

TESRS Asset / Liability Modeling Study

March 4, 2016



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MODELING APPROACH

■ Assets

Asset classes to consider were presented and approved by the Board and the Board Meeting on December 10, 2015. Included were the class returns and volatilities.

From this set of assets classes, five new portfolios representing alternative asset allocations were developed and were analyzed next to the current allocation.

The asset class returns were stochastically modeled under lognormal assumptions without seriality which were then combined into total portfolio returns for each alternative allocation. These were projected 20 years into the future, with 1,000 trials run for each class.

■ Alpha

This study does not assume any manager alpha – the excess return that the managers produce above their benchmarks after fees. Over the last five years, this alpha has been about 90 bps.

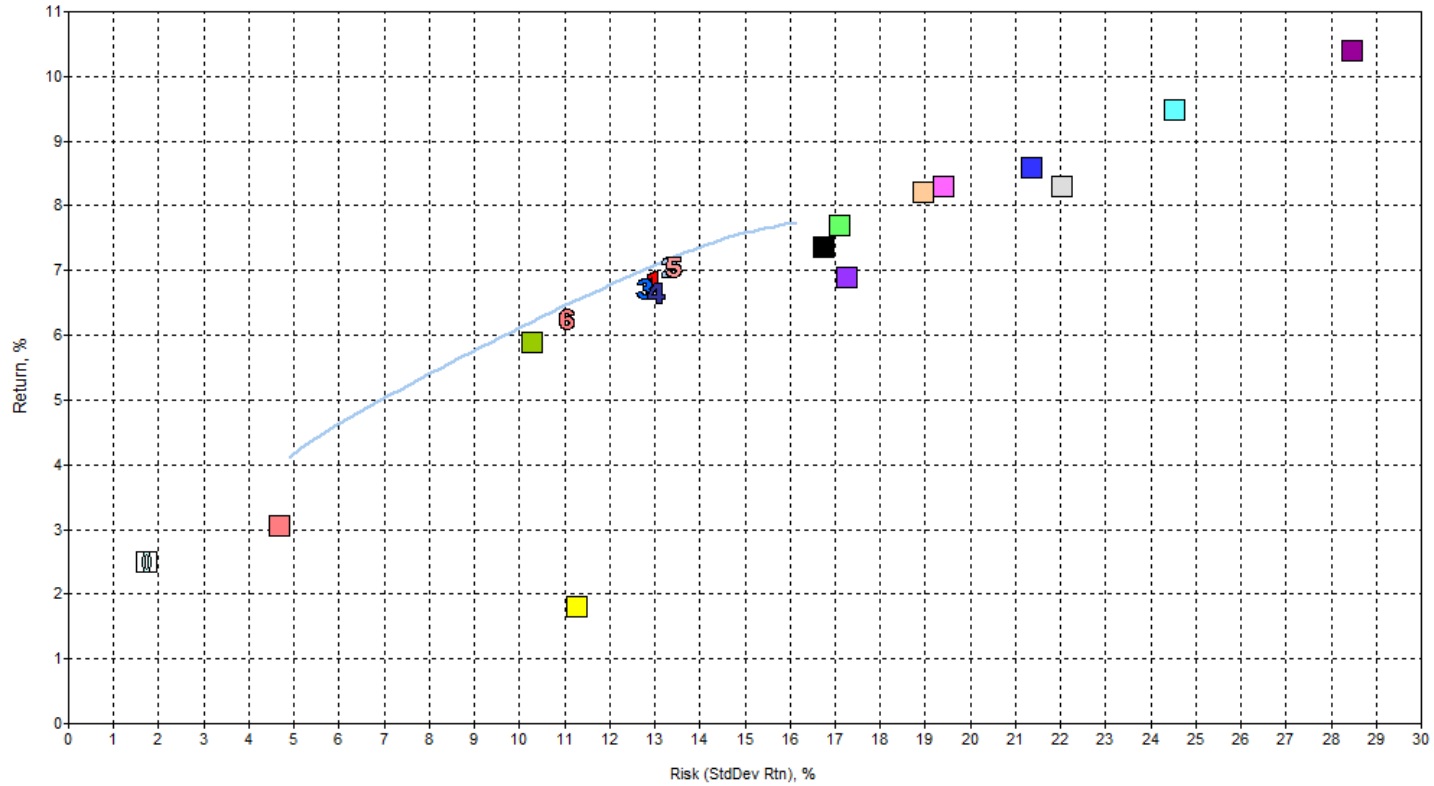
■ Funding

- Liabilities: Liabilities continued to be valued using the current 7.75% actuarial valuation rate. New entrants are expected to replace retirements on an equivalent normal cost basis.
- Contributions: These are calculated to pay the normal cost plus 30-year amortization (rolling) of that year's unfunded actuarial accrued liability, less the maximum portion funded by the state.



Efficient Frontier

Efficient Frontier: Return vs. Risk (StdDev Rtn)

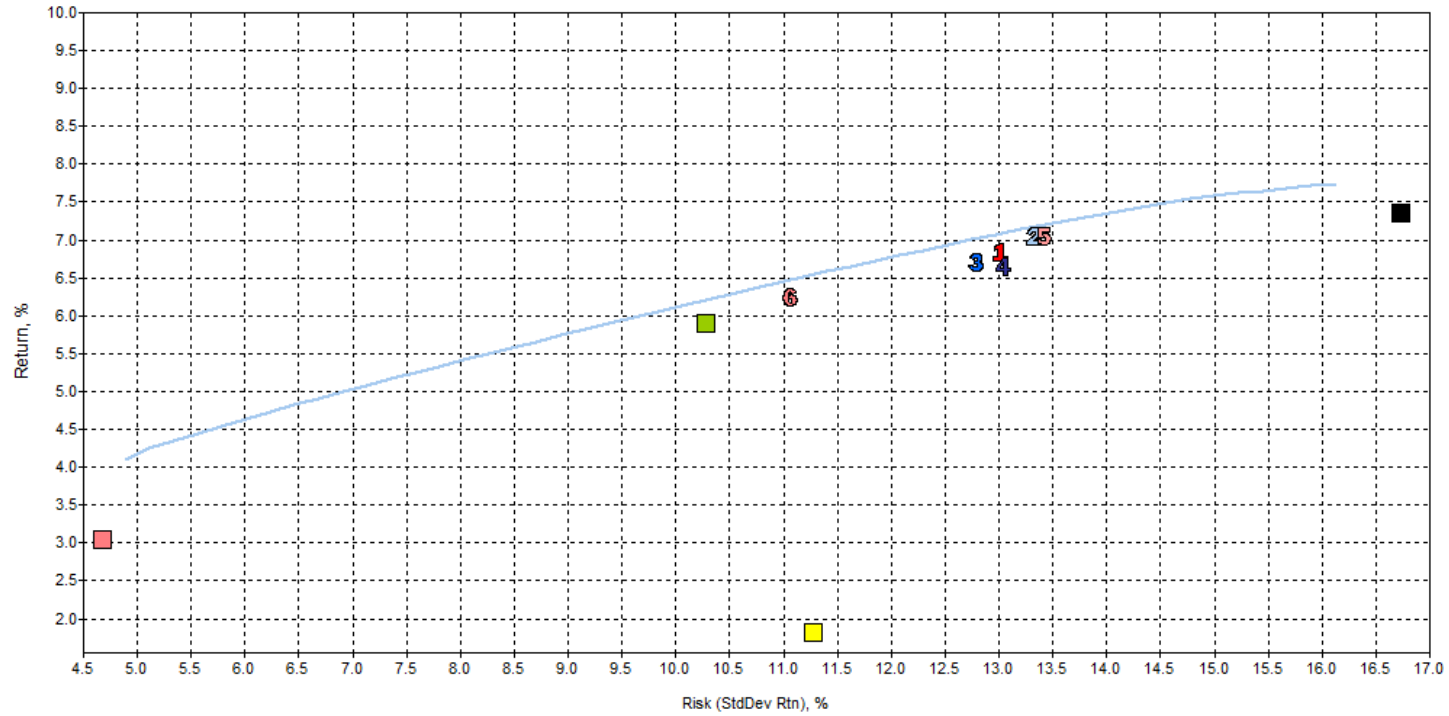


- Frontier
- AA-4 No Int'l Equity
- US Core Fixed Income
- US LC Core
- Foreign Developed Equity
- Current Portfolio
- AA-7 No IB w/RE w/HY
- High Yield FI
- US LC Value
- Emerging Markets Equity
- AA-1 No IB w/HY
- AA-L 60/40 Portfolio
- Non-US Bonds
- US Sm Cap Growth
- Master Limited Partnerships
- AA-2 No EM
- Cash
- US LC Growth
- US Sm Cap Core
- Global Real Estate



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ASSET ALLOCATIONS ANALYZED

Short Version Description

1. Current
2. HY No IB – add high yield, remove international bonds
3. No EM – remove emerging markets equity
4. No Intl Eq – remove all international equity, developed and emerging markets
5. RE HY No IB – add global real estate and high yield bonds, remove international bonds
6. 60/40

Next page shows the allocation within each portfolio.



ASSET ALLOCATIONS ANALYZED

Asset Class	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY	6 60/40
US Core FI	21.00%	21.00%	21.00%	21.00%	21.00%	40.00%
High Yield FI	--	5.00	--	--	5.00	--
Non-US FI	5.00	--	5.00	5.00	--	--
US Large Cap Growth	16.00	16.00	16.00	26.29	14.65	--
US Large Cap Core	--	--	--	--	--	18.00
US Large Cap Value	16.00	16.00	16.00	26.29	14.65	--
US Small Cap Growth	5.00	5.00	5.00	8.21	5.00	--
US Small Cap Core	5.00	5.00	5.00	8.21	5.00	15.00
Foreign Developed Equity	21.00	21.00	27.00	--	19.20	22.00
Emerging Market Equity	6.00	6.00	--	--	5.50	5.00
Master Limited Partnerships	5.00	5.00	5.00	5.00	5.00	--
Global Real Estate	--	--	--	--	5.00	--

	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY No IB	6 60/40
Return	6.84%	7.04%	6.71%	6.66%	7.05%	6.24%
Standard Deviation	13.00%	13.32%	12.79%	13.04%	13.42%	11.05%



Additional details for each allocation follows and include expected return, standard deviation of return, the distribution of modeled returns and the historical returns provided under various lengths of time

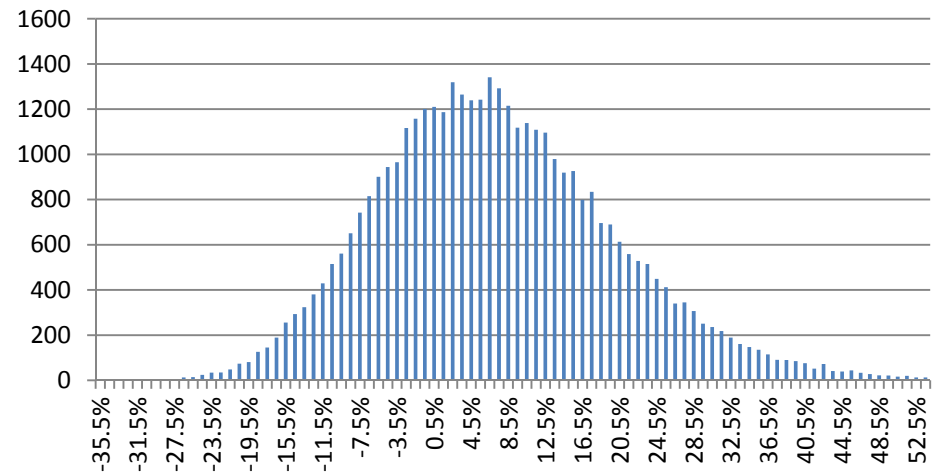


ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	21.0
Non-US FI	5.0
US LC Growth	16.0
US LC Value	16.0
US Sm Growth	5.0
US Sm	5.0
Developed Intl	21.0
Emerging Mkts	6.0
MLPs	5.0

Return	Std Dev
6.84%	13.00%

1 Current



Recent Years	Historical Returns
1	18.71%
5	14.05%
10	8.38%
15	6.71%

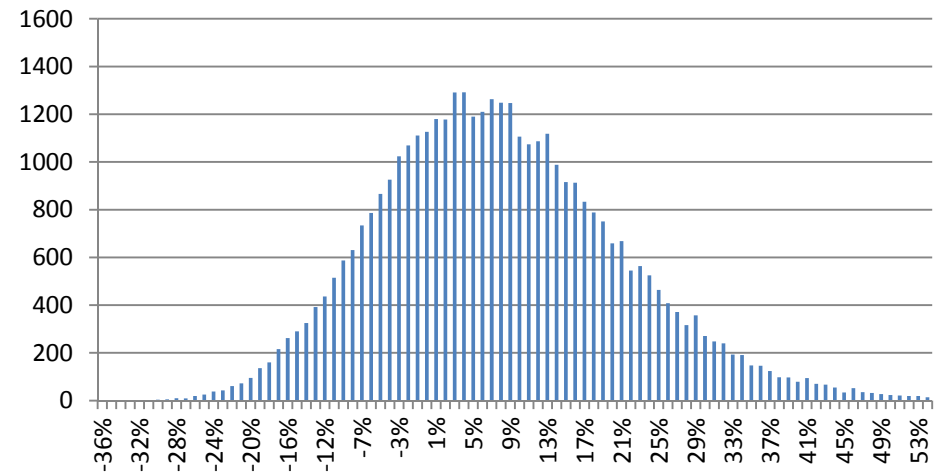


ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	21.0
High Yield FI	5.0
US LC Growth	16.0
US LC Value	16.0
US Sm Growth	5.0
US Sm	5.0
Developed Intl	21.0
Emerging Mkts	6.0
MLPs	5.0

Return	Std Dev
7.04%	13.32%

2 HY No IB



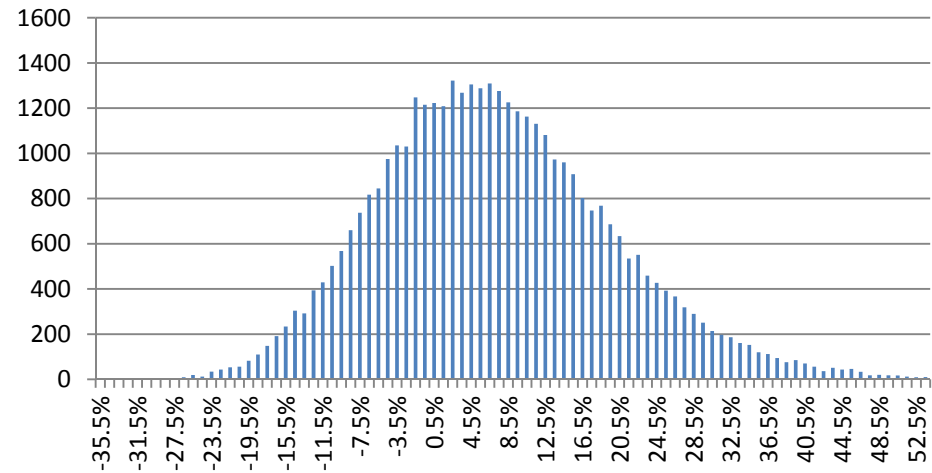
Recent Years	Historical Returns
1	18.86%
5	14.54%
10	8.54%
15	6.75%



ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	21.0
Non-US FI	5.0
US LC Growth	16.0
US LC Value	16.0
US Sm Growth	5.0
US Sm	5.0
Developed Intl	21.0
MLPs	5.0

3 No EM



Return	Std Dev
6.71%	12.79%

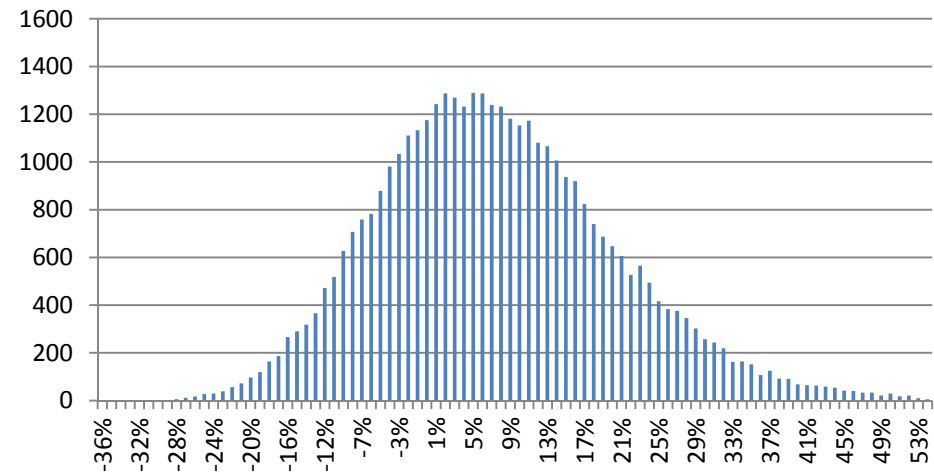
Recent Years	Historical Returns
1	19.27%
5	14.19%
10	8.03%
15	6.40%



ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	21.00
Non-US FI	5.00
US LC Growth	26.29
US LC Value	26.29
US Sm Growth	8.21
US Sm	8.21
MLPs	5.0

4 No Intl Eq



Return	Std Dev
6.66%	13.04%

Recent Years	Historical Returns
1	19.66%
5	16.22%
10	8.36%
15	6.53%

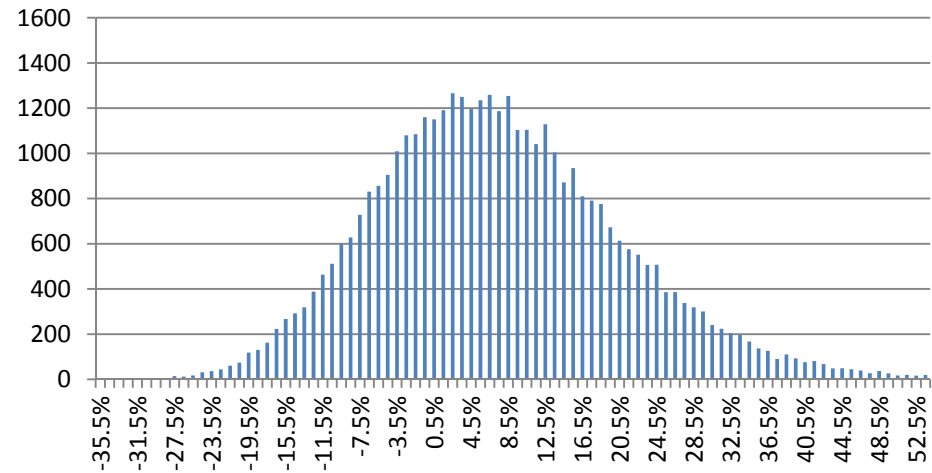


ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	21.00
High Yield FI	5.00
US LC Growth	14.65
US LC Value	14.65
US Sm Growth	5.00
US Sm	5.00
Developed Intl	19.20
Emerging Mkts	5.50
MLPs	5.00
Global RE	5.00

Return	Std Dev
7.05%	13.42%

5 RE HY No IB



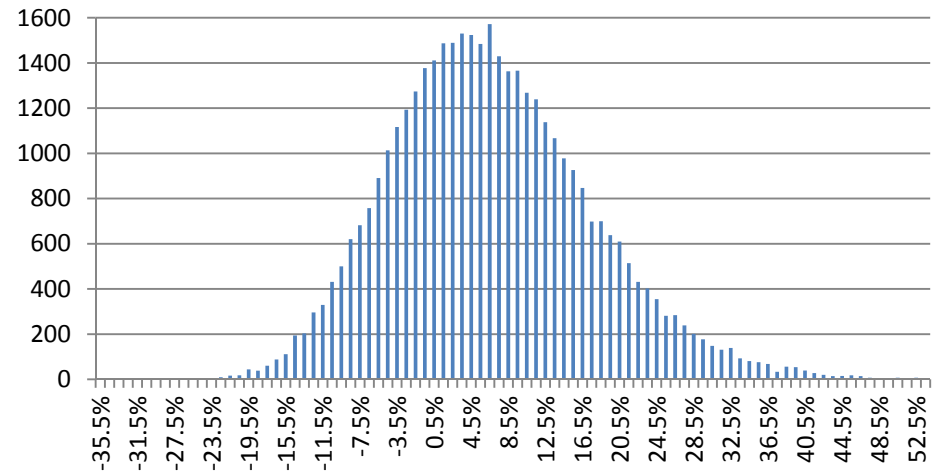
Recent Years	Historical Returns
1	18.41%
5	14.64%
10	8.61%
15	7.01%



ASSET ALLOCATIONS ANALYZED

Asset Class	%
US Core FI	40.0
UL Large Cap	18.0
US Small Cap	15.0
Developed Intl	22.0
Emerging Mkts	5.0

6 60/40



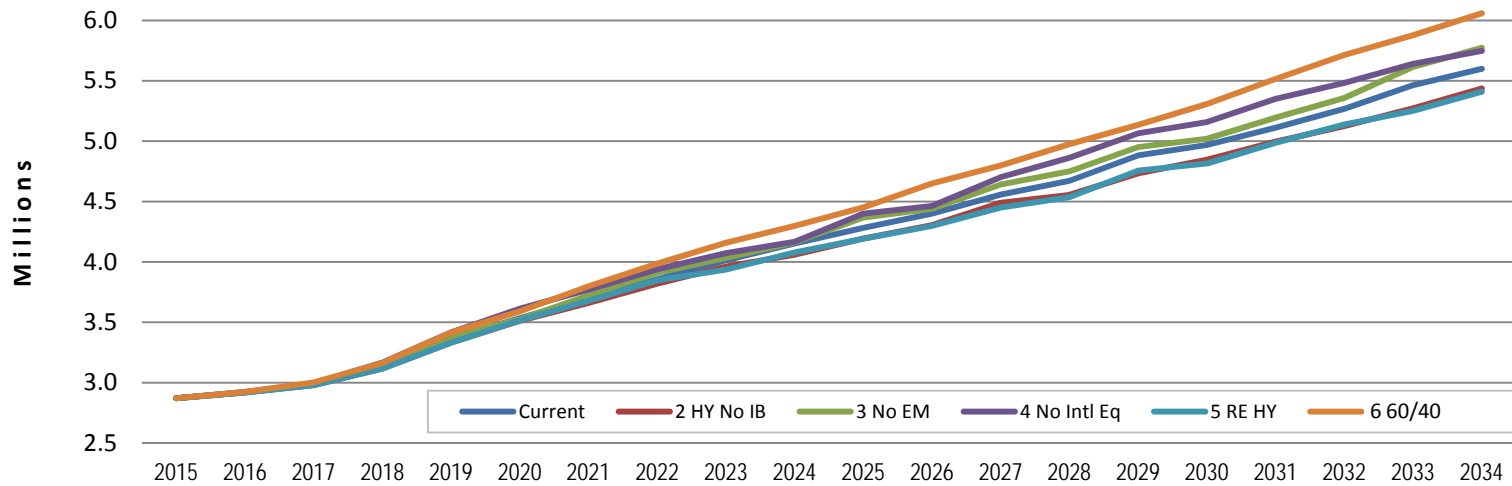
Return	Std Dev
6.24%	11.05%

Recent Years	Historical Returns
1	15.46%
5	11.80%
10	7.41%
15	6.37%



PROJECTED CONTRIBUTIONS

Median Annual Part 1 & 2 Contributions



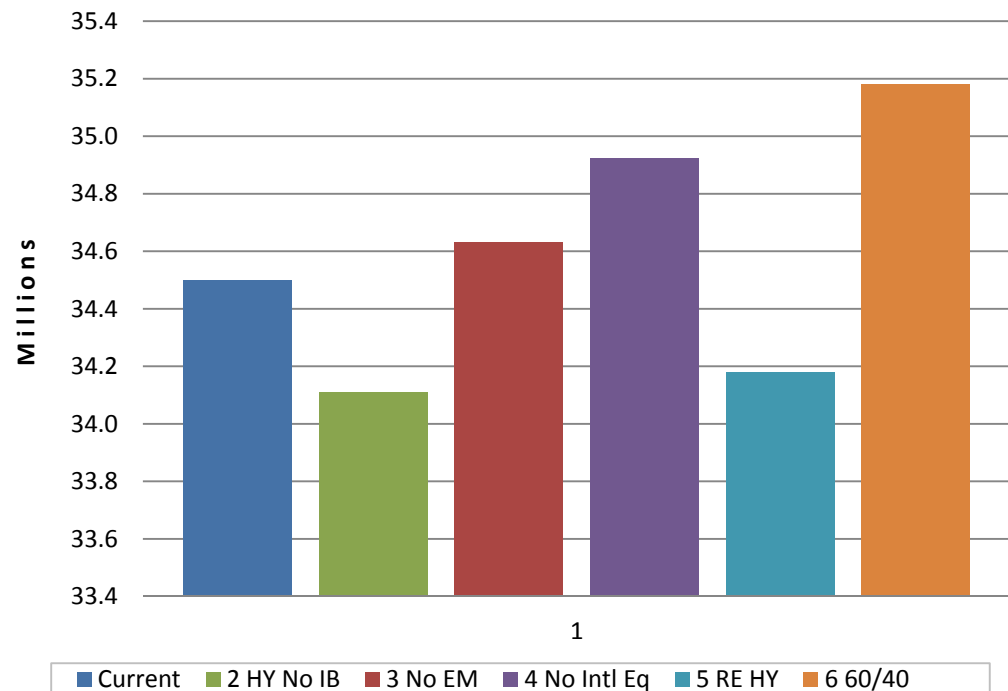
Year 10 Contributions	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY	6 60/40
Min	\$1.3	\$1.3	\$1.3	\$1.3	\$1.3	\$1.3
25 th percentile	2.7	2.5	2.7	2.6	2.5	3.1
Median	4.2	4.1	4.2	4.2	4.1	4.3
75 th percentile	5.3	5.3	5.3	5.3	5.3	5.3
Max	7.9	7.9	7.9	7.8	8.0	7.7



PROJECTED CONTRIBUTIONS

- Sum of contributions for the first 10 years
- See next slide for detail

**Contributions - 10 Years
Median**



PROJECTED CONTRIBUTIONS

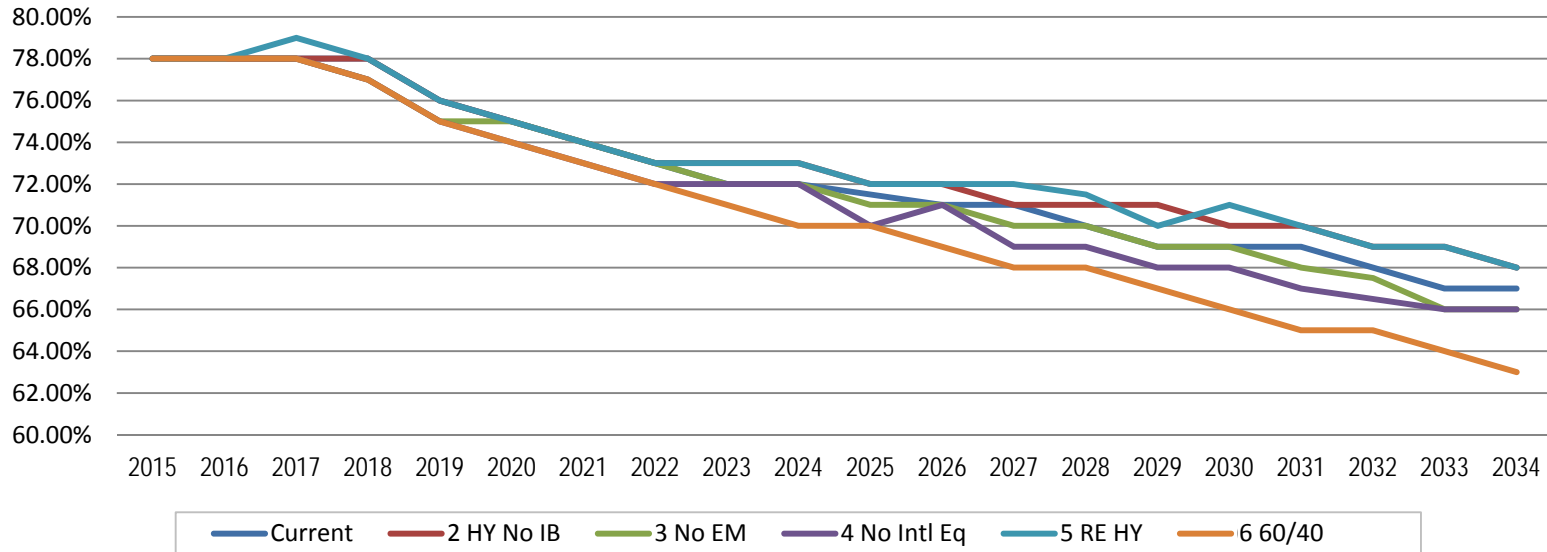
Here is the range of expected contributions, summed over the first 10 years for each allocation.

10-Year Sum of Contributions	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY	6 60/40
Min	\$16.0	\$16.0	\$16.0	\$15.8	\$15.9	\$16.6
25 th percentile	27.2	26.9	27.6	27.9	26.8	29.1
Median	34.5	34.1	34.6	34.9	34.2	35.2
75 th percentile	40.1	39.9	40.0	40.4	39.9	35.8
Max	60.8	61.0	60.9	59.8	61.3	58.2



PROJECTED FUNDED STATUS

Median



Initial funded status is 78%.

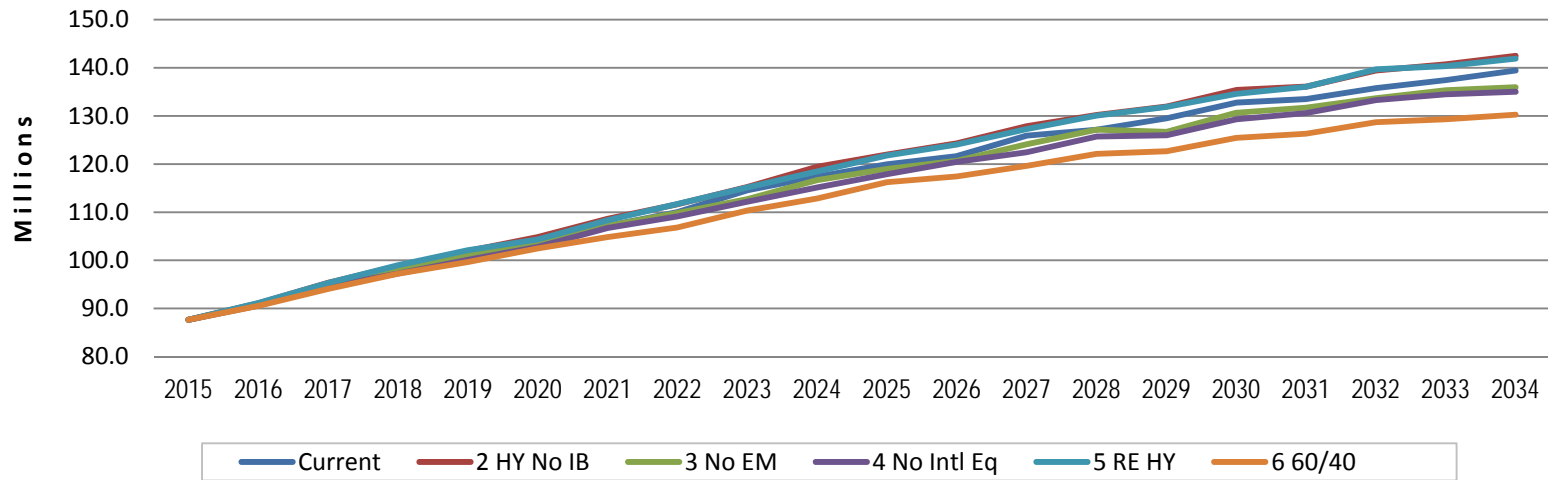
Below is the likelihood of being 78% or higher in year 10.

Allocation	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY	6 60/40
Prob \geq 78%	40%	41%	38%	38%	41%	34%



PROJECTED ASSETS

Market Value of Assets Median



Year 10 Market Values	1 Current	2 HY No IB	3 No EM	4 No Intl Eq	5 RE HY	6 60/40
Min	\$48.6	\$47.9	\$48.8	\$48.8	\$48.5	\$54.6
25 th percentile	94.3	94.9	93.6	92.4	94.7	93.6
Median	117.4	119.4	116.7	115.1	118.5	112.9
75 th percentile	145.2	147.8	143.1	145.1	148.0	135.5
Max	381.0	397.0	375.5	401.4	406.7	313.7



ADDITIONAL NOTES

The outcomes from the projections in this report are dependent on the assumptions used. Differences between our projections and actual amounts depend on the extent to which future experience conforms to the assumptions made for this analysis. It is certain that actual experience will not conform exactly to the assumptions to be used in this analysis. Simulated investment performance results do not reflect actual trading and have certain inherent limitations. The actual financial results for TESRS in future years may not be included among the outcomes presented in this report. Actual amounts will differ from projected amounts to the extent that actual experience is better or worse than expected.

The analysis in this report was prepared utilizing data from third parties and other sources including but not limited to internal computer software and databases. Reasonable care has been taken to assure the accuracy of the data contained herein, and comments are objectively stated and are based on facts gathered in good faith. These reports do not constitute investment advice with respect to the sale or disposition of individual securities. Milliman disclaims responsibility, financial or otherwise, for the accuracy or completeness of this report.

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