Asset Liability Management:
Risk Concepts and Examples

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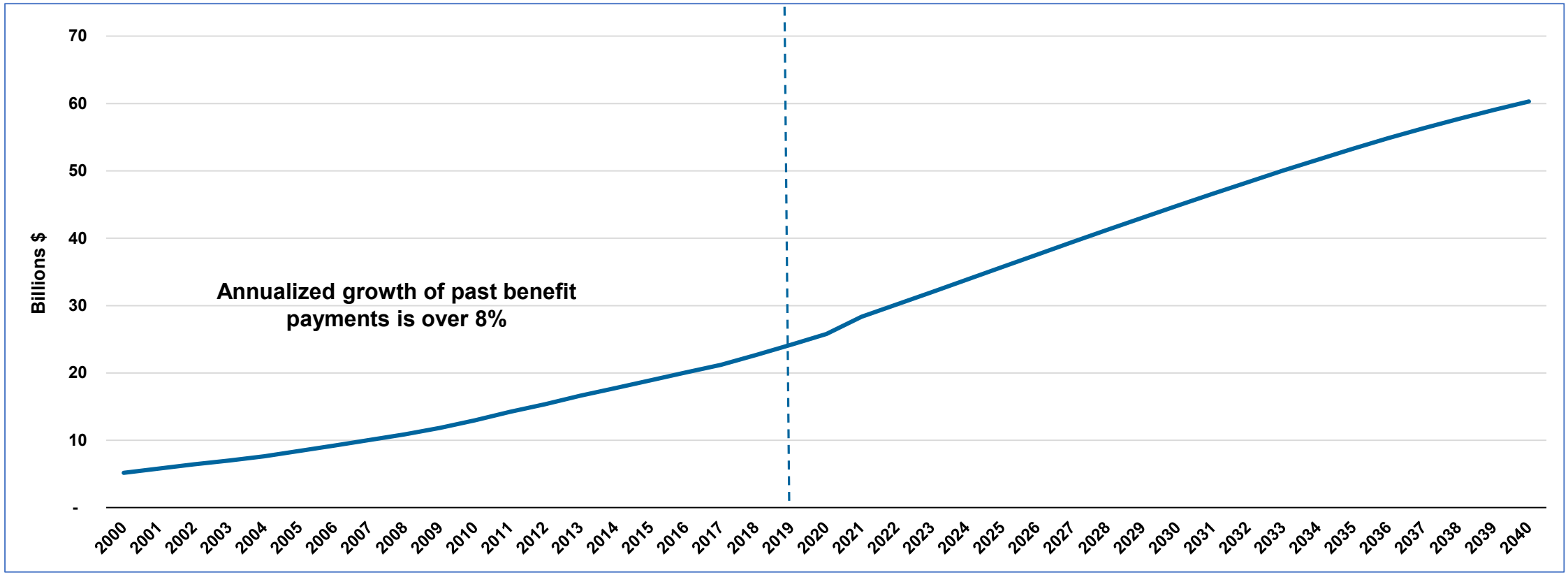
Executive Summary

- The sustainability of the PERF and affiliated plans depends upon managing exposures to demographic, economic and market factors. Over the long term, demographic factors (e.g., mortality rates) are less variable than the economic factors (e.g., GDP, inflation), and the economic factors are less variable than market factors (e.g., returns).
- Current and future liabilities arise from obligations created by commitments made in the past and in the future.
- Contributions and funding ratio depend upon the liabilities, the long-term discount rate, and realized annual returns. This dependence on both realized returns and the estimate of "expected returns" introduces uncertainty into annual contributions.
- The discount rate is based on an estimate of "expected returns". This estimate is based on a view of future economic and market factors, and so is not a sure thing. Thus, there is a risk of the discount rate differing from the true value of "expected returns".
- The capacity of employers to pay contributions and to bear the annual variability of contributions is a key determinant in setting risk appetite.
- Investment returns are the primary source of risk, market factors being more variable than the demographic and economic factors.
- The CalPERS ALM programs assists the Board in selecting a policy portfolio having a reasonable expectation of sustaining the plan. This choice balances the risks arising from the variability of three components: liabilities, contributions and returns

The following slides provide exhibits illustrating the sensitivity of key fund characteristics – funding ratio, contribution rate – to key assumptions, and to the uncertainty of these assumptions.

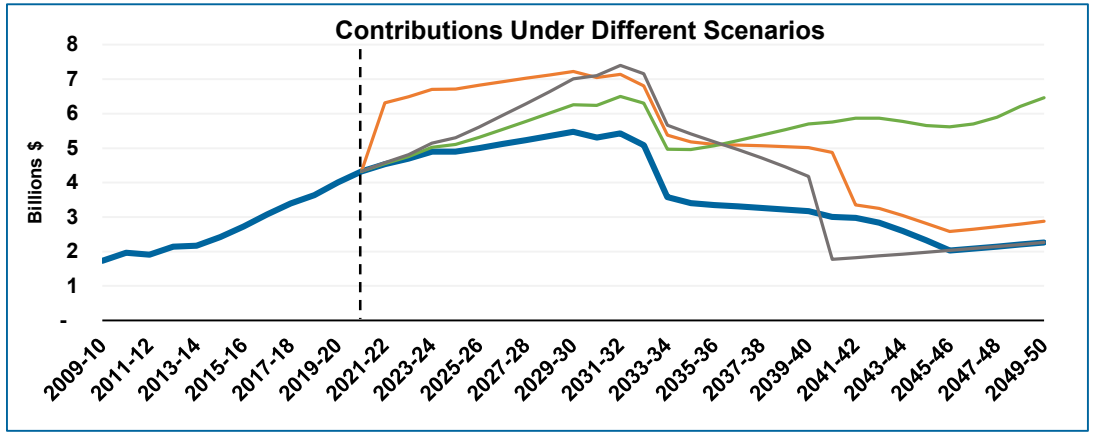
PERF Benefit Payments - PEPRA effects felt in 10 years

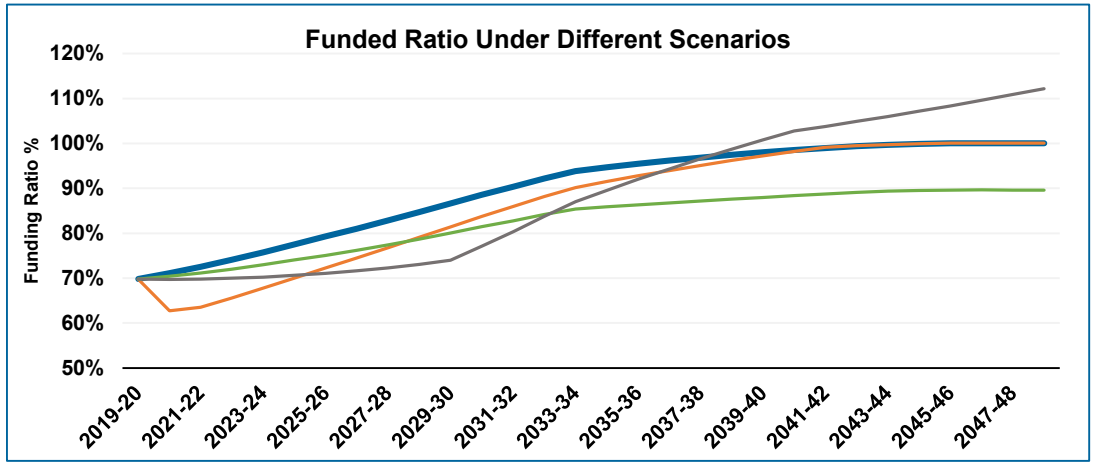


Current and future liabilities arise from obligations created by commitments made in the past and the future.

Data: For illustrative purposes only. Based on estimated open-group benefit payment projections as of 6/30/2019.

Returns and Discount Rate: Impact on Contributions and Funding Ratio





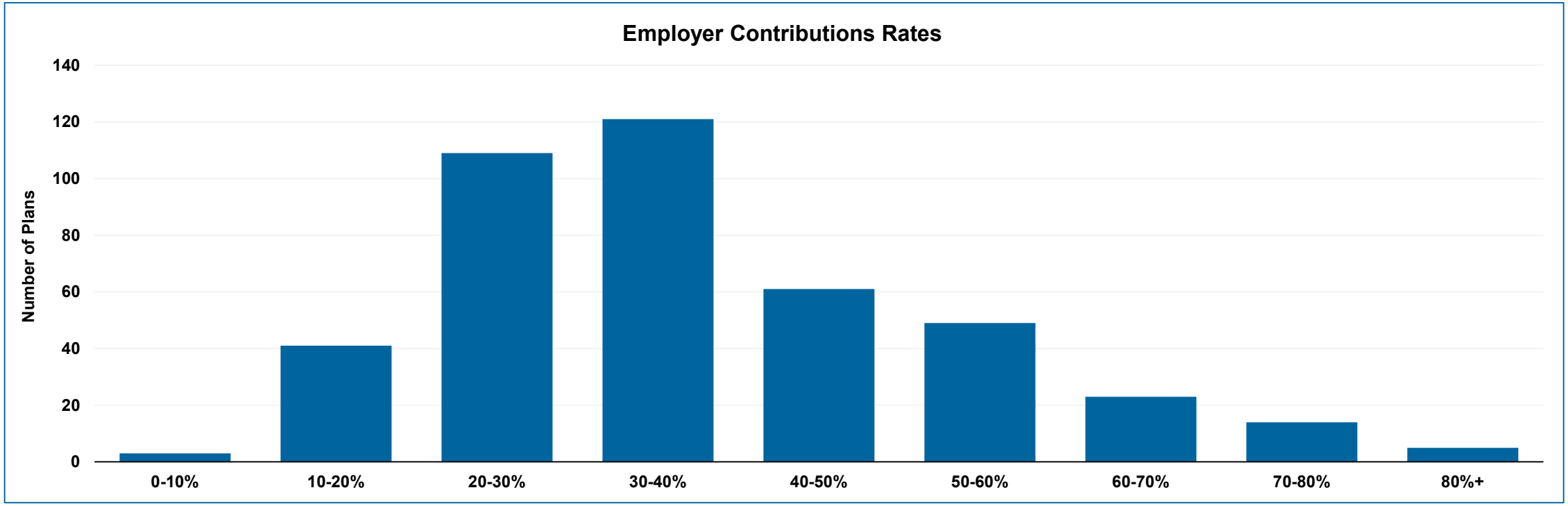
The path of expected contributions depends upon both the discount rate and the actual expected returns. (These examples ignore annual fluctuations caused by return variability)

Example 1: Discount rate = 7% Expected Returns = 7% (**Blue Lines**)	• Contributions increase slowly from $4.3B to $5.4B in 2032, then decline when prior amortization amounts begin to roll off. • Over twenty years, the funding ratio increases to 100%
Example 2: Discount rate = 6% Expected Returns = 6% (**Orange Lines**)	• Contributions jump immediately by $2.0B, then rise slowly to $7.1B in 2032, after which contributions decline. After 20 years, contributions are similar to those in Example 1. • Over twenty years, the funding ratio increases to 100%
Example 3: Discount rate = 7% Expected Returns = 6% (**Green Lines**)	• Contributions increase from $4.3B to $6.5B in 2032, decline for a short period before rising again. • Over twenty years, the funding ratio increases to 90%.
Example 4: Discount rate = 7% Expected returns = 5% for 10 years, 8% for 20 years (**Grey Lines**)	• Contributions increase from $4.3B to $7.4 in 2032, decline for a short period before rising again. • Over twenty years, the funding ratio increases to over 100%.

Contributions and funding ratio depend upon the liabilities, the long-term discount rate, and realized annual returns. This dependence on both realized returns and the estimate of “expected returns” introduces uncertainty into annual contributions.

Data: Example Miscellaneous Plan

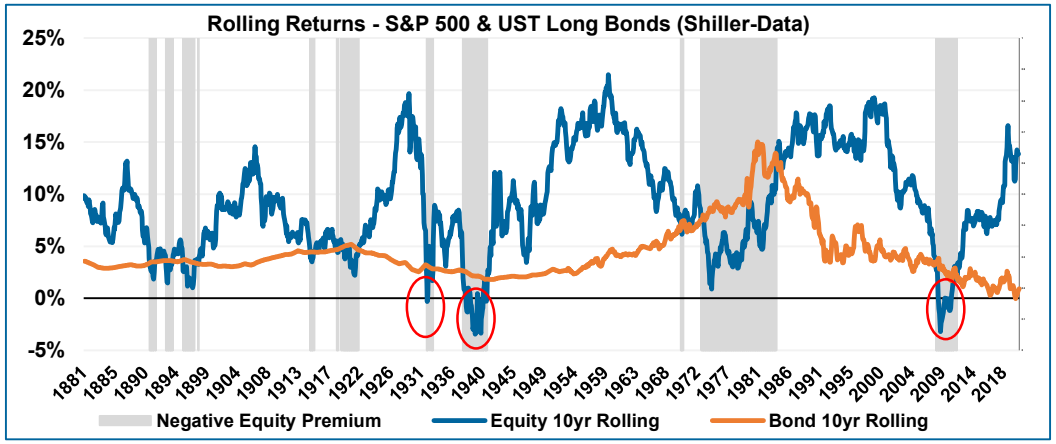
Employer Contributions as Percentage of Payroll

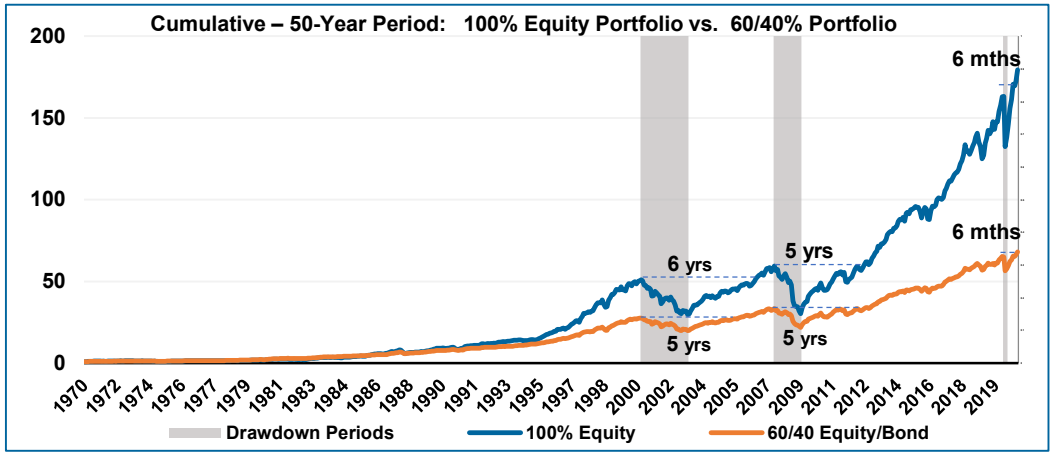


The capacity of employers to pay contributions and bear annual contribution variability is a key determinant in setting risk appetite.

Data: Non-Pooled Employer plans only, as of 06/30/18

Return Variability, and a Tale of Two Portfolios





- Though we rely on equities to participate in economic growth, there is still the potential for losses even over moderate horizons.
  - The extreme shocks of 1929, 1939 and 2008 led to negative equity ten-year rolling returns in the following years (red circles).
- Though we expect equities to outperform bonds - our equity risk premium - there is still the potential for underperformance.
  - The grey areas highlight periods when bonds outperformed equities on a ten-year rolling basis.

Over the last 50 years, a 100% equity portfolio has outperformed a 60/40 portfolio, compounding to 264% the value of the 60/40 portfolio.

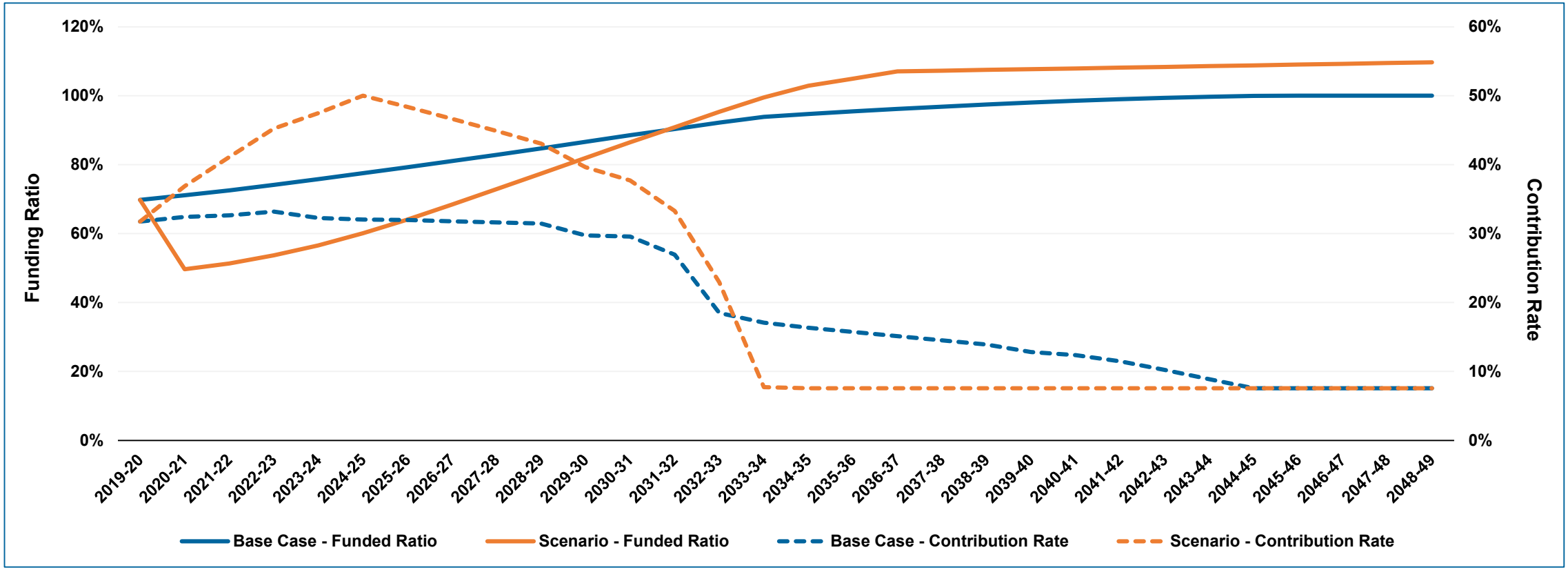
This outperformance comes with significant variability:

- Large drawdowns. In the last 100 years, the S&P has lost more than 30% of its value six times.
- The average time for the S&P to return to its initial value is roughly six years.

Investment returns are the primary source of risk, market factors being more variable than the demographic and economic factors.

Data: Referenced from "Irrational Exuberance" Princeton University Press, 2000, 2005, 2015 – Robert J. Shiller

Return Drawdown and Recovery Similar to 2008, 30yr average = 7%



The long-term funding ratio is robust to shocks, so long as the contribution peak created by the amortization of losses is bearable by employers.

Data: Example Miscellaneous Plan

Summary

CalPERS ALM program will consider these risks:

- Fundamental risks related to extreme increases in contributions and extreme decline in funding ratio
- In the rarest and most extreme cases, a plan is terminated and benefits reduced
- The risks associated with the uncertainty of our assumptions

The exhibits illustrate key drivers of these risks:

- Lower expected returns lead to increased contributions. Based solely on contributions as a percentage of payroll, some employers are more exposed than others to increases in contributions
- Return uncertainty can lead to over-estimating long term expected returns, which results in a contribution rate lower than it should be, and a long-term funding ratio below 100%
- Though extreme return fluctuations induce significant increases in contributions and initial decline in funding ratio, the amortization mechanism restores

Our choice of portfolio has direct bearing on all these risks. By explicitly considering these fundamental risks and uncertainty of assumptions, we can make better decisions and will be better prepared for future outcomes.