North Carolina Department of State Treasurer

Investment Management Division

Investment Strategy Discussion

Investment Advisory Committee Meeting

September 18, 2013

A Xerox Company

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Contents

Project Purpose

- Investment Management Division of the Department of the State Treasurer of North Carolina is undertaking an evaluation of the current and alternative investment strategies for the public retirement systems of the State
- The goals are to develop strategies and tactics that will:
  - Reasonably ensure the earning the actuarially assumed rate of investment return with a desired level of likelihood
  - Maintain levels of diversification suitable for a system of its size, given the investment opportunity set available
  - Develop and employ suitable risk management measures to limit exposure to market downturns
  - Provide the necessary liquidity to meet benefit obligations as they come due

Retirement System Descriptive Information

Retirement System Descriptive Information

	TSERS	LGERS	Judicial	Fire & Rescue	National Guard
Valuation	12/31/2011	12/31/2011	12/31/2011	6/30/2012	12/31/2011
Assumed Investment Return	7.25%	7.25%	7.25%	7.25%	7.25%
Membership					
• Active	310,627	121,638	566	40,870	5,567
• Pay Status	171,786	51,700	562	11,912	4,071
• Terminated Vested	110,686	44,350	55	N/A	4,993
• Disabled	7,279	N/A	N/A	154	N/A
Payroll Growth					
• Current	$12.8B	$5.1B	$67.8M	N/A	N/A
• Prior	$13.1B	$5.1B	$66.6M		
Funded Status (GASB)					
• Actuarial Assets	$58.1B	$19.33B	$460.6M	$338.9M	$91.1M
• Liabilities	$61.8B	$19.37B	$512.6M	$403.8M	$129.5M
• Funded Ratio	94.0%	99.8%	89.9%	83.9%	70.4%
Appropriation Determination					
• Normal Cost (NC)	5.14%	7.07%/7.55%(1)	18.13%	$151.2 / pm	$513,667
• Accrued liability (AL)	3.55%	N/A	9.53%	$206.6 / pm	$4,835,425
• Death Benefit	N/A	N/A	0.35%	N/A	N/A
Cash flow – prior year					
• Contributions	$1.7B	$712.9M	$18.9M	$17.2M	$7,007,443
• Benefits	$3.6B	$940.7M	$32.8M	$25.5M	$6,953,632
• Net cash flow	($1.9B)	($227.8M)	($13.9M)	($8.3M)	$53,811

(1) General employees and firemen / law enforcement officers

Retirement System Descriptive Information

	Registers of Deeds	Legislative Retirement[1]	Death Benefits	Disability Income	Retiree Health[1][2]
Valuation	12/31/2011	12/31/2011	12/31/2011	6/30/2011	12/31/2010
Assumed Investment Return	5.75%	7.25%	5.75%	5.75%	4.25%
Membership					
• Active	100	170	435,227	324,290	347,000
• Pay Status	84	278	94,195	6,754	169,000
• Terminated Vested	2	83	N/A	N/A	35,000
• Disabled	N/A	N/A	N/A	N/A	N/A
Payroll Growth					
• Current	$5.9M	$3.7M	$18.1B	$14.1B	$15.0B
• Prior	$5.9M	$3.7M	$18.4B	$14.4B	$15.1B
Funded Status (GASB)					
• Actuarial Assets	$42.6M	$29.5M	$392.4M	$406.1M	$0.7B
• Liabilities	$22.2M	$23.8M	N/A	$511.4M	$33.5B
• Funded Ratio	192.1%	124.0%	N/A	79.4%	2.1%
Appropriation Determination					
• Normal Cost (NC)	$653,392	23.2%	N/A	0.43%	11.3%
• Accrued liability (AL)	($653,392)	(25.4%)	N/A	--	8.0%
• Death Benefit	N/A	N/A	N/A	N/A	N/A
Cash flow – prior year					
• Contributions	$765,439	$258,549	$46.5M	$77.0M	$2.9B
• Benefits	$1,526,318	$2,148,626	$43.5M	$74.2M	$0.7B
• Net cash flow	($760,879)	($1,890,077)	$3.0M	$2.8M	$2.2B

(1) Valuation not performed by Buck Consultants
(2) Cash flows estimated

Liability/Cost Drivers and Investment Implications

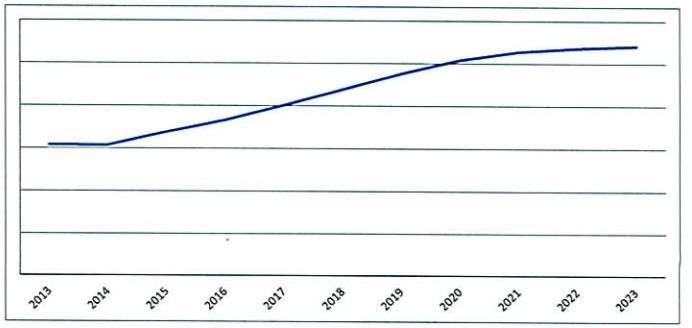
Risk Exposure	Risk Factors	Investment Strategy Implication
Benefit formula	• Benefit multiplier • Service credit • Final salary averaging	Inflation aware investing to address linkage of benefits to salaries and underlying inflation
Cost of Living Adjustments	• Granted when times are good creates exposure to mean reversion • Asymmetry – COLAS granted in better times not rescinded in challenging times • Arbitrary or incomplete evaluation criteria • Political process	Inflation sensitive investing
Demographics	Future new entrants will grow liability	More growth orientation needed than for plans closed to new members
Mortality	Increasing life expectancy raises cost of lifetime annuities	• Growth assets • Increasing investment time horizon

Asset Liability Modeling (ALM) Overview

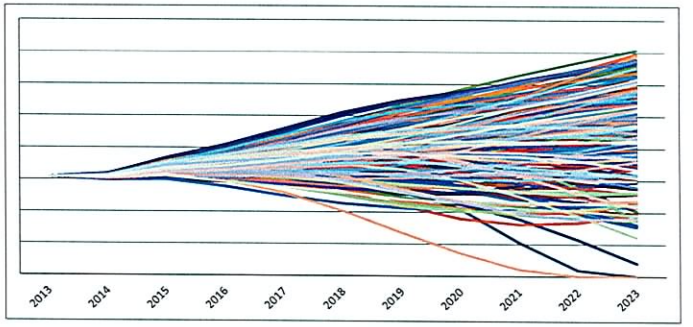
What is an ALM Study?

- In an Asset Liability Model (ALM), actuarial valuations are projected into the future under different scenarios to identify cash contributions, funding levels and other financial information
- Scenarios reflect variability in:
  - Inflation
  - Treasury yields
  - Corporate bond yields
  - Asset class returns, volatility and correlation
  - Investment strategies
- Results show:
  - likelihood of events
    - Funding levels below x%
    - Annual or cumulative contribution above $x
  - range of possible outcomes
    - 5th, 25th, 50th, 75th, 95th percentile results

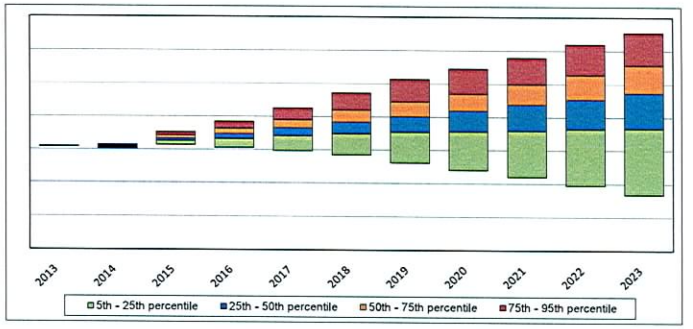
One Scenario



Many Scenarios



Results Summarized



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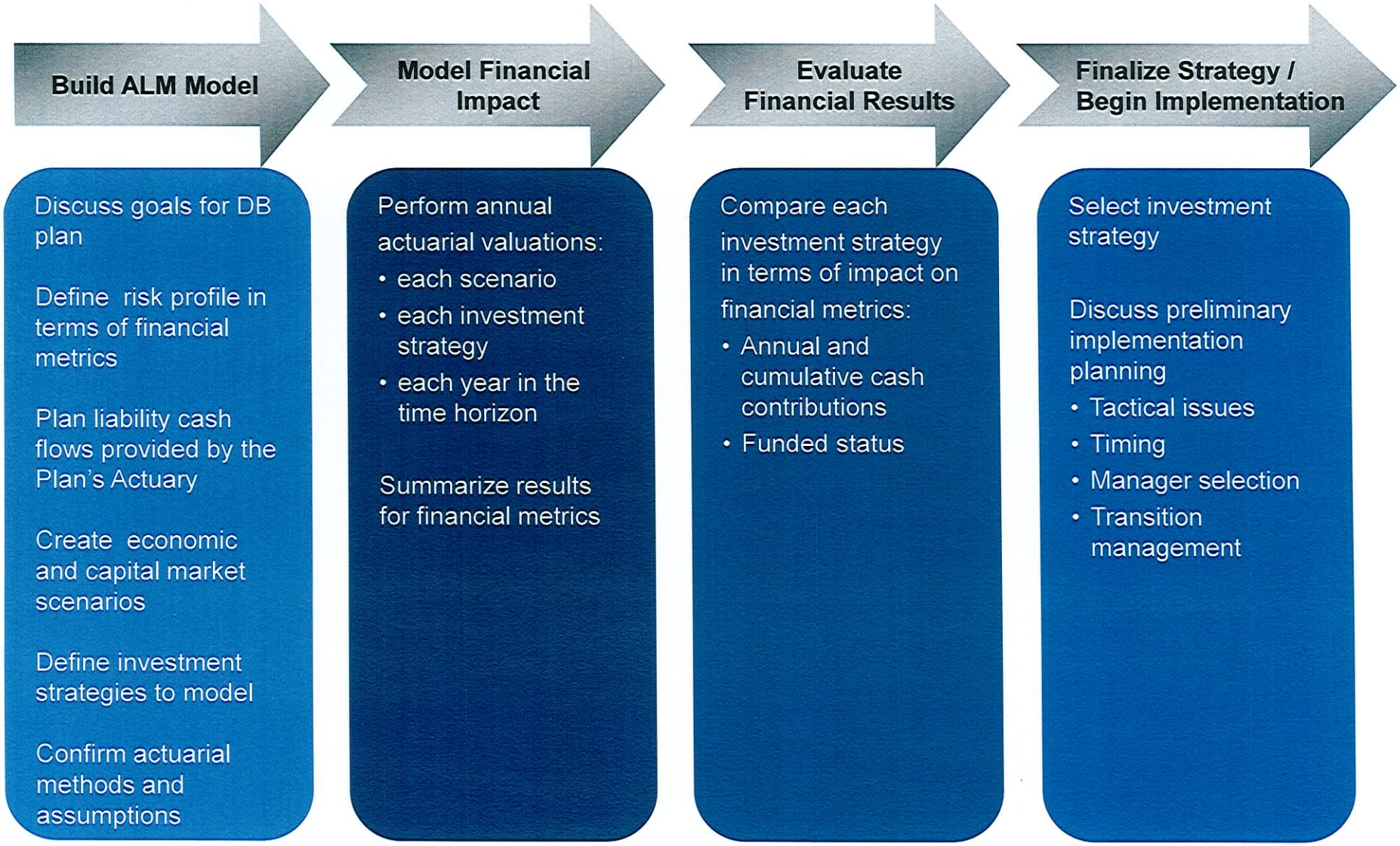
How Are ALM Studies Performed?



How is the Investment Portfolio Modeled?

- Buck uses GEMS®, an award winning Economic Scenario Generator from Conning and Company to model economic and capital market environments. Returns are determined for each asset class and then used to construct portfolio returns.
- Key features of GEMS:
  - Reflects observed capital market phenomena (e.g. non-normal returns distributions, dynamic correlations, stochastic jump volatilities, black swans).
  - Recalibrated to current conditions quarterly and trends to long term equilibriums that reflect historical experience in a variety of economic and capital market environments. Incorporates historical data back to inception of various indices.
  - Models a number of key global economies in an internally consistent manner

How is the Investment Portfolio Modeled (cont.)?

Sampling of GEMS Asset Models

Asset Class Model	Type	Key Attributes
Treasuries	3-factor affine	• Realistic yield distributions • Produces all commonly observed yield curve shapes including inversions • No exploding yields • The ability of the model to fit the initial yield curve • Arbitrage free bond and derivative pricing
Corporate Bonds	GEMS corporate security model	• Model of individual bonds • Stochastic spreads and stochastic transition and default incorporated • Issuer concentration risk can be captured
	GEMS Corporate Yield Model	• Stochastic spreads • Realistic transition and default dynamics • Ability to produce the jump-like behaviors in spreads observed during 2008 crisis • Market-consistent fits to the initial spread curves • Imperfect correlations between spreads
Equity	Stochastic Volatility with Jumps (SVJ)	• Realistic return and volatility behavior • Jump process produces crisis-like events • Ability to price derivatives, including volatility "smile" • Ability to fit to market prices of options
Property	ARX model	• Rent/price index breakdown for multiple property types • Flexible
Inflation	4-factor affine	• Realistic interest rate and inflation dynamics • Realistic yield curve dynamics • Inflation derivatives priced (e.g. LPI Swaps)
Defaultable Sovereign Debt		• Purpose built model recreating the historical spread behavior of Sovereign debt • Incorporates credit events and debt restructuring • Richer analysis of Government bond allocations

Buck 2013 Mid-Year Capital Market Assumptions

Arithmetic Returns and Standard Deviations

	10 Year		20 Year		30 Year	
Asset Class	Expected Return	Std. Dev.	Expected Return	Std. Dev.	Expected Return	Std. Dev.
Cash	0.63%	0.52%	0.87%	0.61%	0.99%	0.64%
US Large Cap	8.67%	17.11%	10.02%	17.83%	10.56%	18.13%
US Mid Cap	10.77%	17.88%	12.22%	18.67%	12.79%	18.97%
US Small Cap	10.85%	18.36%	12.26%	19.08%	12.87%	19.38%
Global Equity	9.51%	15.76%	10.32%	16.26%	10.61%	16.46%
MSCI EAFE	9.81%	16.62%	10.16%	16.99%	10.18%	17.11%
MSCI Emerging Markets	11.11%	20.09%	11.69%	20.50%	12.06%	20.68%
Aggregate Bonds	2.75%	5.04%	4.38%	5.55%	5.20%	5.69%
Intermediate US Government	2.71%	4.36%	4.27%	4.86%	5.05%	5.03%
Long Corporate	3.34%	9.96%	5.41%	10.41%	6.41%	10.53%
Long Term Government Credit	2.68%	5.85%	4.38%	6.41%	5.24%	6.60%
High Yield	3.62%	7.84%	4.96%	8.13%	5.64%	8.18%
TIPS	4.20%	6.44%	5.75%	6.72%	6.48%	6.73%
Global Treasuries	2.24%	8.16%	4.13%	8.96%	5.08%	9.26%
Direct Real Estate	7.70%	6.83%	8.49%	7.11%	8.89%	7.26%
REIT	6.30%	18.93%	7.53%	19.65%	7.99%	19.90%
Hedge Funds	8.05%	6.33%	9.19%	6.50%	9.71%	6.55%
Commodities	8.77%	26.85%	9.18%	27.36%	9.40%	27.38%
Infrastructure	8.27%	19.77%	9.10%	20.41%	9.49%	20.68%
Private Equity	11.84%	28.15%	14.13%	29.32%	15.07%	29.80%
Mortgage Backed Securities	2.64%	5.10%	4.31%	5.74%	5.11%	5.78%
Inflation	2.86%	2.88%	3.12%	3.01%	3.27%	3.01%

Buck 2013 Mid-Year Capital Market Assumptions

Correlations

	Cash	US Large Cap	US Mid Cap	US Small Cap	Global Equity	MSCI EAFE	MSCI Emerging Markets	Aggregate Bonds	Int. US Government	Long Corporate	Long Term Government Credit	High Yield	TIPS	Global Treasuries	NCREIF	REIT	Hedge Funds	Commodities	Infrastructure	Private Equity	Mortgage Backed Securities	Inflation
Cash	1.000	0.170	0.173	0.164	0.126	0.059	0.112	0.134	0.178	-0.041	0.073	0.182	0.193	-0.018	0.229	0.128	0.235	0.170	0.166	0.175	0.144	0.343
US Large Cap	0.170	1.000	0.917	0.869	0.956	0.823	0.653	0.106	0.075	0.185	0.078	0.420	0.056	0.034	0.182	0.624	0.722	0.216	0.787	0.956	0.065	0.048
US Mid Cap	0.173	0.917	1.000	0.943	0.881	0.754	0.623	0.105	0.077	0.173	0.079	0.392	0.053	0.036	0.170	0.649	0.669	0.209	0.754	0.983	0.069	0.038
US Small Cap	0.164	0.869	0.943	1.000	0.835	0.714	0.592	0.099	0.072	0.164	0.074	0.371	0.050	0.033	0.163	0.643	0.638	0.198	0.721	0.968	0.064	0.036
Global Equity	0.126	0.956	0.881	0.835	1.000	0.933	0.730	0.092	0.061	0.175	0.067	0.396	0.041	0.027	0.173	0.603	0.741	0.204	0.823	0.917	0.052	0.031
MSCI EAFE	0.059	0.823	0.754	0.714	0.933	1.000	0.540	0.068	0.038	0.149	0.049	0.333	0.023	0.019	0.146	0.515	0.699	0.174	0.649	0.786	0.032	0.012
MSCI Emerging Markets	0.112	0.653	0.623	0.592	0.730	0.540	1.000	0.065	0.045	0.116	0.047	0.279	0.026	0.017	0.121	0.434	0.485	0.138	0.898	0.641	0.037	0.021
Aggregate Bonds	0.134	0.106	0.105	0.099	0.092	0.068	0.065	1.000	0.992	0.952	0.996	0.366	0.545	0.974	0.126	0.081	0.172	-0.065	0.049	0.107	0.984	-0.131
Int. US Government	0.178	0.075	0.077	0.072	0.061	0.038	0.045	0.992	1.000	0.917	0.985	0.360	0.557	0.951	0.134	0.062	0.159	-0.065	0.026	0.077	0.973	-0.115
Long Corporate	-0.041	0.185	0.173	0.164	0.175	0.149	0.116	0.952	0.917	1.000	0.963	0.369	0.485	0.968	0.090	0.124	0.197	-0.068	0.106	0.179	0.911	-0.183
Long Term Government Credit	0.073	0.078	0.079	0.074	0.067	0.049	0.047	0.996	0.985	0.963	1.000	0.344	0.534	0.988	0.109	0.062	0.143	-0.079	0.025	0.079	0.973	-0.152
High Yield	0.182	0.420	0.392	0.371	0.396	0.333	0.279	0.366	0.360	0.369	0.344	1.000	0.215	0.297	0.124	0.272	0.350	0.083	0.328	0.406	0.338	0.005
TIPS	0.193	0.056	0.053	0.050	0.041	0.023	0.026	0.545	0.557	0.485	0.534	0.215	1.000	0.504	0.153	0.045	0.103	0.200	0.084	0.054	0.535	0.474
Global Treasuries	-0.018	0.034	0.036	0.033	0.027	0.019	0.017	0.974	0.951	0.968	0.988	0.297	0.504	1.000	0.079	0.033	0.093	-0.097	-0.011	0.035	0.956	-0.179
NCREIF	0.229	0.182	0.170	0.163	0.173	0.146	0.121	0.126	0.134	0.090	0.109	0.124	0.153	0.079	1.000	0.114	0.187	0.241	0.200	0.177	0.122	0.282
REIT	0.128	0.624	0.649	0.643	0.603	0.515	0.434	0.081	0.062	0.124	0.062	0.272	0.045	0.033	0.114	1.000	0.458	0.140	0.629	0.659	0.058	0.029
Hedge Funds	0.235	0.722	0.669	0.638	0.741	0.699	0.485	0.172	0.159	0.197	0.143	0.350	0.103	0.093	0.187	0.458	1.000	0.157	0.575	0.696	0.144	0.036
Commodities	0.170	0.216	0.209	0.198	0.204	0.174	0.138	-0.065	-0.065	-0.068	-0.079	0.083	0.200	-0.097	0.241	0.140	0.157	1.000	0.453	0.214	-0.067	0.520
Infrastructure	0.166	0.787	0.754	0.721	0.823	0.649	0.898	0.049	0.026	0.106	0.025	0.328	0.084	-0.011	0.200	0.629	0.575	0.453	1.000	0.777	0.019	0.175
Private Equity	0.175	0.956	0.983	0.968	0.917	0.786	0.641	0.107	0.077	0.179	0.079	0.406	0.054	0.035	0.177	0.659	0.696	0.214	0.777	1.000	0.068	0.042
Mortgage Backed Securities	0.144	0.065	0.069	0.064	0.052	0.032	0.037	0.984	0.973	0.911	0.973	0.338	0.535	0.956	0.122	0.058	0.144	-0.067	0.019	0.068	1.000	-0.118
Inflation	0.343	0.048	0.038	0.036	0.031	0.012	0.021	-0.131	-0.115	-0.183	-0.152	0.005	0.474	-0.179	0.282	0.029	0.036	0.520	0.175	0.042	-0.118	1.000

Key Actuarial Methods and Assumptions – TSERS

Item	Methodology
Assumed Portfolio Return*	7.25%
Actuarial Funding Method*	• Actuarial cost method: Individual entry age normal cost method • Asset smoothing: The actuarial value recognizes 20% of the difference between market value and the expected actuarial value that assumes a rate of return of 7.25%
Funding Policy*	• Two components, stated as a percentage of payroll – Normal cost: uniform percentage of pay from new entrant to termination or retirement – Accrued liability: amortization of unfunded actuarial accrued liability over 12 years
Future Population	Level future population
Mortality*	Mortality rates with improvements from December 31, 2003 using Scale AA

* Based on December 31, 2011 actuarial valuation.

Key Actuarial Methods and Assumptions - TSERS

Item	Methodology
Wages Increases	• General and wage inflation: 3% • Productivity Increase: 0.5% • Representative assumed rates of salary increase – Classroom teachers: 4.25%-7.55% – General employees and other education: 4.25%-5.50% – Law enforcement: 4.25%-9.1%
General Benefit Provisions*	Benefit provisions currently in effect
COLA	• COLA is a significant risk factor that any investment strategy needs to recognize • The incidence of future COLA grants is unknown and recent decisions with respect to COLA grants may not be the best indicator of long term practices • Ignoring a COLA in modeling can significantly understate liabilities and contribution requirements • ***Modeling Approach for ALM***: COLA granted annually to the extent that the COLA could be fully funded from the gain on the Actuarial Value of Assets, but limited to the increase in CPI-U for the year

* Based on December 31, 2011 actuarial valuation.

Preliminary ALM Analysis - TSERS

ALM Model

- Used model developed for TSERS risk study performed in 2012
- Other systems were not modeled in 2012:
  - it was believed that modeling TSERS would provide a reasonable proxy for understanding key retirement system risks
  - purpose of 2012 study was not to determine system-specific investment strategies
- System-specific investment strategy development may be needed to the extent that TSERS is not a suitable benchmark for a given system

ALM Approach

- Test more diverse strategies against "naïve" equity / fixed income / inflation portfolios
- Performance and risk metrics
  - Portfolio betas (Global equity market, inflation)
  - Portfolio volatilities
  - Trade-off analysis

	X Axis	Y Axis
Cost Curve	25th Percentile Tail Inflation Discounted Average Cost	Full Distribution Inflation Discounted Average Cost
Funded Ratio Curve	5th Percentile Funded Ratio @ 5 years	Median Funded Ratio @ 30 years
Return Curve	Probability rolling 3 year CAGR is less than 0%	Probability 30 year CAGR is at least 7.25%

Investment Strategies

TSERS Asset Class	Strategic Policy	July 31, 2013 Actual Allocation
Global Equity	40.50%	47.37%
Fixed Income	36.00%	32.19%
Real Estate	8.00%	7.89%
Alternatives	6.50%	4.49%
Credit	4.50%	4.27%
Inflation	4.50%	2.96%
Cash	0.00%	0.83%
Total	***100.00%***	***100.00%***
Expected Return (Arithmetic)	8.50%	8.59%
Expected Return (Geometric)	8.08%	8.13%
Volatility	9.77%	10.12%

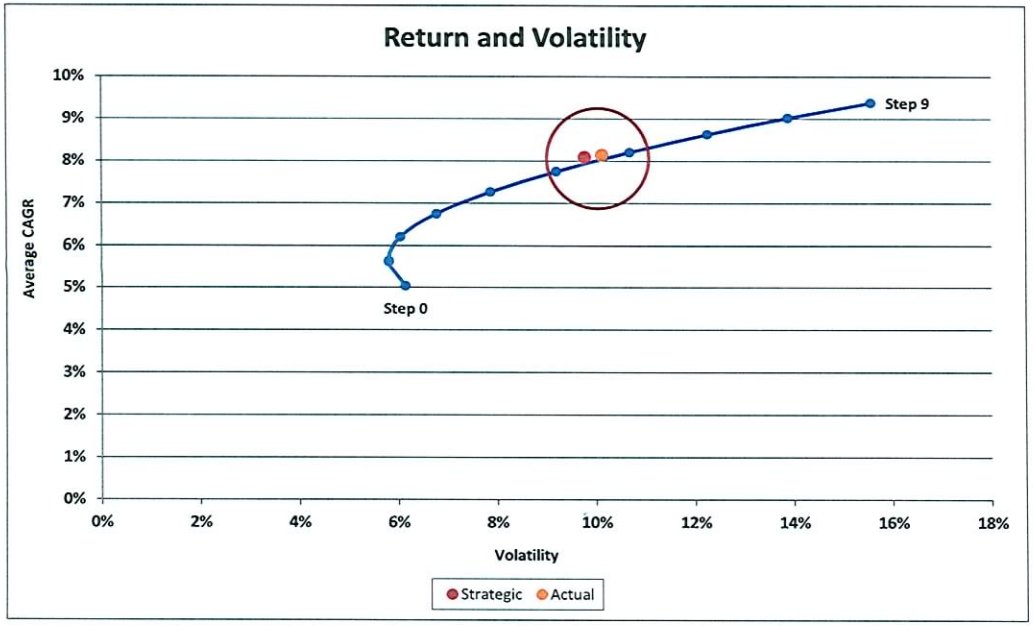
Naïve Investment Strategies

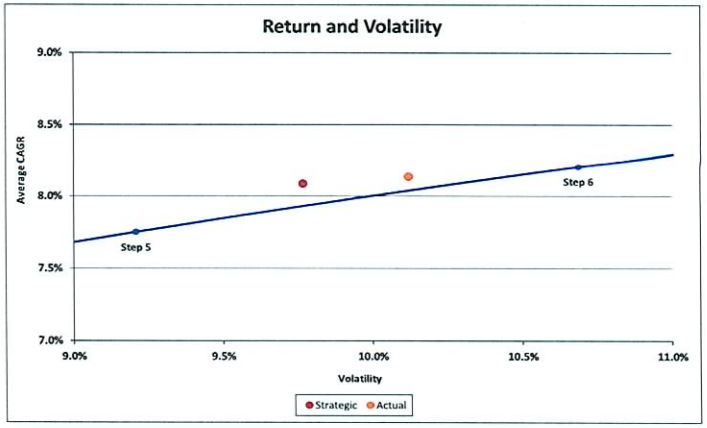
TSRERS Asset Class	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
Global Equity	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
Fixed Income	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
Inflation*	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* Combination of Commodities and TIPS with Commodities increasing linearly from 0% to 100% of Inflation

Return and Volatility Curve – TSERS

30 Year Horizon





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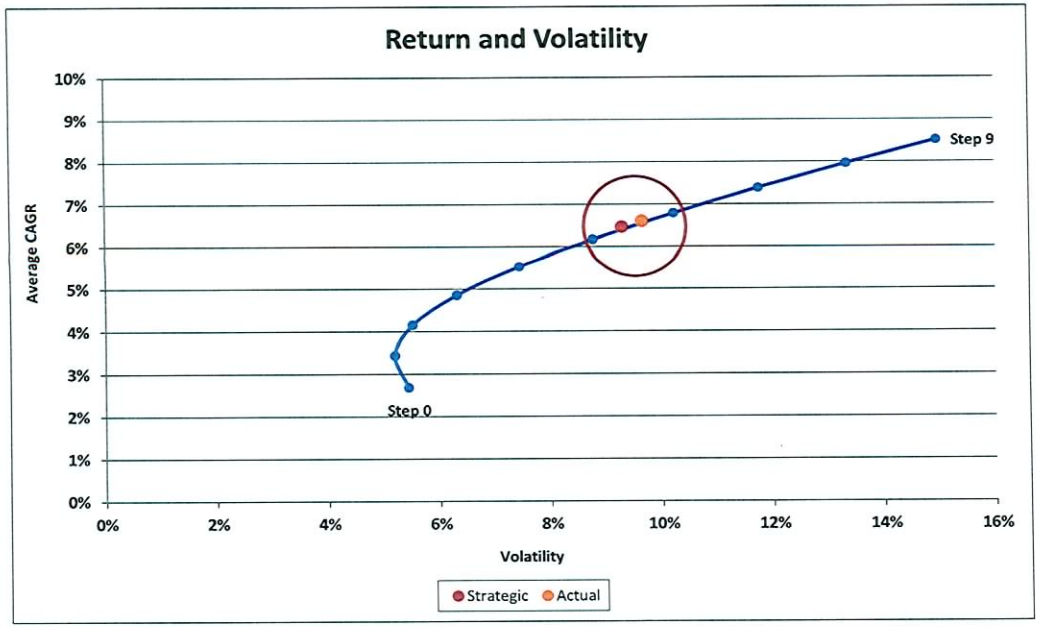
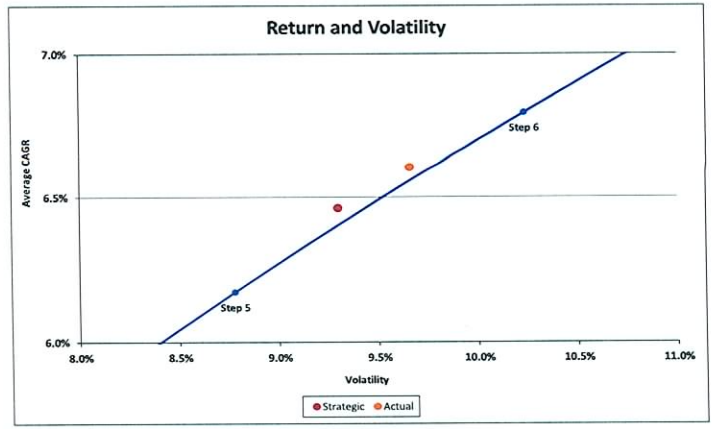
Return and Volatility Curve – TSERS

10 Year Horizon





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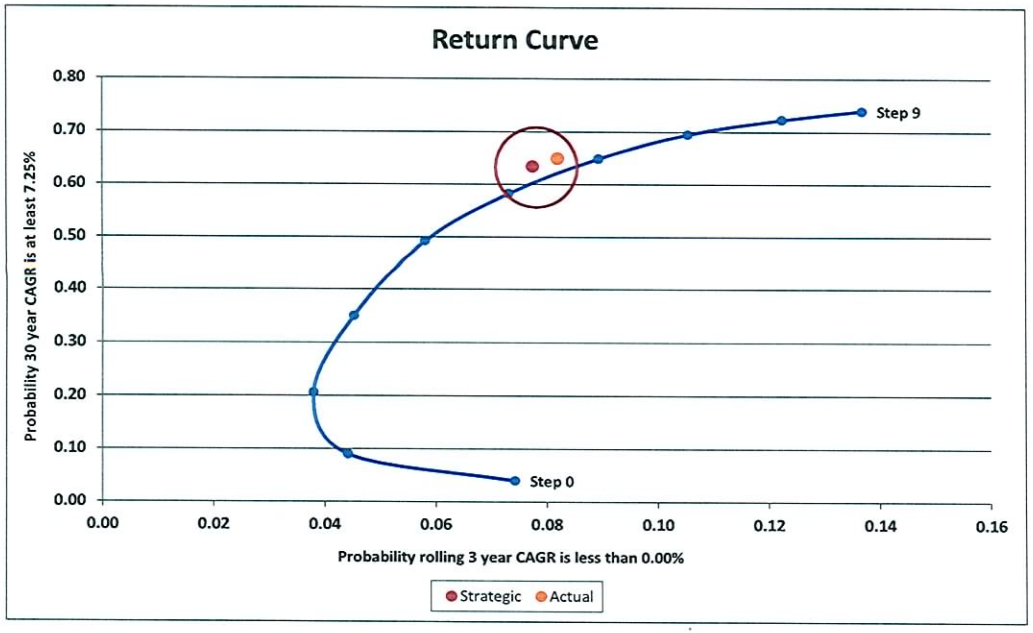
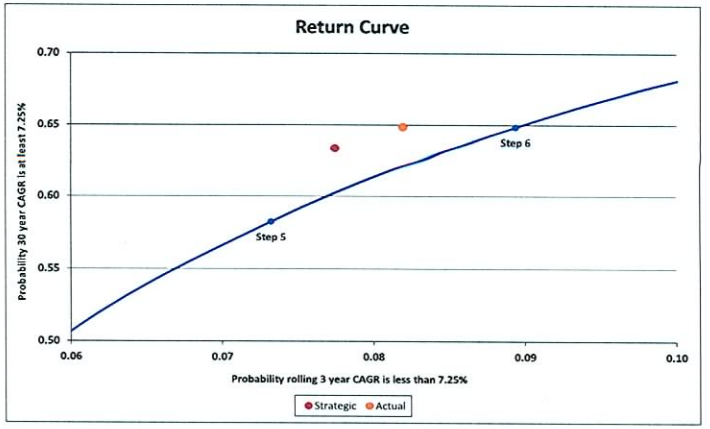
Return Curve – TSERS





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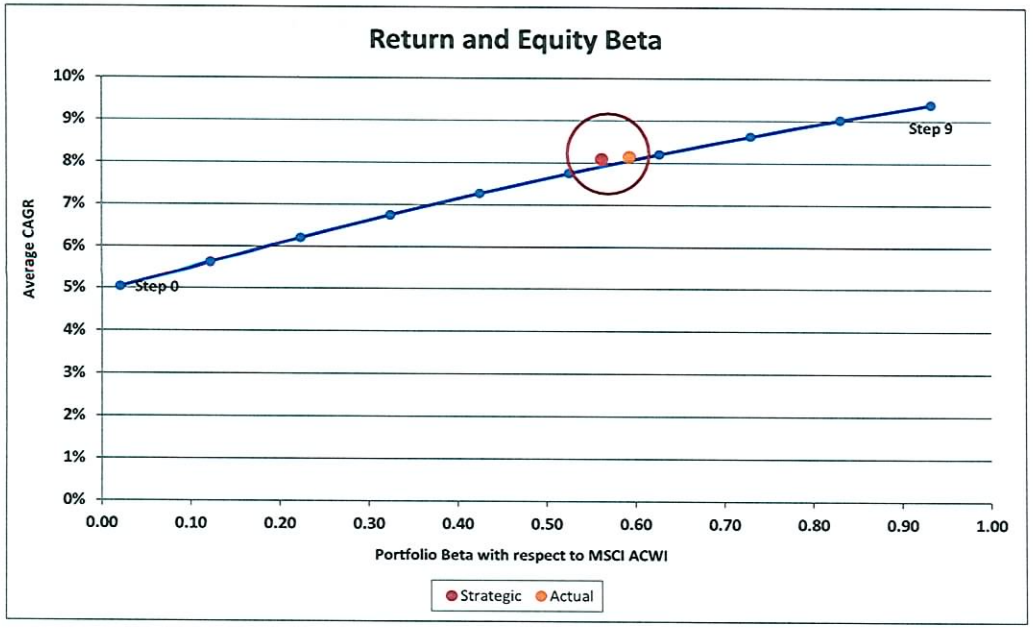
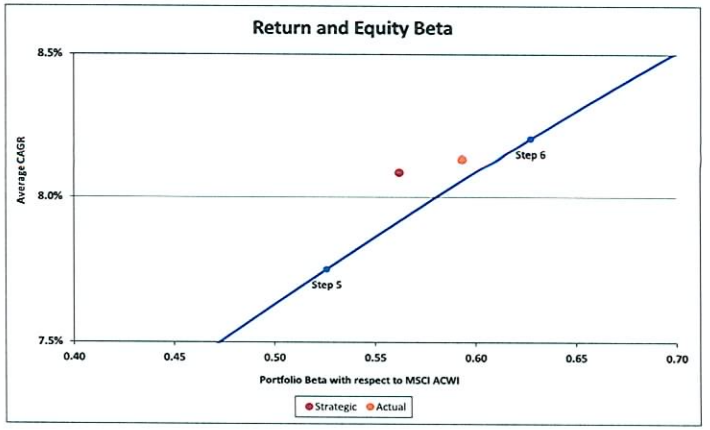
Return and Equity Beta Curve – TSERS





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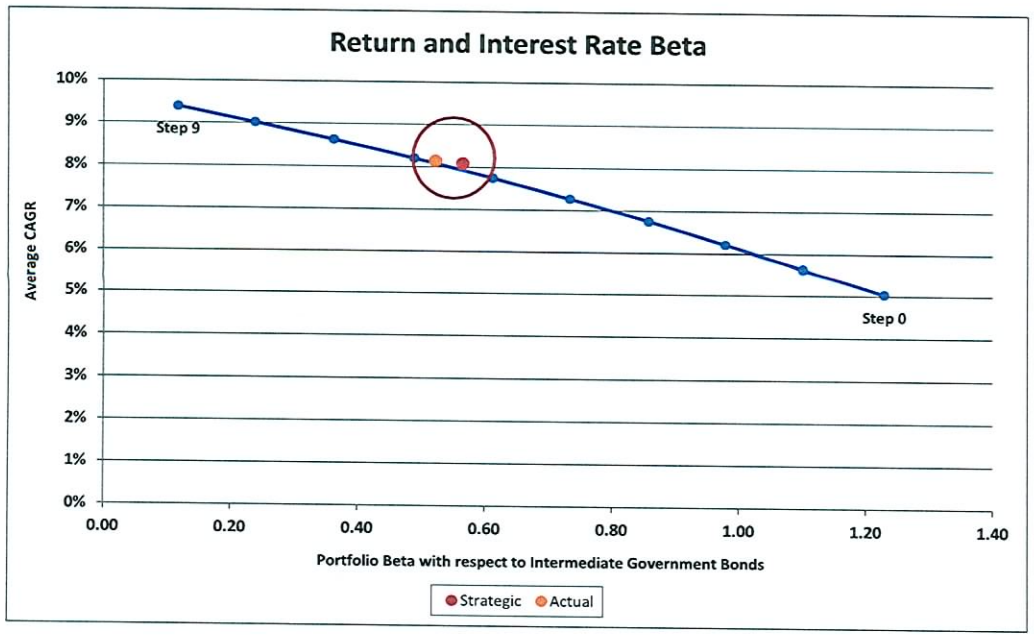
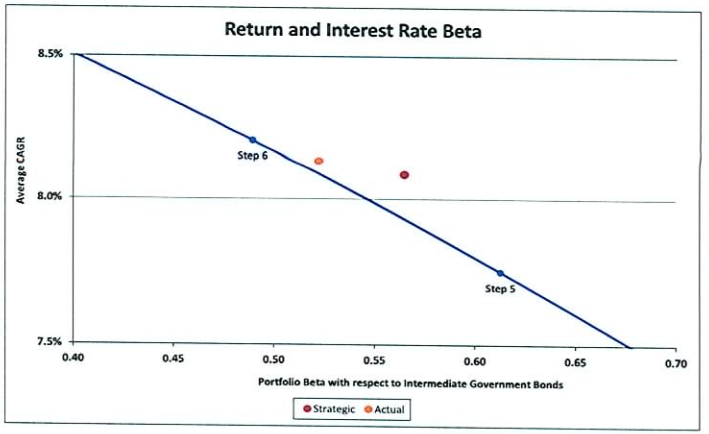
Return and Interest Rate Beta Curve – TSERS





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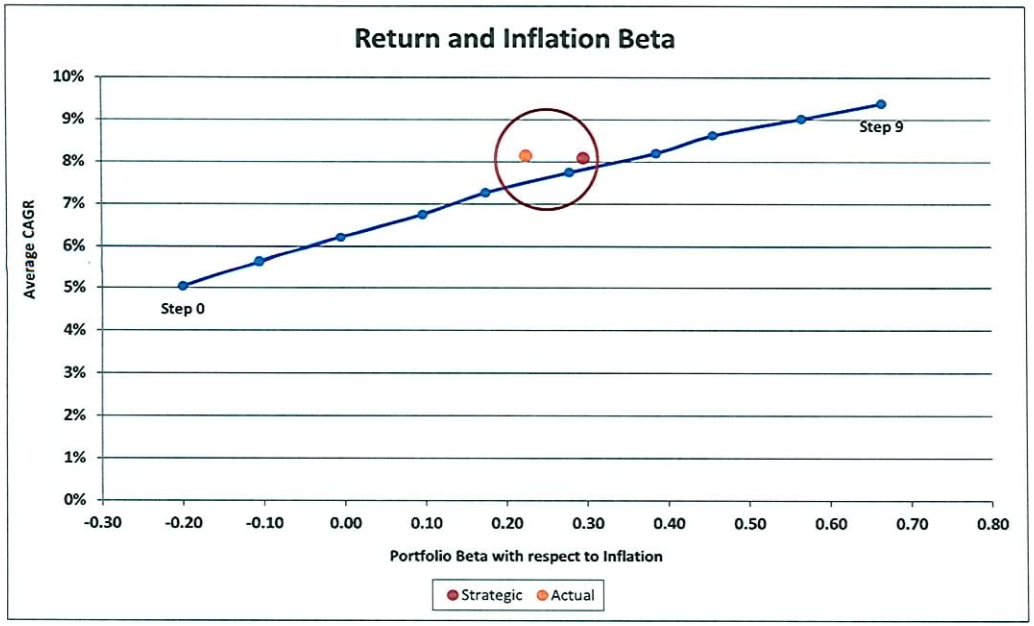
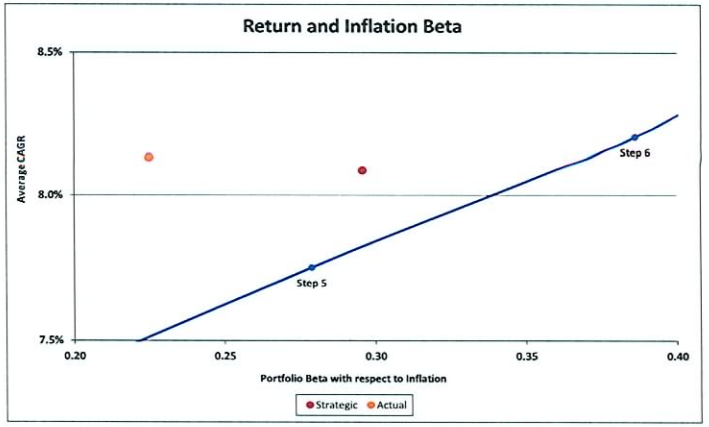
Return and Inflation Beta Curve – TSERS





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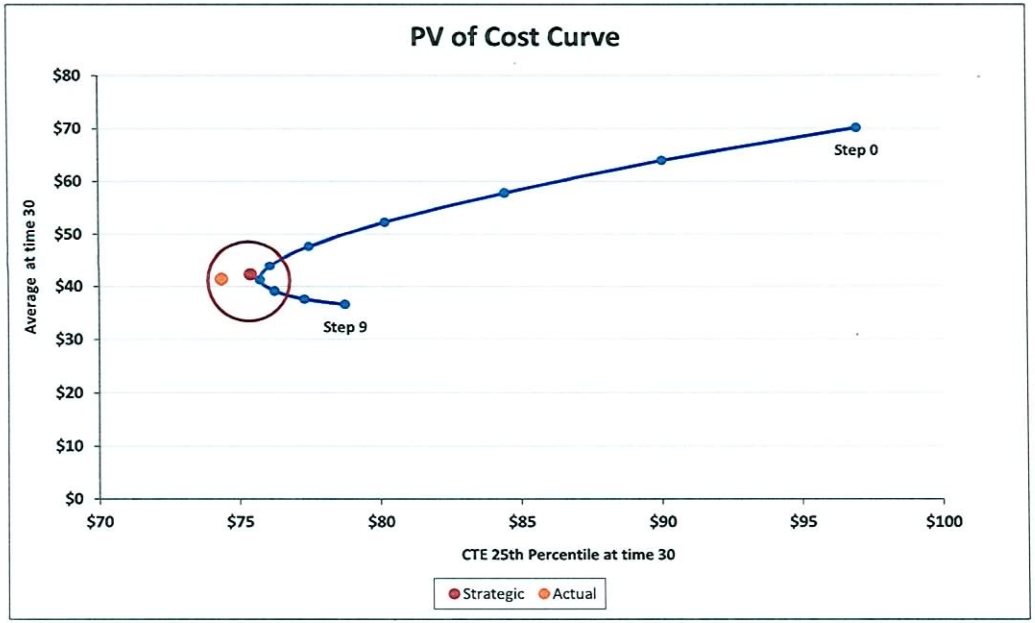
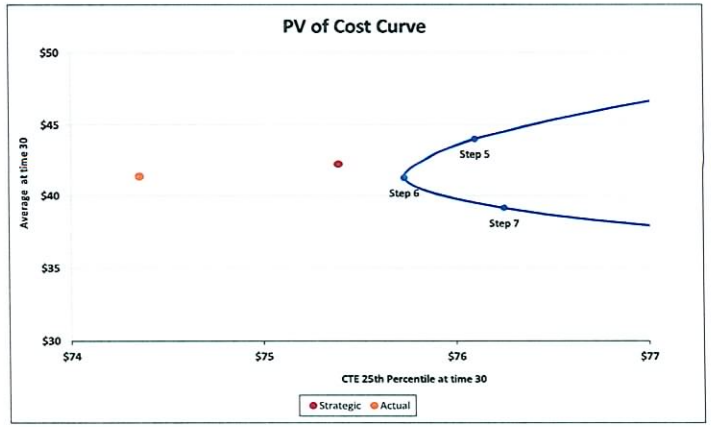
Cost Curve – TSERS





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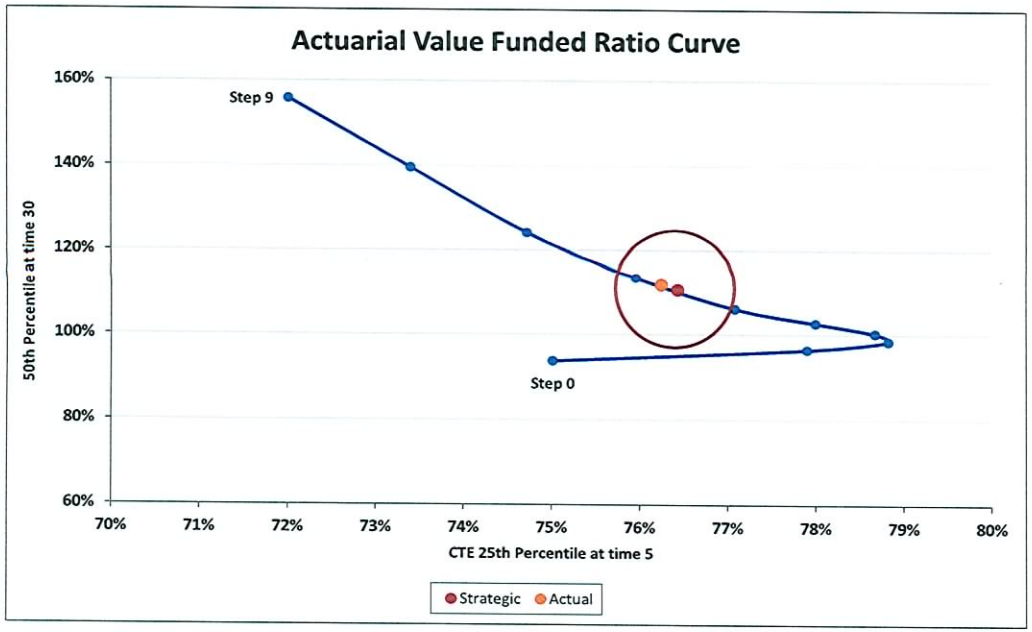
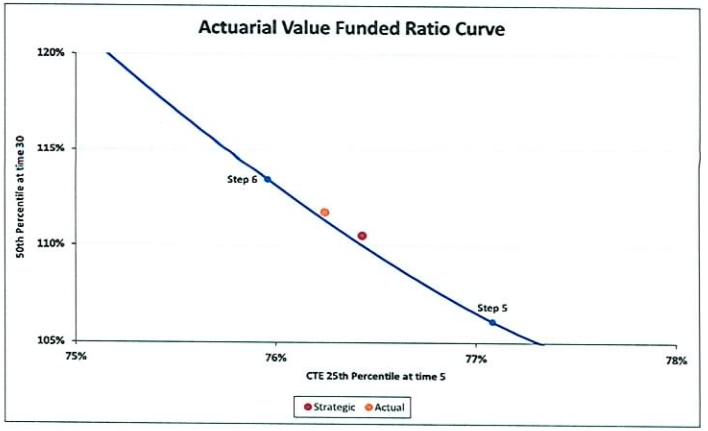
AVA Funded Ratio Curve – TSERS





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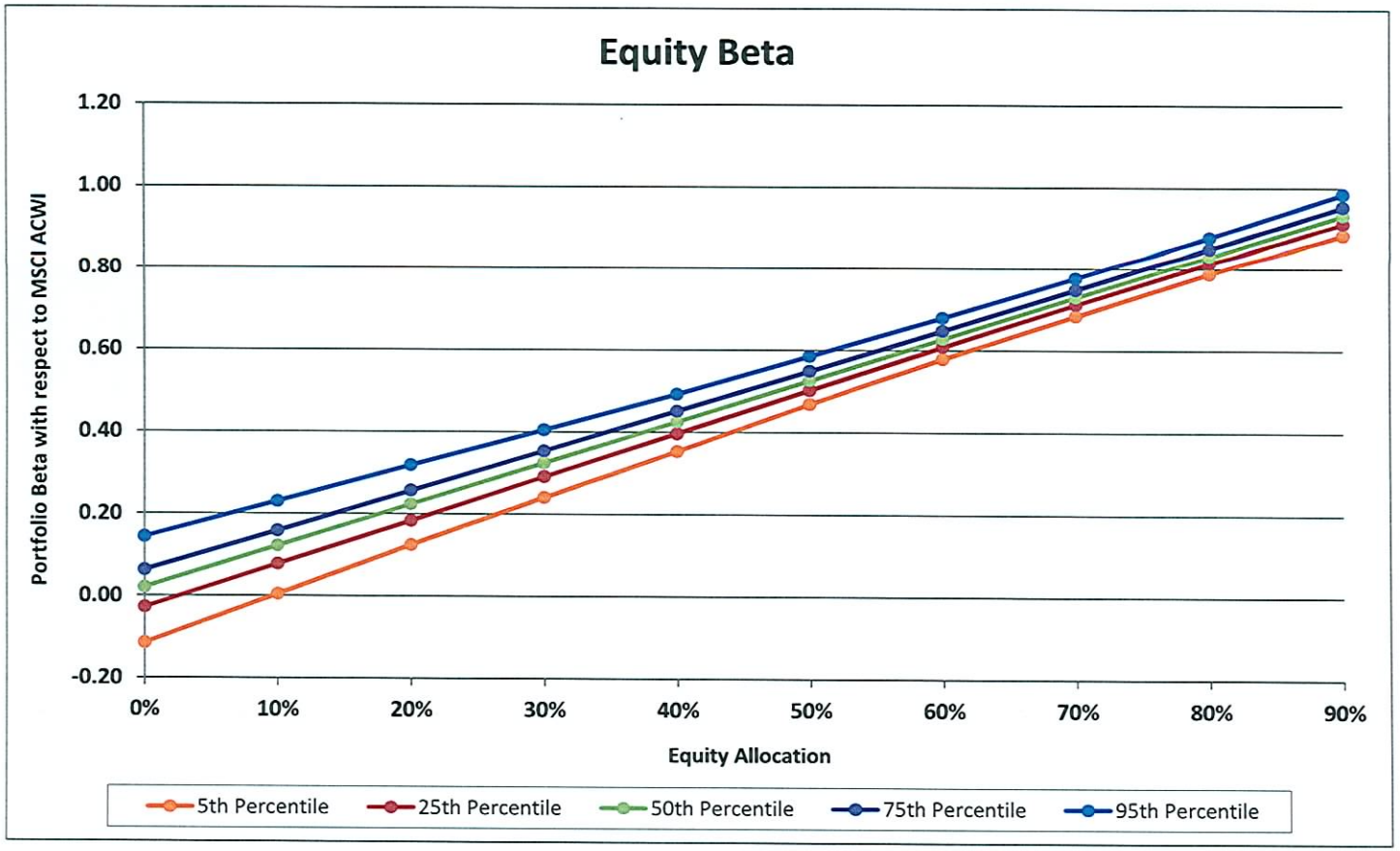
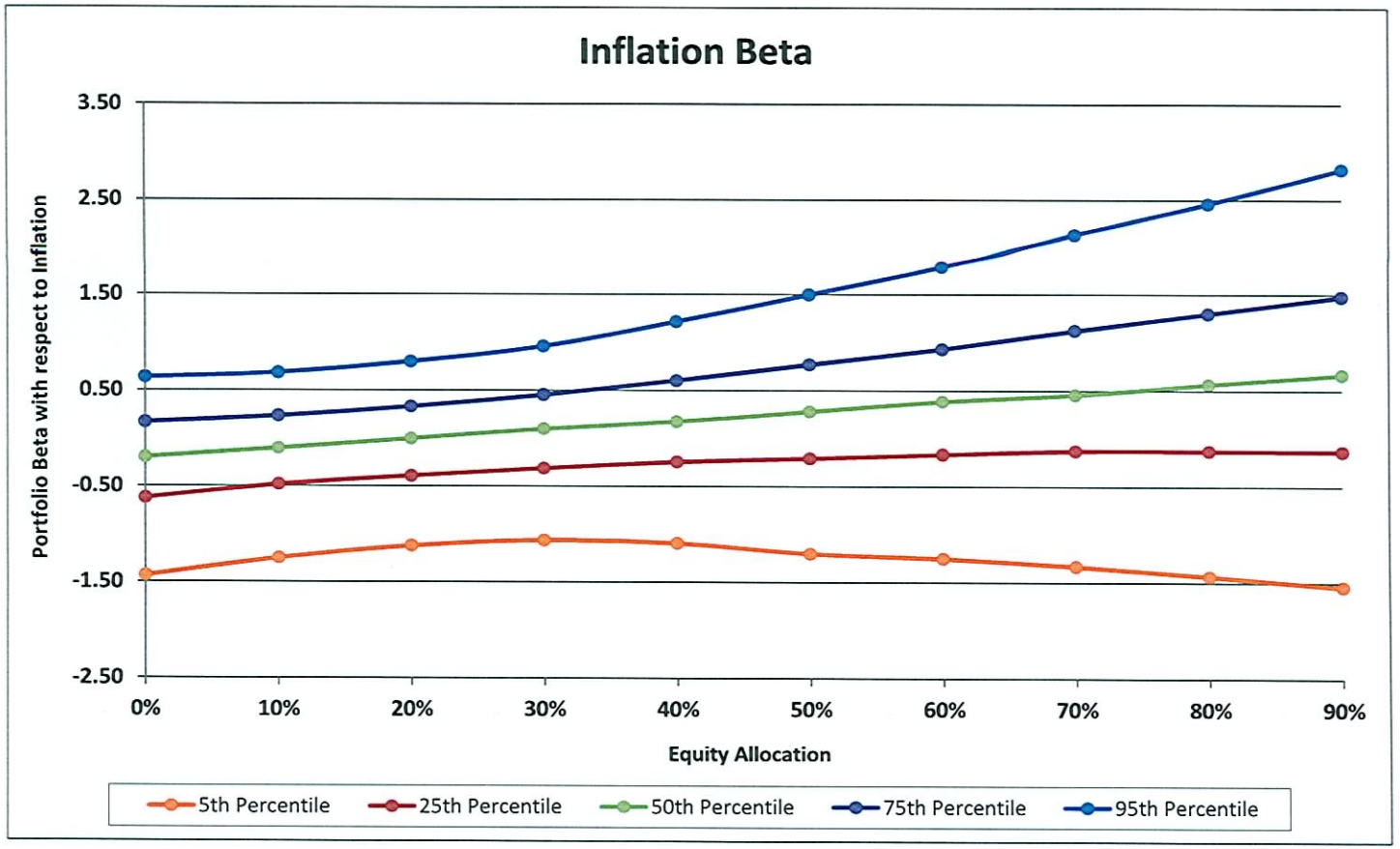
Appendix

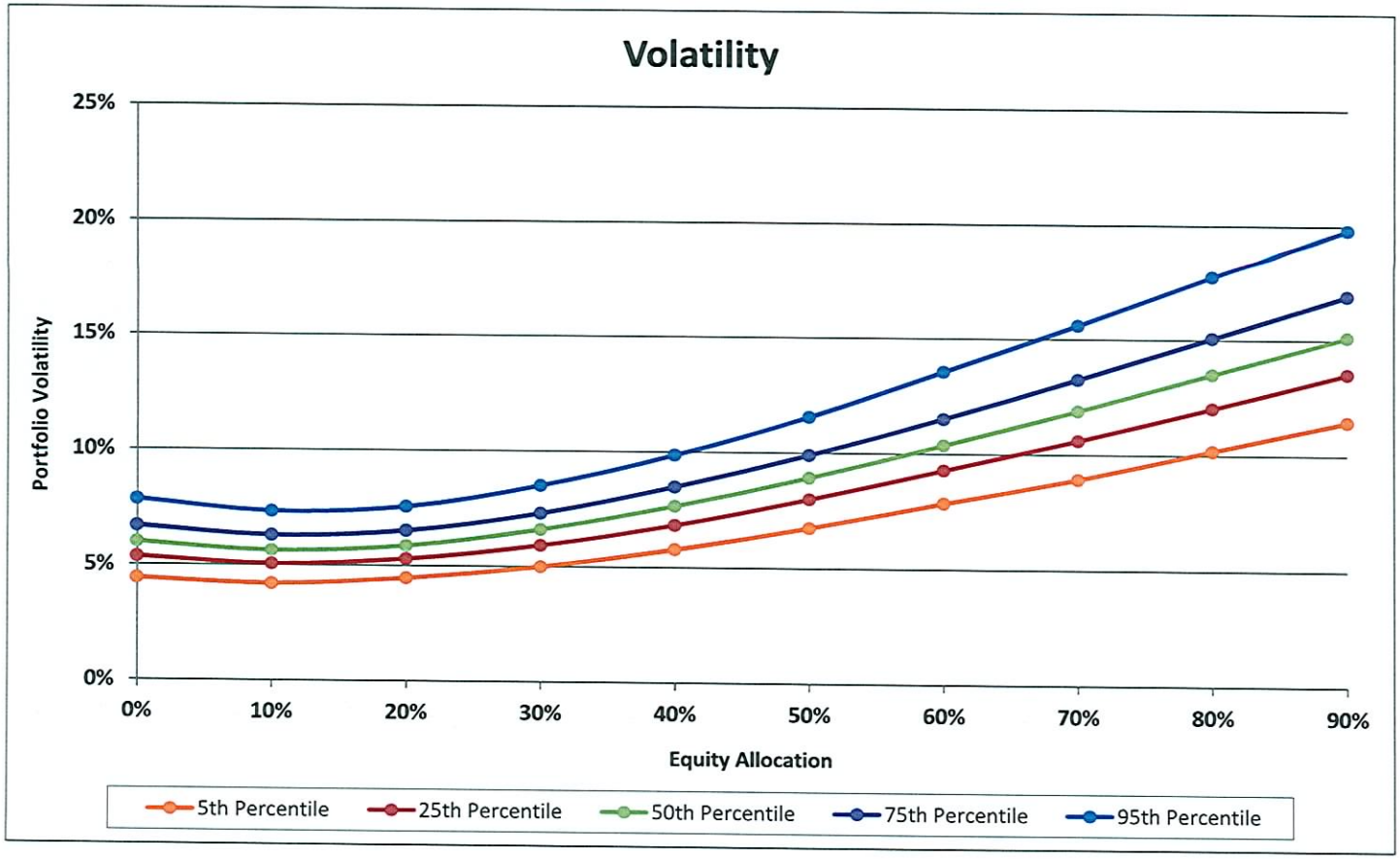
Equity Beta


Equity Beta
Portfolio Beta with respect to MSCI ACWI
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
Equity Allocation
5th Percentile
25th Percentile
50th Percentile
75th Percentile
95th Percentile

Inflation Beta



Volatility


Volatility
25%
20%
15%
10%
5%
0%
Portfolio Volatility
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
Equity Allocation
5th Percentile
25th Percentile
50th Percentile
75th Percentile
95th Percentile

Asset Modeling

Portfolio Mapping to GEMS® Model

Asset Class	Strategic	Actual
Global Equity	40.50%	47.37%
Long Term Government Credit	27.00%	24.14%
Direct Real Estate	7.20%	7.10%
REIT	0.80%	0.79%
Hedge Funds	0.70%	0.48%
Private Equity	5.80%	4.01%
Mortgage Backed Securities	9.00%	8.05%
Distress	2.25%	2.14%
High Yield	2.25%	2.13%
Inflation	4.50%	2.96%
Cash	0.00%	0.83%