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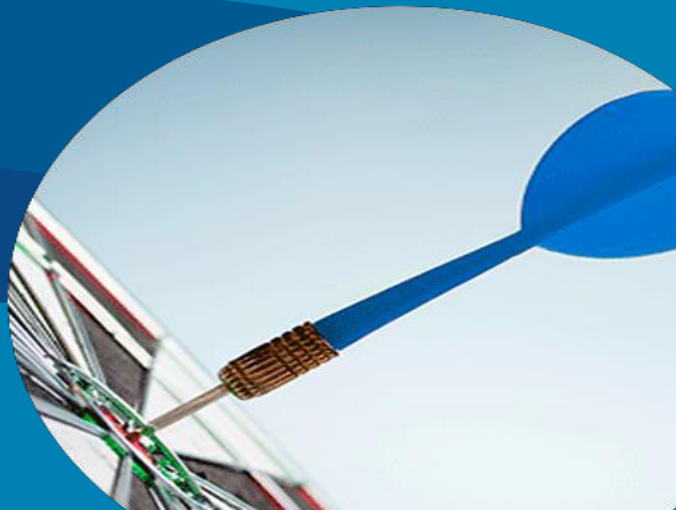
Public Pension Management & Asset Investment Review Commission

July 30, 2018



Stress Test

- A stress test, in financial terminology, is an analysis or simulation designed to determine the ability of a given financial instrument or financial institution to deal with an economic crisis or certain stressors.
  - In investment portfolio management, stress testing is also commonly used for determining portfolio risk and *setting hedging strategies* to mitigate losses.
  - Asset and liability matching stress tests can be used by companies to *ensure proper internal controls and procedures*.
  - Retirement and insurance portfolios also greatly utilize stress testing to ensure *efficient streams of cash flow and payout levels*.

- From Federal Reserve:
  - "*The Comprehensive Capital Analysis and Review (CCAR) is an annual exercise by the Federal Reserve to assess whether the largest bank holding companies operating in the United States* ***have sufficient capital to continue operations throughout times of economic and financial stress and that they have robust, forward-looking capital-planning processes that account for their uniquerisks.***"

https://en.wikipedia.org/wiki/Stress_test_(financial)
https://www.investopedia.com/terms/s/stresstesting.asp
https://www.federalreserve.gov/supervisionreg/stress-tests-capital-planning.htm

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Stress Test

- The purpose is not to feed gentle scenarios into the model to prove the System is “sustainable”.
- Likewise, the purpose is not to just find an extreme set of scenarios to prove it is not.
- The purpose is to learn where the stressors to the System ***are*** and to ***optimize policies and procedures*** (assumptions, funding procedures and methods, and perhaps even benefits) in order to improve sustainability and educate stakeholders of those potential risks.
  - The focus is not on the outcomes of the test.
  - The focus is on the decisions that should be considered, or improvements to the processes, based on the outcomes of the test.

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Questions that can be answered

- How will our funding policy react to different scenarios?
- Why do we have our current assumptions?
- Why do we have different assumptions and methods than our peers?
- How are our risks going to change over time?
- What procedures can provide discipline during good times to assist during a future crisis?
- Why did we make past decisions?

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Typical Procedures

- The way pension funds have typically been stressed is basically more or less as follows:
  - Project historical crisis crash-data into the future. Simulate what would happen and take a look at the consequences.
  - Test crash scenarios on basis of the question: What would happen if…. (prices go down, S&P 500 collapses, etc., etc.).
  - Basically: Take several economic scenarios. Project them on your retirement system and see what happens.

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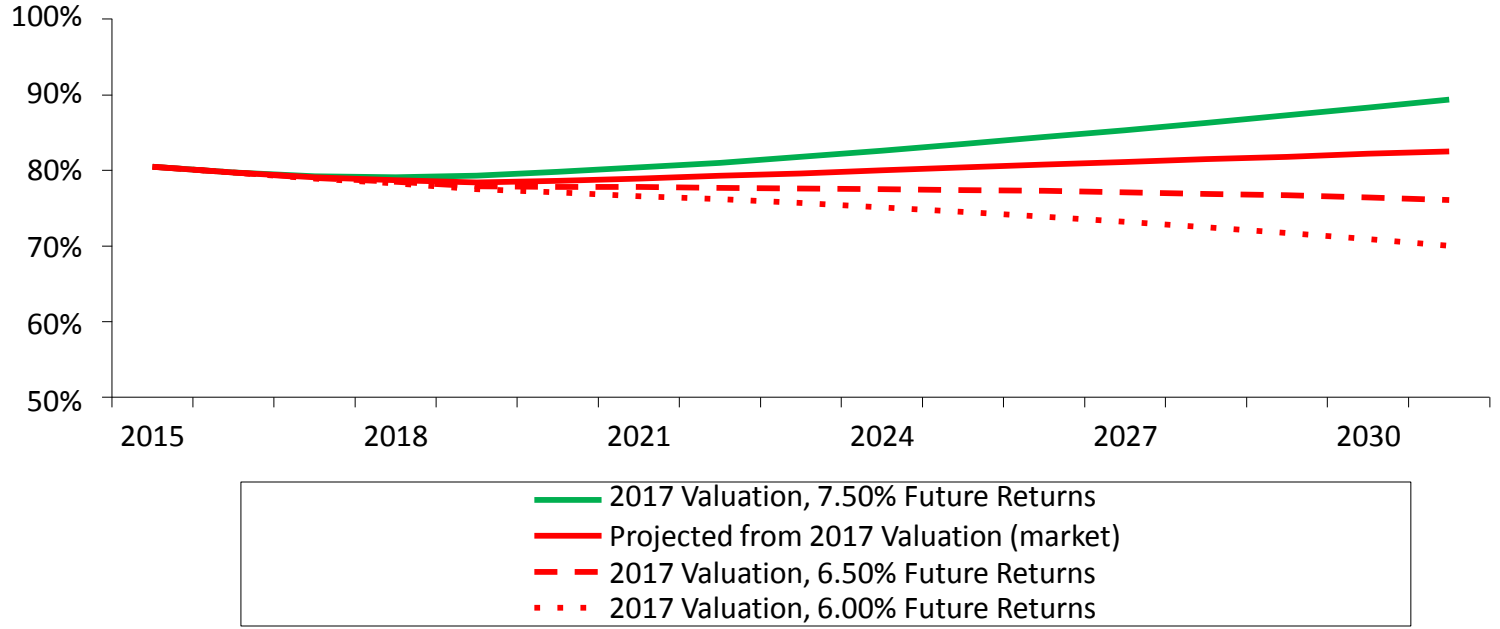
Projection of Funded Ratio
Investment Return Sensitivity



All projections assume contribution policy outlined
in statute continues indefinitely and no future changes to benefits

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A better approach?

- It is possible that stress tests based on arbitrary scenarios can be gamed, as the test is really only as good as the scenarios that are analyzed.

- Many times, it can be beneficial to work backwards by defining the bad outcomes (anti-goals) and then develop scenarios that could lead to this unwanted financial situation.

- This also allows for scaling, or tracking, of tests over years to see trends of improvement (or not)

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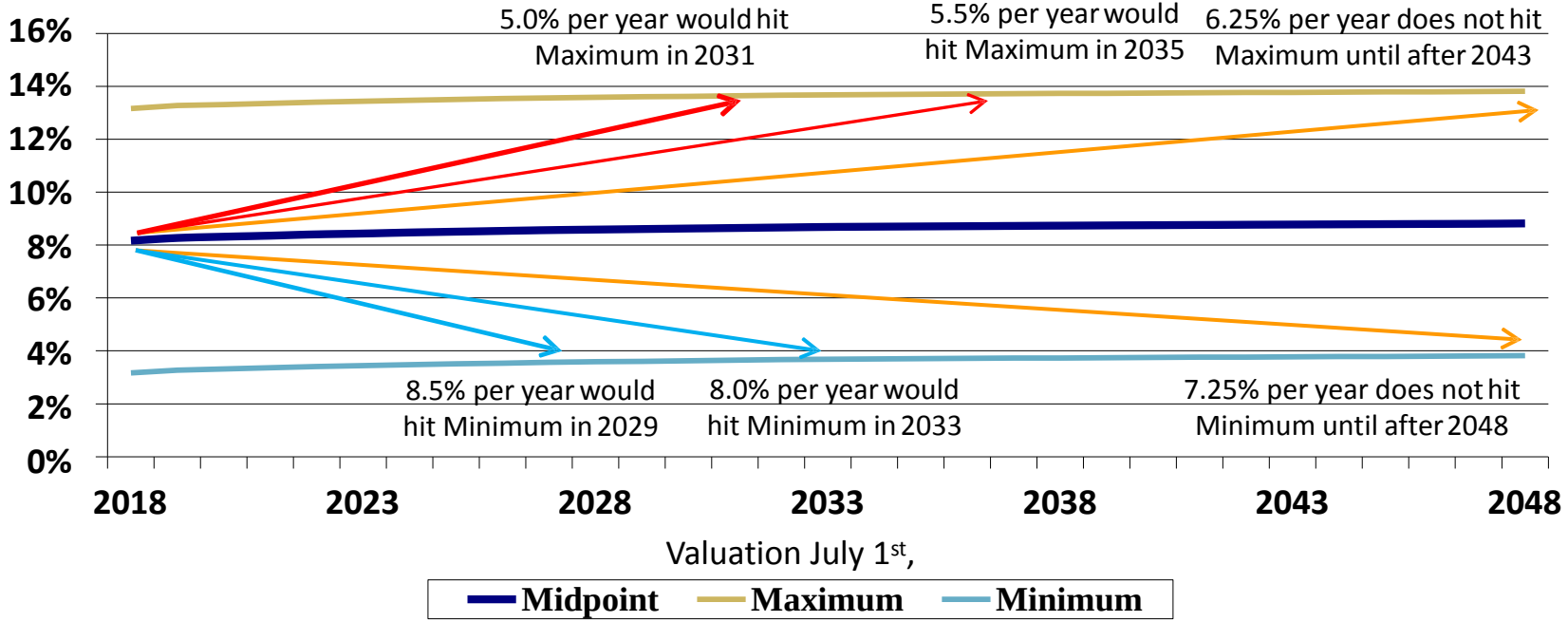
Corridor Scenarios



Scenarios above assume stated returns achieved each year and all other assumptions exactly met

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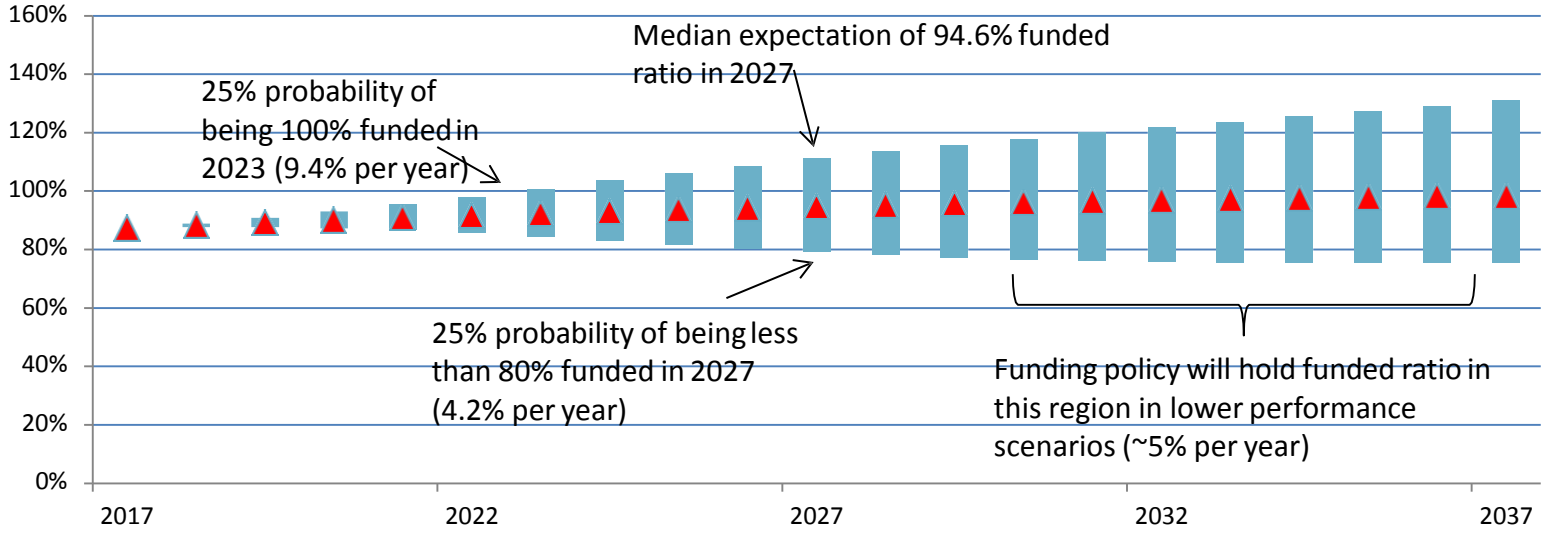
Projected Funded Ratio



Median Expectation

25th-75th percentile of expectation

- **Assumes ADEC met each year**
- **Assumes continuation of current amortization policy & payroll grows at 3.00% per year**
- **Investment returns are only variable in the stochastic process**

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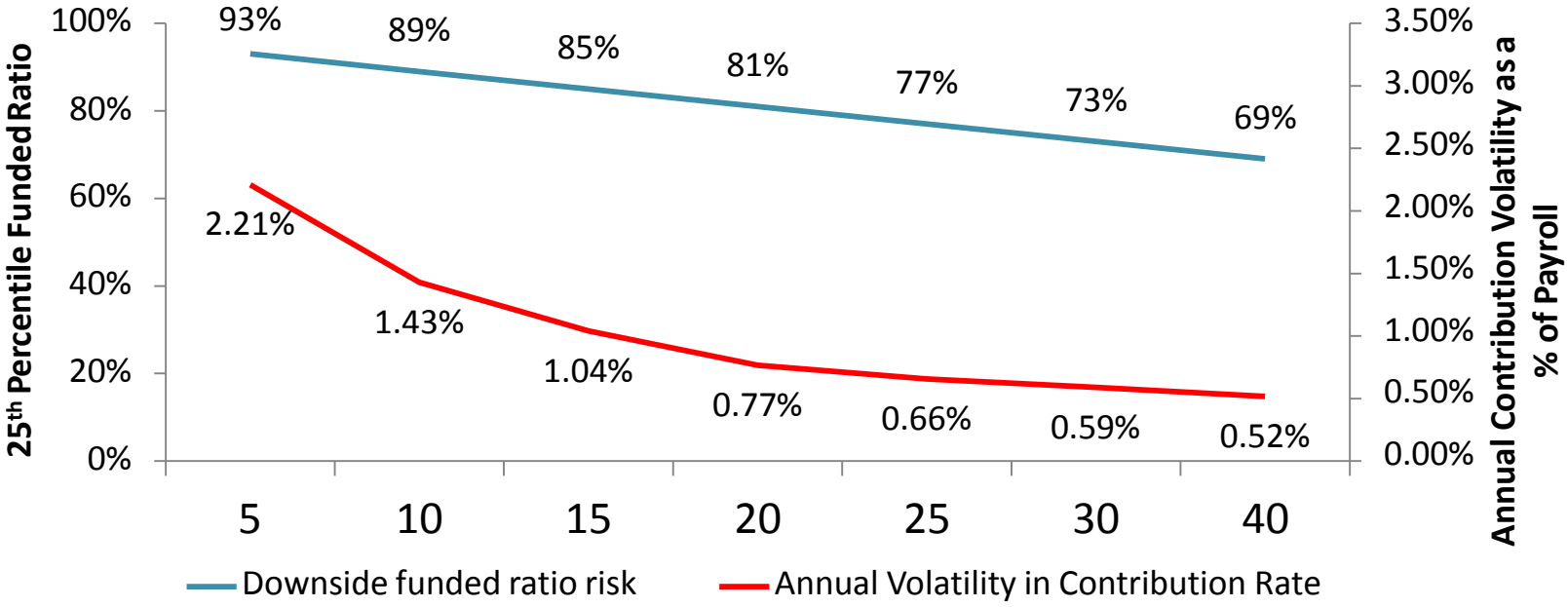
Risk vs Reward:



The downside funded ratio risk is the 25th percentile funded ratio based on the amortization period shown

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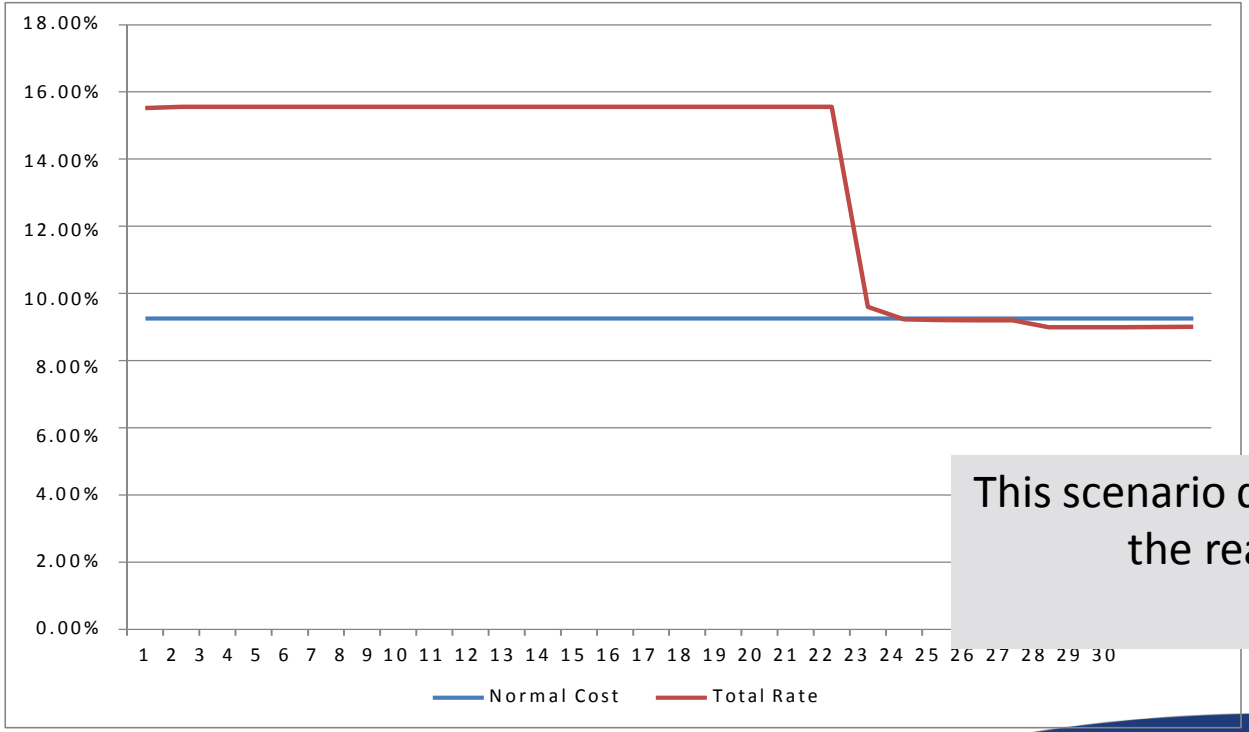
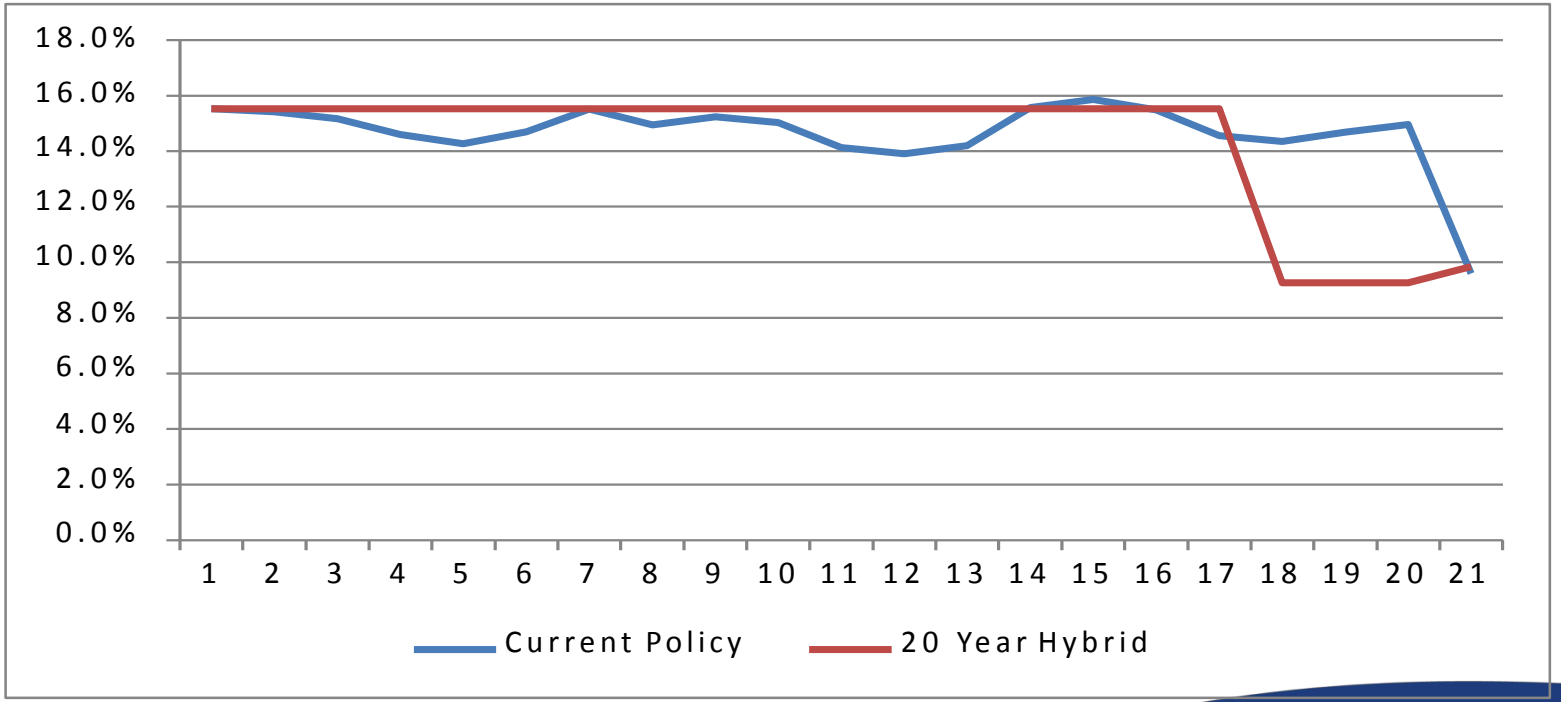
Current Policy: Perfect Scenario



This scenario does not exist in the real world!

Which pattern?



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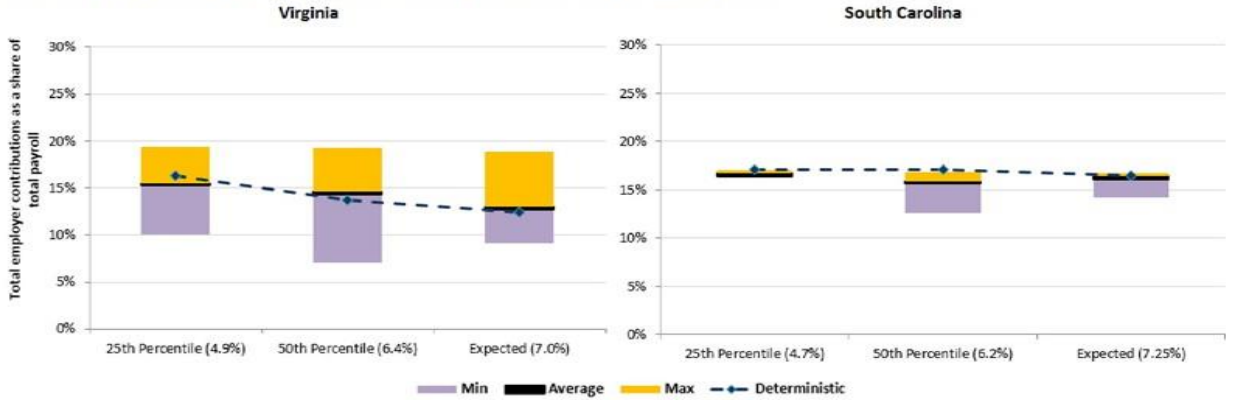
Example of a Floating Funding Policy (South Carolina)

Figure 26

Projected Impact of Volatility of Cost for Virginia Compared with South Carolina

Funding policy has significant impact on range of required contributions



- https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/AWP_92_final.pdf

- SC's Funding policy: Until funding goal is reached: Actual contribution is the greater of the 20 year ARC and last year's Actual Contribution. Utah and Hawaii also use this strategy. Can be called Hybrid 20 or Floating 20.

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Other example of Summarized Tradeoffs

Policy	Current Contribution	Expected Annual Change beginning in year 6	Long term underperformance Value	Estimated Drawdown	Short term shock Value	Lifetime Contribution Factor
7.5% A	100	1.6% annual decline	113	-25%	148	21.3
6.7% A	112	4.3% annual decline	104	-25%	152	19.1
6.0% A	128	4.4% annual decline	97	-20%	142	21.4
6.0% A with Hedge	128	4.4% annual decline	97	-10%	142	21.4
6.0% B with Hedge	100	1.5% annual decline	103	-10%	120	24.1

- Long term underperformance was based on the contribution in 2031 based on actual 5% annual earnings
- Short term shock had a 2 year drawdown, followed by 8 year rebound to achieve the stated expected return for the portfolio.
- Lifetime Contribution Factor is the sum of all future expected employer contributions divided by the first contribution in the 7.5% A (100 equivalent)

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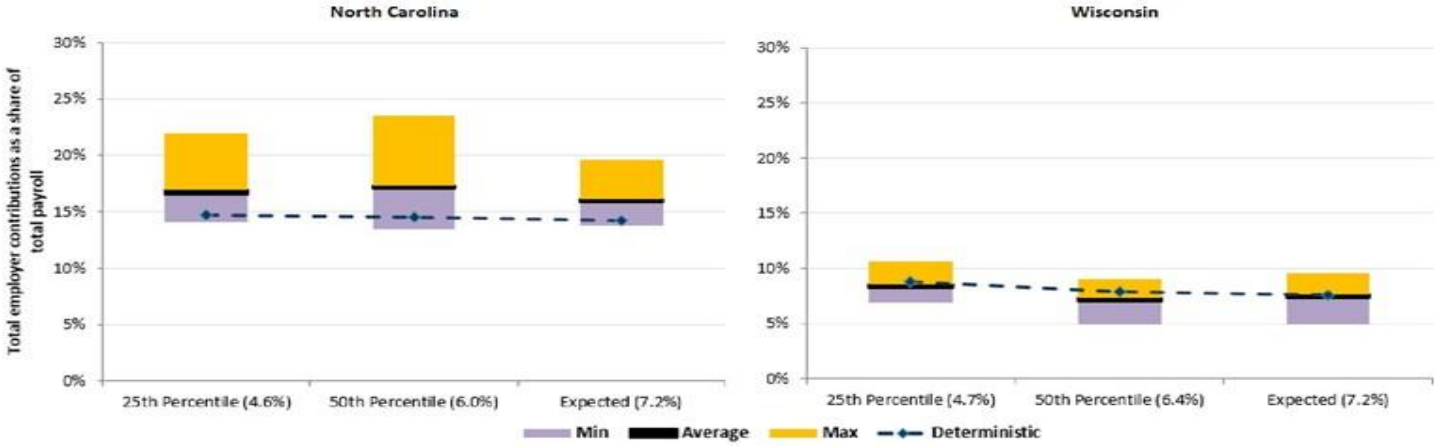
Impact of Contingent Benefit Provisions

Figure 27

Projected Impact of Volatility of Cost for North Carolina Compared with Wisconsin

Risk-sharing provisions limit cost volatility for Wisconsin



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Constructive Ideas that have Come from various forms of ‘Stress Testing’

- Funding policies that are not designed to respond to market downturns have substantial risk as there is no mechanism to create changes when necessary.
- Funding polices that enforce discipline in year to year contribution levels and employ some form of direct rate smoothing (hold rates up when the funding formula would suggest a decrease in the rate may be appropriate) appear to have a profound positive impact on contribution rate volatility.
- Funding policies based on too short an amortization period, and no allowance for offsetting gains and losses, will face substantial budget volatility.
- Benefit provisions that allow for some contingency in the liability show to be able to withstand significant adverse experience. The COLA is by far the most powerful tool for this.

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Final Takeaways on Stress Testing

- All Systems face substantial downside risk.
- For any System, a scenario can be created that will make that System look unsustainable.
- Focus should be on decision making and constructive observations, not specific outcomes.
- Stress tests need to be careful not to interchange potential bad outcomes as the expected or most likely outcomes.
- Systems with poor funded ratios, but recent reforms to increase funding appropriately, will typically show to have less “risk” than well funded plans, meaning a narrower range of outcomes and less contribution volatility.
  - Risk has been traded for Reality.
- A well formulated funding policy has substantial impact on the outcomes.
  - There needs to be an appropriate balance between protecting funded ratios and contribution volatility. Contribution volatility itself is a significant risk factor.
- Benefit packages that have some allowance for contingencies will appear far more sustainable under scenario or stress testing.
- Viewing the results in context of the objectives of the program will allow for better decision making.

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