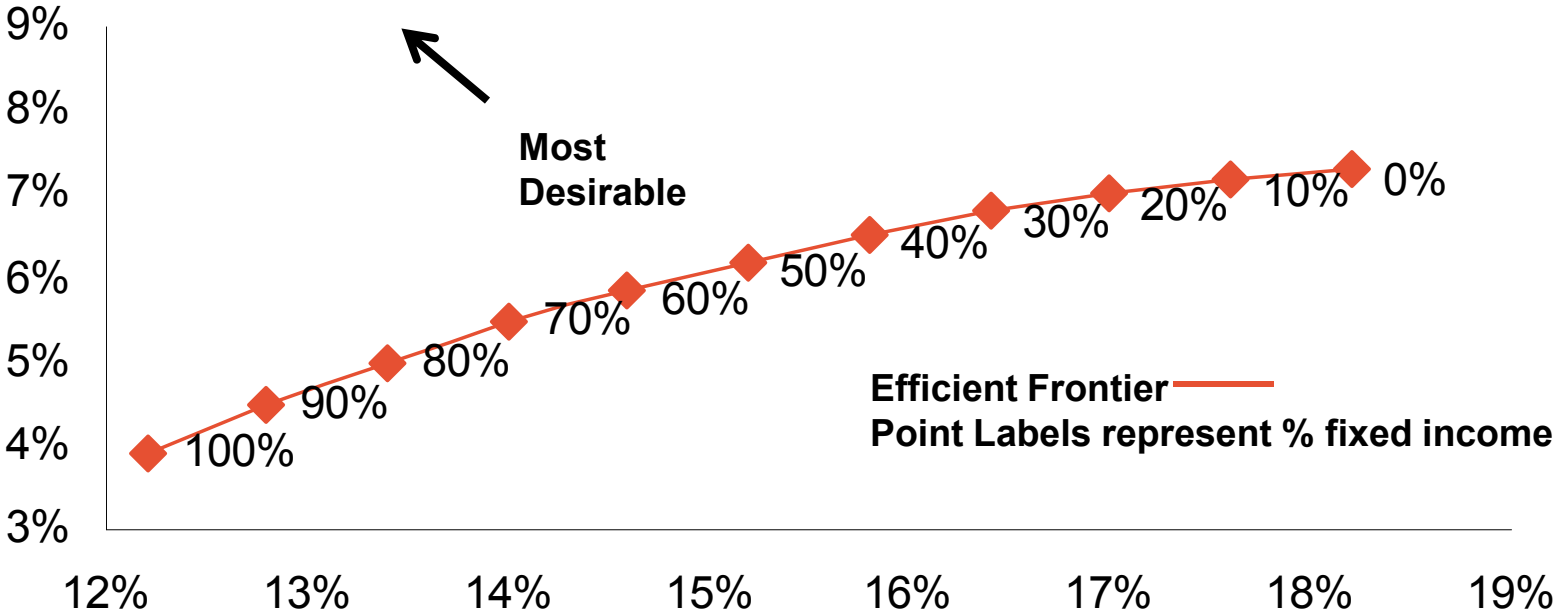
- Do we know how much pension risk we have?
- Do we know how much pension risk we want?
- Where are we taking risk and how much reward can we expect for these risks?
- How can we improve the financial efficiency of the pension program?

Asset Allocations Examined

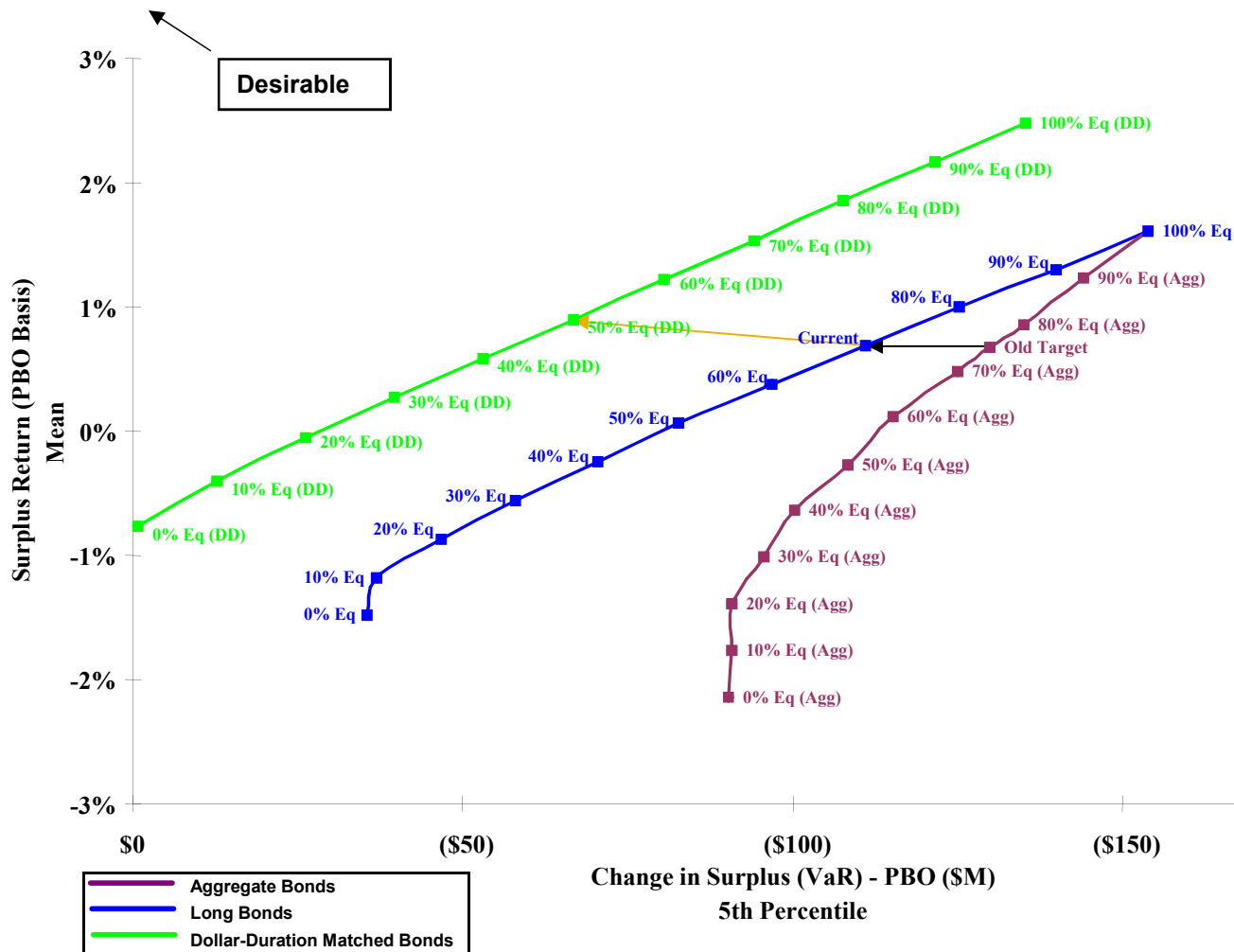
		Return	Risk	US Large Cap Equity	US Small Cap Equity	International Equity	Aggregate Fixed Income	Long Gov/Cred Fixed Income	Dollar Duration Fixed Income
Aggregate Fixed Income	0% Equity	5.62%	5.28%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
	10% Equity	6.00%	5.33%	5.7%	2.1%	2.1%	90.0%	0.0%	0.0%
	20% Equity	6.37%	5.82%	11.4%	4.3%	4.3%	80.0%	0.0%	0.0%
	30% Equity	6.75%	6.64%	17.1%	6.4%	6.4%	70.0%	0.0%	0.0%
	40% Equity	7.13%	7.68%	22.9%	8.6%	8.6%	60.0%	0.0%	0.0%
	50% Equity	7.50%	8.88%	28.6%	10.7%	10.7%	50.0%	0.0%	0.0%
	60% Equity	7.88%	10.17%	34.3%	12.9%	12.9%	40.0%	0.0%	0.0%
	70% Equity	8.25%	11.52%	40.0%	15.0%	15.0%	30.0%	0.0%	0.0%
	Old Target	8.44%	12.22%	42.8%	16.1%	16.1%	25.0%	0.0%	0.0%
	80% Equity	8.63%	12.92%	45.7%	17.1%	17.1%	20.0%	0.0%	0.0%
	90% Equity	9.01%	14.35%	51.4%	19.3%	19.3%	10.0%	0.0%	0.0%
100% Equity	9.38%	15.80%	57.1%	21.4%	21.4%	0.0%	0.0%	0.0%	
Long Fixed Income	0% Equity	6.28%	11.03%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
	10% Equity	6.59%	10.49%	5.7%	2.1%	2.1%	0.0%	90.0%	0.0%
	20% Equity	6.90%	10.18%	11.4%	4.3%	4.3%	0.0%	80.0%	0.0%
	30% Equity	7.21%	10.14%	17.1%	6.4%	6.4%	0.0%	70.0%	0.0%
	40% Equity	7.52%	10.37%	22.9%	8.6%	8.6%	0.0%	60.0%	0.0%
	50% Equity	7.83%	10.85%	28.6%	10.7%	10.7%	0.0%	50.0%	0.0%
	60% Equity	8.14%	11.54%	34.3%	12.9%	12.9%	0.0%	40.0%	0.0%
	Current	8.45%	12.42%	40.0%	15.0%	15.0%	0.0%	30.0%	0.0%
	80% Equity	8.76%	13.44%	45.7%	17.1%	17.1%	0.0%	20.0%	0.0%
	90% Equity	9.07%	14.57%	51.4%	19.3%	19.3%	0.0%	10.0%	0.0%
100% Equity	9.38%	15.80%	57.1%	21.4%	21.4%	0.0%	0.0%	0.0%	
Dollar Duration Fixed Income	0% Equity	7.01%	11.41%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	10% Equity	7.37%	12.07%	5.7%	2.1%	2.1%	0.0%	0.0%	90.0%
	20% Equity	7.71%	12.89%	11.4%	4.3%	4.3%	0.0%	0.0%	80.0%
	30% Equity	8.04%	13.84%	17.1%	6.4%	6.4%	0.0%	0.0%	70.0%
	40% Equity	8.35%	14.89%	22.9%	8.6%	8.6%	0.0%	0.0%	60.0%
	50% Equity	8.67%	16.02%	28.6%	10.7%	10.7%	0.0%	0.0%	50.0%
	60% Equity	8.99%	17.22%	34.3%	12.9%	12.9%	0.0%	0.0%	40.0%
	70% Equity	9.30%	18.48%	40.0%	15.0%	15.0%	0.0%	0.0%	30.0%
	80% Equity	9.62%	19.77%	45.7%	17.1%	17.1%	0.0%	0.0%	20.0%
	90% Equity	9.94%	21.11%	51.4%	19.3%	19.3%	0.0%	0.0%	10.0%
	100% Equity	10.25%	22.47%	57.1%	21.4%	21.4%	0.0%	0.0%	0.0%

Standard Efficient Frontier

Illustrative Efficient Frontier



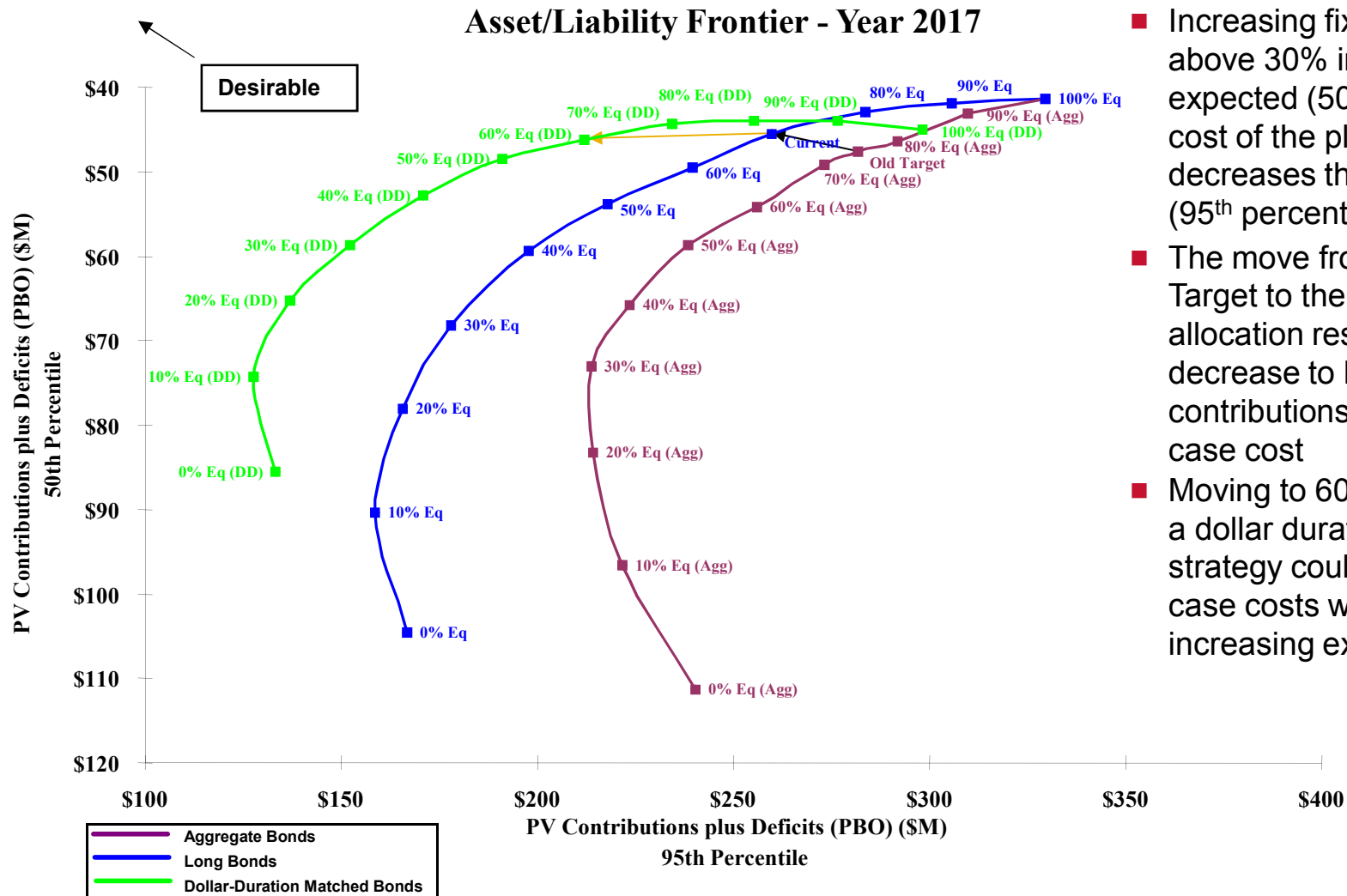
Analysis of Equity / Bond Mix Value at Risk



- Increasing equity levels improve expected outperformance over liabilities but at the expense of higher value at risk
- The move from the Old Target to the Current allocation resulted in a decrease in risk with no change to the expected surplus return
- Moving to 50% equity with a dollar duration bond strategy could reduce worst case Value at Risk significantly while improving performance relative to the liability

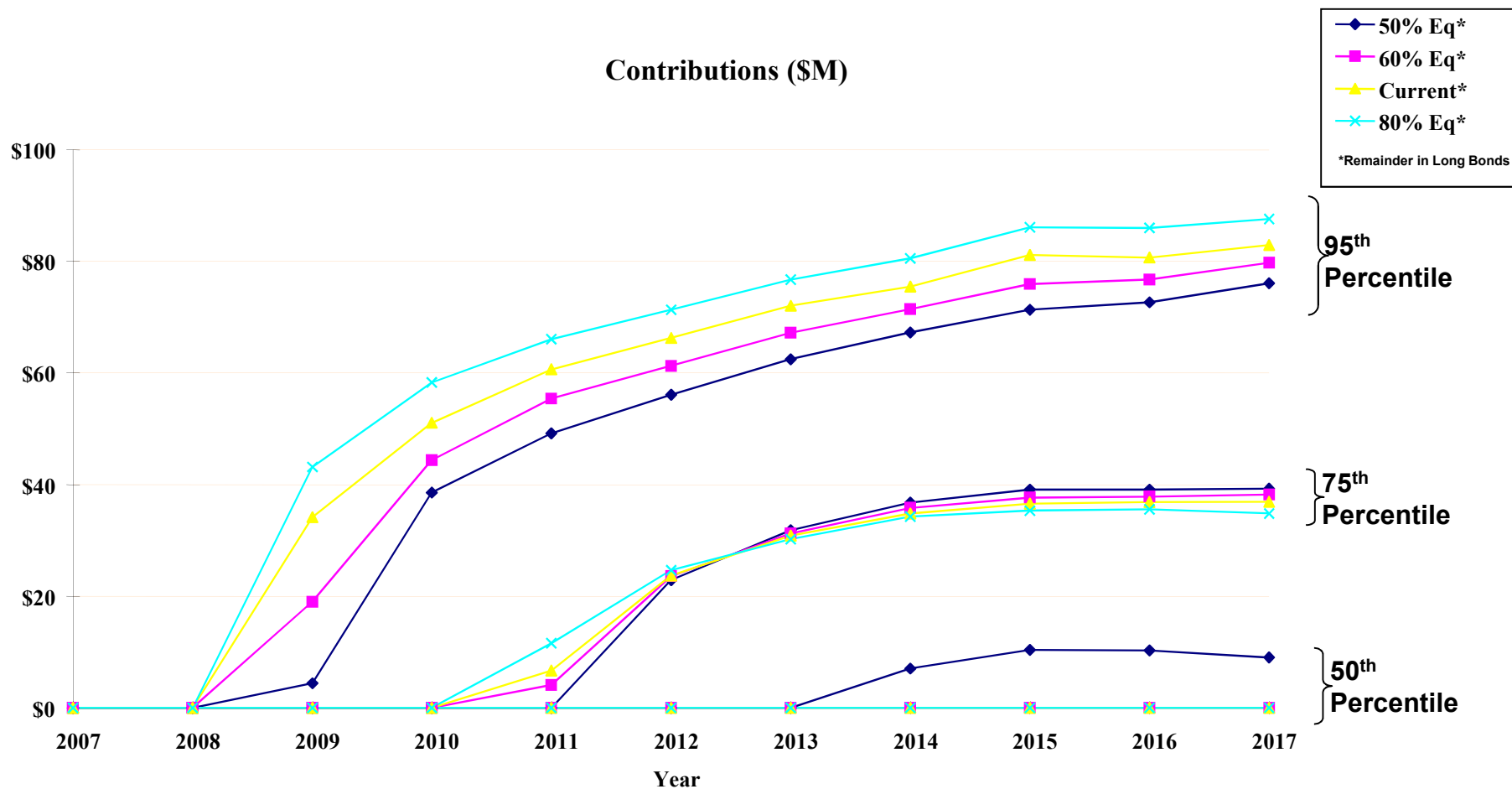
Analysis of Equity / Bond Mix

Cumulative Contributions plus Deficits



- Increasing fixed income above 30% increases the expected (50th percentile) cost of the plan, but decreases the “worst-case” (95th percentile) cost
- The move from the Old Target to the Current allocation resulted in a decrease to both expected contributions and worst-case cost
- Moving to 60% equity with a dollar duration bond strategy could reduce worst case costs without increasing expected costs

Asymmetric Risk in Contributions



- Increasing the fixed income allocation decreases the “worst-case” (95th percentile) cost
- Expected (50th percentile) annual contributions remain at \$0M until equity is decrease to 50%
- As the 50th percentile is zero for allocations with more 60% in equities, there is little desire for more equities

Analysis of Equity / Bond Mix

Summary of Key Results

	50% Eq	60% Eq	70% Eq (Current)	80% Eq	50% Eq (DD)	60% Eq (DD)	70% Eq (DD)	80% Eq (DD)
One Year Short-term Risk Measure								
Expected Return	7.8%	8.1%	8.5%	8.8%	8.7%	9.0%	9.3%	9.6%
Volatility	10.8%	11.5%	12.4%	13.4%	16.0%	17.2%	18.5%	19.8%
Expected Outperformance	0.1%	0.4%	0.7%	1.0%	0.9%	1.2%	1.5%	1.9%
Tracking Error	9.3%	10.8%	12.4%	13.9%	7.4%	9.0%	10.5%	12.0%
Information Ratio	0.7%	3.5%	5.5%	7.1%	12.1%	13.6%	14.6%	15.4%
VaR75 (\$M)	(\$21)	(\$24)	(\$27)	(\$31)	(\$19)	(\$23)	(\$27)	(\$32)
VaR95 (\$M)	(\$83)	(\$97)	(\$111)	(\$125)	(\$67)	(\$81)	(\$94)	(\$108)
Ten Year Results								
PV of Cumulative Contributions (\$M)								
50th Percentile "Median Case"	\$49	\$43	\$39	\$36	\$45	\$42	\$39	\$38
75th Percentile "Bad Case"	\$95	\$98	\$101	\$107	\$89	\$93	\$98	\$105
95th Percentile "Worst Case"	\$193	\$211	\$232	\$250	\$171	\$189	\$206	\$225
PV of Cumulative Contributions plus Deficit (\$M)								
50th Percentile "Median Case"	\$54	\$49	\$45	\$43	\$48	\$46	\$44	\$44
75th Percentile "Bad Case"	\$110	\$115	\$121	\$128	\$100	\$107	\$114	\$123
95th Percentile "Worst Case"	\$218	\$240	\$260	\$284	\$191	\$212	\$234	\$255
PV of Cumulative Expense plus Deferrals (\$M)								
50th Percentile "Median Case"	\$112	\$89	\$66	\$43	\$106	\$84	\$66	\$48
75th Percentile "Bad Case"	\$197	\$190	\$185	\$181	\$191	\$188	\$185	\$185
95th Percentile "Worst Case"	\$327	\$343	\$360	\$379	\$306	\$323	\$342	\$359
Annual Contributions								
95th Percentile Highest Contribution (\$M)	\$93	\$99	\$106	\$113	\$73	\$78	\$84	\$89
Contributions Ever > \$75M	5.2%	6.6%	7.9%	9.9%	0.8%	1.3%	1.9%	2.6%
Contributions Ever > \$100M	0.4%	0.9%	1.6%	2.2%	0.0%	0.1%	0.2%	0.3%

■ Moving from 70% equity to 60% equity:

- Reduces 95th percentile Value at Risk by \$14M
- Reduces worst-case PV Contributions + Deficits by \$20M
- Increases expected PV Contributions + Deficits by \$4M

■ Dollar duration bonds:

- Increase asset only volatility
- Improve Value at Risk and most other asset/liability results
- Require leveraging of assets

Better than Current
Worse than Current
Within 5% of Current

Analysis of Alternatives

Summary of Key Results

	70% Eq (Current)	5% PE	5% HF	5% Infr	5% PE & 5% Infr
One Year Short-term Risk Measure					
Expected Return	8.5%	8.5%	8.3%	8.4%	8.5%
Volatility	12.4%	12.4%	11.8%	11.8%	11.8%
Expected Outperformance	0.7%	0.8%	0.6%	0.6%	0.7%
Tracking Error	12.4%	12.6%	12.1%	12.0%	12.2%
Information Ratio	5.5%	6.2%	4.8%	5.2%	5.9%
VaR75 (\$M)	(\$27)	(\$28)	(\$27)	(\$26)	(\$27)
VaR95 (\$M)	(\$111)	(\$115)	(\$110)	(\$110)	(\$111)
Ten Year Results					
PV of Cumulative Contributions (\$M)					
50th Percentile "Median Case"	\$39	\$38	\$40	\$39	\$38
75th Percentile "Bad Case"	\$101	\$101	\$100	\$99	\$98
95th Percentile "Worst Case"	\$232	\$230	\$225	\$223	\$223
PV of Cumulative Contributions plus Deficit (\$M)					
50th Percentile "Median Case"	\$45	\$44	\$47	\$46	\$43
75th Percentile "Bad Case"	\$121	\$119	\$119	\$116	\$114
95th Percentile "Worst Case"	\$260	\$260	\$253	\$248	\$248
PV of Cumulative Expense plus Deferrals (\$M)					
50th Percentile "Median Case"	\$66	\$62	\$71	\$69	\$66
75th Percentile "Bad Case"	\$185	\$181	\$185	\$182	\$177
95th Percentile "Worst Case"	\$360	\$359	\$353	\$349	\$345
Annual Contributions					
95th Percentile Highest Contribution (\$M)	\$106	\$106	\$105	\$103	\$103
Contributions Ever > \$75M	7.9%	7.9%	7.7%	7.4%	7.4%
Contributions Ever > \$100M	1.6%	1.6%	1.3%	1.2%	1.3%

- **Moving 5% of the equity allocation to:**
 - private equity provides greater return with higher risk
 - hedge funds has minimal positive impact
 - infrastructure reduces expected return slightly and reduces volatility significantly

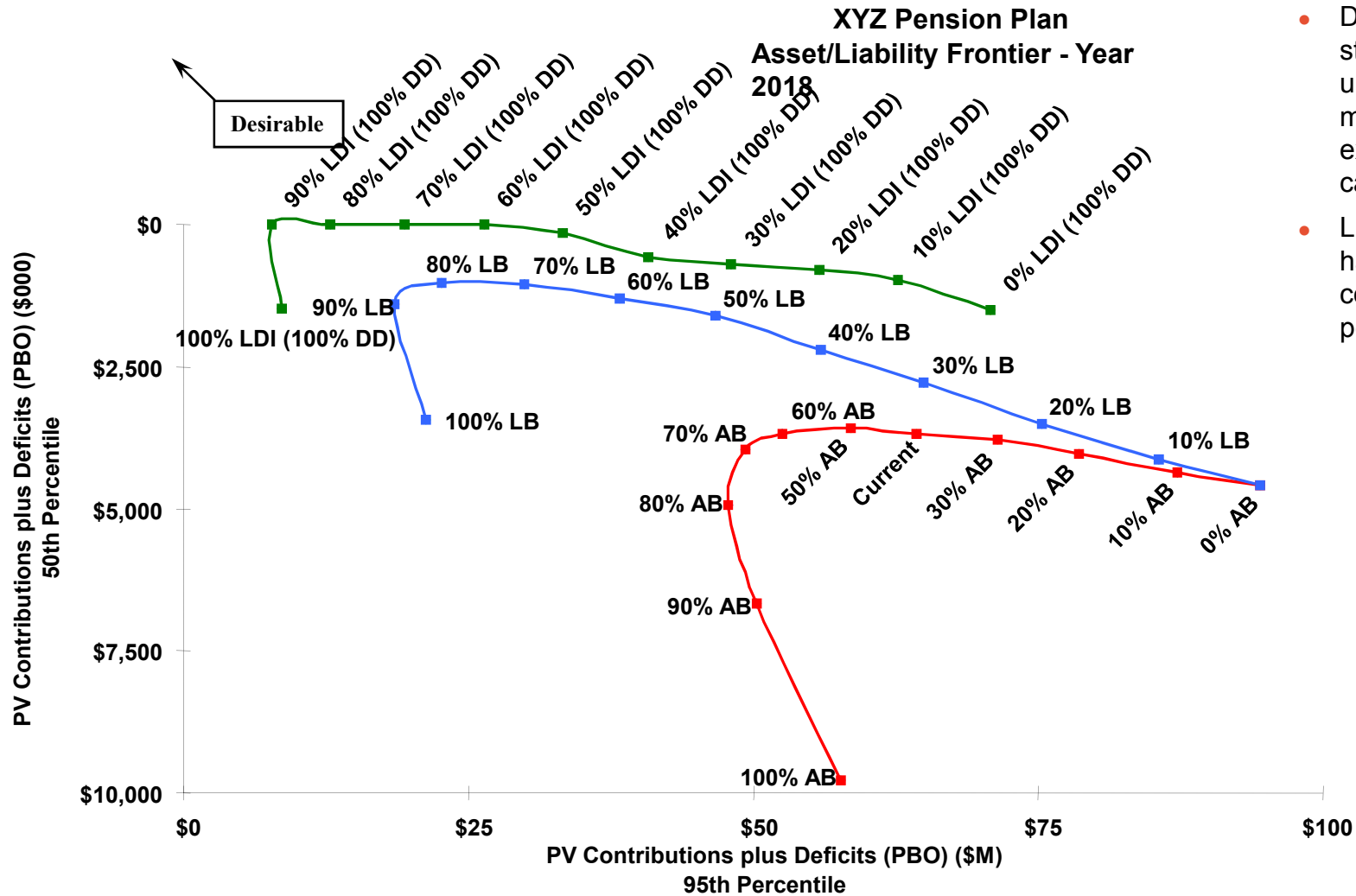
- **Moving 5% of the equity allocation to both private equity and infrastructure improves almost all measures examined**

Better than Current
Worse than Current
Within 3% of Current

Other Cases

Well Funded Frozen Plan: Analysis of Equity/Bond Mix

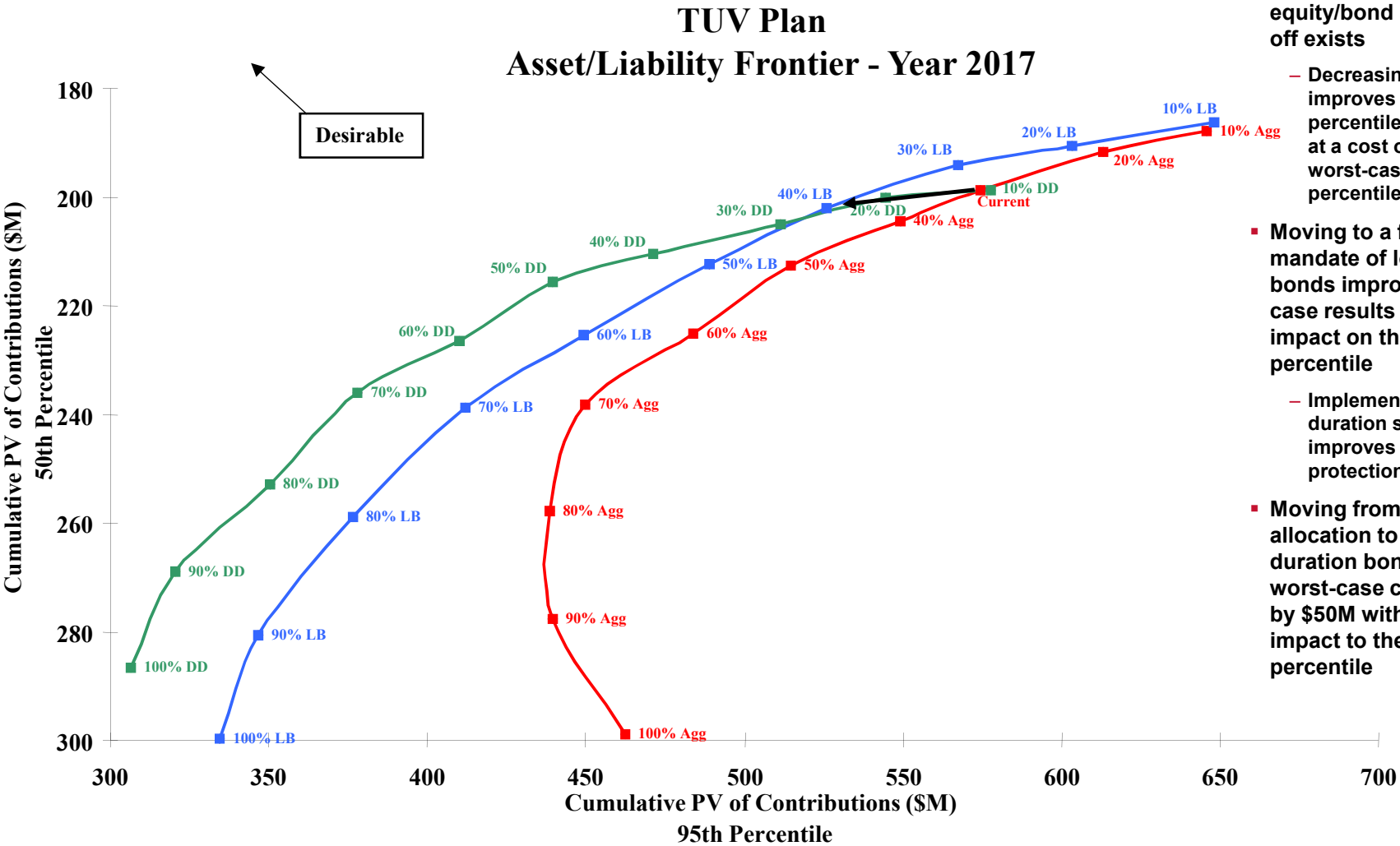
Cumulative Contributions Plus Deficits



- Duration Matching strategies are attractive under this measure to manage both the expected and worse cases
- LDI portfolios 60%-90% have no expected contributions (50th percentile)

Underfunded Frozen Plan: Analysis of Equity/Bond Mix

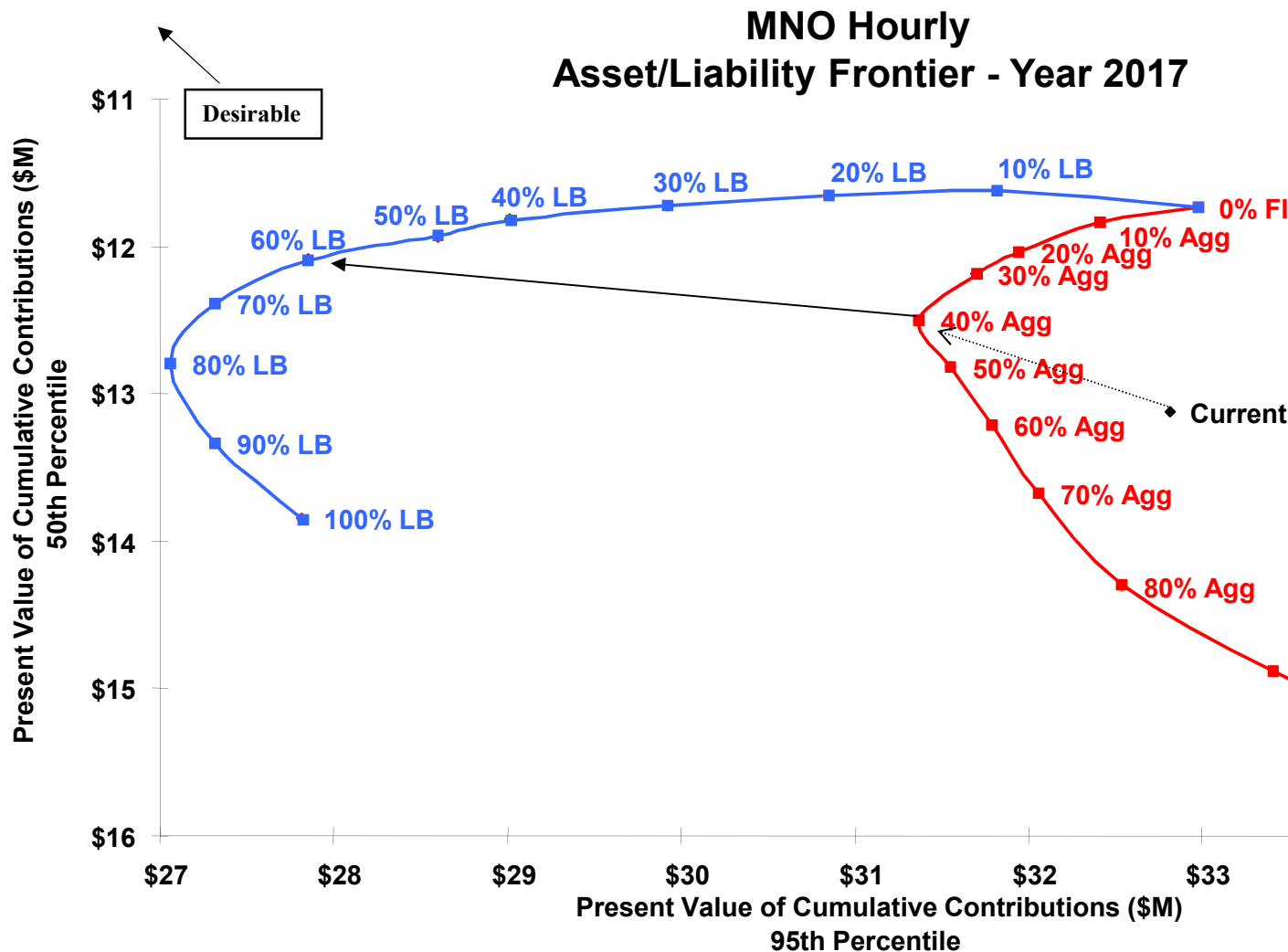
Cumulative Contributions



- Examining the equity/bond split, a trade-off exists
 - Decreasing fixed income improves expected (50th percentile) contributions at a cost of increased worst-case (95th percentile) contributions
- Moving to a fixed income mandate of long duration bonds improves worst case results with minimal impact on the 50th percentile
 - Implementing a dollar duration strategy further improves downside protection
- Moving from the current allocation to 40% long duration bonds improves worst-case contributions by \$50M with minimal impact to the 50th percentile

Underfunded Active Plan w/LS: Analysis of Equity/Bond Mix

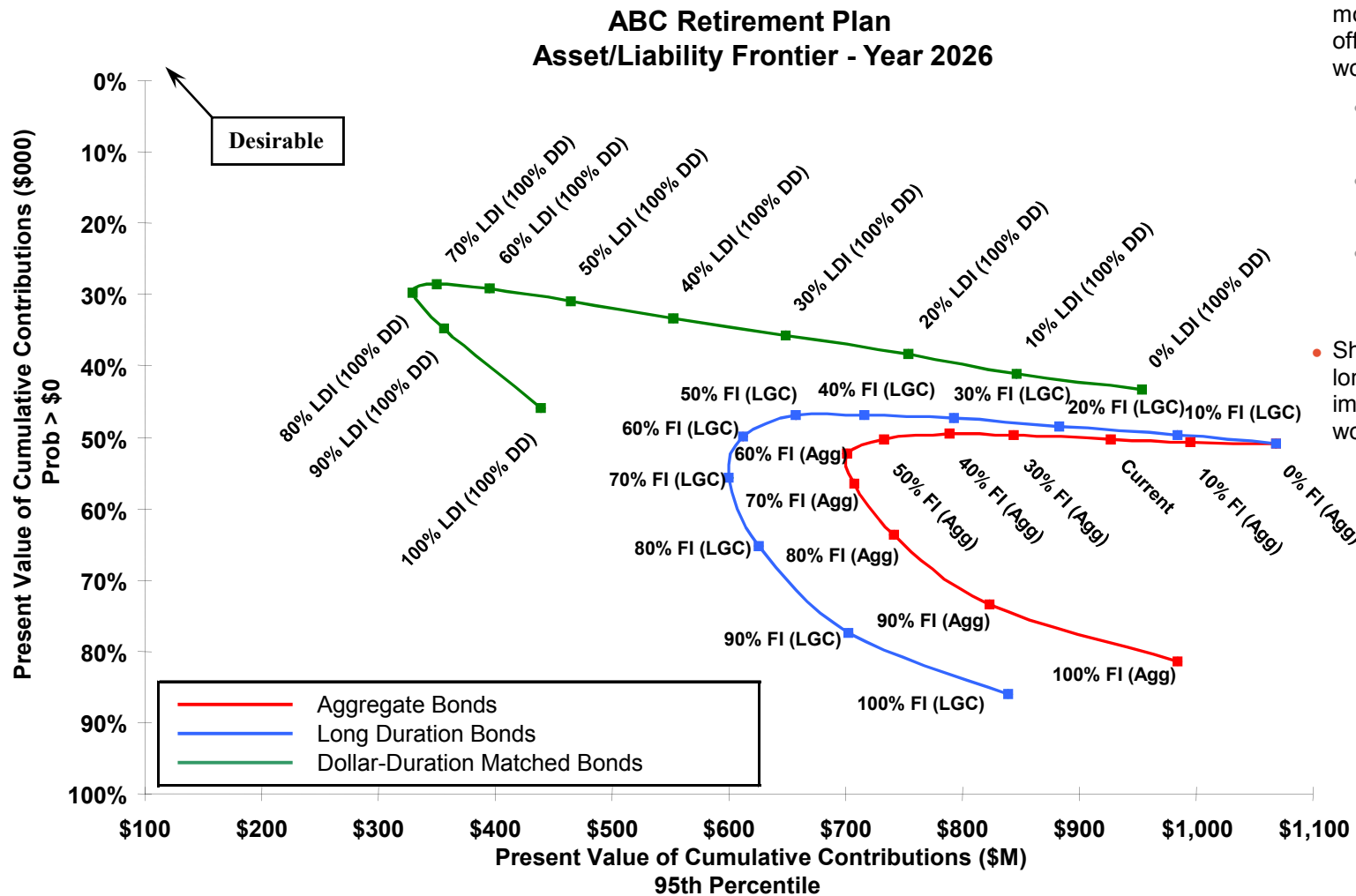
Cumulative Contributions



- Examining the cumulative contributions made over the projection period
 - Using long duration bonds, decreasing fixed income improves expected (50th percentile) contributions at a cost of increased worst-case (95th percentile) results
 - Using aggregate bonds, the same relationship exists for allocations with less than 40% aggregate bonds; Allocations with greater than 40% aggregate bonds appear inefficient
- Long duration bonds show an improvement over aggregate bonds
- Moving from the current allocation to 40% aggregate bonds improves 50th & 95th percentile cumulative contributions by \$0.6M & \$1.4M respectively
 - Moving to an allocation of 60% long bonds further improves worst-case contributions by \$3.6M with minimal impact on 50th percentile results

Well Funded Active Plan: Analysis of Equity/Bond Mix

Cumulative Contributions



- Under the funding policy modeled, a risk/reward trade-off between expected and worst-case cash cost occurs
 - From 0% to 60% bonds for Aggregate bonds
 - From 0% to 70% bonds for Long bonds
 - From 0% to 80% fixed income for the LDI 100% Dollar Duration Strategy
- Shifting the bond strategy to long/government credit bonds improves both expected and worst-case cash cost

Tools for Managing Risk

Tools for Managing Risk

- Payout/Liability Hedging
- Better Diversification
- Risk Steering
- Risk Pricing
- Long-Termism Risk Return Concepts
- Beyond Investment Policy

Closing Thoughts

- Holistic approach to risk management is best
- Liability hedging a great tool and there are many tools beyond diversification and liability hedging
- Take risk and return management approach

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Mark is a Fellow of the Society of Actuaries, an Enrolled Actuary, and a Chartered Enterprise Risk Analyst. Mark is a Member and Former Chair of the Joint Academy/Society of Actuaries Task Force on Financial Economics and the Actuarial Model. He has 25 years of actuarial consulting experience, working on asset liability studies for hundreds of plans with assets from \$20 million to \$100 billion. Mark has written over ten articles and manuscripts on pension risk and asset allocation including "Defined Benefit Plans are More Successful with Bonds", SOA Pension Section News, Sept 2004. He is known worldwide and has been quoted by other actuaries in the *North American Actuarial Journal*, *The Actuary* in the UK, and *Actuary* in Australia. Mark has spoken at Institutional Investors meetings, Financial Research Associates meetings, Society of Actuaries meetings, Association of Financial Professionals meetings, UBS's Masters Level 500 Program, and State Street's Client Conference.

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