

TEACHERS' RETIREMENT BOARD

INVESTMENT COMMITTEE

Item Number: 10

SUBJECT: 2015 Asset Allocation Study – Part 5, Portfolio Modeling

CONSENT: _____

ATTACHMENT(S): 2

ACTION: _____

DATE OF MEETING: September 2, 2015 / 100 mins.

INFORMATION: X

PRESENTER(S): Allan Emkin – PCA,
Stephen McCourt – Meketa, and Staff

POLICY

This item is covered by the [CalSTRS Investment Policy and Management](#) Plan (Teachers' Retirement Board Policy Manual, Section 1000, page A-8). The asset allocation study is a key component in pursuit of the Board's investment performance objectives, including the actuarial rate of interest.

HISTORY OF THE ITEM

This item is the fifth of six sessions scheduled to complete the 2015 Asset Allocation Study.

PURPOSE

The purpose of this item is to review portfolio allocation options and modeling results in order to select a final strategic policy portfolio.

BACKGROUND

Six meetings are scheduled to determine CalSTRS' strategic asset allocation. The first four meetings focused on the differences between PCA's and Meketa's approaches, the set of asset classes to model, the capital markets assumptions to use in portfolio optimization and optimization constraints. The timeline for the 2015 Asset Allocation Study is below.

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| Meeting | Topic | Key Discussion Points | Key Investment Committee Decisions | Key Board-Related Items |
|-----------------------|--|---|---|--|
| February 2015 | Introduction to the Asset Allocation Project | Consultant asset study approach – similarities & differences Role of asset classes | Information | Actuarial valuation policy Earnings/annuity credits for DBS/CB Legal issues associated with DBS/CB |
| April 2015 | Discussion of Investment Opportunities | Detailed discussion of asset classes | Information | Adopt June 30, 2014 actuarial valuation Earnings/annuity credit policy for DBS & CB |
| June 2015 | Capital Markets Assumptions | Introduce capital markets assumptions | Adopt capital markets assumptions | Effect of alternative investment returns on projected program funding Adopt DBS/CB additional earnings/annuity credits, if applicable |
| July 2015 | Portfolio Constraints | Portfolio constraints | Adopt portfolio constraints | |
| September 2015 | Strategic Policy Portfolio | Portfolio allocation options Risk/return of different portfolio combinations | Information | |
| November 2015 | Strategic Policy Portfolio Cont'd | Final review of policy portfolio | Adopt new asset allocation targets and ranges | |
| February 2016 | | | | Adopt experience study |
| April 2016 | | | | Adopt June 30, 2015 valuation Adopt DBS/CB additional earnings/annuity credits, if applicable |

DISCUSSION

The previous four meetings dedicated to this study laid the foundation for portfolio modeling and selection of the strategic policy portfolio. This meeting will focus on a review of different portfolio allocation options from PCA and Meketa, including portfolio weights, risk/return characteristics and the projected path of the plan's funded status for each portfolio. The two consultants will review details of portfolio allocation options in their respective memos and presentations. This memo will introduce and define some of the key risk and return metrics used by the consultants. These metrics can serve as useful tools for comparing different portfolio allocation options and include a mix of short-term and long-term measures. This memo also reviews the risk and return characteristics of the current strategic policy portfolio.

Table 1. Key Risk & Return Metrics

| Metric | Type | Horizon |
|--------------------------------------|---------------|------------|
| Market Value Weight | Weighting | - |
| Expected Return (Arithmetic) | Return | Short Term |
| Expected Volatility | Risk | Short Term |
| Expected Return (Geometric) | Return | Long Term |
| Risk Weights | Weighting | - |
| Expected Tail Loss | Risk | Short Term |
| Projected Funded Status | Risk & Return | Long Term |
| 10th Percentile Funded Status (2046) | Risk | Long Term |

Key Metrics – Definitions

Market Value Weights

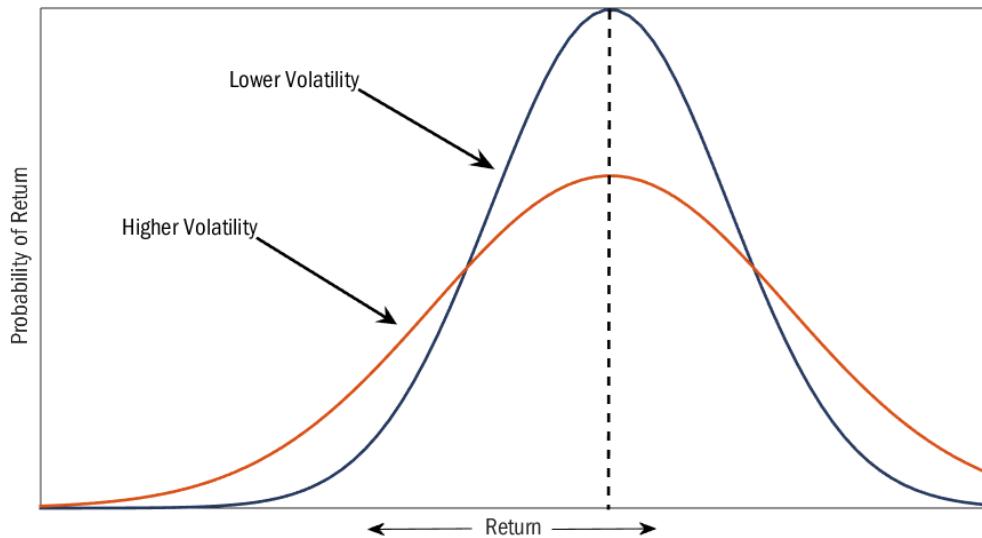
These are the standard weights used in the strategic policy and all reporting. If the portfolio has a value of \$100 and there is \$40 in Asset A and \$60 in Asset B, Asset A has a weight of 40% and Asset B has a weight of 60%.

Expected Return (Arithmetic)

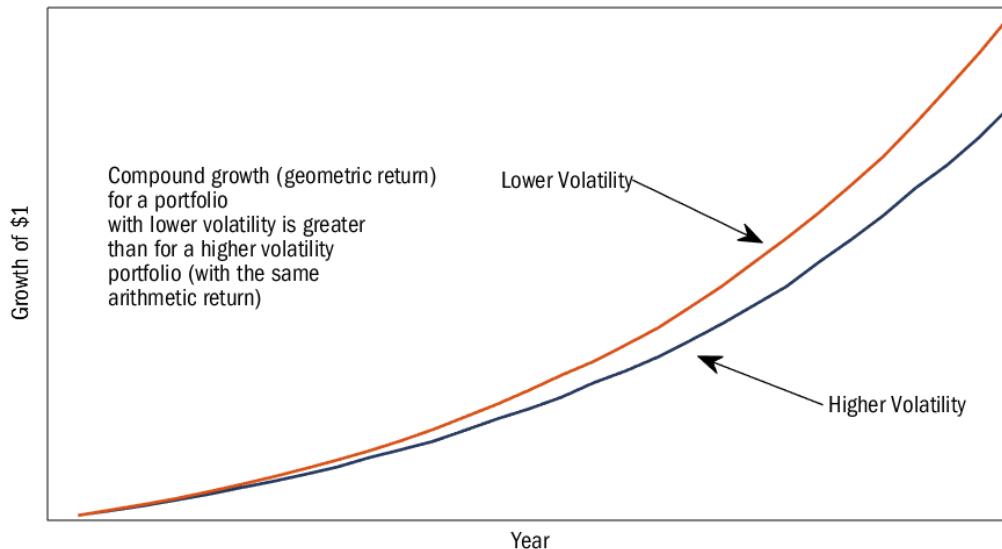
The arithmetic expected return is the average return expected on a portfolio in any single year.

Expected Volatility

Expected Volatility is a measure of dispersion around the expected arithmetic return. A portfolio with higher volatility is expected to experience more extreme (both positive and negative) returns. A portfolio with an expected return of 9% and a volatility of 12% (assuming normally distributed returns) is expected to lose money in a given year about 23% of the time. By contrast, a portfolio with the same 9% expected return but 15% volatility is expected to lose money about 27% of the time.

Figure 1. Volatility Example**Expected Return (Geometric)**

The geometric return is the expected long-term annualized compound return. For two portfolios with the same arithmetic return, the portfolio with higher volatility will have a lower expected geometric return. This tradeoff suggests that a higher expected arithmetic return may not be optimal if it comes at the price of too much added volatility. The assumed actuarial rate of return is a geometric return, so a portfolio's compound return is analogous to the actuarial rate of return.

Figure 2. Geometric Return Example

Risk Weights

Risk Weights are less intuitive than Market Value Weights but are arguably more informative about the sources of variation in a portfolio. They describe what percentage of the portfolio volatility comes from each asset in the portfolio. So if a portfolio has an expected volatility of 15%, where Asset A has a risk weight of 70% and Asset B has a risk weight of 30%, then Asset A is expected to contribute 70% of the volatility in the portfolio. In other words 10.5% of the 15% volatility comes from Asset A and the remaining 4.5% of volatility comes from Asset B. Risk weights can, and often do, vary dramatically from Market Value Weights. This is often a result of one asset having substantially higher volatility than another.

Consider a hypothetical 60/40 portfolio (60% Equity and 40% Fixed Income) as an example. Using the capital markets assumptions for U.S. Equity and Investment Grade Debt, the hypothetical 60/40 portfolio has an expected volatility of 11.5%. The higher volatility in U.S. Equity means that most of this volatility (approximately 95%) comes from Equities.

Table 2. 60/40 Portfolio Risk Weight Example

| | U.S. Equity | Investment Grade Debt |
|---|--------------------|------------------------------|
| Volatility (From Capital Markets Assumptions) | 18.5% | 6% |
| Correlation to U.S. Equity | 1 | 0.05 |
| Market Value Weight | 60% | 40% |
| Risk Weight | 94.6% | 5.4% |

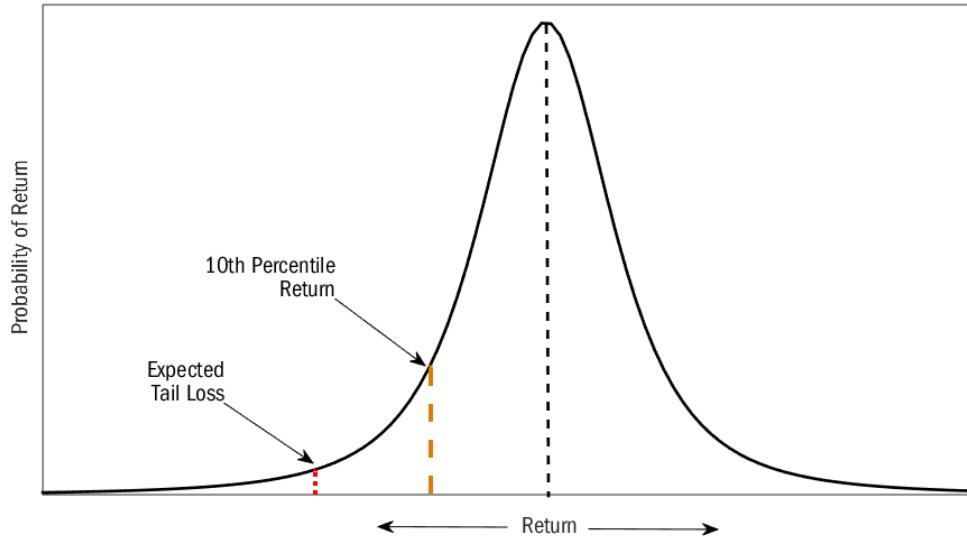
Expected Tail Loss

Volatility is an imperfect measure of risk in a portfolio, particularly when returns exhibit fat tails (more extreme returns than predicted by a normal “bell curve” distribution) or skewed returns (more severe outliers to the negative than positive or vice versa). The Expected Tail Loss (ETL) of a portfolio is the average expected return below a certain threshold. In this way, it only accounts for “bad” volatility (and extreme bad volatility at that). For this study, Meketa and PCA present the ETL at the 10th percentile. The 10th percentile ETL is the average of all expected returns below the 10th percentile.

For a portfolio with an expected return of 9% and a volatility of 12%, the 10th percentile of annual returns is approximately -6.4%. So the 10th percentile ETL of this portfolio is the average of all expected returns below -6.4%. For a portfolio with normally-distributed returns, the ETL doesn’t provide any more information than volatility. But in the presence of fat tails or skewed returns, ETL provides a more complete view of risk than volatility alone.

If one portfolio has a high volatility because of both positive and negative upside, versus another portfolio with more negative downside than positive, ETL will reflect this difference. Another example is that if two portfolios have similar volatility, but one has greater extreme negative outcomes than the other, ETL will reflect the risk of more extreme negative returns.

Figure 3. Expected Tail Loss Example



Projected funded status

The projected funded status for a given portfolio is a direct and intuitive measurement of the portfolio risk relative to the fund's ultimate objective of providing a stable defined benefit. The projected median path is a good indicator of whether the portfolio is expected to meet the funding objective, while the dispersion around that path is an indicator of the risk to meeting that objective.

10th Percentile Funded Status (2046)

The 10th percentile funded status is a measure of extreme tail risk as it relates to the plan funded status for a given portfolio. It means that the fund is expected to experience this level of funding or worse 10% of the time. For example, if a portfolio has a 10th percentile funded status of 50%, it means that the fund (with this portfolio allocation option) is expected in 2046 to be 50% funded or worse 10% of the time.

Risk & Return of the Current Portfolio

Table 3a. Current Portfolio Weights

| Asset Class | Policy Weight | Risk Weight |
|---------------------|----------------------|--------------------|
| U.S. Equity | 36.7% | 46.5% |
| Non-U.S. Equity | 18.3% | 24.4% |
| Fixed Income | 17.0% | 0.5% |
| Private Equity | 13.0% | 19.9% |
| Real Estate | 13.0% | 8.4% |
| Inflation Sensitive | 1.0% | 0.3% |
| Liquidity | 1.0% | 0% |

Table 3b. Current Portfolio – PCA Classes

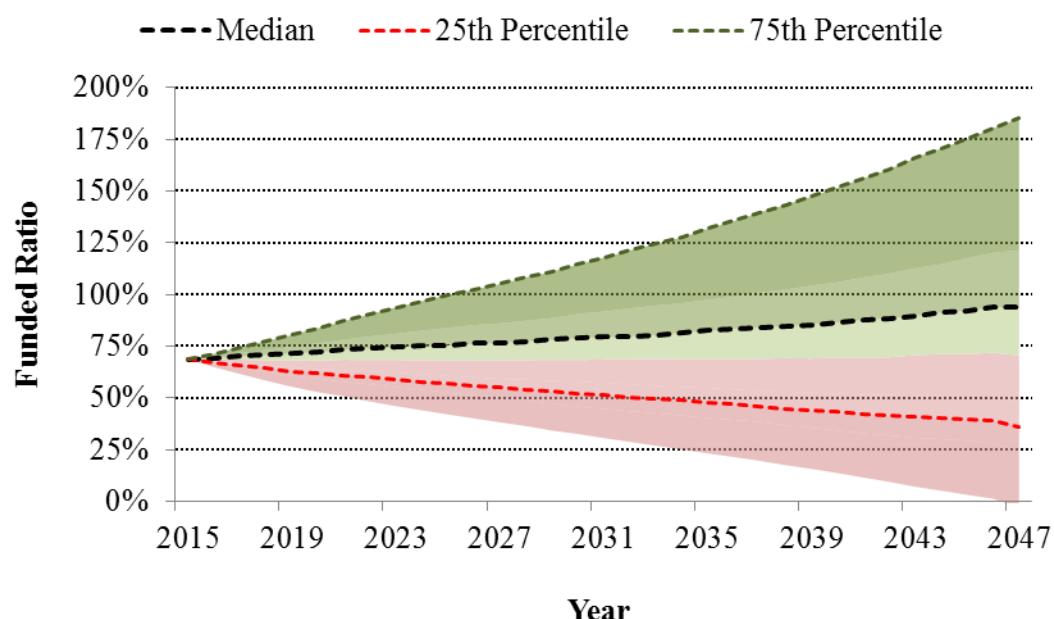
| Strategic Class | Policy Weight |
|----------------------------|----------------------|
| Global Growth | 55.0% |
| Private Growth | 13.0% |
| Real Estate | 13.0% |
| Credit | 6.1% |
| Inflation Sensitive | 1.0% |
| Protection/Liquidity | 11.9% |
| Risk Mitigating Strategies | 0% |

Table 3c. Current Portfolio – Meketa Classes

| Asset Class | Policy Weight |
|---------------------------|----------------------|
| U.S. Equity | 36.7% |
| Developed Non-U.S. Equity | 14.7% |
| Emerging Market Equity | 3.7% |
| Private Equity | 13.0% |
| Investment Grade Bonds | 16.2% |
| TIPS | 0.5% |
| High Yield & Bank Loans | 0.9% |
| Emerging Market Debt | 0% |
| Private Debt | 0% |
| Private Real Estate | 13.0% |
| Private Infrastructure | 0.5% |
| Risk Mitigation | 0% |
| Cash | 1.0% |

Table 4. Current Portfolio – Risk & Return Metrics

| Metric | Value |
|---|--------|
| Expected Return (Arithmetic) | 8.4% |
| Expected Return (Geometric) | 7.4% |
| Expected Volatility | 14.3% |
| Expected Tail Loss | -17.5% |
| 10 th Percentile Funded Ratio (2046) | 0% |

Chart 1. Projected Funded Status – Current PortfolioKey Considerations

The results of the modeling from PCA, Meketa and Staff form a sea of data, charts and analysis on several possible portfolio combinations. Within this sea of analysis there are a handful of key potential changes to the policy portfolio that may improve the risk/return characteristics of the portfolio:

- **Inclusion of Risk Mitigating Strategies (RMS)**

Including RMS in the policy portfolio could materially improve the risk-return profile of the fund. Several portfolios modeled by Meketa and PCA include allocations to RMS up to the maximum constraint of 12%. This is a result of the significant expected diversification benefits from RMS, as it's expected to offset the economic growth risk of Public Equity, Private Equity, Real Estate and Credit strategies. The inclusion of RMS and the level of allocation, should it be included, is the most significant potential change to the current portfolio.

➤ **Increasing Infrastructure**

Portfolios recommended by PCA and Meketa include increases to the Infrastructure allocation over the current target level of approximately 1%. The Infrastructure class is expected to produce long-term returns with very desirable risk levels and attractive diversification benefits relative to other asset classes. In addition, portfolio modeling and optimization generally tends to favor private asset classes. With Private Equity and Real Estate reaching their maximum allocation constraints, Infrastructure also becomes more attractive. The long-term target for the current Inflation Sensitive class, of which Infrastructure is a component, is 6%. However, reaching a significant higher level of investment in Infrastructure could be challenging due to aggressive pricing for some assets, a desire to consistently and systematically invest in the space, and the need to thoroughly review both managers and individual infrastructure opportunities.

➤ **Elimination of Home Country Bias**

Most of the portfolios modeled by Meketa in particular include a significant re-allocation from U.S. equities to Non-U.S. equities. The current policy portfolio has a Global Equity allocation that is approximately 67% to U.S. Equity and 33% to Non-U.S. Equity. This represents a tilt toward U.S. Equity relative to the global market weights of approximately 52% U.S. and 48% Non-U.S. At least one of the portfolios modeled by Meketa changes the mix of U.S. Equity to 56% and Non-U.S. Equity to 44%, weights that are much nearer to the global market weights. The implementation of PCA's Global Growth class could also involve an evaluation of the home country bias.

➤ **Reduction of Traditional Fixed Income**

Some of the portfolios modeled by PCA include a reduction in the allocation to traditional fixed income. Over the past 20 years, the allocation to traditional fixed income has decreased along with the fall in interest rates (and lower expected returns as a result). Historically, traditional fixed income has served as the primary source of diversification in the policy portfolio. The potentially lower level of traditional fixed income is a reflection of much lower long-term expected returns in the class, the inclusion of a new diversifying class (Risk Mitigating Strategies, which has an allocation to U.S. Treasury securities) and different constraint levels used by PCA and Meketa. The constraints used in the modeling by PCA allow for a lower allocation to traditional fixed income than the constraints used by Meketa.

Implementation Timeline

Any significant change to the policy portfolio will involve an implementation plan. Should the Investment Committee choose to make any of the changes noted above or any other changes to the policy, Staff will develop an implementation timeline for review and approval by the Investment Committee. Some changes can be implemented more quickly than others. For example, a small shift between liquid public asset classes like equities and fixed income can be accomplished in less than a year. On the other hand, an allocation to the new Risk Mitigating Strategies class would involve a multi-year implementation plan and further education on the details of the strategies included. Similarly, shifts within the private markets can take years. The

implementation plans allow for adjustments as needed based on factors such as market conditions and Investment Committee feedback.

Summary

In order to meet the plan's objectives, it's necessary to take a certain level of risk. Because of this fact, the risk metrics and detailed analyses for each portfolio are most useful as comparative tools rather than considering them in isolation. A 15% volatility or a -10% expected tail loss for a given portfolio does not by itself have enough information to know if it's "good" or "bad". It depends on how these metrics compare to other portfolios.

It's important to note again the limitations inherent in modeling and optimization. The modeling results rely on a range of assumptions about the future returns of different assets, their dispersion and how they interrelate to one another. Even with "good" assumptions about the future, there is no single perfect measure of risk for a portfolio. And even if there were such a perfect measure, the optimal level of risk to take in the fund is a complex, multi-dimensional problem that involves both quantitative analysis and sound judgment. The portfolio modeling information provided in this study is intended to provide a sound quantitative foundation for making the final decision about the optimal policy portfolio.



MEMORANDUM

Attachment 1
Investment Committee - Item 10
September 2, 2015

To: Investment Committee, CalSTRS
From: Stephen McCourt, Mika Malone, Meketa Investment Group
Date: September 2, 2015
Re: Asset Allocation Study – Policy Portfolio Options and Analyses

Background

This memorandum provides a summary of Meketa Investment Group's asset allocation modeling output for the CalSTRS 2015 Asset Allocation Study. In this memorandum, we provide a review of the modeling inputs and constraints, describe our process for identifying policy portfolios to model, discuss the factor sensitivities of the policy portfolio options, and evaluate risk in a wide variety of ways.

The table below highlights the purpose of the September agenda item in the context of the broader asset allocation study process.

| 2015 Investment Committee Meeting | Asset Allocation Study Steps |
|-----------------------------------|--|
| April | <ul style="list-style-type: none">Review asset classes used in modeling process |
| June | <ul style="list-style-type: none">Adopt capital market assumptions |
| July | <ul style="list-style-type: none">Select asset class optimization constraints |
| September | <ul style="list-style-type: none">Model risk and return characteristics of policy portfolio options |
| November | <ul style="list-style-type: none">Select new asset allocation targets and ranges |

This agenda item is informational only. The intent of this memorandum is to provide context for the Investment Committee to evaluate the broad trade-offs between different asset allocation policies. The modeling process is highly adaptable and customizable, so we are able to modify the policy portfolios in a variety of ways, and can provide a host of additional risk and return metrics if the Investment Committee wishes.

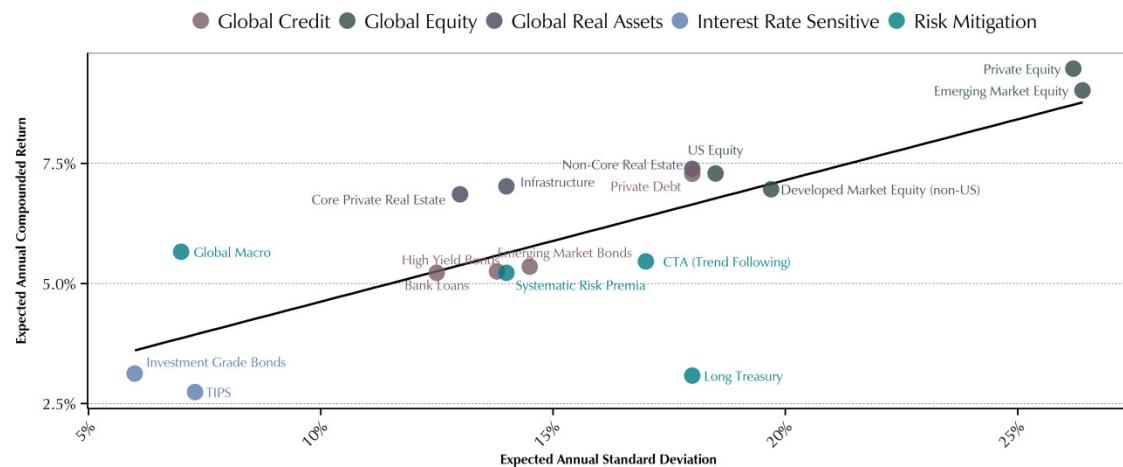
Asset Classes and Model Inputs

Meketa Investment Group has selected a variety of asset classes to use in the asset allocation study. These asset classes, in general, are more granular than those currently used by CalSTRS.

The table below shows how these asset classes “map” to the current CalSTRS policy.

| Macro-Risk Category | Asset Class Categories | Current Asset Allocation (%) |
|-------------------------|--|------------------------------|
| Global Equity | U.S. Equity Developed Equity (non-U.S.) Emerging Market Equity Private Equity | 68 37 15 3 13 |
| Interest Rate Sensitive | Investment Grade Bonds TIPS Cash | 17 16 <1 1 |
| Global Credit | High Yield/Bank Loans Emerging Market Debt Private Debt | 1 1 <1 0 |
| Global Real Assets | Private Real Estate Private Infrastructure | 14 13 1 |
| Risk Mitigation | Risk Mitigation | 0 |

CalSTRS' Investment Committee approved a set of risk, return, and correlation assumptions, based on input from Meketa Investment Group, PCA, and Staff. Meketa Investment Group set its model inputs based on those approved by the Investment Committee. The chart below shows the risk and return expectations for the asset classes modeled by Meketa Investment Group.



Asset Class Constraints

In addition to the asset class inputs that the Investment Committee approved, the Committee also approved a set of constraints to use in the modeling process, based on input from Meketa Investment Group, PCA, and Staff. The model constraints are expressed in the table below. It is important to note that these constraints are not mutually exclusive. Some overlap, or comprise additional underlying asset classes. For example, the private equity constraint, which has a maximum of 13%, *includes* Private Debt, which has its own individual constraint of 5%.

| Asset Class | Minimum (%) | Maximum (%) |
|--|-------------|-------------|
| Public Equity (Incl. U.S., Int'l Dev., EM) | 20 | 70 |
| Private Equity (Incl. Private Debt) | 5 | 13 |
| Investment Grade Debt (Incl. TIPS) | 15 | 25 |
| TIPS | 0 | 5 |
| High Yield and Bank Loans (Combined) | 0 | 5 |
| Emerging Markets Debt | 0 | 5 |
| Private Debt | 0 | 5 |
| Real Estate | 5 | 13 |
| Infrastructure | 0 | 5 |
| Risk Mitigating Strategies | 0 | 12 |
| Emerging Market equity as a % of Non-U.S. Equity | 0 | 25 |

Identifying Policy Portfolio Options

Even with model constraints, there is an infinite set of possible asset allocation portfolios that can be evaluated. Consequently, to gain value from a detailed evaluation of potential asset allocation policies, the identification of policy portfolios is a critical step in the modeling process. In addition to the current CalSTRS policy, Meketa Investment Group has identified 5 policy portfolios to model. In identifying these portfolios, we used several guideposts:

- Identify portfolios with a wide range of risk and return expectations. The five we chose had expected volatilities (standard deviation) between 10.8% and 15.0%, and expected compounded annual returns of between 7.0% and 7.6%.
- Favor mean-variance efficient portfolios at each level of risk and return. (i.e., portfolios should be reasonably close to the model's efficient frontier).
- Consider costs involved in moving the CalSTRS portfolio from its current position.
 - In selecting policy portfolios, we assumed a 10 basis point increase in expected return, or decrease in expected risk, would be required to justify a 5 percentage point departure from a current asset class target.

- Consider the impact and certainty of management fees of different asset allocation policies
 - In selecting policy portfolios, we assumed a 10 basis point increase in expected return (net of fee), or decrease in expected risk, would be required to justify every 2 basis point increase in aggregate management fees.
- Consider the weaknesses and challenges associated with mean-variance optimization (discussed below).

Based on these considerations, we identified the five policy portfolios (A – E) to model. The table below shows the asset allocation, expected return, and expected volatility of each policy portfolio and the current policy.

Asset Allocation Policy Options¹

| | Policy A (%) | Policy B (%) | Policy C (%) | Policy D (%) | Policy E (%) | Current Policy (%) |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|--------------------------|
| Global Equity | | | | | | |
| U.S. Equity | 26 | 26 | 25 | 27 | 26 | 37 |
| Developed Market Equity (non-US) | 6 | 10 | 15 | 18 | 21 | 15 |
| Emerging Market Equity | 2 | 3 | 5 | 6 | 7 | 3 |
| Private Equity | 9 | 11 | 13 | 13 | 13 | 11 |
| Interest Rate Sensitive | | | | | | |
| TIPS | 0 | 0 | 0 | 0 | 0 | 0 |
| Investment Grade Bonds | 22 | 18 | 15 | 15 | 15 | 17 |
| Global Credit | | | | | | |
| High Yield Bonds | 0 | 0 | 0 | 0 | 0 | 1 |
| Emerging Market Bonds | 0 | 0 | 0 | 0 | 0 | 0 |
| Bank Loans | 1 | 1 | 0 | 0 | 0 | 0 |
| Private Debt | 4 | 2 | 0 | 0 | 0 | 2 |
| Global Real Assets | | | | | | |
| Core Private Real Estate | 7 | 7 | 7 | 7 | 7 | 7 |
| Value-Added Real Estate | 6 | 6 | 6 | 6 | 6 | 6 |
| Infrastructure | 5 | 5 | 5 | 5 | 5 | 1 |
| Risk Mitigation | | | | | | |
| Global Macro | 2 | 2 | 1 | 1 | 0 | 0 |
| CTA (Trend Following) | 5 | 4 | 4 | 1 | 0 | 0 |
| Systematic Risk Premia | 1 | 1 | 1 | 0 | 0 | 0 |
| Long Treasury | 4 | 4 | 3 | 1 | 0 | 0 |
| Arithmetic Expected Return | 7.6 | 8.0 | 8.4 | 8.6 | 8.7 | 8.4 |
| Geometric Expected Return | 7.0 | 7.25 | 7.5 | 7.6 | 7.6 | 7.4 |
| Standard Deviation (Risk) | 10.8 | 11.9 | 13.2 | 14.4 | 15.0 | 14.4 |
| Expected Tail Loss ² | -11.3 | -13.0 | -14.8 | -16.7 | -17.6 | -16.9 |
| 10 th Percentile Funded Status ³ | 14 | 12 | 10 | 4 | 2 | 1 |

¹ Projections are based upon inputs adopted by the CalSTRS Investment Committee.

² Expected tail loss is the average loss of each policy portfolio in a 10th percentile or worse outcome.

³ Estimated funded status in 2047 assuming a 10th percentile return outcome.

The policy options on the prior page reflect material differences from the current policy, as measured by the expected level of risk and return. The rest of this memorandum focuses on reviewing how each of these policies react to various types of risk, and how those risks may also impact CalSTRS' funded status, management fees, and tail risk exposure.

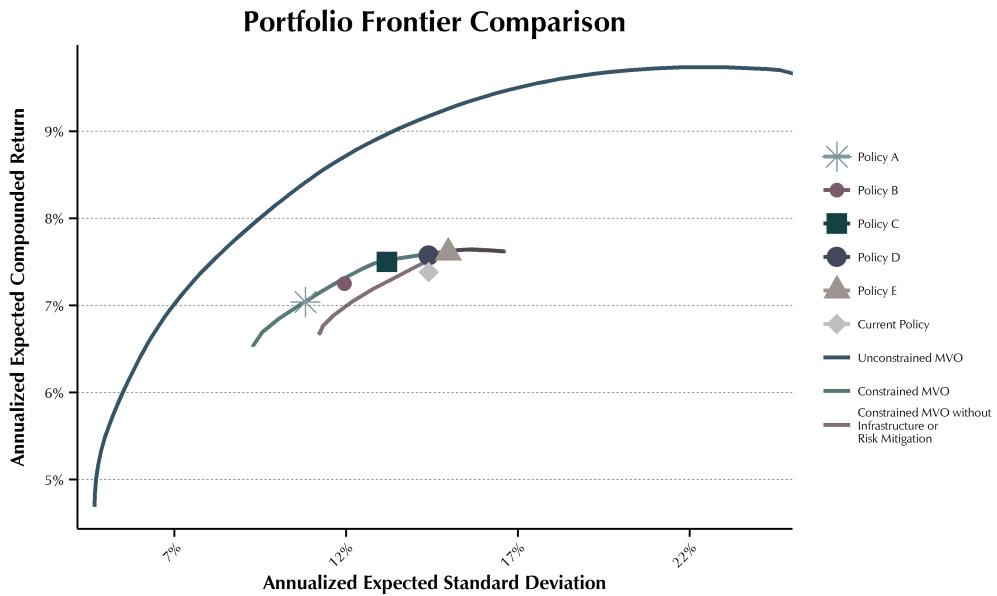
The Efficient Frontier

The "efficient frontier" is the theoretical set of asset allocation policies that maximize the expected return of a portfolio for each unit of risk. Or, conversely, it is also the set of portfolios that minimizes the amount of expected risk for each level of expected return. It is important to stress that the efficient frontier is theoretical, and is the output of mean-variance optimization ("MVO"), the mathematical process typically used to evaluate the risk/return tradeoff of policy portfolios.

While MVO is a very powerful mathematical and modeling tool, it has many shortcomings that one should consider:

- *Garbage in, garbage out* – like any model, the output is only as good as the inputs. MVO requires only three inputs for each asset class: expected return, expected volatility, and the correlation with other asset classes.
- *Over-reliance on standard deviation* – "risk" is a broad concept that can incorporate many definitions (e.g., volatility, liquidity, counterparty risk, credit risk, headline risk). MVO is only able to consider price volatility as risk.
- *Assumption of stable correlations* – MVO models use a single, stable correlation assumption for each asset class. However, in the real world correlations change dramatically over time and, most punitively, increase during periods of market stress. Consequently, MVO tends to overstate the value of diversification.
- *Under-appreciation of tail risks* – MVO generally relies on the assumption that capital market returns are normally distributed. In reality, many capital market returns are not normally distributed, and the most risky asset classes have "fat tails," or a much higher frequency of large negative and positive returns than would be projected by MVO.

The chart below shows the 5 policy portfolios being modeled, the current CalSTRS portfolio, and the constrained and unconstrained efficient frontier.



As you can see, the current policy is farther away from the constrained efficient frontier than each of the 5 policy portfolios being modeled. This means the current allocation can be improved to exhibit modestly better risk-adjusted return characteristics. What is also evident is the extent to which the model constraints impact the risk and return possibilities. Note, however, that the policies that fall on the unconstrained efficient frontier would be viewed by many as unrealistic in the real world. For example, the unconstrained efficient portfolio includes a policy portfolio with the same expected risk level as the current portfolio, but with an expected return 2.8% higher. However, this allocation would require CalSTRS to have 57% invested in private equity, 37% in trend following strategies, and 0% invested in investment grade bonds. In this way, we view the gap between the unconstrained efficient frontier and the constrained efficient frontier largely as evidence of MVO's incompleteness when applying models to the real world.

Finally, we added a third efficient frontier that excludes new investments in infrastructure and risk mitigating strategies. While each of the selected policy portfolios is more mean-variance efficient than the current portfolio, the most significant reason for this improved efficiency is the inclusion of the infrastructure and risk mitigating asset classes. While CalSTRS invests a small amount in strategies incorporated in these asset classes today, the model would maximize the allocation to these asset classes at most risk levels. As discussed in our conclusions, higher allocations to these asset classes would increase meaningfully the management fees paid by CalSTRS.

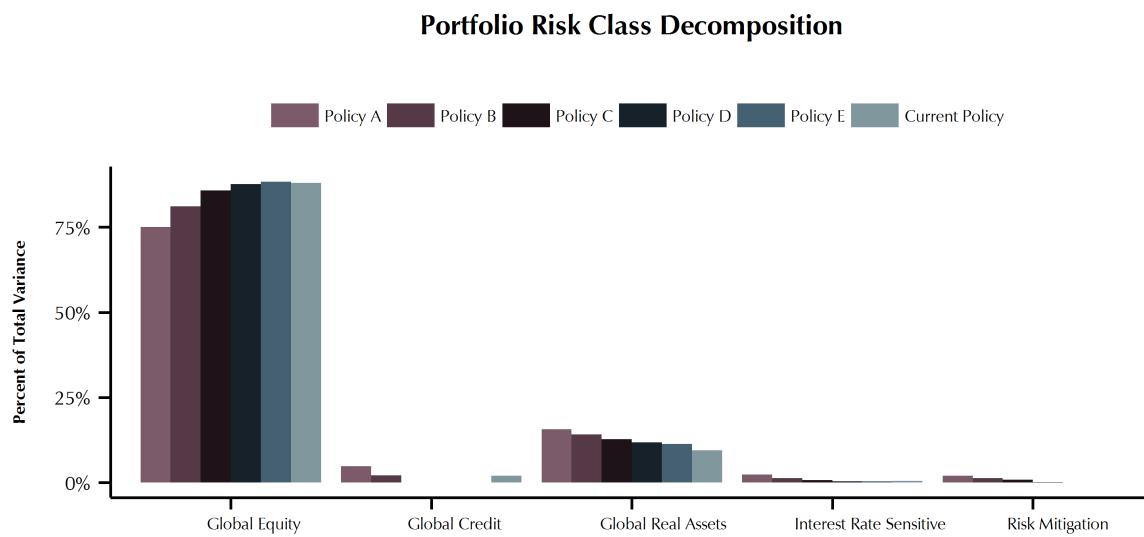
If the Investment Committee chose not to increase allocations to the risk mitigating and infrastructure asset classes, the model shows a slight improvement in efficiency by eliminating the home bias in the global equity portfolio (with a maximum allocation to

emerging markets), and by shifting a portion of the private equity portfolio to private debt strategies, if significantly lower risk policies are preferred.

Factor Sensitivity

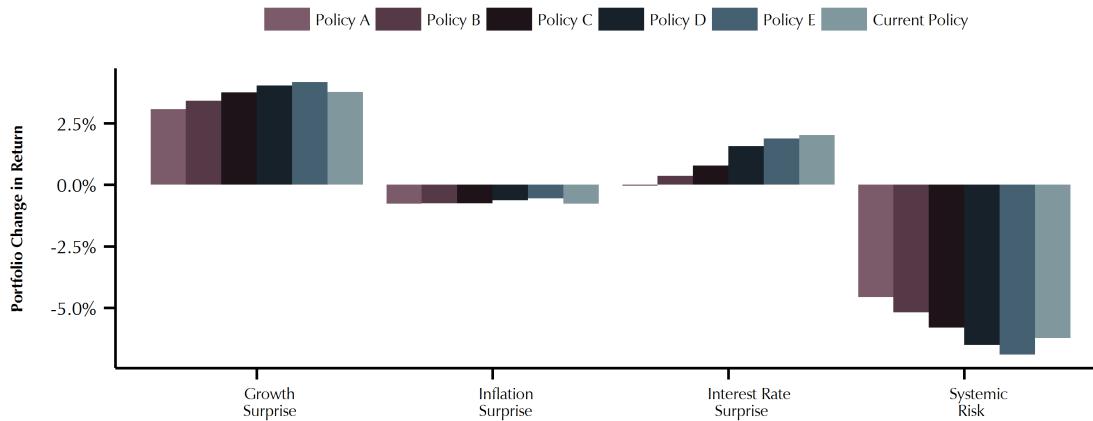
While, traditionally, asset class policies are based on dollar allocations to specific asset classes, it is useful to know how these allocations translate into exposures to broad macroeconomic and capital market risk factors. We show this in a couple of ways.

First, in the chart below, we show the risk (standard deviation) exposure of the current policy and the 5 policy portfolios to 5 broad risk categories: Global Equity, Global Credit, Global Real Assets, Interest Rate Sensitive, and Risk Mitigation. As you can see, each policy portfolio moves CalSTRS risk exposure away from global equity, and towards the other four categories.



Second, we model how the current policy and the 5 policy portfolios created can be expected to behave in the presence of four risk factors modeled by Meketa Investment Group: Growth Surprise, Inflation Surprise, Interest Rate Surprise, and Systemic Risk. In aggregate, we estimate that these four factors explain roughly three-quarters of the volatility in the global capital markets.

Risk Factor Analysis



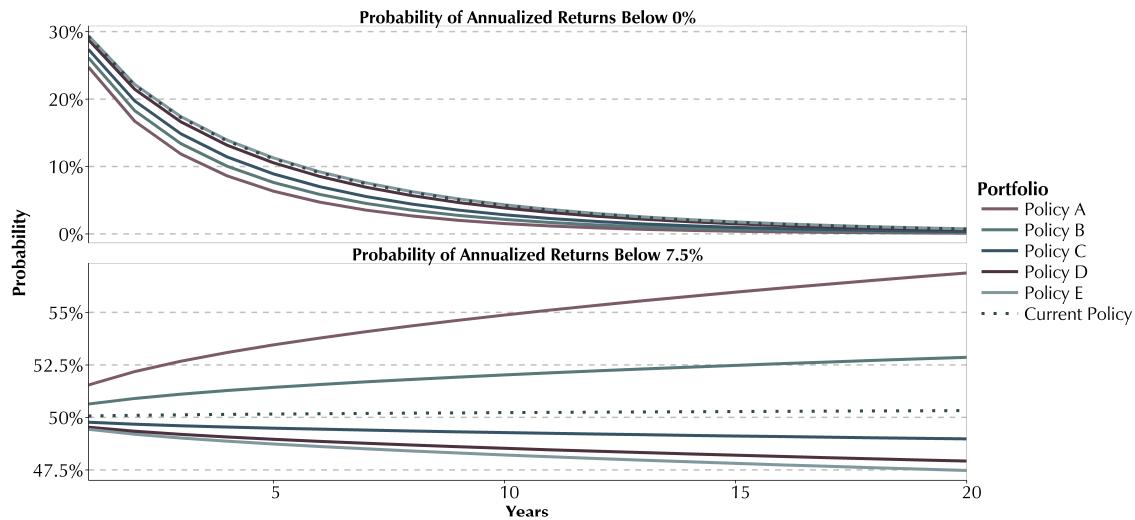
Note that, by far, the largest risks in any of the portfolios are “growth surprise” and “systemic risk.” While inflation risk and interest rate risk are often discussed, and are material, for long-term investors with required rates of return similar to that of CalSTRS, the required equity allocation necessarily focuses the risk in these areas. That being said, policies A-C reduce these large risk exposures somewhat.

Risk Analysis

Meketa Investment Group models risk in a variety of ways, including mean variance analysis, scenario analysis, and stress testing. For CalSTRS, we have also included an analysis of policy portfolio interaction with liabilities, based on a model supplied by Milliman.

Mean variance analysis allows investors to view risks in terms of probabilities. While evaluating probabilities can help inform decisions regarding levels of risk in a portfolio, these probabilities ultimately require an assumption of the underlying distributions of capital market returns. As discussed, return distributions tend not to perfectly fit the assumptions used in mean variance analysis. Consequently, the probabilities should always be seen as approximate.

The two charts below show the probability of the current portfolio and the policy portfolios achieving a 0% annual return over various time periods, and of failing to achieve a 7.5% return over various time periods.

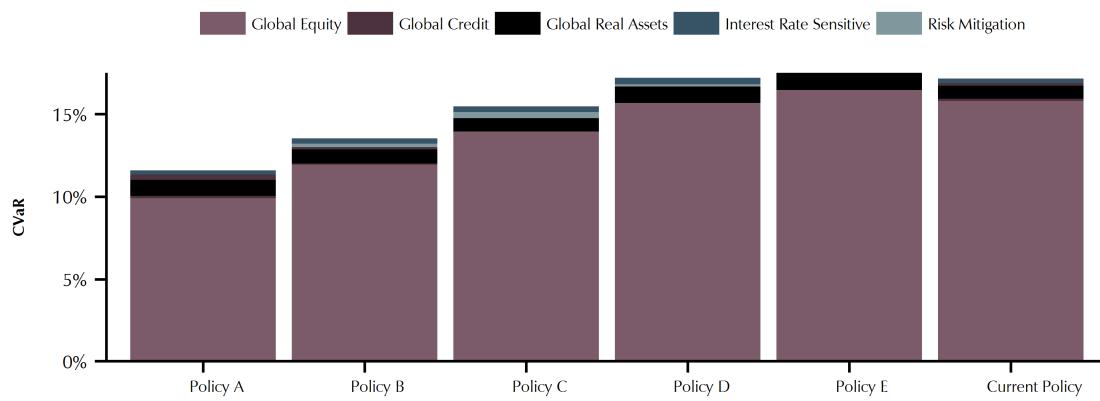


Based on the top chart, each of the policy portfolios matched or reduces the probability of CalSTRS returning less than 0% over all time periods. Further, the more conservative policy portfolios reduce this probability the most.

The bottom chart shows that the more conservative portfolios have a much higher likelihood over time of failing to achieve a 7.5% return. The two charts highlight the natural tension in the asset allocation process that portfolios that protect the best from short term loss, typically are least likely to achieve long term return requirements.

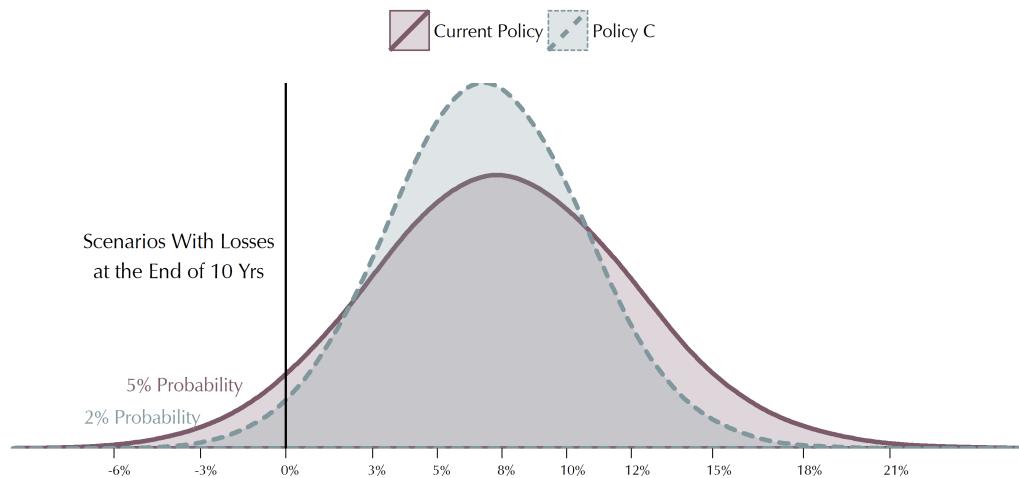
To measure the impact of “tail risks” on the policy portfolios, we calculated the 10th percentile conditional value at risk for each. This measures the expected loss in each policy portfolio in a one-year, 10th percentile outcome. By this measure, each policy portfolio (except Policy E) exhibits less tail risk than the current portfolio.

10th Percentile Conditional Value-At-Risk Decomposition by Risk Class



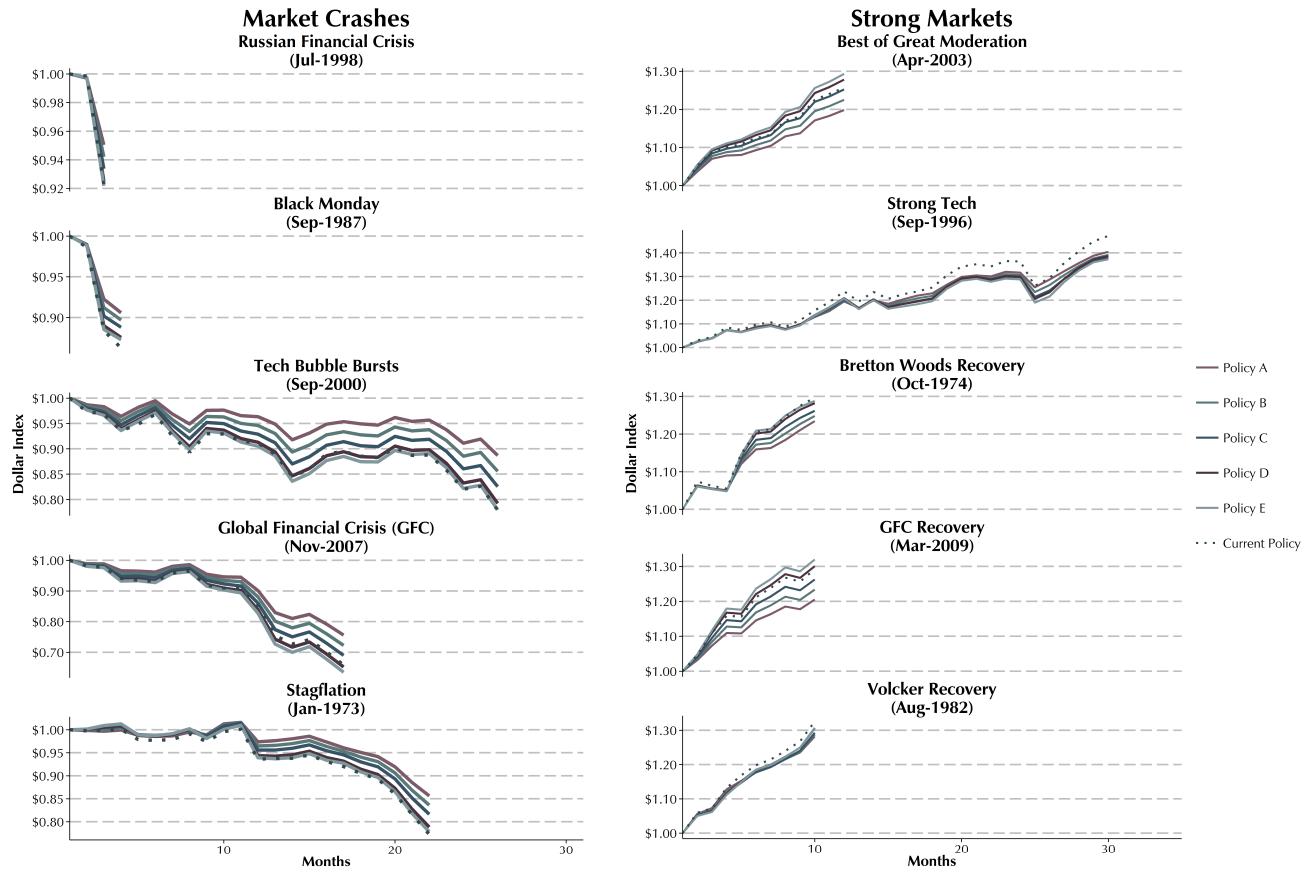
In reviewing the “tail risk” of the current portfolio versus various policy options, it is also important to consider both the time frame, as well as the relative magnitude of each policy’s expected potential for loss. The chart below shows the return distribution of the current policy, compared with Policy C, over annualized ten-year periods. For simplicity purposes, only Policy C is modeled in the chart below, and in many of the charts in the remainder of the document, as the relative difference between the outcomes are very similar between policies A-E, when compared to current policy.

Distribution of Annualized 10 Year Returns



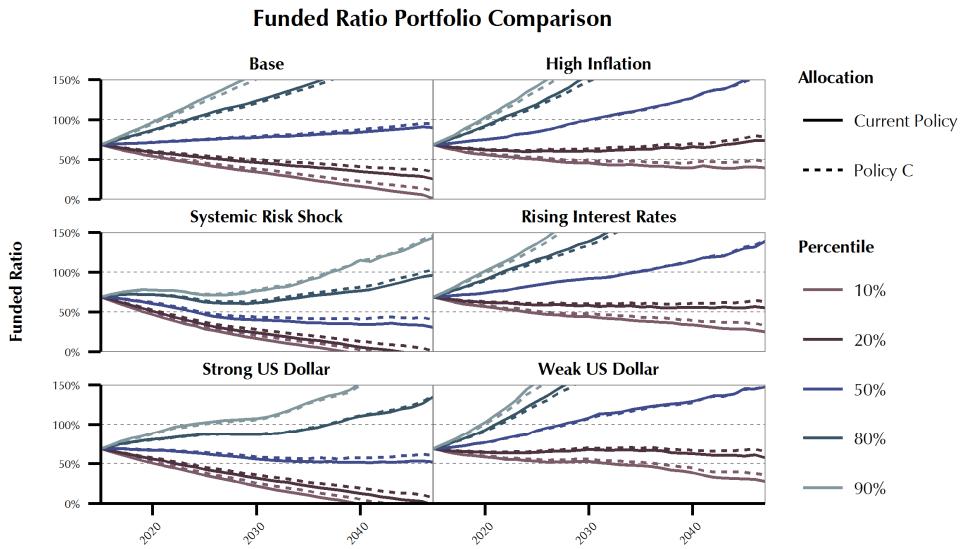
While both policies have a very low probability of losses at the end of a ten-year period, Policy C reduces the probability by 60% (2% probability, versus a 5% probability) compared with the current portfolio policy.

As the probabilities above rely on the risk, return, and correlation inputs to the model, we also conduct scenario analysis to evaluate how the various portfolios would have behaved under actual periods of market stress (positive and negative) that have occurred over the past forty years. The results of this analysis are summarized in the charts below.



Based on this analysis, the periods of actual market stress correspond well with the model's estimates based on expected returns, volatilities, and correlations. In essence, the current portfolio would perform the worst in severe down markets, given its higher equity exposure. In up markets, the current portfolio performs relatively well, but is surpassed in many scenarios by the higher risk policy portfolios.

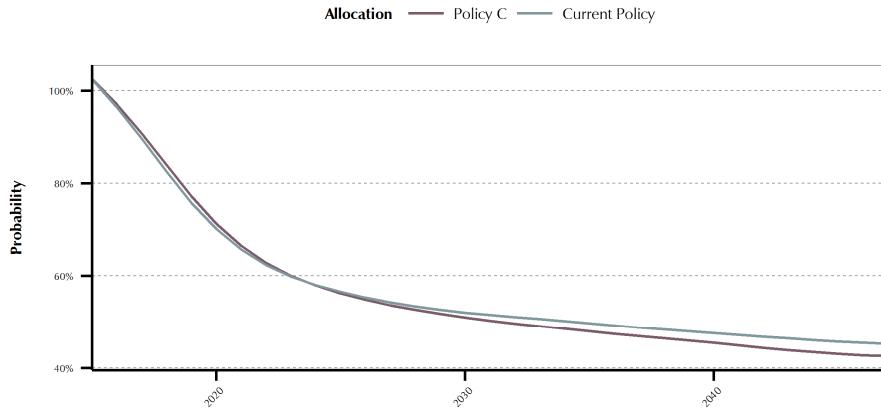
Finally, we stress test each of the portfolios based on the expected behavior of asset classes under a variety of potential regimes in the future. We stress tested the portfolios under five regimes: rising inflation, heightened systemic risk, rising interest rates, rising US dollar, and weakening US dollar. For simplicity purposes, we show the results of Policy C in relation to the current portfolio, as the other policy portfolios have similar outcomes, in relation to the current portfolio. The results of this analysis are below:



The charts above compare the funded ratio for the current policy and policy C under stressed conditions. As noted above, Policies A-E react very similarly in this testing, so only Policy C is shown for clarity. Policy C tends to protect the portfolio better in the median outcome, as well as in the worst case scenarios (those below the 50th percentile), while the current policy increases the funded status more in the best case scenarios. The differences in outcomes are more meaningful as the time period increases.

In evaluating the funded status, we can also estimate the probability of reaching a certain level of funded status over time. The chart below shows the probability of the Policy C and the current portfolio falling below an 80% funded status over various time periods.

Probability of Falling Below a 80% Funded Ratio

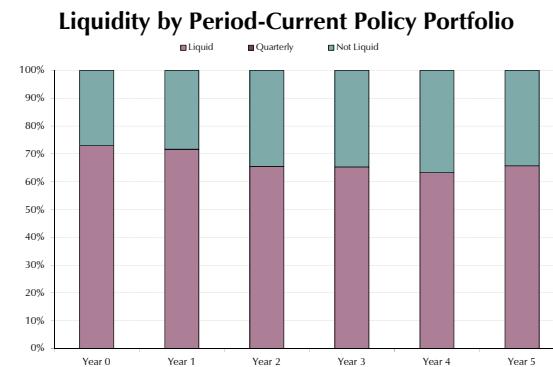
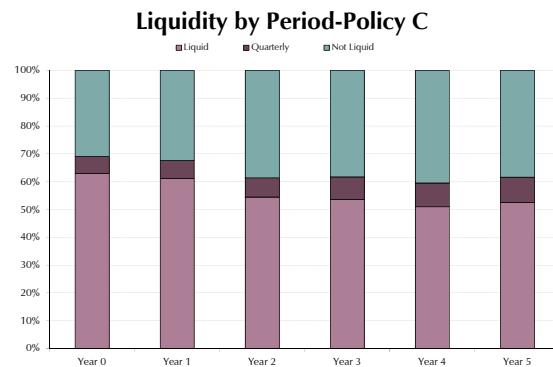
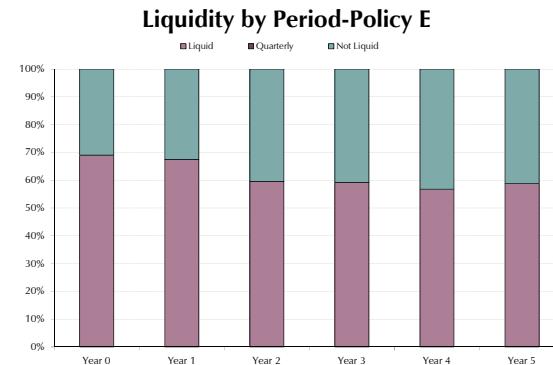
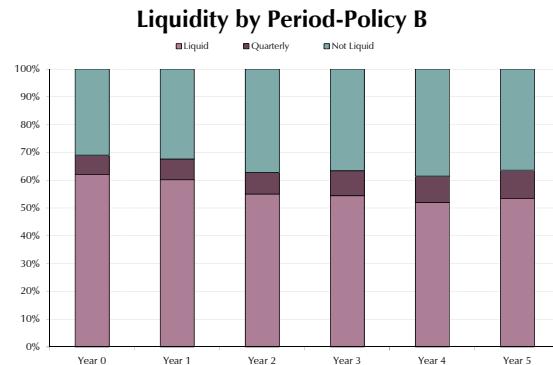
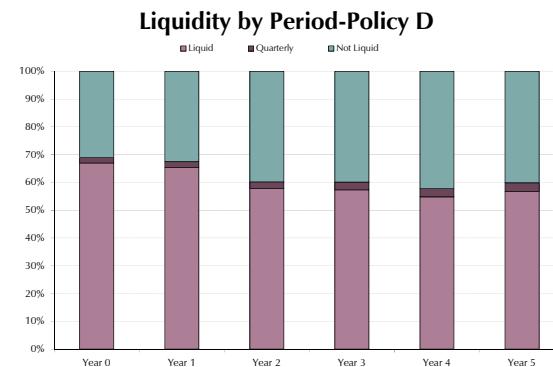
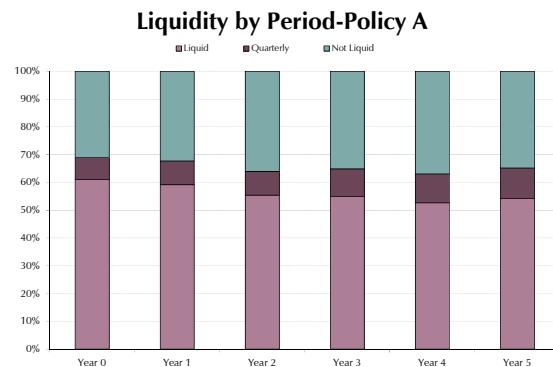


While both the current policy portfolio as well as Policy C have a very high, and nearly overlapping likelihood of falling below an 80% funded ratio in the near term, over

longer time periods, Policy C has a lower probability. In other words, Policy C is more likely to produce a better funded status over the very long term.

Liquidity Analysis

An important part of reviewing asset allocation policies is ensuring that potential policies to be adopted would be sufficiently liquid, in any reasonable environment, to support benefit payments, rebalancing, and other cash needs, without needing to liquidate illiquid asset classes (at large discounts). To test this, we evaluated each portfolio assuming a worst-case capital market environment lasting 5 years (a repeat of 2008/9, but with no rebound in the markets thereafter), under existing benefit and contribution expectations, and incorporating normal rebalancing across asset classes.



Based on this analysis, while each of the policy portfolios would include higher allocations to illiquid asset classes, each would have ample liquidity under even a very severe market environment for the next five years.

Fee Analysis

While the Asset Allocation Study inputs are net of all management fees, Meketa Investment Group believes that management fees remain a very important consideration in the selection of an asset class policy. The primary reason for this is that while the inputs to any asset class model are "estimates" fees paid are a certainty. Therefore, trading certain fees for uncertain return should only be done when the uncertain benefits of higher fees are material.

The table below shows the estimated fee impact of the identified policy portfolios. Note that while all the policy portfolios are more "efficient" than the current portfolio, they also all would likely involve a material increase in fees, largely due to the higher infrastructure allocation and the allocations to risk mitigating asset classes, combined with a reduction in the U.S. Equity allocation.

| | Current Policy ¹ | Policy A | Policy B | Policy C | Policy D | Policy E |
|-------------------------------|-----------------------------|----------|----------|----------|----------|----------|
| U.S. Equity | 37% | 26% | 26% | 25% | 27% | 26% |
| Developed Foreign Equity | 15 | 6 | 10 | 15 | 18 | 21 |
| Emerging Markets Equity | 3 | 2 | 3 | 5 | 6 | 7 |
| Private Equity & Debt | 13 | 13 | 13 | 13 | 13 | 13 |
| Investment Grade Bonds | 17 | 22 | 18 | 15 | 15 | 15 |
| TIPS | 0 | 0 | 0 | 0 | 0 | 0 |
| High Yield | 1 | 0 | 0 | 0 | 0 | 0 |
| EM Debt | 0 | 0 | 0 | 0 | 0 | 0 |
| Bank Loans | 0 | 1 | 1 | 0 | 0 | 0 |
| Real Estate | 13 | 13 | 13 | 13 | 13 | 13 |
| Infrastructure | 1 | 5 | 5 | 5 | 5 | 5 |
| Risk Mitigating | 0 | 12 | 11 | 9 | 3 | 0 |
| Expected Standard Deviation | 14.4 | 10.8 | 11.9 | 13.2 | 14.4 | 15.0 |
| Expected Geometric Return (%) | 7.4 | 7.0 | 7.25 | 7.5 | 7.6 | 7.6 |
| Estimated Fees | 33 | 47 | 47 | 46 | 41 | 39 |

¹ The investment expenses paid by CalSTRS were estimated by the most recent CEM Report (as of 12/31/13) at 41.4 bps. This data reflects actual investments over the 12 months prior. Meketa based our fee estimates, including the 33 bps on the current portfolio, on investment management fees only, and used the long-term return targets for the Fund, as opposed to actual investment weights over the prior 12 months. However, we did use the same estimates by asset class as CEM, where asset classes were the same. Where new asset classes were utilized, we estimated industry averages for those asset classes.

Conclusions

This memorandum provides a large amount of information regarding the very complex process of modeling CalSTRS' asset allocation policy. However, this memorandum only represents a highly summarized version of the deeper analysis we conducted. The Investment Committee should feel free to provide feedback on aspects of the model they wish to change or re-evaluate. The following components of this analysis can be customized by the Investment Committee:

- Policy portfolios being modeled
- Asset class constraints
- Risk metrics
- Economic and capital market risk factors
- Liquidity and cash flow analyses
- Management fee impacts
- Integration with additional liability factors (with input from Milliman)

Based on our analysis, we make the following summary conclusions:

- In terms of mean-variance efficiency, the existing asset allocation policy can be improved, largely through the reduction of expected risk levels, without a corresponding decline in expected return.
 - The improvement in the model's outcomes are largely driven by the introduction of the risk mitigating asset class, and a higher allocation to infrastructure.
 - The model encourages maximizing the emerging markets equity allocation (25% of non-U.S. equity exposure).
 - The model advocates funding these higher allocations by a significant reduction in US equities.
- The addition of more private market assets (i.e., infrastructure) and less liquid trading strategies (risk mitigation strategies), while increasing investment efficiency, would likely increase management fees significantly, as U.S. equities is a very inexpensive asset class for CalSTRS, and infrastructure and risk mitigation more expensive.
- Without the introduction of a meaningfully higher allocation to infrastructure and risk mitigating strategies, the potential improvements in efficiency are much less meaningful.
 - The model points toward eliminating the home bias in the global equity portfolio, and to overweighting emerging market equities.

- At lower levels of risk, the model points toward shifting more of the private equity portfolio from traditional equity strategies (e.g., buyout, venture capital) to more debt-focused strategies (e.g., mezzanine debt, distressed debt, senior lending, etc.).
- Any asset allocation policy that CalSTRS adopts will necessarily mean that equity risks (GDP risk, systemic risk) will dominate the risk of the portfolio. However, several of the policy portfolios modeled moderate slightly the equity risk compared with the existing portfolio.

We look forward to discussing the first output from our Asset Allocation Study with you at the September 2 meeting. If you have any questions, please feel free to reach out to us anytime at 760-795-3450.

SPM/MLM/nca

Date: September 2, 2015

To: CalSTRS Investment Committee (IC)

From: Pension Consulting Alliance, LLC (PCA)

CC: Chris Ailman – CIO

RE: 2015 A/L Study – Session V: Policy Allocation Options

“Three Questions That Every Fund Should Ask Themselves

Bob Prince, CIO, Bridgewater Associates

Stepping back from the market action, we want to pause for a moment and share some thoughts about longer-term investment strategy that have been part of our recent client conversations. When discussing current conditions in relation to their circumstances, we find it useful to ask three basic questions:

What is your required return?

What is your achievable return?

How big of a hit can you take along the way?

By required return we simply mean the return that is necessary for current assets to meet future needs and obligations. Achievable return reflects current asset pricing and skill. And the tolerable hit considers compounding effects. Given how straightforward the questions are, we and the client are often surprised that the answers are not just sitting on the tip of the tongue. The questions are useful because they are common sense, they are grounded in the realities of cash flows and asset pricing, and they naturally lead to a more robust assessment of long-term sustainability across a range of market outcomes and funding strategies.”

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Summary

During this session, the IC will begin deliberating on an allocation policy for CalSTRS' assets. An excellent point-of-departure for beginning this discussion is the three questions raised by Bob Prince on the previous page. Below, we re-state these questions to help make them a little more applicable to CalSTRS' unique set of circumstances:

What is your required return?

Can a return lower than 7.5% allow us to achieve our objectives? If so, how low?

What is your achievable return?

How confident can we be that we can actually achieve our assumptions/objectives?

How big of a hit can you take along the way?

What happens if CalSTRS has a significant fiscal-year drawdown? Can we modify our portfolio to alter such an outcome?

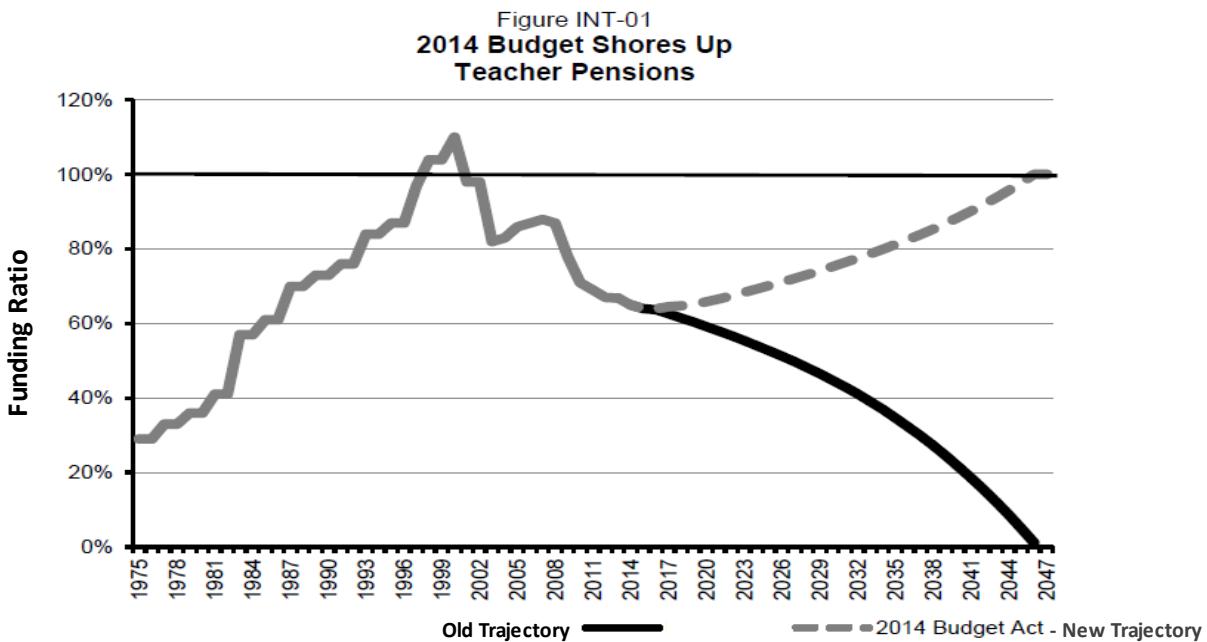
Keeping these questions in mind, the following pages (in particular, the Background and Summary Findings & Conclusions of PCA AL Study sections) present a short list of policy allocation options for IC consideration. Your collective response to the above questions will likely provide significant insight and guidance into how the IC/Board would like to strategically position the asset-side of the CalSTRS balance sheet for the foreseeable future.

Background

The primary objective of this Asset-Liability Study (AL Study) is to examine various policy options for investing CalSTRS' assets and to possibly revise the existing policy. A revision to the current Long-Term Policy (LTP) would occur because there would be a reasonable indication that a new policy would improve the prospects of the pension plan achieving its near-term and long-term funding objectives.

In 2014, CalSTRS achieved a major milestone with the passage of AB 1469. Passage of this bill completely altered the long-term funding trajectory of CalSTRS, reversing the prior long-term trend of moving toward insolvency to a new trajectory of gradually moving toward full-funded status in approximately 30 years (see chart, next page).

While there are several key factors underpinning the funding agreement as a result of AB 1469, the actuarial assumptions underpinning AB 1469 assume that CalSTRS' assets earn close to a compounded annual return of 7.5% over the next 30 years. If this were to actually occur every single year, the funding ratio path would progress along the dotted line in the chart.

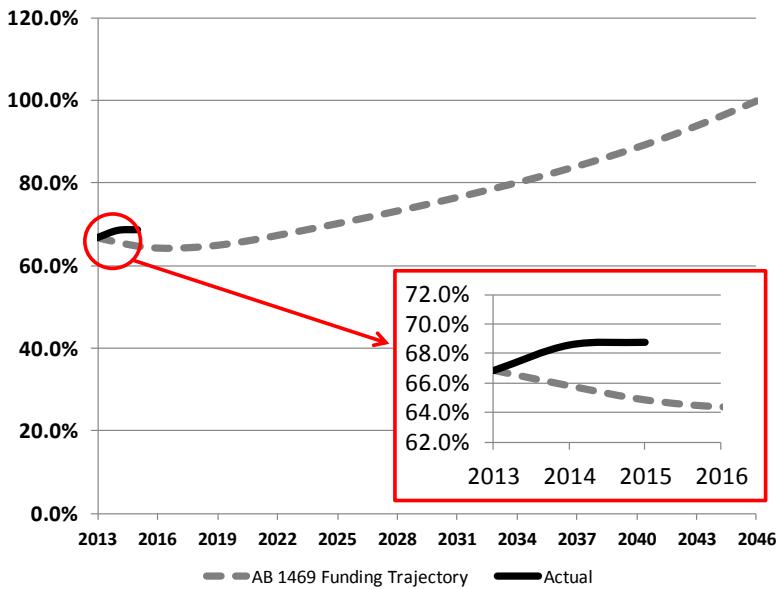


Source: CalSTRS Actuary

From a policy perspective, developing an asset investment strategy that helps the pension plan adhere closely to the new funding ratio trajectory path should prove highly beneficial from a planning and management standpoint.

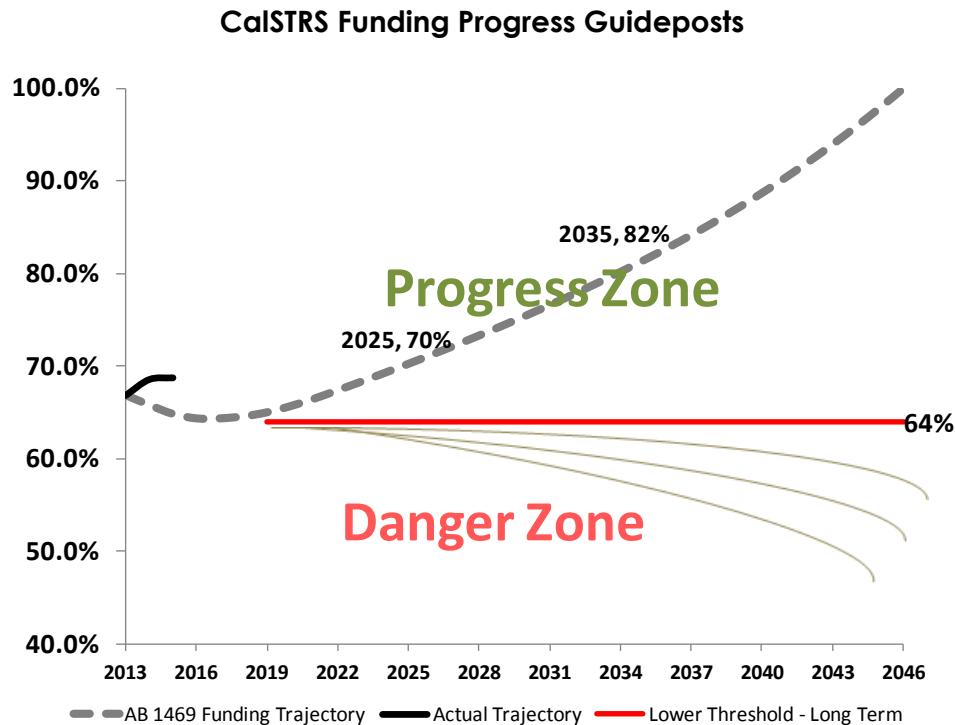
Since AB 1469 became law, CalSTRS has progressed quite favorably versus the projections utilized by the State Department of Finance (see chart below).

Actual CalSTRS Funding Ratio Progress vs. Dept. of Finance Projections



Source: CalSTRS Actuary, Milliman, PCA.

Recent asset return experience has allowed CalSTRS to create a modest buffer versus the agreed-upon funding path, it is highly likely that challenging and volatile investment markets could wipe out this buffer in very short order. Therefore, future asset investment policy should continue to emphasize steady progress along the funding ratio trajectory expected under AB 1469. Utilizing this trajectory as a key reference point, several milestones become evident (see chart below).



Based on the AB 1469 funding trajectory, CalSTRS is expected to achieve a funded status of 70% by 2025 (ten years from now) and 82% by 2035. As of the end of fiscal 2015, CalSTRS' estimated funded ratio was approximately 69%. This latest figure, however, does not fully account for potential actuarial losses as a result of the fiscal 2015 investment return falling below 7.5%. Nonetheless, relative to AB 1469 projections, CalSTRS appears to be well within the "progress zone" delineated on the above chart.

From a risk management perspective, a funding ratio of below approximately 64% as of the end of 2019 could be considered an early signal that CalSTRS may be moving back into a path of deteriorating funding (i.e., very near a downward sloping funding trend). While there is potential to "bounce back" from such a position, statistical analysis indicates that if CalSTRS' funded ratio was 64% as of the end of fiscal 2019, there would be a 40% chance that the funding ratio would be less than 64% in 2045 – in other words, a 40% chance of funding ratio deterioration. From an asset/liability perspective, PCA believes it is critical to utilize the 64% funding ratio as a key threshold over the near term, particularly over these early years of the AB 1469 funding framework. Lowering the chances of breaching this threshold should help CalSTRS avoid long-term funding deterioration in the future.

With this background, the IC can determine whether it is possible to improve upon existing CalSTRS investment policy. In making this determination, the IC has two basic choices:

1. Continue to utilize the largely traditional asset class framework that is currently in place under CalSTRS' existing policy. Under this framework, potential improvements/adjustments are marginal. As a result, seeking improvement in one financial aspect (e.g., lowering near-term downside risk) typically means sacrificing progress toward another financial goal (e.g., achieving longer-term full funding).
2. Entertain modifications to the current policy framework by considering non-traditional or engineered investment approaches. Such modifications often indicate potential for significant improvement without sacrificing progress toward ancillary objectives. However, such modifications often come with important caveats. For example, new investment strategies may not satisfy time-tested standards realized by more traditional strategies. In addition, such modifications may add significant costs to implementing policy.

Keeping these factors in mind, PCA analyzed numerous policy options under both the traditional and modified policy frameworks. A summary of PCA's findings and conclusions are below.

Summary Findings & Conclusions of PCA AL Study

This section provides a synopsis of the key findings and conclusions of the PCA AL Study. Further analysis and detailed information supporting these findings and conclusions can be found in the following Discussion section as well as in the Appendix. Importantly, the modeling process (with all its caveats) provides a framework for decision-making and is not necessarily reliable for producing precise answers. Such a modeling approach should always be considered one key decision-making tool (among others) useful for arriving at a final policy decision.

Findings Relating CalSTRS' Current Long-Term Policy (LTP)

- Based on PCA's simulation modeling, the LTP exhibits a median projected 30-year annualized compound return of 7.5%.
- Utilizing the current LTP, CalSTRS' simulated median funding ratio is projected to be 91% in 2045¹, less than the original deterministic 98% projection reported by the CalSTRS Actuary. This difference is solely due to the volatility associated with producing an actual return versus the perfectly constant assumed deterministic return.
- Based on analytics from the most recent CEM report, the estimated investment costs of managing the LTP are approximately \$821 million/year, or 43 basis points (0.43%) on a total portfolio value of approximately \$191 billion. Of the \$821

¹ Original projections in the planning process extended to 2046. PCA's projections extend to 2045 (a 30-yr. horizon).

million, approximately \$690 million (or 85% of total fees) is attributable to the CalSTRS' private market investments. Excluding CalSTRS' private investments, the cost to manage the remaining 72% of the CalSTRS investment portfolio totals only an estimated 10 basis points per year (0.10%).

- At least 77% of CalSTRS assets are oriented toward some form of economic growth risk. From a risk allocation perspective, approximately 95% of the total risk that CalSTRS accepts is economic growth risk.
- Given the above risk profile, based on PCA's simulation model, there is a 10% chance that CalSTRS' assets could decline by approximately (\$42) billion within the next two years. There is also a 10% chance that CalSTRS assets could increase by approximately \$97 billion.
- Similarly, under the current LTP, there is a 29% probability that CalSTRS would again breach the "danger zone" 64% funding ratio by the end of 2019.

Alternative Policy Options

- Based on several of the findings above, PCA believes that reducing the probability of breaching the "danger" zone funding ratio level in the near-to-intermediate term should be a key priority in developing a policy portfolio.
- As stated in earlier sessions, PCA's modeling involves allocating among seven major strategic classes that, in turn, have pre-set structures involving 22 sub-classes. See the Discussion section and Appendix for further information.
- PCA applied two optimization approaches to arrive at a narrow set of policy options for the IC to consider. Mean-Variance Optimization (MVO) is the well-known traditional methodology for arriving at a set of ideal portfolios. It focuses solely on CalSTRS' assets and their statistical interrelationships to select portfolios. Over the years, practitioners have found several weaknesses associated with MVO. Simulation-based Optimizations (SO) seeks to address these concerns. SO is a multi-period model that can integrate plan balance sheet and financial flows into the optimization process.
- Using the MVO and SO approaches, PCA modeled approximately 100 optimal portfolios for further examination (discussed elsewhere in this report). This list was then narrowed down to eight "policy-equivalent" portfolios exhibiting similar expected risks as current policy, similar expected returns as current policy, or some combination of the two.
- From these eight portfolios, PCA selected four potential portfolios: two that focus primarily on minimizing the risk of intermediate-term funding deterioration (Portfolios B & F) and two that focus primarily on seeking long-term funding improvement (Portfolios G & I). Within each subset, there is a portfolio that includes the proposed new RMS class and a portfolio that excludes the RMS class. (see table, next page).

**Summary of
AL Modeling Outcomes (versus Current Long-Term Policy) – 4 Candidate Portfolios**

| | Portfolio B | Portfolio F | Portfolio G | Portfolio I |
|-----------------------------------|--------------------|--------------------|------------------------|------------------------|
| Primary Goal | Funding Protection | Funding Protection | LT Funding Improvement | LT Funding Improvement |
| Considered Characteristics | | | | |
| Expected LT Funding Level | Reduces | Increases | Increases | Increases |
| Expected Near-Term Funding Risk | Reduces | Reduces | Maintains | Reduces |
| Expected Compound Return | Reduces | Increases | Increases | Increases |
| RMS Inclusion | Excludes | Includes | Excludes | Includes |
| Exposure to Growth-risk classes | Reduces | Reduces | Increases | Increases |
| Cost Structure | Increases | Increases | Reduces | Increases |
| Fixed Income Allocation | Reduces | Reduces | Reduces | Reduces |

As the table highlights, there are numerous tradeoffs associated with each candidate portfolio. Selecting a specific policy (or some variation thereof) will depend heavily upon the IC's preferences about one or more of the above considerations.

- Detailed quantitative analysis of the above four policy options, in addition to the current Long-Term Policy (LTP) are displayed in the table on the next page. The table is broken out into six sections. Section A shows the strategic class mix associated with each alternative policy option. Sections B – E present IC-requested data covering specific key topics. Section F presents financial projections under both the MVO and SO modeling approaches. In the SO section (rows 6-15), there are two sections: Asset Portfolio Projections and Integrated Asset/Liability Projections. This latter section is the key area of focus for this project, particularly rows 14 & 15 (highlighted in **bold**).
- Portfolio A (the LTP), Portfolio B, and Portfolio G utilize only existing CalSTRS strategic classes (i.e., do not consider the proposed new RMS class). Portfolio F and Portfolio I give maximum consideration to the RMS class.
- Versus the current LTP, three of the four alternative policy choices (B, F & I) exhibit lower probabilities of breaching the “danger zone” 64% funding ratio threshold after Year 4 (row 15).
- In terms of long-term funding success, Portfolios F, G, & I produce higher expected 2045 funding ratios than the current LTP, while Portfolio B does not. Of these three, Portfolios F & I also show significantly more potential to reduce near-term funding risk. The common thread of these two portfolios is their allocation to the RMS class. This provides an indication of the expected benefit of the RMS: portfolios with RMS may materially reduce the probability of funding deterioration while also enhancing the long-term funding outcome versus the current LTP.

| Section | Portfolio | A | B | F | G | I |
|---|---|------------------|--------------------|------------------------|--------------------|------------------------|
| | Primary Goal | | Funding Prot. | Funding Prot. | LT Fdg. Impr. | LT Fdg. Impr. |
| | Strategic Class (% of Total) | Long Term Policy | Curr. Classes Only | Curr. Classes Plus RMS | Curr. Classes Only | Curr. Classes Plus RMS |
| A | Global Growth | 51 | 48 | 42 | 64 | 52 |
| | Private Growth | 13 | 13 | 13 | 13 | 13 |
| | Real Estate | 13 | 13 | 13 | 13 | 13 |
| | Credit | 6 | 4 | 4 | 4 | 4 |
| | Inflation Sensitive | 6 | 10 | 10 | 0 | 0 |
| | Protection / Liquidity | 10 | 12 | 6 | 6 | 6 |
| | Risk Mitigating Strategies | 0 | 0 | 12 | 0 | 12 |
| | Cash | 1 | 0 | 0 | 0 | 0 |
| | Total Portfolio | 100 | 100 | 100 | 100 | 100 |
| Growth vs. Stabilizing Alloc. (% of Tot. Port.) | | | | | | |
| B | Growth-oriented | 77 | 74 | 68 | 90 | 78 |
| | Stabilizing | 23 | 26 | 32 | 10 | 22 |
| | Fixed Income | 18 | 16 | 14 | 10 | 14 |
| | Other | 5 | 10 | 18 | 0 | 8 |
| U.S. vs. Non-U.S. Eq. Alloc. (% of Tot. Port.) | | | | | | |
| C | U.S. Equity | 34 | 26 | 23 | 34 | 28 |
| | Non-U.S. Equity | 17 | 22 | 19 | 29 | 24 |
| | Developed | 14 | 18 | 16 | 24 | 20 |
| | Emerging Markets | 3 | 4 | 3 | 5 | 4 |
| Emerging Markets Alloc. (% of Tot. Port.) | | | | | | |
| D | Emerging Mkts. Equity | 3 | 4 | 3 | 5 | 4 |
| | Emerging Mkts. Debt | 0 | 0 | 0 | 0 | 0 |
| | Total Emerging Markets Exposure | 3 | 4 | 3 | 5 | 4 |
| Estimated Management Fees | | | | | | |
| E | Est. Fees Current Portfolio (% of Total) | 0.43 | 0.46 | 0.51 | 0.41 | 0.46 |
| | Estimated Fees (in \$M) | 821 | 884 | 982 | 779 | 871 |
| Financial Projections | | | | | | |
| F | Mean-Variance Model | | | | | |
| 1 | Exp. Annl. Compound Return – 30 Yrs. (%) | 7.6 | 7.5 | 7.5 | 7.9 | 7.7 |
| 2 | Expected SD of 1 Yr Rets. (%) | 13.7 | 12.6 | 11.8 | 14.9 | 13.1 |
| 3 | Exp. SD of 30 Yr. Compound Rets. (%) | 2.5 | 2.3 | 2.2 | 2.7 | 2.4 |
| 4 | Exp. Value of 2-Yr Loss at 10% Prob. (%/\$B) | -16.4/(31.4) | -14.5/(27.7) | -12.6/(24.0) | -18.3/(34.9) | -14.9/(28.4) |
| 5 | Exp. 10% 30-Yr Funded Ratio Threshold (%) | 19.8 | 22.0 | 27.1 | 21.5 | 25.5 |
| | Simulation Model (1000 Scenarios) | | | | | |
| | Asset Portfolio Projections: | | | | | |
| 6 | Med. of 30-Year Arith. Avg. Rets. (%) | 8.4 | 8.1 | 8.1 | 8.8 | 8.4 |
| 7 | Med. of 30-Yr. Compound. Avg. Rets. (%) | 7.5 | 7.4 | 7.6 | 7.7 | 7.7 |
| 8 | Avg. SD - Scenario SDs of 30 Annl. Rets. (%) | 13.6 | 12.3 | 10.7 | 15.1 | 12.3 |
| 9 | SD 30-Year Compound Avg. Rets. (%) | 2.5 | 2.3 | 2.0 | 2.8 | 2.3 |
| 10 | Avg. Loss - Worst 10% 2-Yr. Scenarios (%/\$B) | -22.0/(41.9) | -19.2/(36.7) | -14.3/(27.4) | -25.2/(48.2) | -17.7/(33.7) |
| | Integrated Asset/Liability Projections: | | | | | |
| 11 | Avg. Annual Net Contrib. (% of MV) | -2.7 | -2.7 | -2.7 | -2.7 | -2.7 |
| 12 | Avg. - Highest 10% Net Contribs. (% of MV) | -3.7 | -3.6 | -3.3 | -3.9 | -3.5 |
| 13 | Worst 10% 30-Year Funding Ratios Threshold | 9 | 15 | 28 | 3 | 21 |
| 14 | Med. 30-year Funding Ratio (Reward) | 91 | 88 | 95 | 98 | 99 |
| 15 | Prob. of 64% Thrshld. Breach in 4 Yrs (Risk) | 29 | 26 | 23 | 29 | 25 |

- There is flexibility in designing the RMS class. While the proposed structural blueprint for the RMS is considered “optimal,” other structural blueprints for the class present similar portfolio diversification outcomes (see the Discussion of Risk Mitigating Strategies (RMS) Class section).
- Portfolio B represents a classic return-versus-risk tradeoff. Since Portfolio B utilizes the same classes as the current LTP (i.e., no RMS), reducing risk leads also to a commensurate reduction in expected long-term success (as evidenced by the reduced 2045 expected funding ratio of 88% versus 91% under the current LTP).
- Note also that three of the four alternative policy portfolios (B, F & I) exhibit many other favorable expected downside risk characteristics, as well as lower overall volatilities. Specifically, Portfolio F (with its highly diversified mix of strategic classes, including the RMS) exhibits downside risk that is 35% less than the current LTP (row 10). Based on these figures, during a market-crisis period, Portfolio F could save CalSTRS approximately \$14.5 billion. Portfolios B & I also exhibit downside savings versus the current LTP.
- Turning to other areas of IC interest, the funding protection-oriented portfolios have lower allocations to growth-risk assets, while the long-term funding improvement-oriented portfolios have higher growth-risk asset allocations (Section B in the table). In addition, fixed income assets are also expected to decline by varying degrees as the alternative policy choices seek additional diversification into other areas.
- Three of the four alternative policy options are expected to incur higher costs than the current LTP. Portfolio F incurs the highest incremental cost, costing an estimated \$161 million more than the current LTP. This result occurs because assets are being shifted to more expensive classes such as Inflation Sensitive and the RMS. In contrast, Portfolio G (which places a significant emphasis on lower-cost public growth-oriented assets) would be expected to have investment costs that are nearly \$50 million lower per year than the current LTP.
- Even Portfolio B, which shifts among existing classes, is more expensive than the current LTP due to its high allocation to Inflation Sensitive.
- Regardless of the final policy selected, implementation should be undertaken in a timely, yet deliberate and prudent manner. If a policy option exhibits differences that are significantly different from the CalSTRS Current portfolio, then an implementation plan (possibly covering multiple years) should likely be established.
- Below are the investment cost estimates of CalSTRS’ classes based on the latest CEM Benchmarking report (see next page):

Estimated Investment Costs – by Strategic Class

| Strategic Class | Annual Cost - in basis points |
|----------------------------------|--|
| Global Growth | 11 |
| Credit | 8 |
| Inflation Sensitive | 78 |
| Liquidity/Protection | 8 |
| Risk Mitigating Strategies (RMS) | 53 |
| Private Growth | 167 |
| Real Estate | 75 |

Source: CEM Benchmarking, Investment Cost Effectiveness Analysis, 12/31/2013.

Strategic class costs are largely a function of indexing potential, internal vs. external management, and private markets versus public markets. For example, internally-managed public-market index (or near-index) portfolios make up a large proportion of the Global Growth, Liquidity/Protection, and Credit classes. As a result, these are the least expensive classes to manage. Conversely, since there is heavy emphasis on applying active-oriented, external managers in the private-investment-heavy Inflation Sensitive, Private Growth, and Real Estate classes, they are the most expensive to operate. The proposed RMS class is a hybrid class consisting of a blend of (i) virtually no-cost U.S. Treasuries, (ii) moderate cost CTAs, (iii) moderate cost Alternative Risk Premia strategies, and (iv) high-cost Global Macro strategies. The proposed structural blend of the RMS causes it to be a mid-priced strategic class. As discussed elsewhere in this memo, alternative structures of this class are feasible, at significant lower cost.

Discussion of Current Portfolio & Selected Policy Options

This section begins with a review of CalSTRS current strategic asset allocation policy. A brief description of the strategic allocation policy is covered first, followed by a discussion of key financial projections of the System, incorporating Milliman's model of System liabilities.

Description of Current CalSTRS Allocation Policy

CalSTRS currently allocates its assets utilizing six major strategic classes. These classes are Global Equity, Private Equity, Fixed Income, Inflation Sensitive, Real Estate, and Cash. A seventh class, Absolute Return, garners about 1% of total assets, but has a 0% policy allocation. As discussed in prior sessions and summarized later in this memo, PCA recommends streamlining these classes into seven closely-related, but more broadly-defined strategic classes. The remainder of this memo presents CalSTRS' portfolio under this latter framework, beginning with the actual Current and Long-Term Policy portfolios (see table, next page). Underlying this framework of seven strategic classes are investments in approximately two-dozen CalSTRS sub-classes (see Appendix, page 41).

CalSTRS Current Strategic Allocation Policy – Re-Cast to PCA Strategic Framework

| Strategic Class | Long Term Target (%) | Current Portfolio (%) | Current Portfolio (\$M) | Strategic Role |
|----------------------------|----------------------|-----------------------|-------------------------|--|
| Global Growth | 51 | 58 | 110,612 | Provide long-term growth in assets, primarily through appreciation |
| Private Growth | 13 | 10 | 19,306 | Protect and stabilize assets, provide accessible liquidity and income |
| Real Estate | 13 | 12 | 23,766 | Provide long-term income and appreciation |
| Credit | 6 | 6 | 11,627 | Provide long-term growth through appreciation |
| Inflation Sensitive | 6 | 1 | 1,686 | Maintain purchasing power, stabilize assets, inflation surprise protection |
| Protection / Liquidity | 10 | 10 | 18,611 | Provide consistent growth in assets |
| Risk Mitigating Strategies | 0 | 1 | 1,704 | Provide immediate liquidity |
| Cash | 1 | 2 | 3,564 | Provide immediate liquidity |
| Total Portfolio | 100 | 100 | 190,877 | |

Allocation (% of Tot. Port.)

| Major Asset Group | Long Term Target | Current Portfolio | Current Portfolio (\$M) | |
|-------------------|------------------|-------------------|-------------------------|------------------------|
| Growth-oriented | 77 | 81 | 153,684 | GG +RE+PG |
| Stabilizing | 23 | 19 | 37,193 | Cr + IS + PL + RMS + C |
| Fixed Income | 17 | 18 | 33,803 | Cr + PL + C |
| Other | 6 | 1 | 3,390 | IS+ RMS |

Allocation (% of Tot. Port.)

| Global Equity Segment | Long Term Target | Current Portfolio | Current Portfolio (\$M) |
|-----------------------|------------------|-------------------|-------------------------|
| U.S. Equity | 34 | 38 | 73,329 |
| Non-U.S. Equity | 17 | 20 | 37,283 |
| Emerging Markets | 3 | 3 | 5,974 |

Allocation (% of Tot. Port.)

| EM Segments | Long Term Target | Current Portfolio | Current Portfolio (\$M) |
|-----------------------|------------------|-------------------|-------------------------|
| Emerging Mkts. Equity | 3 | 3 | 5,974 |
| Emerging Mkts. Debt | 0 | 0 | 1 |
| % of Total Portfolio | 3 | 3 | 5,975 |

| | % of assets | In \$ millions |
|---|-------------|----------------|
| Est. Investment Costs – Current Portfolio | 0.36 | 681 |

The table above also shows several sub-allocation breakouts of interest to the IC. As these breakouts indicate (i) the CalSTRS total portfolio is heavily tilted toward assets exhibiting exposures to growth risk, (ii) there is a significant 2/3-1/3 home bias tilt in the Global Equity portfolio, (iii) CalSTRS currently invests approximately \$6 billion in Emerging Markets, and (iv) CalSTRS pays out approximately \$681 million in management costs per year (not including carried interest on private investments).

Coinciding with the above allocation information is the projection of outcomes for this allocation policy utilizing the recently adopted CalSTRS capital market assumptions (see table below).

Projected Outcomes – Current CalSTRS Allocation Policy

| Strategic Class | Current Portfolio (%) | Long Term Target (%) |
|---|-----------------------|----------------------|
| Global Growth | 58 | 51 |
| Private Growth | 10 | 13 |
| Real Estate | 12 | 13 |
| Credit | 6 | 6 |
| Inflation Sensitive | 1 | 6 |
| Protection / Liquidity | 10 | 10 |
| Risk Mitigating Strategies | 1 | 0 |
| Cash | 2 | 1 |
| Total Portfolio | 100 | 100 |
| <i>Mean-Variance Model</i> | | |
| Expected Arithmetic Avg. Return | 8.4 | 8.4 |
| Expected Annualized Compound Return – 30 Yrs. | 7.5 | 7.6 |
| Expected SD of 1 Yr Returns | 13.9 | 13.7 |
| Expected SD of 30 Yr. Compound Return | 2.5 | 2.5 |
| Expected %/\$ Value of 2-Yr Loss at 10% Probability (%/\$B) | -17.0 / (\$32.5B) | -16.4 / (\$31.4B) |
| Expected 10% 30-Year Funded Ratio Threshold | 18.2 | 19.8 |
| <i>Simulation Model</i> | | |
| Average of 1,000 Scenario 30-Year Arith. Avg. Returns | 8.3 | 8.4 |
| Median of 1,000 Scenario 30-Year Arith. Avg. Returns | 8.4 | 8.4 |
| Average of 1,000 Scenario 30-Year Compound. Avg. Returns | 7.4 | 7.4 |
| Median of 1,000 Scenario 30-Year Compound. Avg. Returns | 7.4 | 7.5 |
| Average SD of 1,000 Scenario SDs of 30 Annual Returns | 14.0 | 13.6 |
| SD of 1,000 Scenario 30-Year Compound Avg. Returns | 2.6 | 2.5 |
| Avg. %/\$ Loss of Worst 10% 2-Year Scenarios (%/\$B) | -23.2 / (\$44.3B) | -22.0 / (\$41.9B) |
| Avg. Annual Net Contribution – next 10 yrs. (% of MV) | -2.7 | -2.7 |
| Avg. of Worst 10% Annual Net Contributions – next 10 yrs. (% of MV) | -3.8 | -3.7 |
| Worst 10% of 1,000 30-Year Funded Ratio Scenarios Threshold | 5.0 | 9.0 |
| Median 30-year Funded Ratio | 89.8 | 90.6 |
| Growth Risk Allocation (GG + PG + RE) | 96.9 | 95.1 |

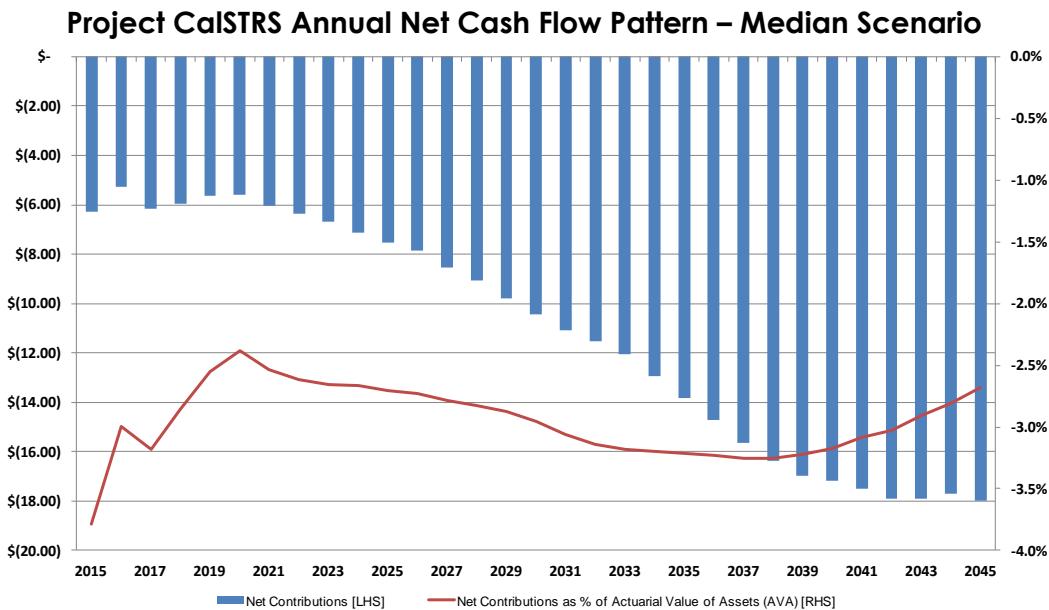
As the table shows, under the Mean-Variance (MV) modeling section, the long-term expected compound annualized return for the current CalSTRS allocation policy is 7.6%. A reasonable range around this long-term outcome can be described using the “Expected SD of 30 Yr. Compound Return,” which is 2.5%, meaning that (based on the assumptions) there is a 2-in-3 chance that CalSTRS’ policy portfolio will produce a long-term annual compound return between 5.1% and 10.1% (i.e., the expected 7.6% +/- the expected SD of 2.5%). Similar methods are used to compute the other MV-based estimates.

The Simulation Model section produces similar statistics as under the MV section, utilizing 1,000 simulations of market scenarios consistent with CalSTRS’ MV capital market assumptions. Simulation analysis can be useful because, unlike the MV modeling approach, it produces widely diverging paths of outcomes and allows certain inputs to vary widely, better reflecting what may occur in the real world.

While several of the Simulation Model statistics are equivalent to those produced by the MV Model, downside outcomes are often more pronounced under the Simulation Model than under the MV Model. This differential reflects the Simulation Model's ability to better capture and measure potential crisis outcomes more realistically than the traditional MV Model.

For example, in the table above, the MV framework indicates that there is a 10% chance that CalSTRS could lose more than (\$31) billion over the next 2-years (the length of a typical equity bear market). Under the simulation modeling framework, this 10% outcome is estimated to be close to (\$42) billion. The difference lies in the finding that the MV framework may not adequately capture significant potential downside outcomes that actually occur in the investment markets.

The simulations also indicate that plan liquidity (in terms of net cash flows) should prove manageable over the next decade. Based on AB 1469, contributions into CalSTRS are expected to rise out to approximately six years from now. From that point forward, contributions, as a percent of Total Portfolio market value, are expected to steadily decline. This means that by about 2022, the annual net outflow of the plan (contributions minus benefits) will begin to rise steadily, from around 2.5% of market value, to 3.25% of market value by 2035 (see chart below).



The simulation model indicates that median net contributions over the next decade will be approximately 2.7% of Total Portfolio market value (i.e., ~\$6 billion per year). If a market crisis hits within the next decade, simulated net contributions could rise quickly to 3.7% of Total Portfolio market value. Under this scenario, based on the agreed upon contribution structure, the dollar value of net contributions are assumed to adjust marginally to ~\$7 billion per year. Based on these findings and assumptions, overall near-term plan liquidity should be adequate to cover the plan's overall cash flow considerations over the next decade.

Selecting Policy Options

Methodologies utilized to determine optimal policy options analyze portfolios across “reward versus risk” dimensions. When examining portfolios in an asset-only context (without regard to an institution’s or individual’s liabilities), expected long-term investment return is typically utilized as a proxy for “reward” while the expected volatility of that investment return (typically its expected statistical variance or standard deviation) is the proxy for “risk.” When the methodology incorporates liabilities into the modeling process (an “asset-liability study”), then the reward-versus-risk dimensions typically encompass broader measures of an institution’s financial health. For public pension funds such as CalSTRS, these reward-versus-risk dimensions often involve the funded ratio (projected actuarial assets/actuarial liabilities) of the pension system. For example, as a “reward” measure, planners might use the end-of-horizon funding ratio (e.g., the funding ratio after 30 years) achieving a desired level (such as 100%). For the “risk” dimension, practitioners might measure and analyze the variability of the funding ratio over time, and/or establish a minimum threshold that the funding ratio should not breach. Depending on the system being reviewed, other system-wide measures might be incorporated into the portfolio optimization process. Examples of alternative measures could be: the level and/or volatility of contributions into the system, analysis of the period utilized to amortize the unfunded liability, the level and variability of net contributions (contributions minus benefits), etc.

PCA believes an asset-liability-based optimization approach for selecting optimal asset portfolios is the most appropriate methodology for CalSTRS. Studying portfolio options through the asset-liability lens allows decision-makers to examine the impact that varying asset portfolios can have on the potential outcomes of the overall retirement system. Typically, through this exercise, decision-makers gain an awareness of the significant volatility that asset investments introduce into the system. Given this awareness, decision makers can examine, deliberate, and possibly adopt a policy portfolio that marginally or dramatically alters shorter- and/or longer-term financial outcomes of the system.

For this project, there are two features that distinguish the PCA approach. First, as discussed in prior meetings, PCA will utilize a strategic class structure involving seven major classes. Twenty-two minor classes are structured to define these seven classes. Second, PCA utilizes its simulation-based asset-liability model to determine optimized portfolios (the liability portion of the model being furnished by CalSTRS’ actuary, Milliman).

PCA Strategic Class Framework

In the April 2015 IC meeting, PCA presented the following framework for organizing CalSTRS' assets going forward:

CalSTRS 2015 AL Study Moving from Asset Classes to Purpose-Driven Strategic Classes

| Current Asset Classes | Role | | Proposed Strategic Class | Role |
|-----------------------|-------------------------|----------------------------|--------------------------|-------------------------|
| Global Equity | Appreciation | Split Fixed into 2 classes | Global Growth | Appreciation |
| Private Equity | Appreciation | | Private Growth | Appreciation |
| Real Estate | Income/Appreciation | | Real Estate | Income/Appreciation |
| Fixed Income | Stability/income | | Credit | Income |
| | | | Interest Rates/Liquidity | Liquidity/Stability |
| Inflation Sensitive | Inflation participation | | Inflation Sensitive | Inflation Participation |
| | | New class> | Crisis Risk Offset | Protection |
| Absolute Return | Stable return | <Eliminate | | |

Re-mapping CalSTRS current policy and actual allocations into the strategic classes appears as follows:

Allocation of CalSTRS Assets in PCA Strategic Class Framework

| Current Asset Classes | LT Target - % | Current - % | | PCA Strategic Class | LT Target - % | Current - % |
|-----------------------|---------------|----------------------|----------------------------|----------------------------|---------------|-------------|
| Global Equity | 51 | 58 | Split Fixed into 2 classes | Global Growth | 51 | 58 |
| Private Equity | 13 | 10 | | Private Growth | 13 | 10 |
| Real Estate | 13 | 13 | | Real Estate | 13 | 13 |
| Fixed Income | 17 | 18 | | Credit | 6 | 6 |
| Inflation Sensitive | 6 | 1 | | Interest Rates/Liquidity | 11 | 12 |
| | | | | Inflation Sensitive | 6 | 1 |
| | | New class> | | Risk Mitigating Strategies | 0 | 1 |
| Absolute Return | 0 | 1 | <Eliminate | | | |

The only major distinctions between the two frameworks are: (i) the division of fixed income into two classes, better reflecting the major roles and risks of each type of fixed income class and (ii) the elimination of the Absolute Return class with the potential replacement being the Risk Mitigating Strategies (RMS) class. All other class allocations transfer directly from a respective CalSTRS class to its mirror-image in the PCA Strategic Class framework. Importantly, the Global Growth and Inflation Sensitive classes under PCA's optimization framework are modeled to have underlying future investment structures that are different than what is in place under the current Global Equity and Inflation Sensitive. These

differences reflect, after significant discussion with senior investment staff, expectations for evolving the classes over time taking into account the objectives and risk profiles of each class. For example, Global Growth is modeled to have a more equally-balanced U.S./Non-U.S. structure with a higher level of emerging markets than currently and a significant 25% of the class allocated to certain stabilized growth strategies that are now being incubated in the Innovation Portfolio. Inflation Sensitive is expected to evolve to contain new allocations to additional types of real assets and floating-rate investments (see Appendix for explicit allocation structures). For comparison purposes, CalSTRS' actual allocations at the sub-class level are used to define both CalSTRS' current Long-Term Policy allocation and the Current Actual portfolio. Any "optimal" alternative will reflect the proposed asset class structures as laid out in the Appendix (page 36).

Simulation-based optimization

PCA's will apply two optimization methodologies: a simulation-based approach and the traditional mean-variance optimization approach. As we have highlighted in previous memos, mean-variance optimization (MVO) exhibits certain key weaknesses:

- The distribution of returns are assumed to be normal or lognormal, implying a high degree of symmetry across the range of potential outcomes;
- Asset class returns are assumed to be stationary and random. In other words, there is no relationship between returns in one period and the next.
- MVO is a single-period model. As a result, it assumes all of its inputs (particularly correlations) remain constant over the length of the period (or investment horizon). In crisis periods, correlations can spike dramatically.

Simulation approaches, while exhibiting their own set of caveats, can overcome these problems to a significant degree. Distributions of various classes' investment returns are allowed to fluctuate over time rather than being forced to behave under a prescribed theoretical pattern. Investment returns are also not required to be generated in a random, independent process – any form of time-varying pattern can occur. Finally, simulations cover multiple periods, allowing investment returns and their accompanying correlations to ebb and flow based on the contexts the markets might present.

Many practitioners utilize MVO to identify optimal portfolios and then measure their behavior utilizing simulation procedures. PCA believes this represents a partial solution and may not capture certain risks appropriately during the optimization process. As a result, PCA utilizes simulations in its optimization procedures as well. One outcome of this approach is that the optimization dimensions become much more flexible and potentially more intuitive to decision-makers.

Optimization Results

In this section, we will present several optimal portfolio options that CalSTRS might consider. The first set of options will examine MV-optimal portfolios in an asset-only context. Within this set there will be two groups: (i) a group that includes the Risk Mitigating Strategies (RMS) class and (ii) a group that does not include the RMS class. Comparing the output from these two groups should provide a preliminary indication of the potential impact of the RMS class.

The second set of options will examine simulation-optimal portfolios where the risk and reward measures are quantified in terms relating directly to the financial health of CalSTRS. Reward will be characterized as achieving long-term funding progress by the end of the 30-year planning horizon. Risk will be characterized as falling through the 64% funding ratio at the end of the next four years. Breaching this lower-threshold funding ratio would be an early signal of a fairly high potential that CalSTRS would again return to its pre-2014 AB 1469 funding path, which was projected to diminish to a funding ratio of 0% by 2043. As with the above MVO portfolios, there will be two groups of analysis – one with RMS and one without RMS.

Policy Options under M-V Optimization Approach

Within PCA's pre-established constraints (see below), there is a range of optimal portfolios that maximize return for a given level of risk. This range of portfolios is deemed the "efficient frontier" (see top panel, Exhibit 1).

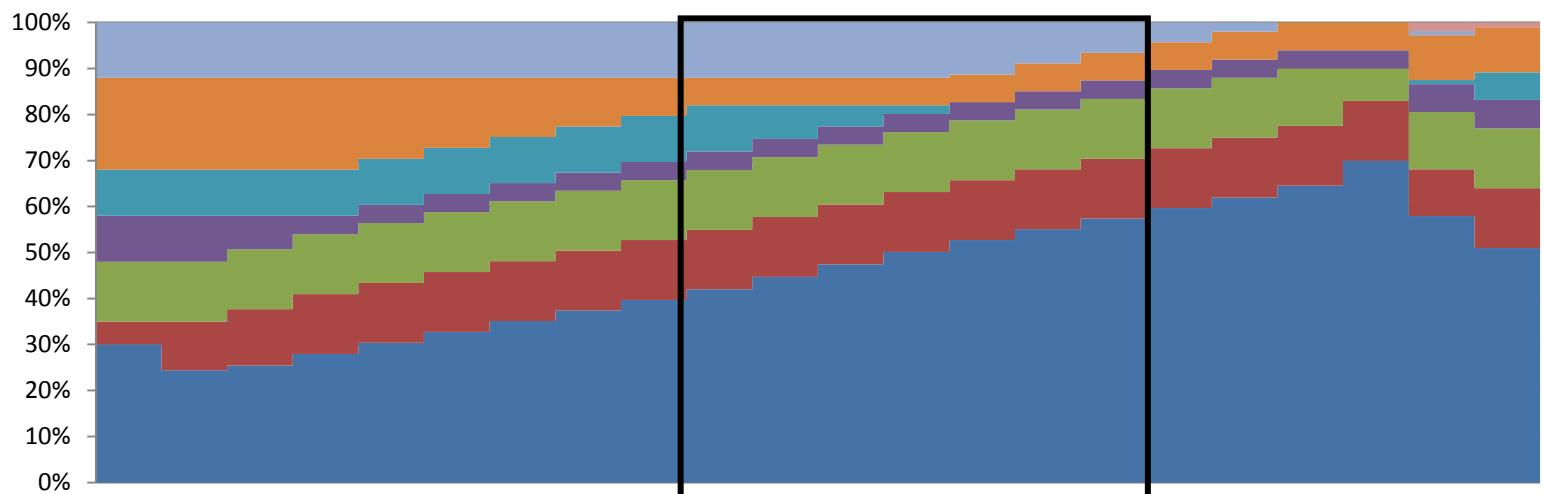
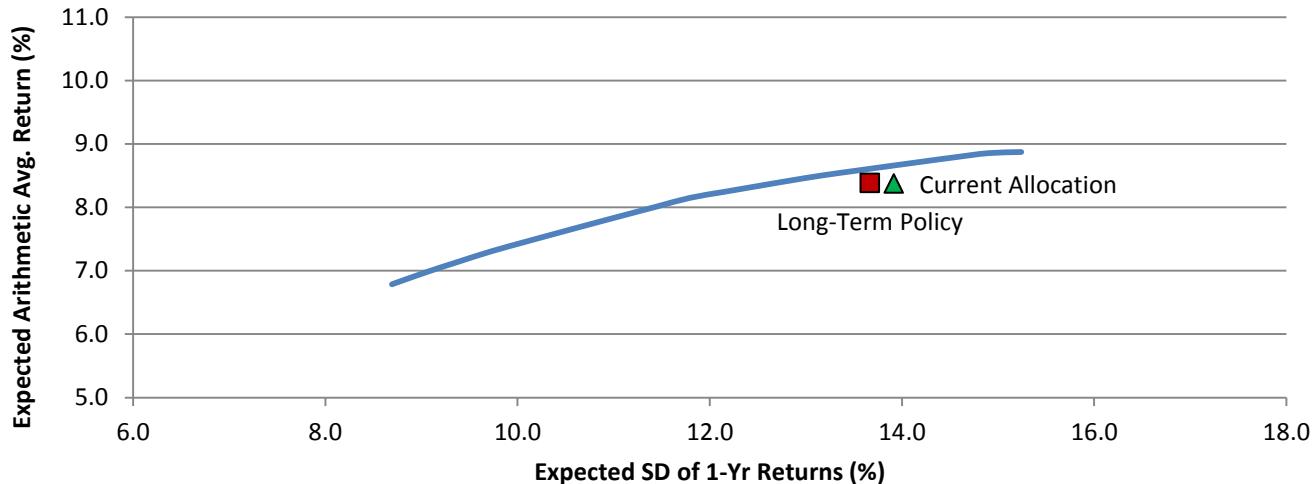
Approved PCA Constraints – including new RMS class

| Strategic Class | Minimum - % | Maximum - % |
|----------------------------------|--------------------|--------------------|
| Global Growth | 20 | 70 |
| Credit | 4 | 10 |
| Inflation Sensitive | 0 | 10 |
| Liquidity/Protection | 6 | 20 |
| Risk Mitigating Strategies (RMS) | 0 | 12 |
| Private Growth | 5 | 13 |
| Real Estate | 5 | 13 |

Based on Exhibit 1, portfolios in this first group (including the RMS class) range from lower-risk/lower-return Portfolio 1 (with an expected 20-year annualized compound return of 6.5% and an annualized volatility (SD) of 8.7%) to higher-risk/higher-return Portfolio 20 (with an expected compound return of 7.9% and an annualized volatility (SD) of 15.2%). In comparison, CalSTRS's Long-Term Policy portfolio is expected to produce a compound return of 7.6% and experience 13.9% annualized volatility.

Exhibit 1

Mean Variance Efficient Frontier



| Portfolio | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | CA | LTP | |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|----|
| Gbl Gr. | 30 | 24 | 25 | 28 | 30 | 33 | 35 | 37 | 40 | 42 | 45 | 47 | 50 | 53 | 55 | 57 | 60 | 62 | 65 | 70 | 58 | 51 | |
| Priv. Gr. | 5 | 11 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 13 | |
| Real Est. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 7 | 12 | 13 |
| Credit | 10 | 10 | 7 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | |
| Infl. Sens. | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 7 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | |
| Prot./Liq. | 20 | 20 | 20 | 20 | 18 | 15 | 13 | 11 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 10 | 10 | |
| RMS | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 9 | 7 | 4 | 2 | 0 | 0 | 1 | 0 | |
| Cash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | |

| | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Arithmetic Return | 6.8 | 7.0 | 7.1 | 7.3 | 7.5 | 7.6 | 7.7 | 7.9 | 8.0 | 8.2 | 8.2 | 8.3 | 8.4 | 8.5 | 8.6 | 8.6 | 8.7 | 8.8 | 8.9 | 8.9 | 8.4 | 8.4 |
| Standard Deviation | 8.7 | 9.0 | 9.4 | 9.7 | 10.1 | 10.4 | 10.8 | 11.1 | 11.5 | 11.8 | 12.1 | 12.5 | 12.8 | 13.2 | 13.5 | 13.9 | 14.2 | 14.6 | 14.9 | 15.2 | 13.9 | 13.7 |
| 20-yr Geo. Return | 6.5 | 6.6 | 6.8 | 6.9 | 7.0 | 7.1 | 7.2 | 7.3 | 7.4 | 7.5 | 7.6 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 | 7.8 | 7.9 | 7.9 | 7.9 | 7.5 | 7.6 |

To compare portfolios on the efficient frontier with CalSTRS's LTP, it is instructive to narrow the efficient frontier to those portfolios that fall between minimum acceptable return (i.e., 7.5% compound return, with lowest possible risk) to similar-risk (with highest possible compound return). These portfolios are represented by the boxed region overlaying the bottom two panels of Exhibit 1.

The minimum-acceptable-return-lowest-risk portfolio is represented by Portfolio 10 and the similar-risk-highest-return portfolio is represented by Portfolio 16. The allocations of these portfolios (isolated below) represent the range of options near the LTP that the IC should be most comfortable with (as none of these options exhibit higher potential risk than the current LTP).

Selected M-V Optimal Portfolios vs. CalSTRS LTP – including new RMS class

| Strategic Class | Portfolio 10 Same Return w/ Lower Risk | Portfolio 16 Same Risk w/ Higher Return | Long- Term Policy |
|----------------------------------|--|---|-------------------------|
| Global Growth | 42 | 57 | 51 |
| Credit | 4 | 4 | 6 |
| Inflation Sensitive | 10 | 0 | 6 |
| Liquidity/Protection | 6 | 6 | 11 |
| Risk Mitigating Strategies (RMS) | 12 | 7 | 0 |
| Private Growth | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 |
| | | | |
| Expected 20-Year Compound Return | 7.5 | 7.8 | 7.6 |
| Expected Annual SD | 11.8 | 13.9 | 13.7 |
| Return/Risk | 0.64 | 0.56 | 0.55 |

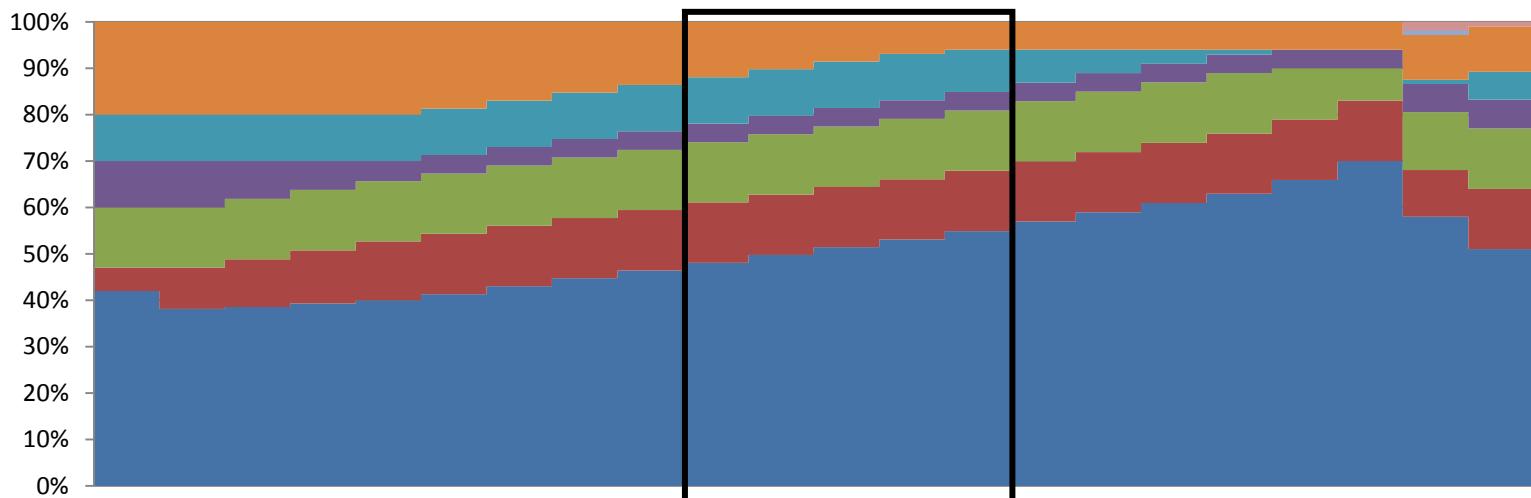
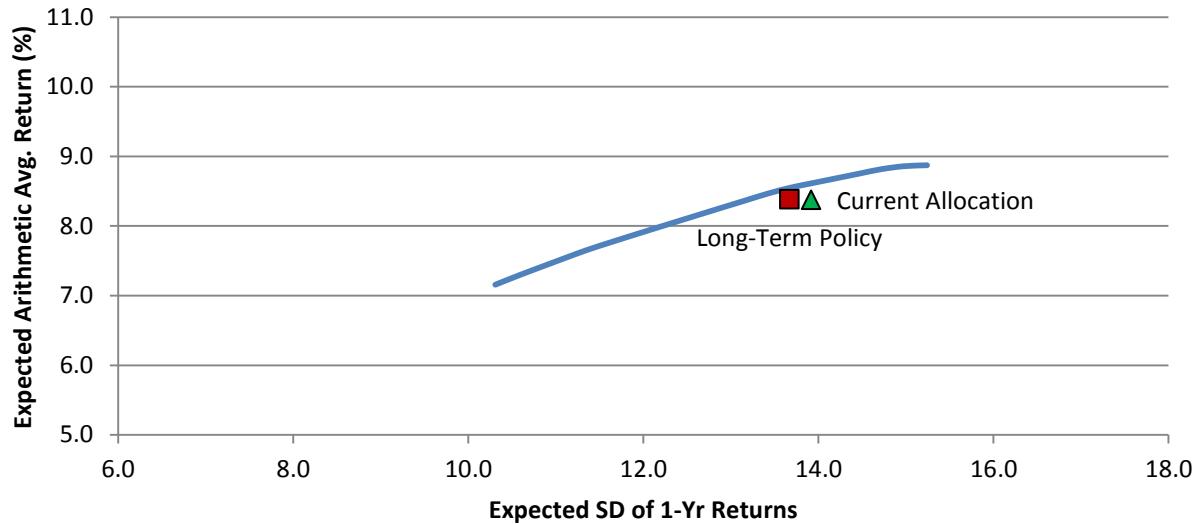
An initial review of the table indicates several preliminary findings:

- Including the RMS, CalSTRS may be able to reduce its total volatility by over 15% while still achieving an expected long-term compound return of 7.5%;
- The allocation to growth-related risky assets varies significantly, from 59% (Global Growth + Private Growth + Credit) in Portfolio 10, to 74% in Portfolio 16. The LTP has 70% in growth-related risky assets.
- Regardless of the alternative portfolio selected, the RMS receives from 7% to 12% of Total Portfolio assets. Principal Protection and Credit (i.e., CalSTRS fixed income assets) are utilized to fund a significant portion of the RMS
- Finally, Private Growth and Real Estate always achieve their maximum allocations, which are equivalent to the allocations under the current LTP.

Exhibit 2 shows the M-V efficient frontier, LTP, and range of equivalent portfolio options to the LTP, but excluding the proposed RMS class. In this case, the representative portfolios are: Portfolio 10, for minimum-acceptable-return-lowest-risk, and Portfolio 14, for similar-risk-highest-return (see table on page following Exhibit 2).

Exhibit 2

Mean Variance Efficient Frontier ex-RMS



| Portfolio | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | CA | LTP |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| Glbl Gr. | 42 | 38 | 39 | 39 | 40 | 41 | 43 | 45 | 46 | 48 | 50 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 66 | 70 | 58 | 51 |
| Priv. Gr. | 5 | 9 | 10 | 11 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 13 |
| Real Est. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 11 | 7 | 12 | 13 |
| Credit | 10 | 10 | 8 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | |
| Infl. Sens. | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 7 | 5 | 3 | 1 | 0 | 0 | 1 | 6 |
| Prot./Liq. | 20 | 20 | 20 | 20 | 20 | 19 | 17 | 15 | 14 | 12 | 10 | 9 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 10 | 10 |
| RMS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |

| | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Arithmetic Return | 7.2 | 7.3 | 7.4 | 7.5 | 7.7 | 7.8 | 7.9 | 8.0 | 8.1 | 8.2 | 8.3 | 8.4 | 8.5 | 8.6 | 8.6 | 8.7 | 8.8 | 8.8 | 8.9 | 8.9 | 8.4 | 8.4 |
| Standard Deviation | 10.3 | 10.6 | 10.8 | 11.1 | 11.3 | 11.6 | 11.9 | 12.1 | 12.4 | 12.6 | 12.9 | 13.2 | 13.4 | 13.7 | 13.9 | 14.2 | 14.5 | 14.7 | 15.0 | 15.2 | 13.9 | 13.7 |
| 20-yr Geo. Return | 6.7 | 6.8 | 6.9 | 7.0 | 7.1 | 7.2 | 7.2 | 7.3 | 7.4 | 7.5 | 7.5 | 7.6 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 | 7.9 | 7.9 | 7.9 | 7.5 | 7.6 |

The allocations of these portfolios (isolated below) represent the range of options near the LTP that the IC should be most comfortable with, but do not exhibit an allocation to the RMS class.

Selected M-V Optimal Portfolios vs. CalSTRS LTP – excl. RMS class

| Strategic Class | Portfolio 10 Same Return w Lower Risk | Portfolio 14 Same Risk w Higher Return | Long-Term Policy |
|----------------------------------|--|---|------------------|
| Global Growth | 48 | 55 | 51 |
| Credit | 4 | 4 | 6 |
| Inflation Sensitive | 10 | 9 | 6 |
| Liquidity/Protection | 12 | 6 | 11 |
| Risk Mitigating Strategies (RMS) | 0 | 0 | 0 |
| Private Growth | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 |
| | | | |
| Expected 20-Year Compound Return | 7.5 | 7.7 | 7.6 |
| Expected Annual SD | 12.6 | 13.7 | 13.7 |
| Return/Risk | 0.65 | 0.56 | 0.55 |

A review of the table indicates several preliminary finding for potential optimal alternative portfolios that exclude RMS:

- Portfolio 10, above, is very similar to Portfolio 10 in the prior table in terms of its return vs. risk profile. As a substitute for the RMS class, the M-V approach allocated assets to Global Growth and Liquidity/Protection. Compared to current LTP, as expected, there is a modest reduction in growth-oriented assets, more Inflation Sensitive assets, and a similar allocation to fixed-income-type assets.
- Portfolio 14, the similar-risk-highest-return portfolio, has a significant allocation to Inflation Sensitive, whereas in the prior table, Portfolio 16 had a zero allocation to Inflation Sensitive, but had an allocation to RMS.
- Based on the expected returns, risks, and return/risk ratios, there is little difference between portfolios utilizing the RMS and those portfolios that do not utilize the RMS (although total volatility on Portfolio 10 is 10% than the current LTP). As a result, the M-V optimization approach seems to indicate that the RMS may not add significant value to the current CalSTRS LTP.

Similar to the M-V portfolios that included RMS, Private Growth and Real Estate always achieve their maximum allocations, which are equivalent to the allocations under the current LTP. This pattern indicates that, under an M-V approach, private market investments are viewed as highly attractive, based on the CalSTRS capital market assumptions.

Policy Options under Simulation Optimization Approach

Optimization utilizing a simulation approach allows integration of both an asset simulation model and the CalSTRS liability model. The asset simulation model incorporates a wide range of return outcomes and does not constrain assets to normally-distributed (symmetric, perfectly random) behavior. Asset behavior is often distributed in a more chaotic fashion, better reflecting potential real-world outcomes. Through the integration of the asset and liability models, projections of plan financial condition can take place and certain measures of financial condition can be utilized to determine optimal portfolios.

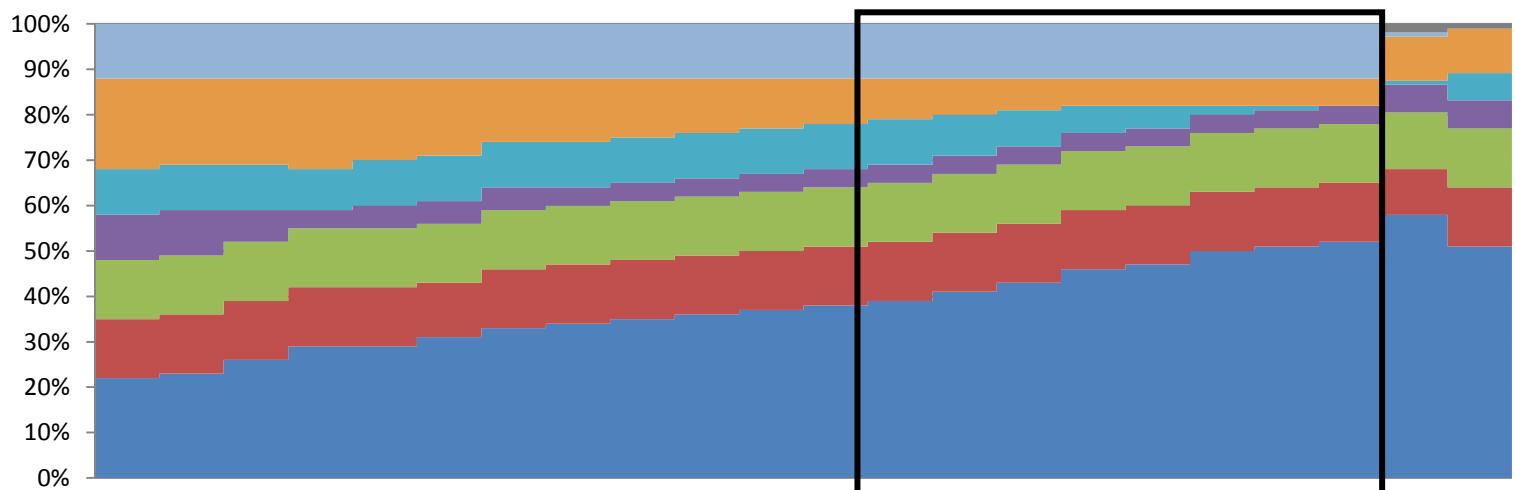
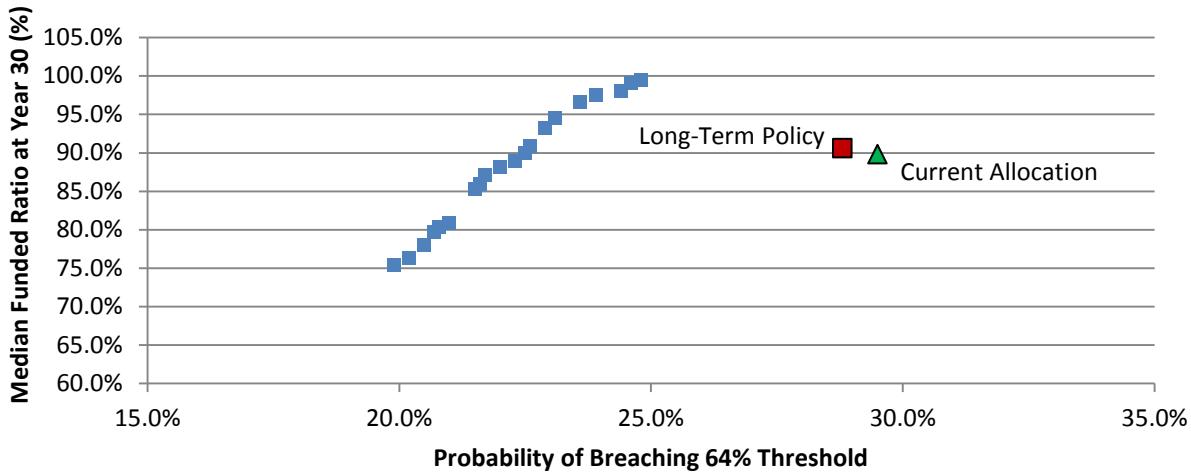
For PCA's optimizations based on simulated results, the nature of CalSTRS's funding ratio is used to measure both the reward and risk dimensions. Reward is characterized as achieving long-term funding progress by the end the 30-year planning horizon. Risk will be characterized as the potential of being below a 64% funded ratio threshold four years from now. Breaching this lower threshold funded ratio would be an important early signal of a significantly increased potential that CalSTRS would again return to its pre-2015 AB 1469 funding path, which was projected to diminish to a funding ratio of 0% by 2043.

Using these measures of reward and risk, an alternative efficient frontier can be created that contrasts with the M-V efficient frontier (see Exhibit 3).

The upper panel in Exhibit 3 is similar to the upper panels in Exhibits 1 and 2, but is framed in terms of long-term funding progress (reward) and potential near-term funding deterioration (risk). In contrast to Exhibits 1 and 2, CalSTRS' current allocation and LTP show up much farther to the right relative to the other "optimal" portfolios, indicating that there are other viable options versus existing policy. These relative tradeoffs are quantified further in the bottom table. The two far right-hand columns in the lower table show the policy mixes of CalSTRS' current allocation and LTP. Below the mixes are four additional rows showing the simulated long-term funding ratio, the probability of breaching 64% four years from now, the simulated long-term compound return, and the simulated volatilities of the two portfolios. The table shows that these two allocations are expected to achieve a long-term funding ratio of approximately 90% after 30 years while exhibiting approximately a 30% probability of breaching the lower 64% funding threshold four years from now. In contrast, Portfolios 13-20 on the funding/simulation efficient frontier produced higher simulated 30-year funding ratios while also exhibiting lower probabilities of breaching the lower threshold. Such figures indicate that there is potential to significantly improve the return/risk profile of CalSTRS' allocation policy.

Exhibit 3

Simulation-based/Funding-Oriented Efficient Frontier



| Portfolio | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | CA | LTP |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| Glbl Gr. | 22 | 23 | 26 | 29 | 29 | 31 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 41 | 43 | 46 | 47 | 50 | 51 | 52 | 58 | 51 |
| Priv. Gr. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 13 |
| Real Est. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 13 |
| Credit | 10 | 10 | 7 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 |
| Infl. Sens. | 10 | 10 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 6 | 5 | 2 | 1 | 0 | 1 | 6 |
| Prot./Liq. | 20 | 19 | 19 | 20 | 18 | 17 | 14 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 6 | 6 | 6 | 6 | 10 | 10 |
| RMS | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 1 | 0 |
| Cash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |

| | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|
| Median Funding | 75 | 76 | 78 | 80 | 80 | 81 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 93 | 94 | 97 | 97 | 98 | 99 | 99 | 90 | 91 |
| Prob. 64% Breach | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 30 | 29 |
| Compound Return | 6.8 | 6.8 | 6.9 | 7.0 | 7.1 | 7.1 | 7.2 | 7.3 | 7.3 | 7.3 | 7.4 | 7.4 | 7.4 | 7.5 | 7.5 | 7.6 | 7.6 | 7.6 | 7.7 | 7.7 | 7.4 | 7.5 |
| Standard Deviation | 7.7 | 7.9 | 8.2 | 8.5 | 8.6 | 8.7 | 9.2 | 9.3 | 9.5 | 9.7 | 9.9 | 10.0 | 10.2 | 10.5 | 10.9 | 11.4 | 11.5 | 12.0 | 12.2 | 12.3 | 14.0 | 13.6 |

The table below shows two alternative allocation policies that (i) simulated to a similar long-term funding ratio as the current LTP, but exhibited lower potential to breach the lower funding ratio level (Portfolio 13) or (ii) simulated a higher funding ratio at a commensurate (actually lower) level of funding risk (Portfolio 20).

Selected Simulation-Optimal Portfolios vs. CalSTRS LTP – including new RMS class

| Strategic Class | Portfolio 13 Similar Funding Outcome w/ Lower Funding Risk | Portfolio 20 Same Risk w/ Higher Return | Long- Term Policy (LTP) |
|--|---|--|----------------------------------|
| Global Growth | 39 | 52 | 51 |
| Credit | 4 | 4 | 6 |
| Inflation Sensitive | 10 | 0 | 6 |
| Liquidity/Protection | 9 | 6 | 11 |
| Risk Mitigating Strategies (RMS) | 12 | 12 | 0 |
| Private Growth | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 |
| | | | |
| Simulated Median 30-Year Funding Ratio | 91 | 99 | 91 |
| Probability of <64% Funding Ratio | 23 | 25 | 29 |
| Expected 30-Year Compound Return | 7.4 | 7.7 | 7.5 |
| Expected Annual SD | 10.2 | 12.3 | 13.6 |

Based on the table, the median funding ratio at the end of 30-years for the current LTP is 91%. Based on the simulated projections, the LTP also has a 29% probability of breaching the lower funding ratio threshold. The LTP is expected to produce a 7.5% compound return with double-digit annual volatility (SD of 13.6) in these returns.

The other two options reflect either (i) preserving the long-term funding ratio outcome of the LTP, but with lower near-term funding risk or (ii) accepting a similar level of near-term funding risk while producing a better long-term funding outcome. Portfolio 13 simulates to preserve the long-term funding ratio while reducing the short term risk. Pursuing this objective results in a compound return that is only 10bps lower than the LTP. The main benefit of this allocation is its significant decrease in the scenarios that are below 64% after 4-years. On an expected annual standard deviation basis Portfolio 13 is also roughly one-third less volatile than the current LTP. Lowering the volatility is captured with some dramatic shifts away from the LTP, materially decreasing Global Growth, significantly increasing Inflation Sensitive, and maintaining a maximum allocation to the new RMS class. In this respect, Portfolio 13 would be a dramatic departure from the current LTP.

At the other end of the spectrum, Portfolio 20 produces a better projected funding outcome than the current LTP. It does this largely by shifting assets out of Inflation Sensitive, Credit and Liquidity/Protection and into the new RMS class. Global Growth increases slightly. These moves cause the Portfolio to maintain its largely growth-risk bias, but utilize the expected downside protection of the RMS to smooth out the pattern of returns.

Exhibit 4 (next page) shows the simulation efficient frontier, LTP, and range of equivalent portfolio options to the LTP, but excluding the proposed RMS class. The representative portfolios in this case are: Portfolio 14, for preserving the long-term funding ratio outcome of the LTP, but with lower near-term risk, and Portfolio 20, for accepting a similar level of near-term risk while producing a better long-term funding outcome.

The allocations of these portfolios (isolated below) represent another range of options near the LTP that the IC should be most comfortable with, but do not exhibit an allocation to the RMS class.

Selected Simulation-Optimal Portfolios vs. CalSTRS LTP – excl. RMS class

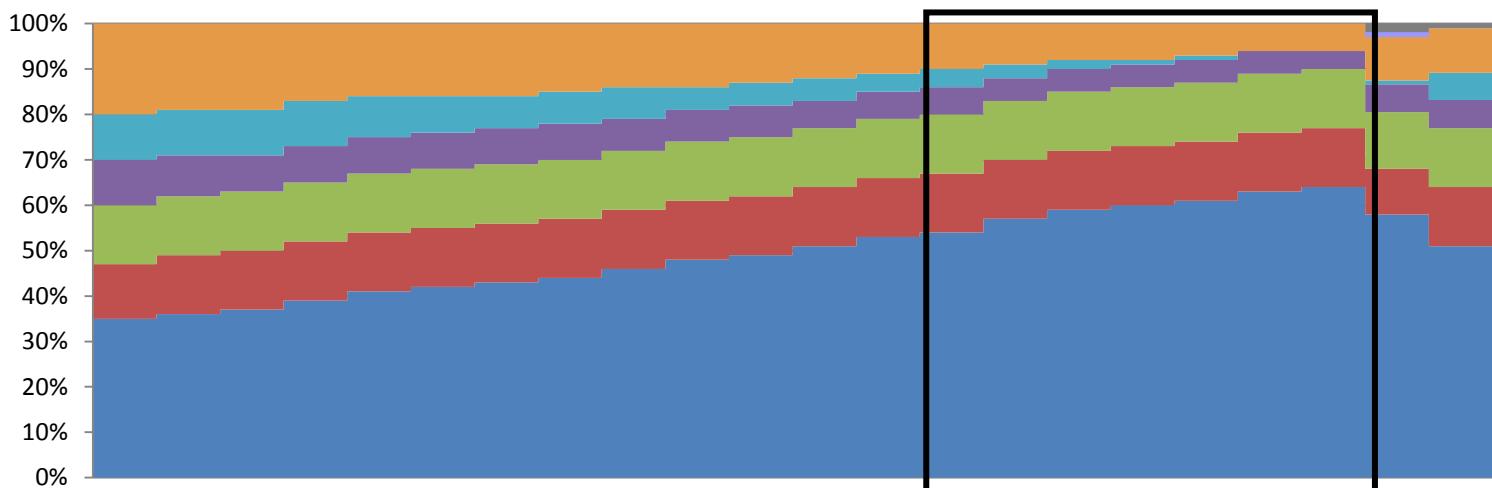
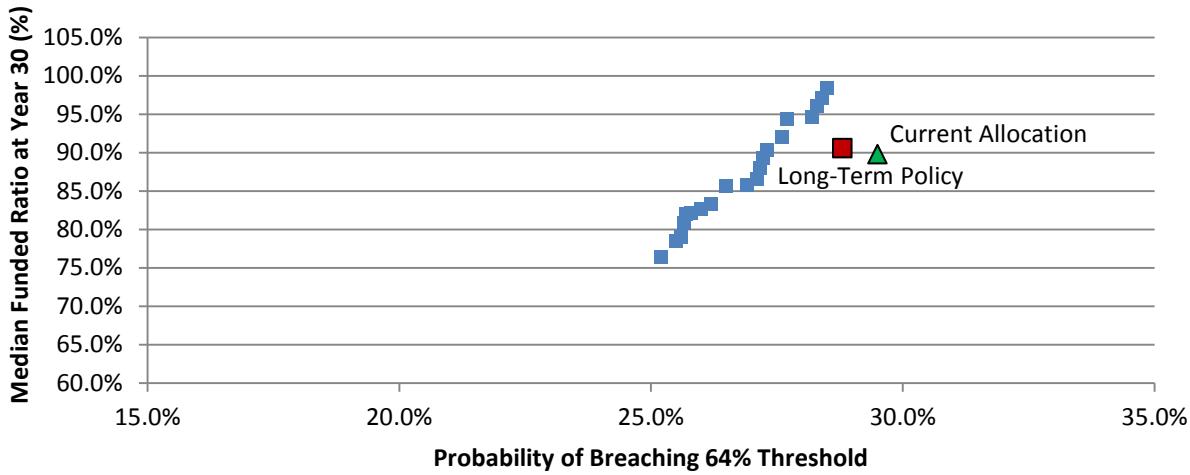
| Strategic Class | Portfolio 14 Similar Funding Outcome w/ Lower Funding Risk | Portfolio 20 Same Risk w/ Higher Return | Long- Term Policy (LTP) |
|--|---|--|----------------------------------|
| Global Growth | 54 | 64 | 51 |
| Credit | 6 | 4 | 6 |
| Inflation Sensitive | 4 | 0 | 6 |
| Liquidity/Protection | 10 | 6 | 11 |
| Risk Mitigating Strategies (RMS) | 0 | 0 | 0 |
| Private Growth | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 |
| | | | |
| Simulated Median 30-Year Funding Ratio | 90 | 98 | 91 |
| Probability of <64% Funding Ratio | 27 | 29 | 29 |
| Expected 30-Year Compound Return | 7.5 | 7.7 | 7.5 |
| Expected Annual SD | 13.4 | 15.1 | 13.6 |

Preliminary findings for potential optimal alternative portfolios that exclude the RMS:

- The allocation of Portfolio 14, above, is very similar to the current LTP, with some minor adjustments. Portfolio 14 also has less Inflation Sensitive and slightly less Liquidity/Protection. Offsetting these reductions is a 3% increase to Global Growth. These allocation shifts have a minimal impact on the expected 30-year compound return, simulated median funded ratio, and simulated downside risk outcomes.
- Portfolio 20 has a substantially higher allocation to Global Growth than the current LTP. Offsetting reductions in Credit, Inflation Sensitive, and Liquidity/Protection fund the Global Growth increase. Such shifts would likely further concentrate the portfolio toward more growth-risk. Given these shifts, Portfolio 20 produces a materially higher long-term funding outcome than the current LTP. However, notice that while the long-term simulated compound return rises, overall volatility also increases by over 10% (15.1 vs. 13.6).

Exhibit 4

Simulation-based/Funding-Oriented Efficient Frontier



| Portfolio | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | CA | LTP |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| Glbl Gr. | 35 | 36 | 37 | 39 | 41 | 42 | 43 | 44 | 46 | 48 | 49 | 51 | 53 | 54 | 57 | 59 | 60 | 61 | 63 | 64 | 58 | 51 |
| Priv. Gr. | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 13 |
| Real Est. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 13 |
| Credit | 10 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 6 | 6 |
| Infl. Sens. | 10 | 10 | 10 | 10 | 9 | 8 | 7 | 7 | 7 | 5 | 5 | 5 | 4 | 4 | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 6 |
| Prot./Liq. | 20 | 19 | 19 | 17 | 16 | 16 | 16 | 15 | 14 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 6 | 6 | 10 | 10 |
| RMS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cash | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |

| | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Median Funding | 76 | 79 | 79 | 81 | 82 | 82 | 83 | 83 | 86 | 86 | 87 | 88 | 89 | 90 | 92 | 94 | 95 | 96 | 97 | 98 | 90 | 91 |
| Prob. 64% Breach | 25 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 30 | 29 |
| Compound Return | 6.9 | 7.0 | 7.0 | 7.1 | 7.1 | 7.1 | 7.2 | 7.2 | 7.3 | 7.3 | 7.3 | 7.4 | 7.4 | 7.5 | 7.6 | 7.6 | 7.6 | 7.7 | 7.7 | 7.7 | 7.4 | 7.5 |
| Standard Deviation | 10.1 | 10.5 | 10.6 | 10.9 | 11.3 | 11.4 | 11.6 | 11.8 | 12.1 | 12.4 | 12.6 | 12.9 | 13.2 | 13.4 | 13.9 | 14.2 | 14.4 | 14.6 | 14.9 | 15.1 | 14.0 | 13.6 |

Comparison of Optimal Alternative Policies

In the prior section, PCA examined optimal alternative allocation policies utilizing two optimization methodologies: MVO and Simulation. Under each approach, PCA also analyzed candidate portfolios that allowed for inclusion of the Risk Mitigating Strategies (RMS) class as an allocation option and analyzed candidate portfolios that excluded RMS as a class option.

Detailed information on these eight portfolio options is displayed in Exhibit 5. For each mix, Exhibit 5 contains each portfolio's (i) strategic allocation mix, (ii) allocation levels to growth vs. stabilizing assets (including fixed income), (iii) allocation detail on public equity assets and emerging market assets, estimated fee costs associated with each option, and (iv) several forward-looking investment return and funding progress statistics. The portfolios are labeled A through I, with CalSTRS' policy portfolio set as Portfolio A. Portfolios B through I are ordered by the level of the expected funding ratio after 30 years (second row from the bottom). Portfolio B's expected 30-year funding ratio is simulated to be 88%, while Portfolio I's funding ratio after 30-years is expected to be 99%.

There are several themes among these various options:

- All optimal portfolios (whether using an MVO or simulation-based optimization approach) allocated the maximum to Private Growth and Real Estate.
- When allowed to do so, the optimization processes always allocated to the RMS class. In three of four cases, the RMS received its maximum allocation of 12%. In the fourth case (Portfolio H), it received a significant 7% of total assets.
- All portfolio options produced a return at or near the long-term assumed actuarial return of a compound annualized 7.5%.
- All portfolio options produced simulated near-term funding risk (bottom) that was no worse than CalSTRS' current LTP.

The portfolio options varied across several attributes:

- The allocation to growth-driven assets (Global Growth, Private Growth, and Real Estate) varied widely, based on the desired risk level. Growth-driven assets ranged from a low of 65% to a high of 90% of total assets.
- Short-term drawdown risks varied widely. For example, the largest simulated 2-year drawdown was (at the 10% probability level) was \$48.2 billion (Portfolio G), while the smallest simulated drawdown was \$25.1 billion (Portfolio D). Similarly, the highest simulated probability of falling through the critical 64% threshold was 29% (Current LTP and Portfolio G) and the lowest probability was 23% (Portfolios D and F).
- There was also wide dispersion on the level of the funding ratio in the 10% worst outcomes at the end of 30 years. The lowest worst 10% 30-year funding ratio was only 3% (Portfolio G) while the highest worst 10% 30-year funding ratio was 29% (Portfolio D).

Exhibit 5 – Summary Statistics – CalSTRS LTP & Candidate Endpoint Policy Options

| Portfolio | A | B | C | D | E |
|-------------------------------------|-------------------------|----------------------|-----------------------|-----------------------|----------------------|
| Strategic Class (% of Total) | Long Term Policy Target | MVO x RMS LRisk/SRew | Sim. x RMS LRisk/SRew | Sim. w RMS LRisk/SRew | MVO x RMS SRisk/HRew |
| Global Growth | 51 | 48 | 54 | 39 | 55 |
| Private Growth | 13 | 13 | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 | 13 | 13 |
| Credit | 6 | 4 | 6 | 4 | 4 |
| Inflation Sensitive | 6 | 10 | 4 | 10 | 9 |
| Protection / Liquidity | 10 | 12 | 10 | 9 | 6 |
| Risk Mitigating Strategies | 0 | 0 | 0 | 12 | 0 |
| Cash | 1 | 0 | 0 | 0 | 0 |
| Total Portfolio | 100 | 100 | 100 | 100 | 100 |

Growth vs. Stabilizing Allocation (% of Tot. Portfolio)

| | | | | | |
|-----------------|----|----|----|----|----|
| Growth-oriented | 77 | 74 | 80 | 65 | 81 |
| Stabilizing | 23 | 26 | 20 | 35 | 19 |
| Fixed Income | 17 | 16 | 16 | 17 | 10 |
| Other | 6 | 10 | 4 | 18 | 9 |

U.S. vs. Non-U.S. Eq. Allocation (% of Tot. Portfolio)

| | | | | | |
|------------------|----|----|----|----|----|
| U.S. Equity | 34 | 26 | 29 | 21 | 30 |
| Non-U.S. Equity | 17 | 22 | 25 | 18 | 25 |
| Developed | 14 | 18 | 21 | 15 | 20 |
| Emerging Markets | 3 | 4 | 4 | 3 | 5 |

Emerging Markets Allocations (% of Tot. Portfolio)

| | | | | | |
|---------------------------------|---|---|---|---|---|
| Emerging Mkts. Equity | 3 | 4 | 4 | 3 | 5 |
| Emerging Mkts. Debt | 0 | 0 | 0 | 0 | 0 |
| Total Emerging Markets Exposure | 3 | 4 | 4 | 3 | 5 |

Estimated Management Fees

| | | | | | |
|---|------|------|------|------|------|
| Estimated Fees Current Portfolio (% of Total) | 0.43 | 0.46 | 0.43 | 0.51 | 0.46 |
| Estimated Fees (in \$M) | 821 | 884 | 818 | 979 | 880 |

Financial Projections

| Mean-Variance Model | | | | | |
|--|--------------|--------------|--------------|--------------|--------------|
| Expected Annlzd. Compound Return – 30 Yrs. (%) | 7.6 | 7.5 | 7.6 | 7.4 | 7.7 |
| Expected SD of 1 Yr Returns (%) | 13.7 | 12.6 | 13.5 | 11.3 | 13.7 |
| Expected SD of 30 Yr. Compound Return (%) | 2.5 | 2.3 | 2.5 | 2.1 | 2.5 |
| Expected Value of 2-Yr Loss at 10% Prob. (%/\$B) | -16.4/(31.4) | -14.5/(27.7) | -16.0/(30.6) | -11.8/(22.6) | -16.1/(30.8) |
| Expected 10% 30-Year Funded Ratio Threshold (%) | 19.8 | 22.0 | 21.0 | 26.4 | 23.0 |
| Simulation Model (1000 Scenarios) | | | | | |
| Med. of 30-Year Arith. Avg. Returns (%) | 8.4 | 8.1 | 8.4 | 8.0 | 8.5 |
| Med. of 30-Year Compound. Avg. Returns (%) | 7.5 | 7.4 | 7.5 | 7.4 | 7.6 |
| Avg. SD of Scenario SDs of 30 Annual Returns (%) | 13.6 | 12.3 | 13.4 | 10.2 | 13.6 |
| SD 30-Year Compound Avg. Returns (%) | 2.5 | 2.3 | 2.5 | 1.9 | 2.5 |
| Avg. %/\$ Loss of Worst 10% 2-Year Scenarios (%/\$B) | -22.0/(41.9) | -19.2/(36.7) | -21.8/(41.6) | -13.1/(25.1) | -21.9/(41.8) |
| Worst 10% 30-Year Funded Ratios Threshold | 9 | 15 | 9 | 29 | 11 |
| Med. 30-year Funded Ratio (Reward) | 91 | 88 | 90 | 91 | 95 |
| Prob. of 64% Threshold Breach after 4 Yrs. (Risk) | 29 | 26 | 27 | 23 | 27 |

Exhibit 5 – Summary Statistics – CalSTRS LTP & Candidate Endpoint Policy Options (cont.)

| Portfolio | A | F | G | H | I |
|------------------------------|-------------------------|----------------------|----------------------|----------------------|----------------------|
| Strategic Class (% of Total) | Long Term Policy Target | MVO w RMS LRisk/SRew | Sim x RMS HRew/SRisk | MVO w RMS HRew/SRisk | Sim w RMS HRew/SRisk |
| Global Growth | 51 | 42 | 64 | 57 | 52 |
| Private Growth | 13 | 13 | 13 | 13 | 13 |
| Real Estate | 13 | 13 | 13 | 13 | 13 |
| Credit | 6 | 4 | 4 | 4 | 4 |
| Inflation Sensitive | 6 | 10 | 0 | 0 | 0 |
| Protection / Liquidity | 10 | 6 | 6 | 6 | 6 |
| Risk Mitigating Strategies | 0 | 12 | 0 | 7 | 12 |
| Cash | 1 | 0 | 0 | 0 | 0 |
| Total Portfolio | 100 | 100 | 100 | 100 | 100 |

Growth vs. Stabilizing Allocation (% of Tot. Portfolio)

| | | | | | |
|-----------------|----|----|----|----|----|
| Growth-oriented | 77 | 68 | 90 | 83 | 78 |
| Stabilizing | 23 | 32 | 10 | 17 | 22 |
| Fixed Income | 17 | 14 | 10 | 12 | 14 |
| Other | 6 | 18 | 0 | 4 | 8 |

U.S. vs. Non-U.S. Eq. Allocation (% of Tot. Portfolio)

| | | | | | |
|------------------|----|----|----|----|----|
| U.S. Equity | 34 | 23 | 34 | 31 | 28 |
| Non-U.S. Equity | 17 | 19 | 29 | 26 | 24 |
| Developed | 14 | 16 | 24 | 21 | 20 |
| Emerging Markets | 3 | 3 | 5 | 5 | 4 |

Emerging Markets Allocations (% of Tot. Portfolio)

| | | | | | |
|---------------------------------|---|---|---|---|---|
| Emerging Mkts. Equity | 3 | 3 | 5 | 5 | 4 |
| Emerging Mkts. Debt | 0 | 0 | 0 | 0 | 0 |
| Total Emerging Markets Exposure | 3 | 3 | 5 | 5 | 4 |

Estimated Management Fees

| | | | | | |
|---|------|------|------|------|------|
| Estimated Fees Current Portfolio (% of Total) | 0.43 | 0.51 | 0.41 | 0.43 | 0.46 |
| Estimated Fees (in \$M) | 821 | 982 | 779 | 830 | 871 |

Financial Projections

| Mean-Variance Model | | | | | |
|--|--------------|--------------|--------------|--------------|--------------|
| Expected Annlzd. Compound Return – 30 Yrs. (%) | 7.6 | 7.5 | 7.9 | 7.8 | 7.7 |
| Expected SD of 1 Yr Returns (%) | 13.7 | 11.8 | 14.9 | 13.9 | 13.1 |
| Expected SD of 30 Yr. Compound Return (%) | 2.5 | 2.2 | 2.7 | 2.5 | 2.4 |
| Expected Value of 2-Yr Loss at 10% Prob. (%/\$B) | -16.4/(31.4) | -12.6/(24.0) | -18.3/(34.9) | -16.4/(31.3) | -14.9/(28.4) |
| Expected 10% 30-Year Funded Ratio Threshold (%) | 19.8 | 27.1 | 21.5 | 23.8 | 25.5 |
| Simulation Model (1000 Scenarios) | | | | | |
| Med. of 30-Year Arith. Avg. Returns (%) | 8.4 | 8.1 | 8.8 | 8.6 | 8.4 |
| Med. of 30-Year Compound. Avg. Returns (%) | 7.5 | 7.6 | 7.7 | 7.7 | 7.7 |
| Avg. SD of Scenario SDs of 30 Annual Returns (%) | 13.6 | 10.7 | 15.1 | 13.5 | 12.3 |
| SD 30-Year Compound Avg. Returns (%) | 2.5 | 2.0 | 2.8 | 2.5 | 2.3 |
| Avg. %/\$ Loss of Worst 10% 2-Year Scenarios (%/\$B) | -22.0/(41.9) | -14.3/(27.4) | -25.2/(48.2) | -21.0/(40.0) | -17.7/(33.7) |
| Worst 10% 30-Year Funded Ratios Threshold | 9 | 28 | 3 | 15 | 21 |
| Med. 30-year Funded Ratio (Reward) | 91 | 95 | 98 | 99 | 99 |
| Prob. of 64% Threshold Breach after 4 Yrs. (Risk) | 29 | 23 | 29 | 27 | 25 |

Narrowing this spectrum of options down to a shorter list of viable policy choices revolves around two issues: (i) the position of the IC with regard to mitigating overall plan risk and (ii) the implementation of the new RMS class.

In presenting options below, PCA's position is that CalSTRS should consider an allocation policy that mitigates the overall plan's funding risk, either materially or marginally, while maintaining or improving CalSTRS' progress along its longer-term path to enhancing its funding position (as measured by the funding ratio). Given this stance, several of the above options become more attractive than others.

From a risk mitigation standpoint, Portfolio F produced simulated results that improve upon the current LTP's long-term funding prospects (long-term simulated funding ratio of 95% versus 91% for the LTP) while also minimizing near-term downside risks. Portfolio F exhibits the lowest probability of breaching the 64% funding ratio over the next four years. In addition, its expected 10%-probability 2-year drawdown is materially lower than the current LTP (\$27.4B vs. \$41.9B).

The key caveat to Portfolio F is its 12% long-term allocation to the RMS class, which is a new class. While the RMS should provide material downside enhancement to the CalSTRS investment portfolio, its expected implementation costs are relatively high compared to the traditional classes that will fund the class, but lower than the private markets classes. As a result, despite the fact that all the capital market assumptions are net-of-fee and that Portfolio F provides competitive risk-adjusted returns, Portfolio F is the most costly option to implement, pushing expected management costs up by almost 20% (from 43bp per year to 51bp) as a result of how the capital would be sourced. If expense minimization is a critical factor then other solutions (restructuring the RMS or sourcing from the private classes) are available.

If the IC chose to exclude RMS from consideration, then PCA believes Portfolio B is likely the most attractive choice from a risk mitigation standpoint. It has the lowest simulated drawdown of the non-RMS optimal portfolios as well as the lowest simulated probability of breaching the lower-threshold funding ratio level. Compared to other options not utilizing the RMS, Portfolio B reduces expected downside funding risk the most and improves upon the current LTP. Its long-term expected compound return comes close to matching long-term policy. Portfolio B also marginally reduces growth-oriented assets and actually increases the overall allocation to fixed income assets. One drawback of Portfolio B is that it is expected to produce a long-term funding ratio that is slightly less than what is expected under the current LTP.

From a funding improvement standpoint, Portfolio I produced simulated results that significantly improve upon the current LTP's long-term funding prospects (long-term simulated 30-year funding ratio of 99% versus 91% for the LTP) while also minimizing near-term downside risks. Portfolio I exhibits a significantly lower probability of breaching the 64% funding ratio over the next four years. In addition, its simulated (expected) long-term annualized compound return rises to 7.7% versus 7.5% for the current LTP.

A key differentiator of Portfolio I is its 12% long-term allocation to the RMS class, which is a new class. In addition, Portfolio I eliminates the allocation to Inflation Sensitive.

If the IC elects to exclude RMS from consideration, then PCA believes Portfolio G is likely the most attractive choice from a funding improvement standpoint. It has the highest simulated median 30-year funding ratio as well as one of the highest compounded annual returns, a simulated 7.7% versus the current LTP's 7.5%. Portfolio G also exhibits downside funding risk probability that is equivalent to the current LTP. Finally, Portfolio G is estimated to be less costly than the current LTP.

Of concern with Portfolio G is its dramatic increase in growth-oriented assets. Growth assets increase to approximately 90% of the Total Portfolio with only 10% allocated to fixed income-type assets. In addition, Portfolio G exhibits the highest drawdown risk of any of the alternative policy choices: there is a 10% chance that this portfolio will decline by over \$48 billion over a typical 2-year bear market (versus \$41 billion for the current LTP).

Discussion of Risk Mitigating Strategies (RMS) Class

Since the February 2015 meeting, PCA has provided detailed rationale for including the RMS in the AL Study process (see Appendix). As the above discussion on portfolio options highlight, an RMS-type class may provide significant downside benefits to a defined benefit plan such as CalSTRS. In summary, the RMS class is a class that offsets CalSTRS' larger growth-risk allocations. During periods when growth-risk assets depreciate rapidly, the RMS is expected to appreciate materially and by a more significant amount than standard fixed income portfolios.

As might be expected, the modeling process provided additional evidence of the potential contribution of the RMS class. In Portfolio F (with a 12% allocation the RMS), severe drawdown risk is materially reduced, the probability of re-entering a funding deterioration trend declines significantly, and the long-term funding prospects for the overall plan improve.

In this section, we provide additional analysis on potential structures for the RMS. As highlighted elsewhere in this report and shown in the Appendix, the modeled structure of RMS class consists of four components (see table below).

Modeled Structure of RMS Class

| Component Asset Class | Allocation - % |
|------------------------------|-----------------------|
| Long U.S. Treasuries | 35 |
| Systematic Trend Following | 40 |
| Alternative Risk Premia | 10 |
| Global Macro | 15 |
| Total | 100 |

Each of these components is included in the RMS because of its capability to diversify against the downsides of growth risk and because these components are

complementary to one another. As shown elsewhere in this report, the cost of implementing the RMS is reasonable, estimated to be between 50bp – 60bp per year, lower than what CalSTRS is expected to pay for implementing its Real Estate, Inflation Sensitive, and Private Growth classes. In addition, compared to these classes and CalSTRS' other classes, the RMS can be scaled to size relatively quickly: all the component classes can easily digest incremental investments of several billion dollars.

As discussed in the Appendix, the main purpose of this type of strategic class is to provide asset appreciation during periods of dramatic market dislocation/decline. In the overwhelming number of these types of environments, when the crisis occurs, investors flee to the world's safest investments, U.S. Dollars and U.S. Treasuries. In particular, Long-duration U.S. Treasury Bonds (e.g. with maturities exceeding 20 years) consistently produce double-digit returns during crisis periods (see table below).

**Investment Performance of Selected Classes – Last 2 Equity Bear Markets
(cumulative % change)**

| Component Asset Class | 6/2000 – 9/2002 | 10/2007 – 12/2008 |
|--------------------------|-----------------|-------------------|
| U.S. Equities Index | -41 | -39 |
| Diversified Bond Index | +24 | +5 |
| Long U.S. Treasury Index | +34 | +43 |

Over the last two market crises, Long U.S. Treasuries have consistently provided nearly a complete offset to equity market declines. Core bond portfolios, however, have an inconsistent track record at providing an adequate appreciation during a time of crisis.

Despite providing very strong results during crisis periods, Long U.S. Treasuries still exhibit significant risks. Long Treasuries are very susceptible to interest rate increases, particularly if they are unexpected. A Long U.S. Treasury Bond is 2X to 3X more sensitive to interest rate changes than the typical core bond portfolio. However, U.S. Treasuries exhibit no default risk. This means an investor can recoup any interim capital depreciation simply by holding the U.S. Treasury bond until it matures. This claim cannot be made with other types of bonds, particularly during a crisis period when bond defaults across other bond types can jump dramatically.

Given the above findings, Long U.S. Treasuries should hold a core position within the RMS class. The analysis below shows various structures for the RMS, moving incrementally from the RMS being 100% U.S. Long Treasuries, to the multi-component structure utilized in the AL Study. Portfolio F is utilized as the reference portfolio.

The analysis indicates that much of the benefits of the RMS derive simply from the inclusion of Long U.S. Treasuries (see RMS Framework 1). In comparison to utilizing the LTP, long-term funding progress is preserved, downside risk is reduced, and the probability of drifting into a deteriorating funding trend declines materially (from 29% probability to 25%). Note that the cost of implementing a 100% Long Treasury RMS is very low, estimated to be approximately \$5 million per year for a ~\$20 billion Long U.S. Treasury portfolio.

However, as the projections also highlight, a Long U.S. Treasury portfolio is also very risky, with an estimated annual volatility over 20% (very high!). To mitigate this level of concentration, three other complementary strategies were considered. Of these strategies, Systematic Trend Following (STF) (implemented through CTAs) proved to be highly attractive. Since STF attempts to capture trends evident across several variations of well-known risk premiums, one might consider STF to be a "systematic" investment approach. Such systematic engineering, however, is not meant to add value, but to capture key movements in various markets as they occur. Typically, such systematic approaches utilize rules-based algorithms to capture the appropriate risk exposures. Given that these strategies operate in highly-liquid markets, once the rules are in place, implementation is relatively automatic and straightforward.

Portfolio F – utilizing alternative RMS Structures

| Portfolio | F |
|-------------------------------------|-------|
| <i>Strategic Class (% of Total)</i> | w RMS |
| Global Growth | 42 |
| Private Growth | 13 |
| Real Estate | 13 |
| Credit | 4 |
| Inflation Sensitive | 10 |
| Protection / Liquidity | 6 |
| Risk Mitigating Strategies | 12 |
| Cash | 0 |
| Total Portfolio | 100 |

RMS Component Structure (% of RMS Class)

In AL Study

| RMS Framework | 1 | 2 | 3 | 4 |
|---------------------------------------|-----|----|----|----|
| U.S. Long Treasuries | 100 | 50 | 33 | 35 |
| Systematic Trend Following Strategies | 0 | 50 | 33 | 40 |
| Alternative Risk Premia | 0 | 0 | 33 | 10 |
| Global Macro Strategies | 0 | 0 | 0 | 15 |

Estimated Management Fees of RMS Class

| | | | | |
|------------------------------------|-----|-----|------|------|
| Estimated Fees of RMS (% of Total) | .02 | .26 | 0.34 | 0.53 |
| Estimated Fees (in \$M) | 5 | 60 | 78 | 123 |

Estimated Management Fees of Total Portfolio

| | | | | |
|---|------|------|------|------|
| Estimated Fees Current Portfolio (% of Total) | 0.45 | 0.48 | 0.49 | 0.51 |
| Estimated Fees (in \$M) | 864 | 920 | 938 | 982 |

Financial Projections

| <i>RMS Class – Isolated, Mean-Variance Statistics</i> | | | | |
|---|--------------|--------------|--------------|--------------|
| Expected Annlzd. Compound Return – 30 Yrs. (%) | 2.8 | 4.7 | 5.3 | 5.3 |
| Expected SD of 1 Yr Returns (%) | 20.8 | 15.5 | 11.9 | 12.0 |
| <i>Simulation Model of Total Portfolio (1000 Scenarios)</i> | | | | |
| Med. of 30-Year Arith. Avg. Returns (%) | 8.1 | 8.1 | 8.1 | 8.1 |
| Med. of 30-Year Compound. Avg. Returns (%) | 7.4 | 7.6 | 7.5 | 7.6 |
| Avg. SD of Scenario SDs of 30 Annual Returns (%) | 11.1 | 10.6 | 11.0 | 10.7 |
| SD 30-Year Compound Avg. Returns (%) | 2.0 | 1.9 | 2.0 | 2.0 |
| Avg. %/\$ Loss of Worst 10% 2-Year Scenarios (%/\$B) | -15.9/(30.3) | -13.6/[26.0] | -15.1/[28.9] | -14.3/[27.4] |
| Worst 10% 30-Year Funded Ratios Threshold | 22 | 30 | 25 | 28 |
| Med. 30-year Funded Ratio (Reward) | 92 | 95 | 95 | 95 |
| Prob. of 64% Threshold Breach after 4 Yrs. (Risk) | 25 | 23 | 23 | 23 |

The table highlights that inclusion of STF (see RMS Framework column 2) alongside Long U.S. Treasuries contributes significant marginal improvement to an RMS class, particularly at the overall portfolio level (see Simulation section at the bottom of the table). Virtually all financial projections metrics improve: long-term compound return, downside volatilities, 30-year estimated funded ratio, etc. Also note that the annual volatility of the RMS class itself drops materially (from 20.8 to 15.5).

The other two RMS structures introduce Alternative Risk Premia (a similar systematic investment strategy) and Global Macro (an active hedge fund strategy) in order to further diversify the class and lower its volatility to a more tolerable level. As the data indicates, high level Total Portfolio diversification benefits do not change dramatically from the earlier 50% U.S. Long Treasury/50% STF structure. However, these strategies allow the RMS to produce more consistent results over time, particularly during periods when U.S. Treasuries are not performing well. In this respect, these latter two strategies are complements to the first two components, delivering more consistent (less episodic) performance outcomes in non-crisis periods. As a result, under the full structure, the RMS class should produce more tolerable interim returns between crises.

As more components are added, the costs of RMS implementation also rise. Implementing a Long U.S. Treasury portfolio is very low-cost. Introducing STF into the structure causes the implementation costs of the RMS to rise dramatically (from \$5 million/year to approximately \$60 million, assuming a full 12% allocation at the Total Portfolio level). If CalSTRS were to implement the fully-diversified RMS structure, costs would double over the two-component structure (to approximately \$120 million, assuming a full 12% allocation).

Any one of the above four RMS structures are worthy of consideration for inclusion into CalSTRS' strategic structure. If the IC believes downside protection/performance is a critical concern one of these structures should likely be selected. If a decision is made to implement a specific version of the RMS, regardless of the structure PCA recommends that CalSTRS take a phased approach to funding the class over a period of three years, or less. While each of these components is readily scalable, it is likely of value to ramp up experience with the RMS class in a deliberate, prudent, and careful manner.

Appendix

Assigned Structures of Broad Strategic Classes Recommended by PCA

| Strategic Class | Component | within-class Allocation % | Key Role of Strategic Class and Its Underlying Components |
|-----------------------------------|---------------------------------------|----------------------------------|--|
| <i>Global Growth</i> | US Equity | 37.5% | Provide long-term growth primarily through capital appreciation |
| | NonUS Equity | 37.5% | |
| | Sub Total | 75.0% | |
| | Fundamental Low Volatility Strategies | 8.0% | |
| | Non-market-cap Indexing Strategies | 8.0% | |
| | Option-writing strategies | 9.0% | |
| | Sub Total | 25.0% | |
| | Total | 100.0% | |
| | | | |
| | | | |
| <i>Credit</i> | US Credit | 54.0% | Provide income |
| | NonUS Credit | 12.0% | |
| | Sub Total | 66.0% | |
| | US High Yield | 17.0% | |
| | NonUS High Yield | 5.0% | |
| | Bank Loans | 7.0% | |
| | Emerging Market Debt | 5.0% | |
| | Sub Total | 34.0% | |
| | Total | 100.0% | |
| | | | |
| <i>Inflation Sensitive</i> | TIPS | 30.0% | Maintain purchasing power, provide stability |
| | Timber | 10.0% | |
| | Infrastructure | 30.0% | |
| | Agriculture | 10.0% | |
| | Commodities | 15.0% | |
| | Bank Loans | 5.0% | |
| | Total | 100% | |
| <i>Liquidity/Protection</i> | Interest Rates | 53.0% | Protect principal, provide accessible liquidity |
| | Securitized | 47.0% | |
| | Total | 100% | |
| | | | |
| <i>Risk Mitigation Strategies</i> | Treasury Duration (Long Duration) | 35.0% | Provide appreciation during market dislocations |
| | Trend Following Strategies | 40.0% | |
| | Alternative Premia Strategies | 10.0% | |
| | Global Macro | 5.0% | |
| | Total | 100% | |
| | | | |
| <i>Private Growth</i> | Private Equity | 100.0% | Provide long-term appreciation |
| <i>Real Estate</i> | Real Estate (Core & Non Core) | 100.0% | Provide long-term income and appreciation |

DISCUSSION OF RMS CLASS – FROM FEBRUARY 2015 IC MEETING

Potential New Strategic Class: Crisis Risk Offset, Description & Rationale

As indicated previously, in order for a strategic class to stand on its own, we believe it must have a “purpose-driven” functional role and/or risk profile that is distinct from other classes. Based on the dimensions described earlier (growth vs. stability, private vs. public, and income vs. appreciation), a new strategic class should exhibit a high level of uniqueness, both in terms of historical, as well as expected, outcomes.

In order for a strategic class to be valuable, it must impact the greater CalSTRS portfolio in a meaningful way. It has been established that over 80% of the portfolio’s assets have significant exposures to economic growth risk. Therefore, in order to have a real impact, a new class should be diversifying to growth risk, meaningful (i.e., scalable at CalSTRS’ scale and with an offsetting risk contribution commensurate with that of CalSTRS’ growth-oriented classes), and available at reasonable cost. In fact, if the modeling process quantifies the benefits of such a class, it will likely be at an allocation that is of significant size. Therefore, implementation of this class at a material level will likely be critical to its success.

With these requirements specified, the purpose-driven Crisis Risk Offset Class (CRO) is designed specifically to offset declines in strategic classes having significant growth risk exposure (i.e., most of CalSTRS’ existing portfolio), in multiple economic/market scenarios where growth-exposed assets will likely decline precipitously.

Therefore, our research focused on the question “What is diversifying to growth risk?” What assets rise when assets with exposure to growth risk decline? The asset with the purest exposure to growth risk is public equity. Fortunately, the return data on public equity is extremely good, so testing the diversification potential of various candidate assets and strategies was straightforward. Also, since we were careful to define the required attributes of the class, many potential strategies and assets were excluded from consideration. In fact, we further limited the universe under consideration to highly liquid strategies, with daily pricing, that operate in the deepest, most liquid markets in the world: namely treasury cash and futures markets, exchange-traded markets, and currency/commodities markets. After defining our purpose and limiting the potential strategies under consideration, three potential components of a CRO class met each of our specifications:

U.S. Treasury Duration - Investments in long-duration Treasury portfolios tend to appreciate when there is a flight-to-quality during an economic/market crisis. This is due to their U.S. dollar base and their interest rate duration. Considered to be a default-risk-free asset, pricing of Treasuries is continuous and certain, and backed by deep and liquid futures markets. Exposure to U.S. Treasury duration provides an immediate offset in a crisis, mitigating “gap” risk inherent in more economically-dependent strategies. While the annual returns to Treasuries might not be positive over the full length of an equity bear market period (particularly in rising inflation environments), Treasuries do tend to appreciate during the first months of a growth/equity market shock.

Systematic Trend Following Strategies - Trend following strategies involve investing in markets that have been rising and shorting markets that have been falling, betting that those trends continue. The position taken in each type of trending market is determined by assessing the past return in that

market over the relevant look-back horizon. Therefore, the strategy can benefit in rising or falling markets, as long as the rise or fall in the market is not immediate (e.g., 10/19/1987 -20% in a single day, 9/11/2001 -14% for the week, 10/13/2008 announcement of \$700 billion bank bailout plan +11% single day). In other words, trend following strategies typically exploit the longer-run fallouts associated with market crises.

Systematic Alternative Premia Strategies – Alternative premia are compensated risk premia that are not growth risk exposed. These are alternative premia (alternative to economic growth risk), because the risk exposure sought is not growth risk exposure. Strategies are constructed to be “growth neutralized” in liquid markets, isolating on a risk factor that is expected to be compensated. Examples of factors that have historically exhibited non-growth risk compensation include value, momentum, carry and low volatility. For example, the State of Oregon is currently implementing “diversifying premia” strategies with a target of \$1.7 billion. In addition, AQR, a major institutional manager is implementing over \$25 billion of alternative premia strategies for various institutional clients.

The two “systematic” strategies described above might be viewed by some as active strategies since they are not static, buy-and-hold strategies seeking to replicate a cash market benchmark. However, these strategies are not active in the sense that their portfolio exposures are determined mathematically, absent of human judgment.

As highlighted above, all three components utilize investment markets that are highly liquid. Therefore, they should be relatively straightforward to implement in a timely manner. For example, CalSTRS already has the infrastructure in place to manage the US Treasuries Duration component internally. The other two components require external management. The Innovation team has actually funded approximately \$1 billion across these two approaches. Given these factors, PCA believes CalSTRS could establish a material initial weighting in this class relatively quickly, with a phase-in to full-scale occurring over approximately 18-30 months.

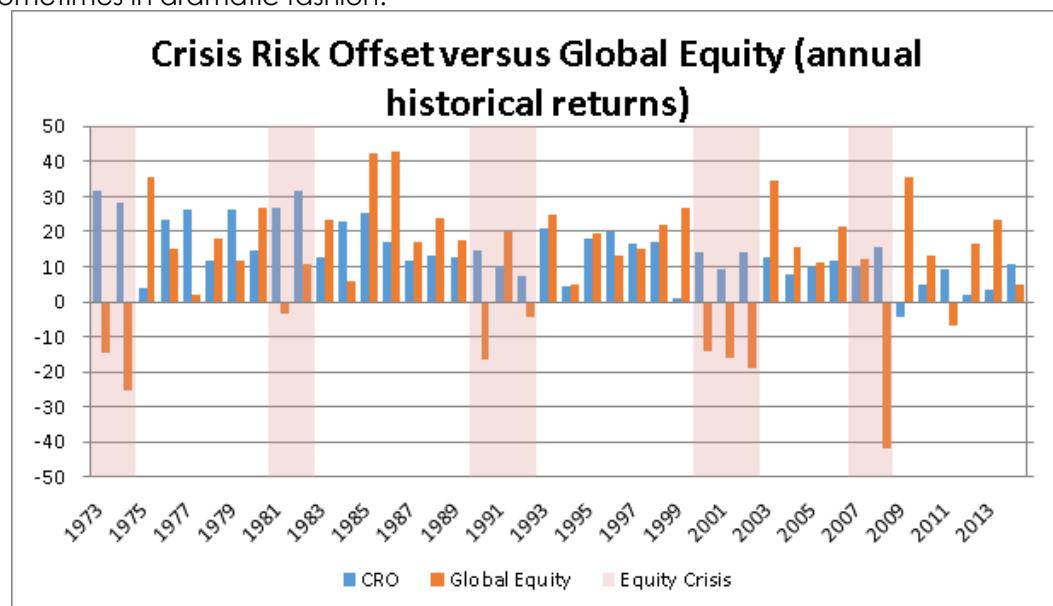
Combined, a portfolio of the three aforementioned strategies (weighted 30% Treasury duration, 40% trend following strategies, and 30% alternative premia strategies) is better than any single strategy in isolation:

Summary of Diversification Potential of CRO Strategic Class

| CRO Strategy | Risk Exposures | Diversifies Growth? | Liquid? Scalable? | Correlation to Global Equity | # of calendar years positive when equity < 0. 1973 - 2014 |
|---|----------------------------|---------------------|-------------------|------------------------------|---|
| U.S. Treasury Duration ⁱ | Rates | Yes | Yes | -0.09 | 6 of 10 |
| Trend Following Strategies ⁱⁱ | Time vary, directional | Yes | Yes | -0.50 | 9 of 10 |
| Alternative Premia ⁱⁱⁱ | Alt Premia, market neutral | Yes | Yes | +0.25 | 7 of 10 |
| Portfolio of CRO Strategies ^{iv} | Weighted 30%, 40%, 30% | Yes | Yes | -0.25 | 10 of 10 |

Additional descriptions of each sub-strategy and academic documentation, is presented in the end notes, as well as a discussion of portfolio weighting. Each of these components has a low or negative long-term correlation to public growth assets (i.e., equities), but more importantly, the conditional returns of the CRO class as a whole to global equities is positive when global equities suffer declines. These conditional returns are extremely valuable (providing offset through rapid increases in value) during equity/growth risk crises.

Historically, a very basic hypothetical class structure (based on actual historical data, and the weighing scheme previously disclosed), behaved as the blue bars behaved below, relative to global equities (orange bars). Historically, each year in which equity markets had a negative annual return, the CRO provided positive offset, sometimes in dramatic fashion.



During difficult times for public equity markets the CRO class, as modeled, would have provided significant, positive returns historically. Though past historical results are no guarantee of future returns, we believe that such a class is implementable and would provide similar return behavior on a forward looking basis. We believe this class is worth considering and should be incorporated into the modeling phase of the 2015 AL Study.

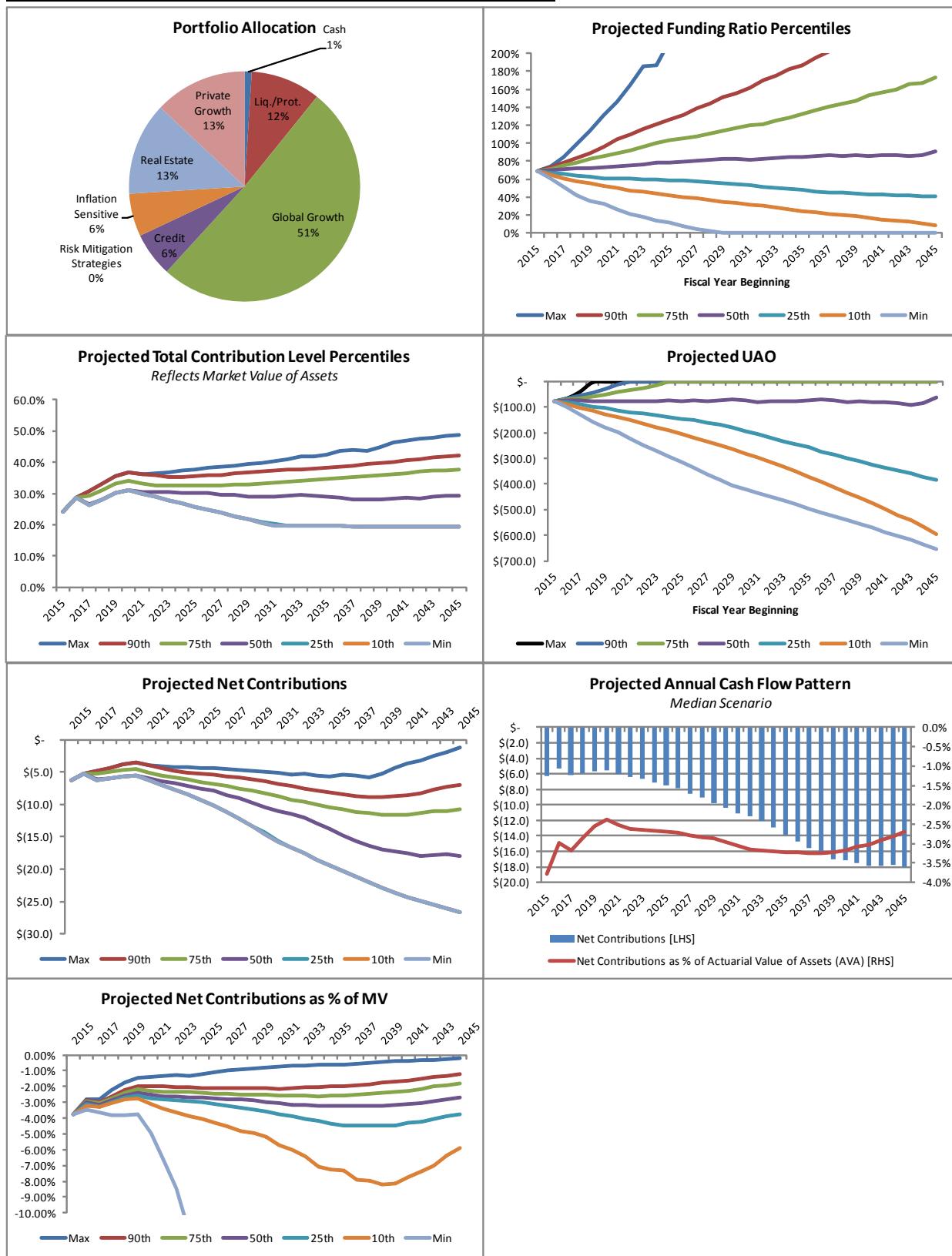
CalSTRS A/L Study Summary Statistics: Long-Term Policy Portfolio

| Strategic Class Percentages | Current | LTP | Diff. | Strategic Class Dollar Amounts | Current | LTP | Diff. |
|-----------------------------------|---------------|---------------|--------------|-----------------------------------|--------------------|--------------------|--------------------|
| Cash | 1.9% | 1.0% | -0.9% | Cash | \$3,564.5 | \$1,908.8 | -\$1,655.7 |
| Liquidity/Protection | 9.8% | 9.8% | 0.0% | Liquidity/Protection | \$18,610.8 | \$18,705.9 | \$95.2 |
| Interest Rates | 5.3% | 5.3% | 0.0% | Interest Rates | \$10,114.2 | \$10,165.9 | \$51.7 |
| Securitized | 4.5% | 4.5% | 0.0% | Securitized | \$8,496.5 | \$8,540.0 | \$43.4 |
| Global Growth | 57.9% | 51.0% | -6.9% | Global Growth | \$110,612.1 | \$97,347.2 | -\$13,264.9 |
| US Equity | 38.0% | 33.5% | -4.6% | US Equity | \$72,557.4 | \$63,856.1 | -\$8,701.3 |
| Non-US Equity | 19.5% | 17.2% | -2.3% | Non-US Equity | \$37,282.9 | \$32,811.8 | -\$4,471.1 |
| Developed Non-US Equity | 16.4% | 14.4% | -2.0% | Developed Non-US Equity | \$31,308.5 | \$27,553.9 | -\$3,754.6 |
| Emerging Markets Equity | 3.1% | 2.8% | -0.4% | Emerging Markets Equity | \$5,974.4 | \$5,257.9 | -\$716.5 |
| Fundamental Low Vol | 0.3% | 0.3% | 0.0% | Fundamental Low Vol | \$564.0 | \$496.4 | -\$67.6 |
| Non-Market Cap Indexing | 0.0% | 0.0% | 0.0% | Non-Market Cap Indexing | \$0.0 | \$0.0 | \$0.0 |
| Option-writing Strategies | 0.1% | 0.1% | 0.0% | Option-writing Strategies | \$207.8 | \$182.9 | -\$24.9 |
| Credit | 6.1% | 6.2% | 0.1% | Credit | \$11,627.2 | \$11,834.4 | \$207.1 |
| US Credit | 4.4% | 4.5% | 0.1% | US Credit | \$8,360.5 | \$8,509.4 | \$148.9 |
| Non-US Credit | 0.1% | 0.1% | 0.0% | Non-US Credit | \$148.7 | \$151.4 | \$2.6 |
| US High Yield | 1.2% | 1.3% | 0.0% | US High Yield | \$2,350.8 | \$2,392.7 | \$41.9 |
| Non-US High Yield | 0.0% | 0.0% | 0.0% | Non-US High Yield | \$0.0 | \$0.0 | \$0.0 |
| Bank Loans | 0.4% | 0.4% | 0.0% | Bank Loans | \$695.9 | \$708.3 | \$12.4 |
| Emerging Markets Debt | 0.0% | 0.0% | 0.0% | Emerging Markets Debt | \$71.3 | \$72.6 | \$1.3 |
| Risk Mitigation Strategies | 0.9% | 0.0% | -0.9% | Risk Mitigation Strategies | \$1,704.4 | \$0.0 | -\$1,704.4 |
| Treasury Duration | 0.0% | 0.0% | 0.0% | Treasury Duration | \$0.0 | \$0.0 | \$0.0 |
| Trend Following | 0.2% | 0.0% | -0.2% | Trend Following | \$372.5 | \$0.0 | -\$372.5 |
| Alternative Premia | 0.2% | 0.0% | -0.2% | Alternative Premia | \$359.9 | \$0.0 | -\$359.9 |
| Global Macro | 0.5% | 0.0% | -0.5% | Global Macro | \$972.0 | \$0.0 | -\$972.0 |
| Inflation Sensitive | 0.9% | 6.0% | 5.1% | Inflation Sensitive | \$1,685.9 | \$11,452.6 | \$9,766.7 |
| TIPS | 0.3% | 2.0% | 1.7% | TIPS | \$554.0 | \$3,763.4 | \$3,209.4 |
| Timber | 0.0% | 0.0% | 0.0% | Timber | \$0.0 | \$0.0 | \$0.0 |
| Infrastructure | 0.5% | 3.5% | 3.0% | Infrastructure | \$985.2 | \$6,692.6 | \$5,707.4 |
| Agriculture | 0.0% | 0.0% | 0.0% | Agriculture | \$0.0 | \$0.0 | \$0.0 |
| Commodities/MLPs | 0.1% | 0.5% | 0.4% | Commodities/MLPs | \$146.7 | \$996.6 | \$849.9 |
| Bank Loans | 0.0% | 0.0% | 0.0% | Bank Loans | \$0.0 | \$0.0 | \$0.0 |
| Real Estate | 12.5% | 13.0% | 0.5% | Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | 10.1% | 13.0% | 2.9% | Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | 100.0% | 100.0% | 0.0% | Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | LTP | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.01% | 0.00% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.11% | 0.00% |
| Credit | 0.08% | 0.08% | 0.00% |
| Risk Mitigation Strategies | 1.27% | 0.00% | -1.27% |
| Inflation Sensitive | 0.78% | 0.78% | 0.00% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.43% | 0.07% |

| Strategic Class - Fees \$ | Current | LTP | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.2 | -\$0.2 |
| Liquidity/Protection | \$14.0 | \$14.1 | \$0.1 |
| Global Growth | \$122.4 | \$107.7 | -\$14.7 |
| Credit | \$9.1 | \$9.2 | \$0.2 |
| Risk Mitigation Strategies | \$21.6 | \$0.0 | -\$21.6 |
| Inflation Sensitive | \$13.1 | \$89.0 | \$75.9 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$820.7 | \$139.5 |

CalSTRS A/L Study Summary Statistics: Long-Term Policy Portfolio



CalSTRS A/L Study Summary Statistics: Portfolio B

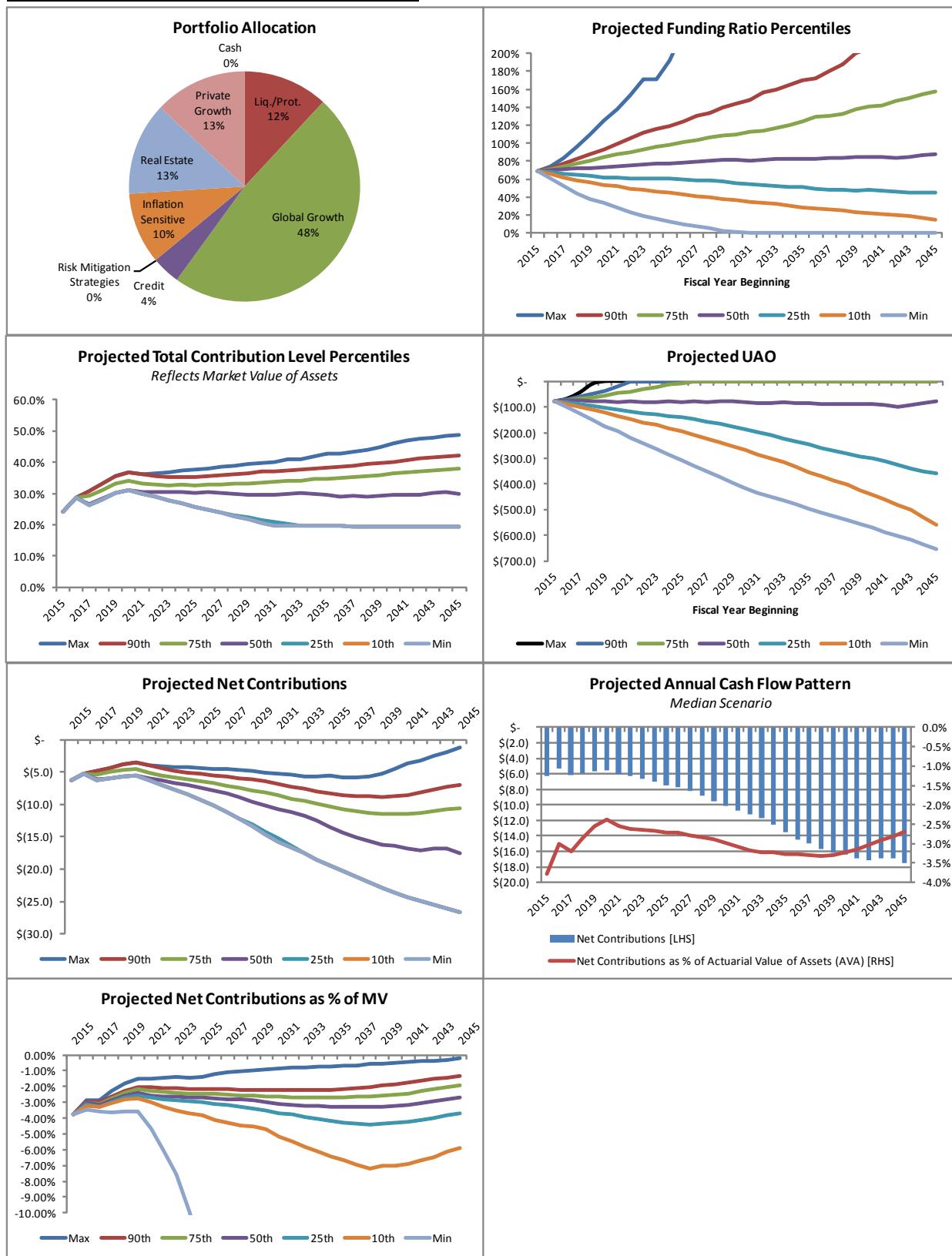
| Strategic Class Percentages | Current | Portfolio B | Diff. |
|-----------------------------------|---------------|---------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 11.9% | 2.2% |
| Interest Rates | 5.3% | 6.3% | 1.0% |
| Securitized | 4.5% | 5.6% | 1.2% |
| Global Growth | 57.9% | 48.1% | -9.9% |
| US Equity | 38.0% | 18.0% | -20.0% |
| Non-US Equity | 19.5% | 18.0% | -1.5% |
| Developed Non-US Equity | 16.4% | 14.1% | -2.3% |
| Emerging Markets Equity | 3.1% | 3.9% | 0.8% |
| Fundamental Low Vol | 0.3% | 3.8% | 3.6% |
| Non-Market Cap Indexing | 0.0% | 3.8% | 3.8% |
| Option-writing Strategies | 0.1% | 4.3% | 4.2% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 0.0% | -0.9% |
| Treasury Duration | 0.0% | 0.0% | 0.0% |
| Trend Following | 0.2% | 0.0% | -0.2% |
| Alternative Premia | 0.2% | 0.0% | -0.2% |
| Global Macro | 0.5% | 0.0% | -0.5% |
| Inflation Sensitive | 0.9% | 10.0% | 9.1% |
| TIPS | 0.3% | 3.0% | 2.7% |
| Timber | 0.0% | 1.0% | 1.0% |
| Infrastructure | 0.5% | 3.0% | 2.5% |
| Agriculture | 0.0% | 1.0% | 1.0% |
| Commodities/MLPs | 0.1% | 1.5% | 1.4% |
| Bank Loans | 0.0% | 0.5% | 0.5% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class Dollar Amounts | Current | Portfolio B | Diff. |
|-----------------------------------|--------------------|--------------------|--------------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$22,752.5 | \$4,141.8 |
| Interest Rates | \$10,114.2 | \$12,058.8 | \$1,944.6 |
| Securitized | \$8,496.5 | \$10,693.7 | \$2,197.2 |
| Global Growth | \$110,612.1 | \$91,773.6 | -\$18,838.5 |
| US Equity | \$72,557.4 | \$34,415.1 | -\$38,142.3 |
| Non-US Equity | \$37,282.9 | \$34,415.1 | -\$2,867.8 |
| Developed Non-US Equity | \$31,308.5 | \$26,878.2 | -\$4,430.3 |
| Emerging Markets Equity | \$5,974.4 | \$7,536.9 | \$1,562.5 |
| Fundamental Low Vol | \$564.0 | \$7,341.9 | \$6,777.9 |
| Non-Market Cap Indexing | \$0.0 | \$7,341.9 | \$7,341.9 |
| Option-writing Strategies | \$207.8 | \$8,259.6 | \$8,051.8 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| US Credit | \$8,360.5 | \$4,122.9 | -\$4,237.6 |
| Non-US Credit | \$148.7 | \$916.2 | \$767.5 |
| US High Yield | \$2,350.8 | \$1,298.0 | -\$1,052.8 |
| Non-US High Yield | \$0.0 | \$381.8 | \$381.8 |
| Bank Loans | \$695.9 | \$534.5 | -\$161.4 |
| Emerging Markets Debt | \$71.3 | \$381.8 | \$310.5 |
| Risk Mitigation Strategies | \$1,704.4 | \$0.0 | -\$1,704.4 |
| Treasury Duration | \$0.0 | \$0.0 | \$0.0 |
| Trend Following | \$372.5 | \$0.0 | -\$372.5 |
| Alternative Premia | \$359.9 | \$0.0 | -\$359.9 |
| Global Macro | \$972.0 | \$0.0 | -\$972.0 |
| Inflation Sensitive | \$1,685.9 | \$19,087.7 | \$17,401.8 |
| TIPS | \$554.0 | \$5,726.3 | \$5,172.3 |
| Timber | \$0.0 | \$1,908.8 | \$1,908.8 |
| Infrastructure | \$985.2 | \$5,726.3 | \$4,741.1 |
| Agriculture | \$0.0 | \$1,908.8 | \$1,908.8 |
| Commodities/MLPs | \$146.7 | \$2,863.2 | \$2,716.5 |
| Bank Loans | \$0.0 | \$954.4 | \$954.4 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | Portfolio B | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.00% | -1.27% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.46% | 0.11% |

| Strategic Class - Fees \$ | Current | Portfolio B | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$17.5 | \$3.5 |
| Global Growth | \$122.4 | \$121.6 | -\$0.8 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$0.0 | -\$21.6 |
| Inflation Sensitive | \$13.1 | \$136.6 | \$123.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$884.0 | \$202.8 |

CalSTRS A/L Study Summary Statistics: Portfolio B



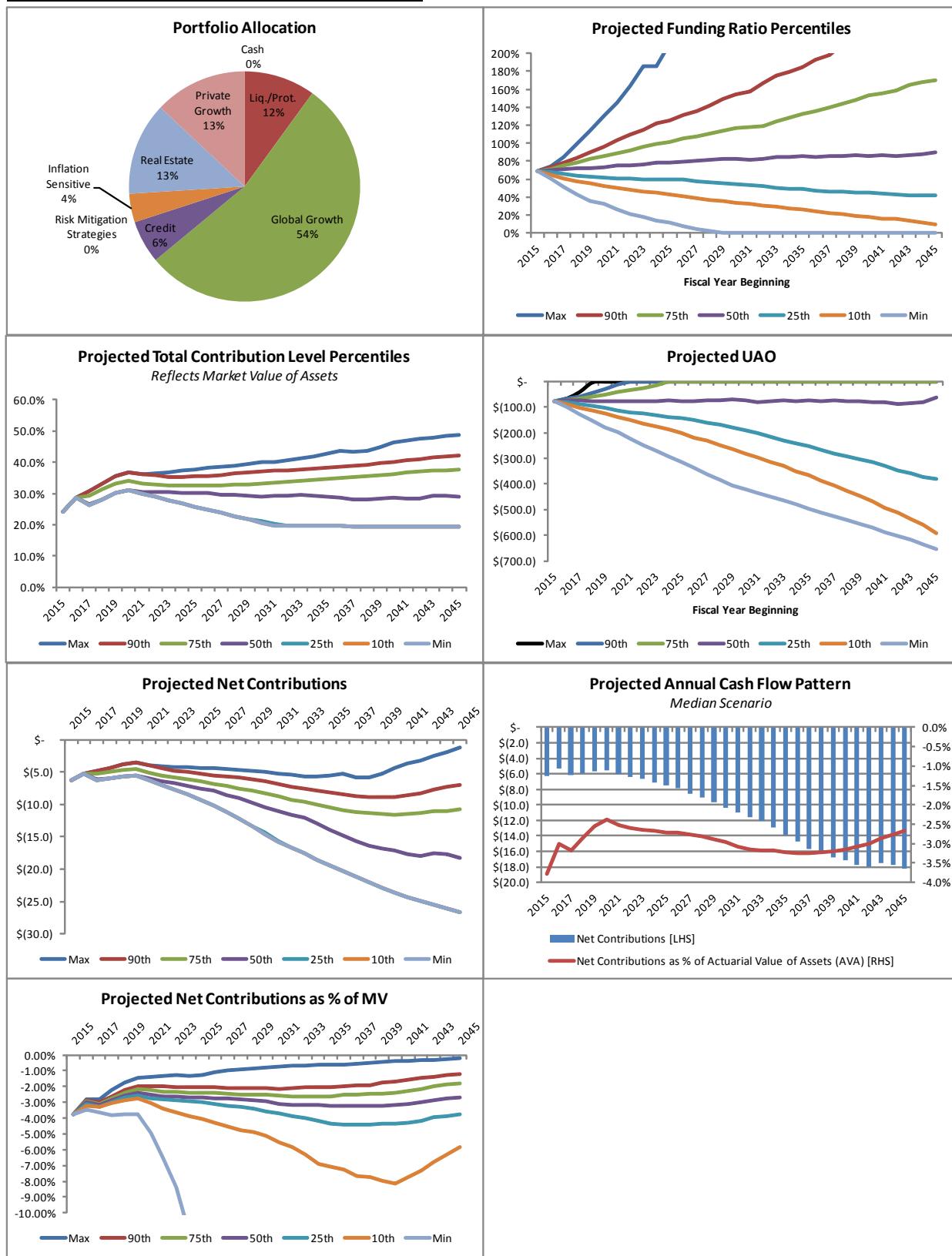
CalSTRS A/L Study Summary Statistics: Portfolio C

| Strategic Class Percentages | Current | Portfolio C | Diff. |
|-----------------------------------|---------------|---------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 10.0% | 0.2% |
| Interest Rates | 5.3% | 5.3% | 0.0% |
| Securitized | 4.5% | 4.7% | 0.2% |
| Global Growth | 57.9% | 54.0% | -3.9% |
| US Equity | 38.0% | 20.3% | -17.8% |
| Non-US Equity | 19.5% | 20.3% | 0.7% |
| Developed Non-US Equity | 16.4% | 15.8% | -0.6% |
| Emerging Markets Equity | 3.1% | 4.4% | 1.3% |
| Fundamental Low Vol | 0.3% | 4.3% | 4.0% |
| Non-Market Cap Indexing | 0.0% | 4.3% | 4.3% |
| Option-writing Strategies | 0.1% | 4.9% | 4.8% |
| Credit | 6.1% | 6.0% | -0.1% |
| US Credit | 4.4% | 3.2% | -1.1% |
| Non-US Credit | 0.1% | 0.7% | 0.6% |
| US High Yield | 1.2% | 1.0% | -0.2% |
| Non-US High Yield | 0.0% | 0.3% | 0.3% |
| Bank Loans | 0.4% | 0.4% | 0.1% |
| Emerging Markets Debt | 0.0% | 0.3% | 0.3% |
| Risk Mitigation Strategies | 0.9% | 0.0% | -0.9% |
| Treasury Duration | 0.0% | 0.0% | 0.0% |
| Trend Following | 0.2% | 0.0% | -0.2% |
| Alternative Premia | 0.2% | 0.0% | -0.2% |
| Global Macro | 0.5% | 0.0% | -0.5% |
| Inflation Sensitive | 0.9% | 4.0% | 3.1% |
| TIPS | 0.3% | 1.2% | 0.9% |
| Timber | 0.0% | 0.4% | 0.4% |
| Infrastructure | 0.5% | 1.2% | 0.7% |
| Agriculture | 0.0% | 0.4% | 0.4% |
| Commodities/MLPs | 0.1% | 0.6% | 0.5% |
| Bank Loans | 0.0% | 0.2% | 0.2% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class - Fees % | Current | Portfolio C | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.00% | -1.27% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.43% | 0.07% |

| Strategic Class - Fees \$ | Current | Portfolio C | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$14.7 | \$0.7 |
| Global Growth | \$122.4 | \$136.6 | \$14.2 |
| Credit | \$9.1 | \$11.7 | \$2.7 |
| Risk Mitigation Strategies | \$21.6 | \$0.0 | -\$21.6 |
| Inflation Sensitive | \$13.1 | \$54.6 | \$41.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$818.1 | \$136.9 |

CalSTRS A/L Study Summary Statistics: Portfolio C



CalSTRS A/L Study Summary Statistics: Portfolio D

| Strategic Class % | Current | Portfolio D | Diff. |
|----------------------------|---------------|---------------|-------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 9.0% | -0.8% |
| Global Growth | 57.9% | 39.0% | -18.9% |
| Credit | 6.1% | 4.0% | -2.1% |
| Risk Mitigation Strategies | 0.9% | 12.0% | 11.1% |
| Inflation Sensitive | 0.9% | 10.0% | 9.1% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |
| Total Fees % | 0.36% | 0.51% | 0.16% |

| Strategic Class \$ | Current | Portfolio D | Diff. |
|----------------------------|--------------------|--------------------|--------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$17,178.9 | -\$1,431.8 |
| Global Growth | \$110,612.1 | \$74,442.0 | -\$36,170.1 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| Risk Mitigation Strategies | \$1,704.4 | \$22,905.2 | \$21,200.8 |
| Inflation Sensitive | \$1,685.9 | \$19,087.7 | \$17,401.8 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |
| Total Fees \$ | \$681.2 | \$979.2 | \$298.0 |

| Growth vs. Stabilizing Assets | Current | Portfolio D | Diff. |
|-------------------------------|---------|-------------|--------|
| Growth-oriented | 80.5% | 65.0% | -15.5% |
| Stabilizing | 19.5% | 35.0% | 15.5% |
| Fixed Income | 17.7% | 17.2% | -0.5% |
| Other | 1.8% | 17.8% | 16.0% |

| Growth vs. Stabilizing Assets | Current | Portfolio D | Diff. |
|-------------------------------|-------------|-------------|-------------|
| Growth-oriented | \$153,684.0 | \$124,069.9 | -\$29,614.1 |
| Stabilizing | \$37,192.8 | \$66,806.9 | \$29,614.1 |
| Fixed Income | \$33,802.5 | \$32,830.8 | -\$971.7 |
| Other | \$3,390.3 | \$33,976.1 | \$30,585.8 |

| Risk Allocation (MV Based) | Current | Portfolio D | Diff. |
|----------------------------|---------|-------------|--------|
| Cash | 0.0% | 0.0% | 0.0% |
| Liquidity/Protection | 0.2% | 0.6% | 0.3% |
| Global Growth | 71.2% | 54.4% | -16.9% |
| Credit | 2.6% | 2.1% | -0.4% |
| Risk Mitigation Strategies | 0.0% | 2.0% | 1.9% |
| Inflation Sensitive | 0.3% | 3.1% | 2.8% |
| Real Estate | 9.1% | 11.9% | 2.8% |
| Private Growth | 16.6% | 26.0% | 9.4% |

| Public Equity Segment Allocation | Current | Portfolio D | Diff. |
|----------------------------------|------------|-------------|-------------|
| U.S. Equity | \$73,047.2 | \$40,570.9 | -\$32,476.3 |
| Non-US Equity | \$37,564.9 | \$33,871.1 | -\$3,693.8 |
| Emerging Markets | \$5,974.4 | \$6,113.5 | \$139.1 |

| Public Equity Segment | Current | Portfolio D | Diff. |
|-----------------------|---------|-------------|--------|
| U.S. Equity | 38.3% | 21.3% | -17.0% |
| Non-US Equity | 19.7% | 17.7% | -1.9% |
| Emerging Markets | 3.1% | 3.2% | 0.1% |

| Emerging Markets Segment | Current | Portfolio D | Diff. |
|--------------------------|---------|-------------|-------|
| Emerging Markets Equity | 3.1% | 3.2% | 0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| % of Total Portfolio | 3.2% | 3.4% | 0.2% |

| Mean Variance Model | Current | Portfolio D | Diff. |
|---------------------------|-------------|-------------|-------------|
| Arith. Avg. Ret | 8.4% | 8.0% | -0.4% |
| Ann. Comp. Ret (30) | 7.5% | 7.4% | -0.1% |
| SD of 1-Yr Rets | 13.9% | 11.3% | -2.6% |
| SD of 30-Yr Comp. Rets | 2.5% | 2.1% | -0.5% |
| 2-Yr 10% Prob Loss % | -17.0% | -11.8% | 5.2% |
| 2-Yr 10% Prob Loss \$ | -\$32,458.3 | -\$22,601.1 | \$9,857.2 |
| 2-Yr 10% Prob. Gain % | 57.9% | 49.0% | -8.9% |
| 2-Yr 10% Prob. Gain \$ | \$110,443.1 | \$93,451.6 | -\$16,991.5 |
| 10%-tile 30yr Fund. Ratio | 0.0% | 26.4% | 26.4% |

| Simulation Model (1,000) | Current | Portfolio D | Diff. |
|---------------------------------|-------------|-------------|-------------|
| Avg. of Avg. 30-Yr Rets | 8.3% | 7.9% | -0.4% |
| Med. Of Avg. 30-Yr Rets | 8.4% | 8.0% | -0.4% |
| Avg. of 30-Yr Comp. Rets | 7.4% | 7.4% | 0.1% |
| Med. Of 30-Yr Comp. Rets | 7.4% | 7.4% | 0.0% |
| Avg SD of 30-Yr Ann. Rets | 14.0% | 10.2% | -3.8% |
| SD of 30-Yr Comp. Rets | 2.6% | 1.9% | -0.8% |
| 2-Yr 10% Prob Loss % | -23.2% | -13.1% | 10.1% |
| 2-Yr 10% Prob Loss \$ | -\$44,298.6 | -\$25,065.6 | \$19,233.0 |
| 2-Yr 10% Prob. Gain % | 51.8% | 41.2% | -10.6% |
| 2-Yr 10% Prob. Gain \$ | \$98,847.1 | \$78,686.9 | -\$20,160.3 |
| Med. Avg. 1-Yr Net Ctb \$ | -\$6.2 | -\$6.1 | \$0.1 |
| Med. Avg. 1-Yr Net Ctb %MV | -2.7% | -2.7% | 0.0% |
| Avg. 1-Yr Worst 10% Net Ctb \$ | -\$6.6 | -\$6.6 | \$0.0 |
| Avg. 1-Yr Worst 10% Net Ctb %MV | -3.7% | -3.3% | 0.4% |
| 10%-tile 30yr Fund. Ratio | 5.0% | 28.5% | 23.4% |
| Med. 30-Yr Funded Ratio | 89.8% | 90.9% | 1.1% |
| 4-Year Prob of Breach 64% | 29.5% | 22.6% | -6.9% |

CalSTRS A/L Study Summary Statistics: Portfolio D

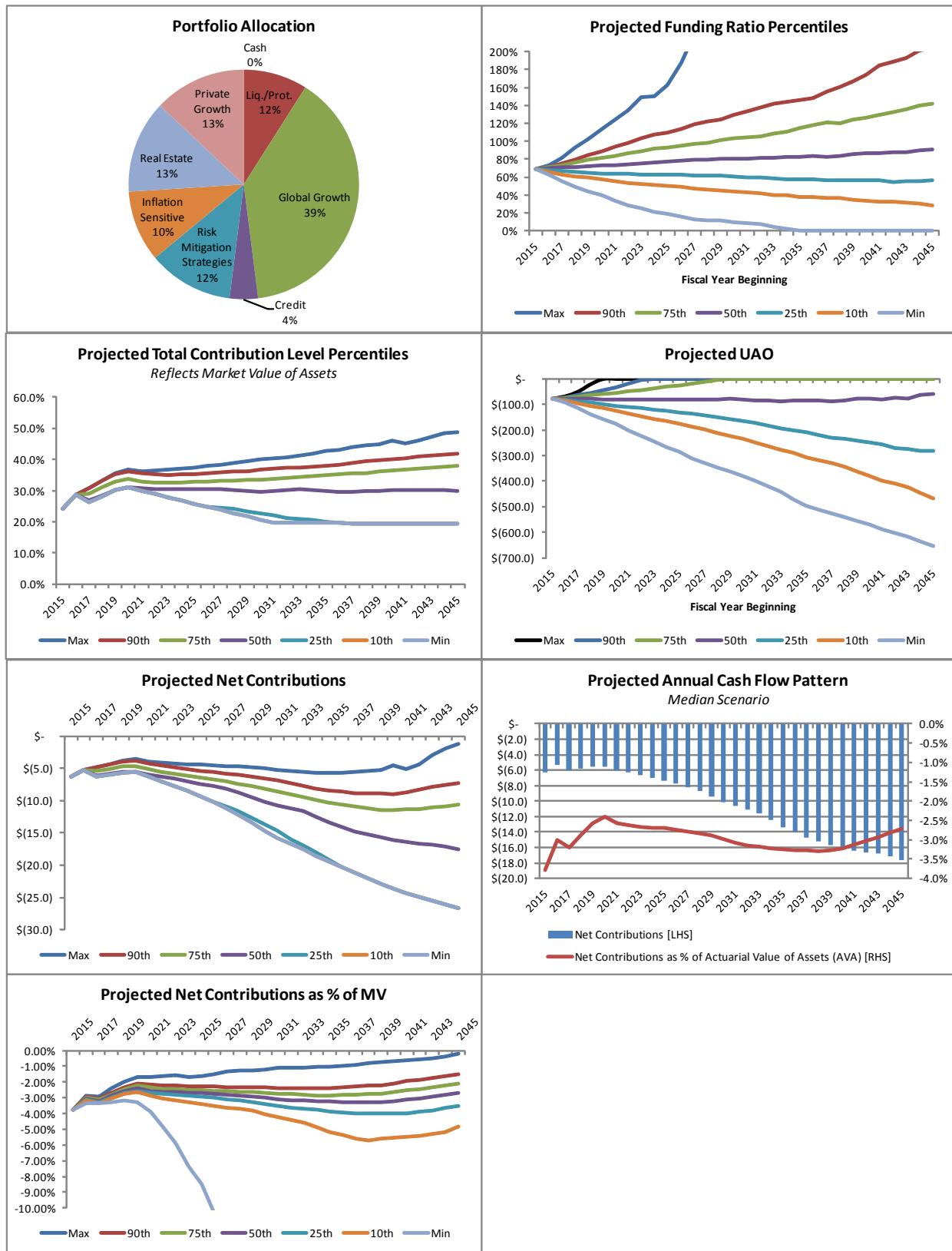
| Strategic Class Percentages | Current | Portfolio D | Diff. |
|-----------------------------------|---------------|---------------|---------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 9.0% | -0.8% |
| Interest Rates | 5.3% | 4.8% | -0.5% |
| Securitized | 4.5% | 4.2% | -0.2% |
| Global Growth | 57.9% | 39.0% | -18.9% |
| US Equity | 38.0% | 14.6% | -23.4% |
| Non-US Equity | 19.5% | 14.6% | -4.9% |
| Developed Non-US Equity | 16.4% | 11.4% | -5.0% |
| Emerging Markets Equity | 3.1% | 3.2% | 0.1% |
| Fundamental Low Vol | 0.3% | 3.1% | 2.8% |
| Non-Market Cap Indexing | 0.0% | 3.1% | 3.1% |
| Option-writing Strategies | 0.1% | 3.5% | 3.4% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 12.0% | 11.1% |
| Treasury Duration | 0.0% | 4.2% | 4.2% |
| Trend Following | 0.2% | 4.8% | 4.6% |
| Alternative Premia | 0.2% | 1.2% | 1.0% |
| Global Macro | 0.5% | 1.8% | 1.3% |
| Inflation Sensitive | 0.9% | 10.0% | 9.1% |
| TIPS | 0.3% | 3.0% | 2.7% |
| Timber | 0.0% | 1.0% | 1.0% |
| Infrastructure | 0.5% | 3.0% | 2.5% |
| Agriculture | 0.0% | 1.0% | 1.0% |
| Commodities/MLPs | 0.1% | 1.5% | 1.4% |
| Bank Loans | 0.0% | 0.5% | 0.5% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class Dollar Amounts | Current | Portfolio D | Diff. |
|-----------------------------------|--------------------|--------------------|--------------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$17,178.9 | -\$1,431.8 |
| Interest Rates | \$10,114.2 | \$9,104.8 | -\$1,009.4 |
| Securitized | \$8,496.5 | \$8,074.1 | -\$422.4 |
| Global Growth | \$110,612.1 | \$74,442.0 | -\$36,170.1 |
| US Equity | \$72,557.4 | \$27,915.7 | -\$44,641.7 |
| Non-US Equity | \$37,282.9 | \$27,915.7 | -\$9,367.2 |
| Developed Non-US Equity | \$31,308.5 | \$21,802.2 | -\$9,506.3 |
| Emerging Markets Equity | \$5,974.4 | \$6,113.5 | \$139.1 |
| Fundamental Low Vol | \$564.0 | \$5,955.4 | \$5,391.4 |
| Non-Market Cap Indexing | \$0.0 | \$5,955.4 | \$5,955.4 |
| Option-writing Strategies | \$207.8 | \$6,699.8 | \$6,492.0 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| US Credit | \$8,360.5 | \$4,122.9 | -\$4,237.6 |
| Non-US Credit | \$148.7 | \$916.2 | \$767.5 |
| US High Yield | \$2,350.8 | \$1,298.0 | -\$1,052.8 |
| Non-US High Yield | \$0.0 | \$381.8 | \$381.8 |
| Bank Loans | \$695.9 | \$534.5 | -\$161.4 |
| Emerging Markets Debt | \$71.3 | \$381.8 | \$310.5 |
| Risk Mitigation Strategies | \$1,704.4 | \$22,905.2 | \$21,200.8 |
| Treasury Duration | \$0.0 | \$8,016.8 | \$8,016.8 |
| Trend Following | \$372.5 | \$9,162.1 | \$8,789.6 |
| Alternative Premia | \$359.9 | \$2,290.5 | \$1,930.6 |
| Global Macro | \$972.0 | \$3,435.8 | \$2,463.8 |
| Inflation Sensitive | \$1,685.9 | \$19,087.7 | \$17,401.8 |
| TIPS | \$554.0 | \$5,726.3 | \$5,172.3 |
| Timber | \$0.0 | \$1,908.8 | \$1,908.8 |
| Infrastructure | \$985.2 | \$5,726.3 | \$4,741.1 |
| Agriculture | \$0.0 | \$1,908.8 | \$1,908.8 |
| Commodities/MLPs | \$146.7 | \$2,863.2 | \$2,716.5 |
| Bank Loans | \$0.0 | \$954.4 | \$954.4 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | Portfolio D | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.53% | -0.74% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.51% | 0.16% |

| Strategic Class - Fees \$ | Current | Portfolio D | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$13.2 | -\$0.8 |
| Global Growth | \$122.4 | \$98.6 | -\$23.7 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$122.5 | \$100.9 |
| Inflation Sensitive | \$13.1 | \$136.6 | \$123.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$979.2 | \$298.0 |

CalSTRS A/L Study Summary Statistics: Portfolio D



CalSTRS A/L Study Summary Statistics: Portfolio E

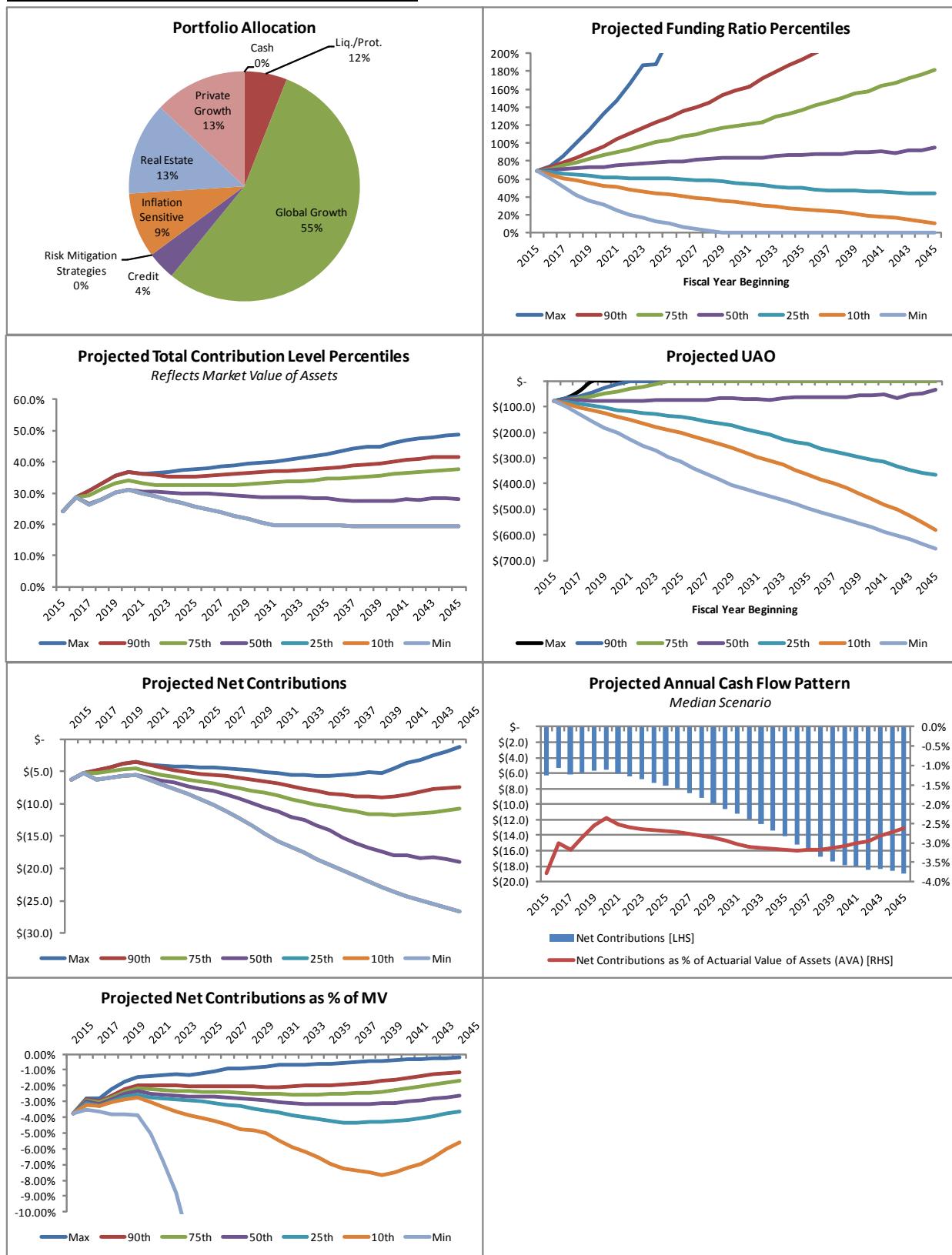
| Strategic Class Percentages | Current | Portfolio E | Diff. |
|-----------------------------------|---------------|---------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 6.0% | -3.8% |
| Interest Rates | 5.3% | 3.2% | -2.1% |
| Securitized | 4.5% | 2.8% | -1.6% |
| Global Growth | 57.9% | 54.9% | -3.1% |
| US Equity | 38.0% | 20.6% | -17.4% |
| Non-US Equity | 19.5% | 20.6% | 1.0% |
| Developed Non-US Equity | 16.4% | 16.1% | -0.3% |
| Emerging Markets Equity | 3.1% | 4.5% | 1.4% |
| Fundamental Low Vol | 0.3% | 4.4% | 4.1% |
| Non-Market Cap Indexing | 0.0% | 4.4% | 4.4% |
| Option-writing Strategies | 0.1% | 4.9% | 4.8% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 0.0% | -0.9% |
| Treasury Duration | 0.0% | 0.0% | 0.0% |
| Trend Following | 0.2% | 0.0% | -0.2% |
| Alternative Premia | 0.2% | 0.0% | -0.2% |
| Global Macro | 0.5% | 0.0% | -0.5% |
| Inflation Sensitive | 0.9% | 9.1% | 8.2% |
| TIPS | 0.3% | 2.7% | 2.4% |
| Timber | 0.0% | 0.9% | 0.9% |
| Infrastructure | 0.5% | 2.7% | 2.2% |
| Agriculture | 0.0% | 0.9% | 0.9% |
| Commodities/MLPs | 0.1% | 1.4% | 1.3% |
| Bank Loans | 0.0% | 0.5% | 0.5% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class Dollar Amounts | Current | Portfolio E | Diff. |
|-----------------------------------|--------------------|--------------------|-------------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$11,452.6 | -\$7,158.2 |
| Interest Rates | \$10,114.2 | \$6,069.9 | -\$4,044.3 |
| Securitized | \$8,496.5 | \$5,382.7 | -\$3,113.8 |
| Global Growth | \$110,612.1 | \$104,753.2 | -\$5,858.9 |
| US Equity | \$72,557.4 | \$39,282.4 | -\$33,275.0 |
| Non-US Equity | \$37,282.9 | \$39,282.4 | \$1,999.5 |
| Developed Non-US Equity | \$31,308.5 | \$30,679.6 | -\$628.9 |
| Emerging Markets Equity | \$5,974.4 | \$8,602.9 | \$2,628.5 |
| Fundamental Low Vol | \$564.0 | \$8,380.3 | \$7,816.3 |
| Non-Market Cap Indexing | \$0.0 | \$8,380.3 | \$8,380.3 |
| Option-writing Strategies | \$207.8 | \$9,427.8 | \$9,220.0 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| US Credit | \$8,360.5 | \$4,122.9 | -\$4,237.6 |
| Non-US Credit | \$148.7 | \$916.2 | \$767.5 |
| US High Yield | \$2,350.8 | \$1,298.0 | -\$1,052.8 |
| Non-US High Yield | \$0.0 | \$381.8 | \$381.8 |
| Bank Loans | \$695.9 | \$534.5 | -\$161.4 |
| Emerging Markets Debt | \$71.3 | \$381.8 | \$310.5 |
| Risk Mitigation Strategies | \$1,704.4 | \$0.0 | -\$1,704.4 |
| Treasury Duration | \$0.0 | \$0.0 | \$0.0 |
| Trend Following | \$372.5 | \$0.0 | -\$372.5 |
| Alternative Premia | \$359.9 | \$0.0 | -\$359.9 |
| Global Macro | \$972.0 | \$0.0 | -\$972.0 |
| Inflation Sensitive | \$1,685.9 | \$17,408.0 | \$15,722.1 |
| TIPS | \$554.0 | \$5,222.4 | \$4,668.4 |
| Timber | \$0.0 | \$1,740.8 | \$1,740.8 |
| Infrastructure | \$985.2 | \$5,222.4 | \$4,237.2 |
| Agriculture | \$0.0 | \$1,740.8 | \$1,740.8 |
| Commodities/MLPs | \$146.7 | \$2,611.2 | \$2,464.5 |
| Bank Loans | \$0.0 | \$870.4 | \$870.4 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | Portfolio E | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.00% | -1.27% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.46% | 0.10% |

| Strategic Class - Fees \$ | Current | Portfolio E | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$8.8 | -\$5.2 |
| Global Growth | \$122.4 | \$138.8 | \$16.4 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$0.0 | -\$21.6 |
| Inflation Sensitive | \$13.1 | \$124.6 | \$111.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$880.5 | \$199.3 |

CalSTRS A/L Study Summary Statistics: Portfolio E



CalSTRS A/L Study Summary Statistics: Portfolio F

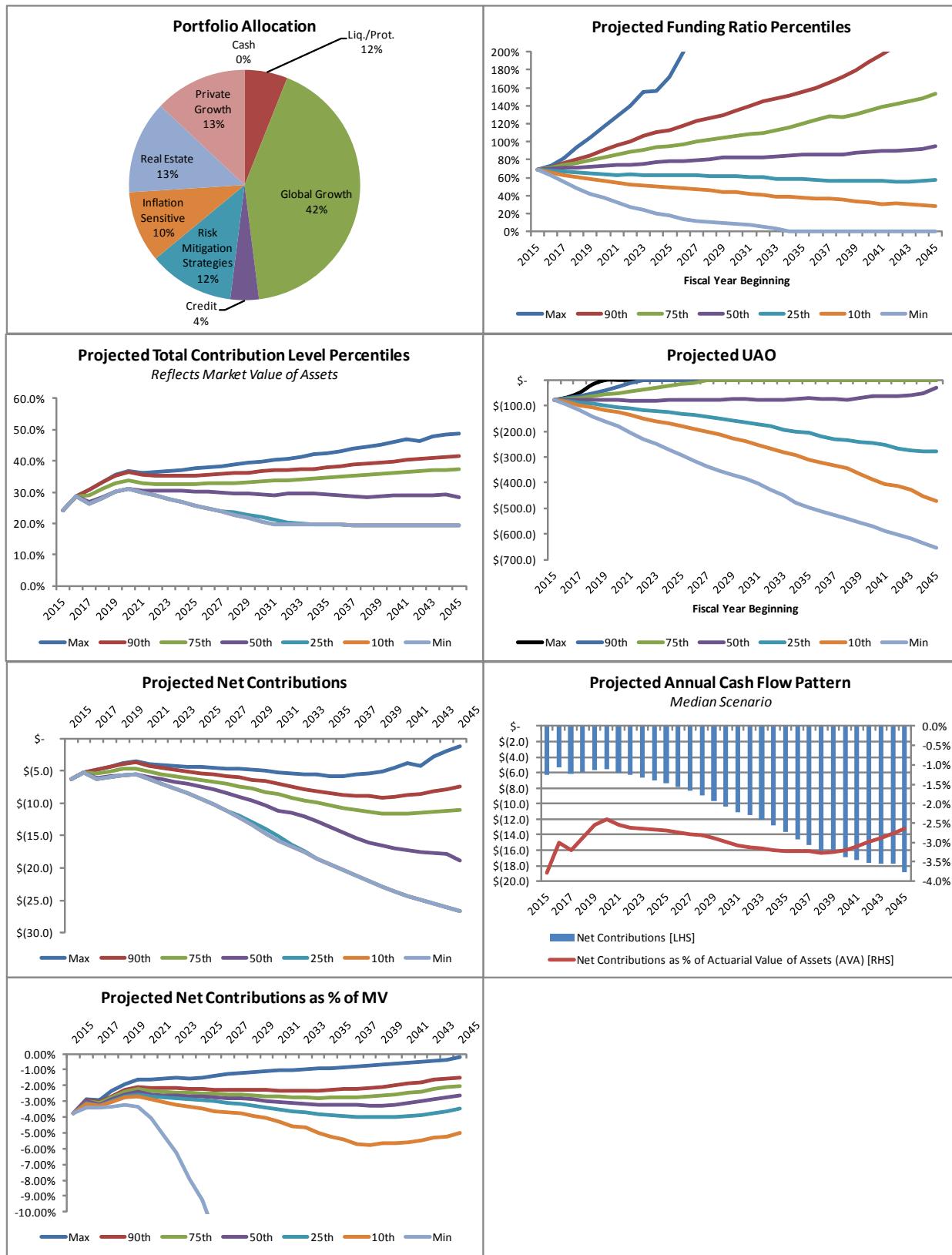
| Strategic Class Percentages | Current | Portfolio F | Diff. |
|-----------------------------------|---------------|---------------|---------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 6.0% | -3.7% |
| Interest Rates | 5.3% | 3.2% | -2.1% |
| Securitized | 4.5% | 2.8% | -1.6% |
| Global Growth | 57.9% | 42.0% | -16.0% |
| US Equity | 38.0% | 15.7% | -22.3% |
| Non-US Equity | 19.5% | 15.7% | -3.8% |
| Developed Non-US Equity | 16.4% | 12.3% | -4.1% |
| Emerging Markets Equity | 3.1% | 3.4% | 0.3% |
| Fundamental Low Vol | 0.3% | 3.4% | 3.1% |
| Non-Market Cap Indexing | 0.0% | 3.4% | 3.4% |
| Option-writing Strategies | 0.1% | 3.8% | 3.7% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 12.0% | 11.1% |
| Treasury Duration | 0.0% | 4.2% | 4.2% |
| Trend Following | 0.2% | 4.8% | 4.6% |
| Alternative Premia | 0.2% | 1.2% | 1.0% |
| Global Macro | 0.5% | 1.8% | 1.3% |
| Inflation Sensitive | 0.9% | 10.0% | 9.1% |
| TIPS | 0.3% | 3.0% | 2.7% |
| Timber | 0.0% | 1.0% | 1.0% |
| Infrastructure | 0.5% | 3.0% | 2.5% |
| Agriculture | 0.0% | 1.0% | 1.0% |
| Commodities/MLPs | 0.1% | 1.5% | 1.4% |
| Bank Loans | 0.0% | 0.5% | 0.5% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class Dollar Amounts | Current | Portfolio F | Diff. |
|-----------------------------------|--------------------|--------------------|--------------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$11,509.9 | -\$7,100.9 |
| Interest Rates | \$10,114.2 | \$6,100.2 | -\$4,014.0 |
| Securitized | \$8,496.5 | \$5,409.6 | -\$3,086.9 |
| Global Growth | \$110,612.1 | \$80,111.0 | -\$30,501.1 |
| US Equity | \$72,557.4 | \$30,041.6 | -\$42,515.8 |
| Non-US Equity | \$37,282.9 | \$30,041.6 | -\$7,241.3 |
| Developed Non-US Equity | \$31,308.5 | \$23,462.5 | -\$7,846.0 |
| Emerging Markets Equity | \$5,974.4 | \$6,579.1 | \$604.7 |
| Fundamental Low Vol | \$564.0 | \$6,408.9 | \$5,844.9 |
| Non-Market Cap Indexing | \$0.0 | \$6,408.9 | \$6,408.9 |
| Option-writing Strategies | \$207.8 | \$7,210.0 | \$7,002.2 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| US Credit | \$8,360.5 | \$4,122.9 | -\$4,237.6 |
| Non-US Credit | \$148.7 | \$916.2 | \$767.5 |
| US High Yield | \$2,350.8 | \$1,298.0 | -\$1,052.8 |
| Non-US High Yield | \$0.0 | \$381.8 | \$381.8 |
| Bank Loans | \$695.9 | \$534.5 | -\$161.4 |
| Emerging Markets Debt | \$71.3 | \$381.8 | \$310.5 |
| Risk Mitigation Strategies | \$1,704.4 | \$22,905.2 | \$21,200.8 |
| Treasury Duration | \$0.0 | \$8,016.8 | \$8,016.8 |
| Trend Following | \$372.5 | \$9,162.1 | \$8,789.6 |
| Alternative Premia | \$359.9 | \$2,290.5 | \$1,930.6 |
| Global Macro | \$972.0 | \$3,435.8 | \$2,463.8 |
| Inflation Sensitive | \$1,685.9 | \$19,087.7 | \$17,401.8 |
| TIPS | \$554.0 | \$5,726.3 | \$5,172.3 |
| Timber | \$0.0 | \$1,908.8 | \$1,908.8 |
| Infrastructure | \$985.2 | \$5,726.3 | \$4,741.1 |
| Agriculture | \$0.0 | \$1,908.8 | \$1,908.8 |
| Commodities/MLPs | \$146.7 | \$2,863.2 | \$2,716.5 |
| Bank Loans | \$0.0 | \$954.4 | \$954.4 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | Portfolio F | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.53% | -0.74% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.51% | 0.16% |

| Strategic Class - Fees \$ | Current | Portfolio F | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$8.9 | -\$5.2 |
| Global Growth | \$122.4 | \$106.1 | -\$16.2 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$122.5 | \$100.9 |
| Inflation Sensitive | \$13.1 | \$136.6 | \$123.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$982.4 | \$301.2 |

CalSTRS A/L Study Summary Statistics: Portfolio F



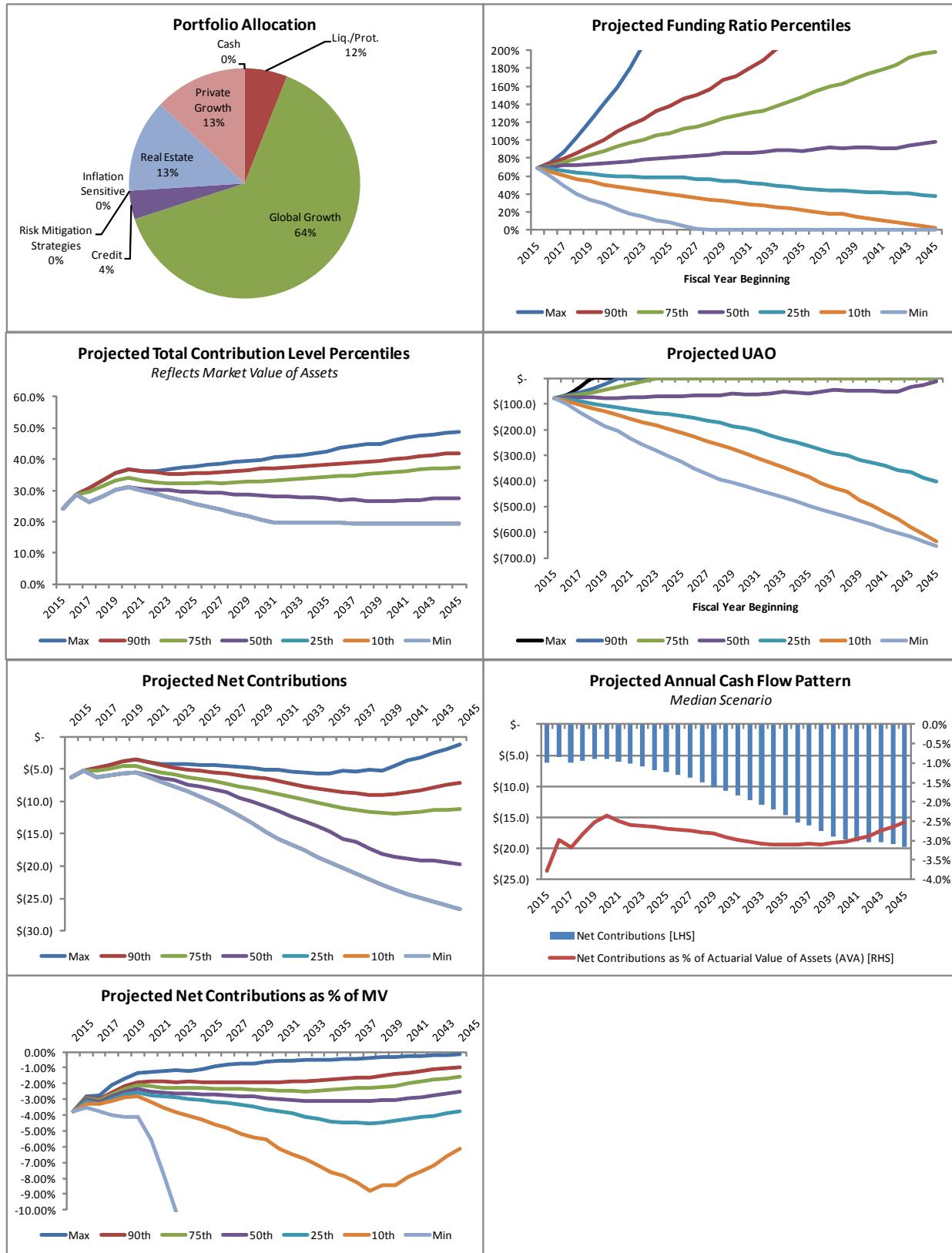
CalSTRS A/L Study Summary Statistics: Portfolio G

| Strategic Class Percentages | Current | Portfolio G | Diff. |
|------------------------------------|----------------|--------------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 6.0% | -3.8% |
| Interest Rates | 5.3% | 3.2% | -2.1% |
| Securitized | 4.5% | 2.8% | -1.6% |
| Global Growth | 57.9% | 64.0% | 6.1% |
| US Equity | 38.0% | 24.0% | -14.0% |
| Non-US Equity | 19.5% | 24.0% | 4.5% |
| Developed Non-US Equity | 16.4% | 18.7% | 2.3% |
| Emerging Markets Equity | 3.1% | 5.3% | 2.1% |
| Fundamental Low Vol | 0.3% | 5.1% | 4.8% |
| Non-Market Cap Indexing | 0.0% | 5.1% | 5.1% |
| Option-writing Strategies | 0.1% | 5.8% | 5.7% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 0.0% | -0.9% |
| Treasury Duration | 0.0% | 0.0% | 0.0% |
| Trend Following | 0.2% | 0.0% | -0.2% |
| Alternative Premia | 0.2% | 0.0% | -0.2% |
| Global Macro | 0.5% | 0.0% | -0.5% |
| Inflation Sensitive | 0.9% | 0.0% | -0.9% |
| TIPS | 0.3% | 0.0% | -0.3% |
| Timber | 0.0% | 0.0% | 0.0% |
| Infrastructure | 0.5% | 0.0% | -0.5% |
| Agriculture | 0.0% | 0.0% | 0.0% |
| Commodities/MLPs | 0.1% | 0.0% | -0.1% |
| Bank Loans | 0.0% | 0.0% | 0.0% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class - Fees % | Current | Portfolio G | Diff. |
|---------------------------------|----------------|--------------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.00% | -1.27% |
| Inflation Sensitive | 0.78% | 0.00% | -0.78% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.41% | 0.05% |

| Strategic Class - Fees \$ | Current | Portfolio G | Diff. |
|----------------------------------|----------------|--------------------|---------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$8.8 | -\$5.2 |
| Global Growth | \$122.4 | \$161.9 | \$39.5 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$0.0 | -\$21.6 |
| Inflation Sensitive | \$13.1 | \$0.0 | -\$13.1 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$779.0 | \$97.8 |

CalSTRS A/L Study Summary Statistics: Portfolio G



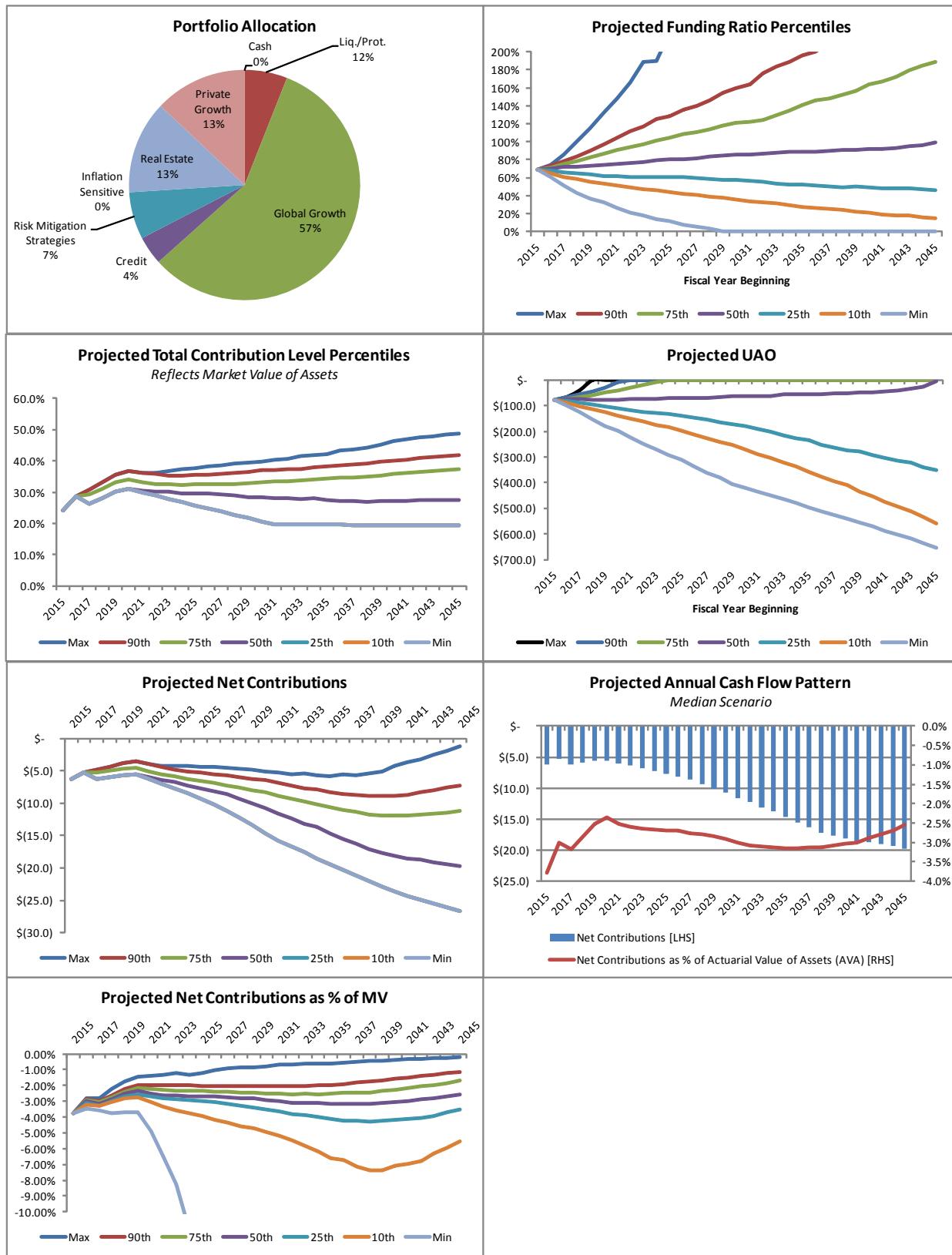
CalSTRS A/L Study Summary Statistics: Portfolio H

| Strategic Class Percentages | Current | Portfolio H | Diff. |
|------------------------------------|----------------|--------------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 6.0% | -3.8% |
| Interest Rates | 5.3% | 3.2% | -2.1% |
| Securitized | 4.5% | 2.8% | -1.6% |
| Global Growth | 57.9% | 57.4% | -0.5% |
| US Equity | 38.0% | 21.5% | -16.5% |
| Non-US Equity | 19.5% | 21.5% | 2.0% |
| Developed Non-US Equity | 16.4% | 16.8% | 0.4% |
| Emerging Markets Equity | 3.1% | 4.7% | 1.6% |
| Fundamental Low Vol | 0.3% | 4.6% | 4.3% |
| Non-Market Cap Indexing | 0.0% | 4.6% | 4.6% |
| Option-writing Strategies | 0.1% | 5.2% | 5.1% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 6.6% | 5.7% |
| Treasury Duration | 0.0% | 2.3% | 2.3% |
| Trend Following | 0.2% | 2.6% | 2.4% |
| Alternative Premia | 0.2% | 0.7% | 0.5% |
| Global Macro | 0.5% | 1.0% | 0.5% |
| Inflation Sensitive | 0.9% | 0.0% | -0.9% |
| TIPS | 0.3% | 0.0% | -0.3% |
| Timber | 0.0% | 0.0% | 0.0% |
| Infrastructure | 0.5% | 0.0% | -0.5% |
| Agriculture | 0.0% | 0.0% | 0.0% |
| Commodities/MLPs | 0.1% | 0.0% | -0.1% |
| Bank Loans | 0.0% | 0.0% | 0.0% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class - Fees % | Current | Portfolio H | Diff. |
|---------------------------------|----------------|--------------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.53% | -0.74% |
| Inflation Sensitive | 0.78% | 0.00% | -0.78% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.43% | 0.08% |

| Strategic Class - Fees \$ | Current | Portfolio H | Diff. |
|----------------------------------|----------------|--------------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$8.8 | -\$5.2 |
| Global Growth | \$122.4 | \$145.2 | \$22.8 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$67.4 | \$45.7 |
| Inflation Sensitive | \$13.1 | \$0.0 | -\$13.1 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$829.7 | \$148.5 |

CalSTRS A/L Study Summary Statistics: Portfolio H



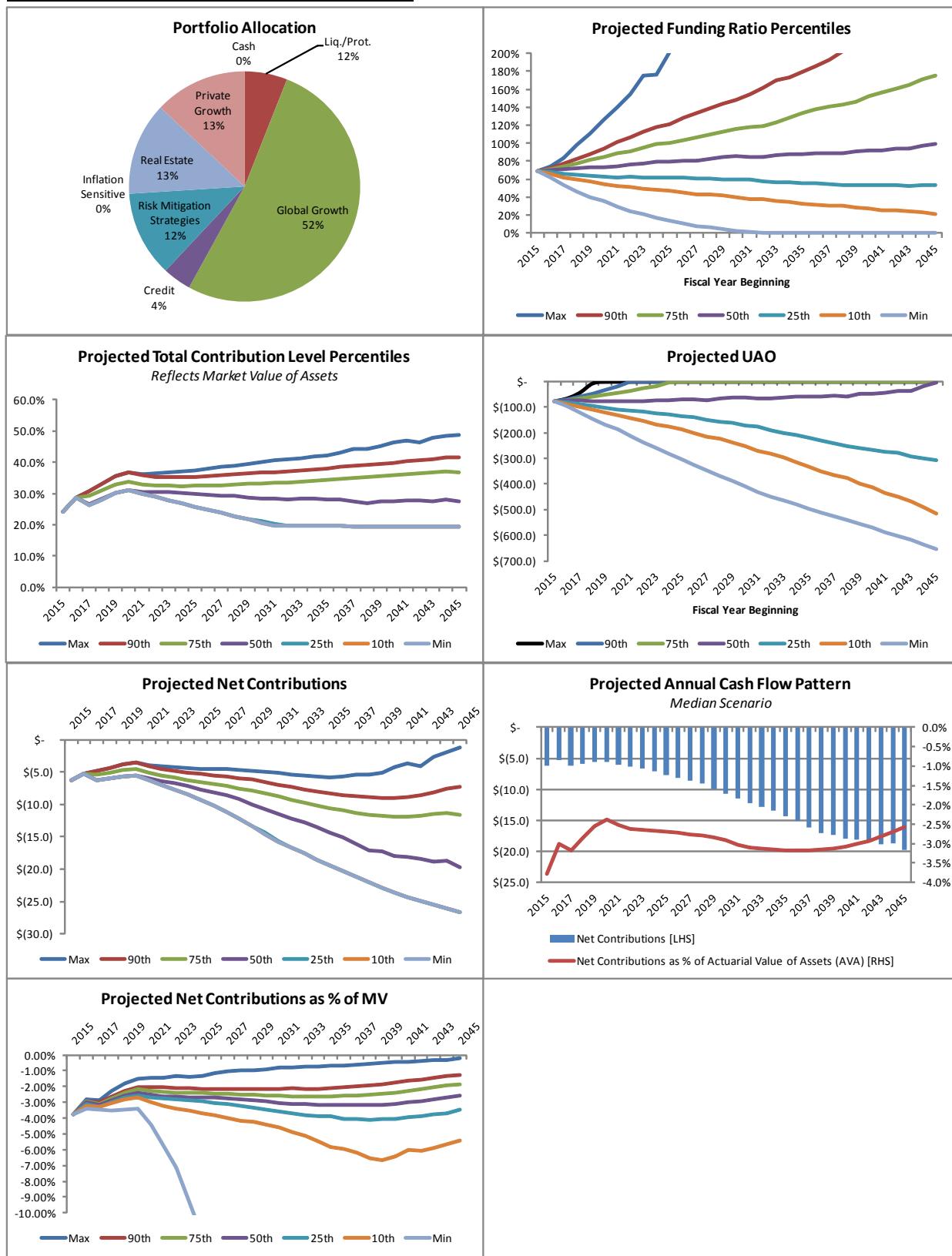
CalSTRS A/L Study Summary Statistics: Portfolio I

| Strategic Class Percentages | Current | Portfolio I | Diff. |
|-----------------------------------|---------------|---------------|--------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 6.0% | -3.8% |
| Interest Rates | 5.3% | 3.2% | -2.1% |
| Securitized | 4.5% | 2.8% | -1.6% |
| Global Growth | 57.9% | 52.0% | -5.9% |
| US Equity | 38.0% | 19.5% | -18.5% |
| Non-US Equity | 19.5% | 19.5% | 0.0% |
| Developed Non-US Equity | 16.4% | 15.2% | -1.2% |
| Emerging Markets Equity | 3.1% | 4.3% | 1.1% |
| Fundamental Low Vol | 0.3% | 4.2% | 3.9% |
| Non-Market Cap Indexing | 0.0% | 4.2% | 4.2% |
| Option-writing Strategies | 0.1% | 4.7% | 4.6% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 12.0% | 11.1% |
| Treasury Duration | 0.0% | 4.2% | 4.2% |
| Trend Following | 0.2% | 4.8% | 4.6% |
| Alternative Premia | 0.2% | 1.2% | 1.0% |
| Global Macro | 0.5% | 1.8% | 1.3% |
| Inflation Sensitive | 0.9% | 0.0% | -0.9% |
| TIPS | 0.3% | 0.0% | -0.3% |
| Timber | 0.0% | 0.0% | 0.0% |
| Infrastructure | 0.5% | 0.0% | -0.5% |
| Agriculture | 0.0% | 0.0% | 0.0% |
| Commodities/MLPs | 0.1% | 0.0% | -0.1% |
| Bank Loans | 0.0% | 0.0% | 0.0% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class - Fees % | Current | Portfolio I | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.53% | -0.74% |
| Inflation Sensitive | 0.78% | 0.00% | -0.78% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.46% | 0.10% |

| Strategic Class - Fees % | Current | Portfolio I | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$8.8 | -\$5.2 |
| Global Growth | \$122.4 | \$131.5 | \$9.1 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$122.5 | \$100.9 |
| Inflation Sensitive | \$13.1 | \$0.0 | -\$13.1 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$871.1 | \$189.9 |

CalSTRS A/L Study Summary Statistics: Portfolio I



CalSTRS A/L Study Summary Statistics: MID Portfolio

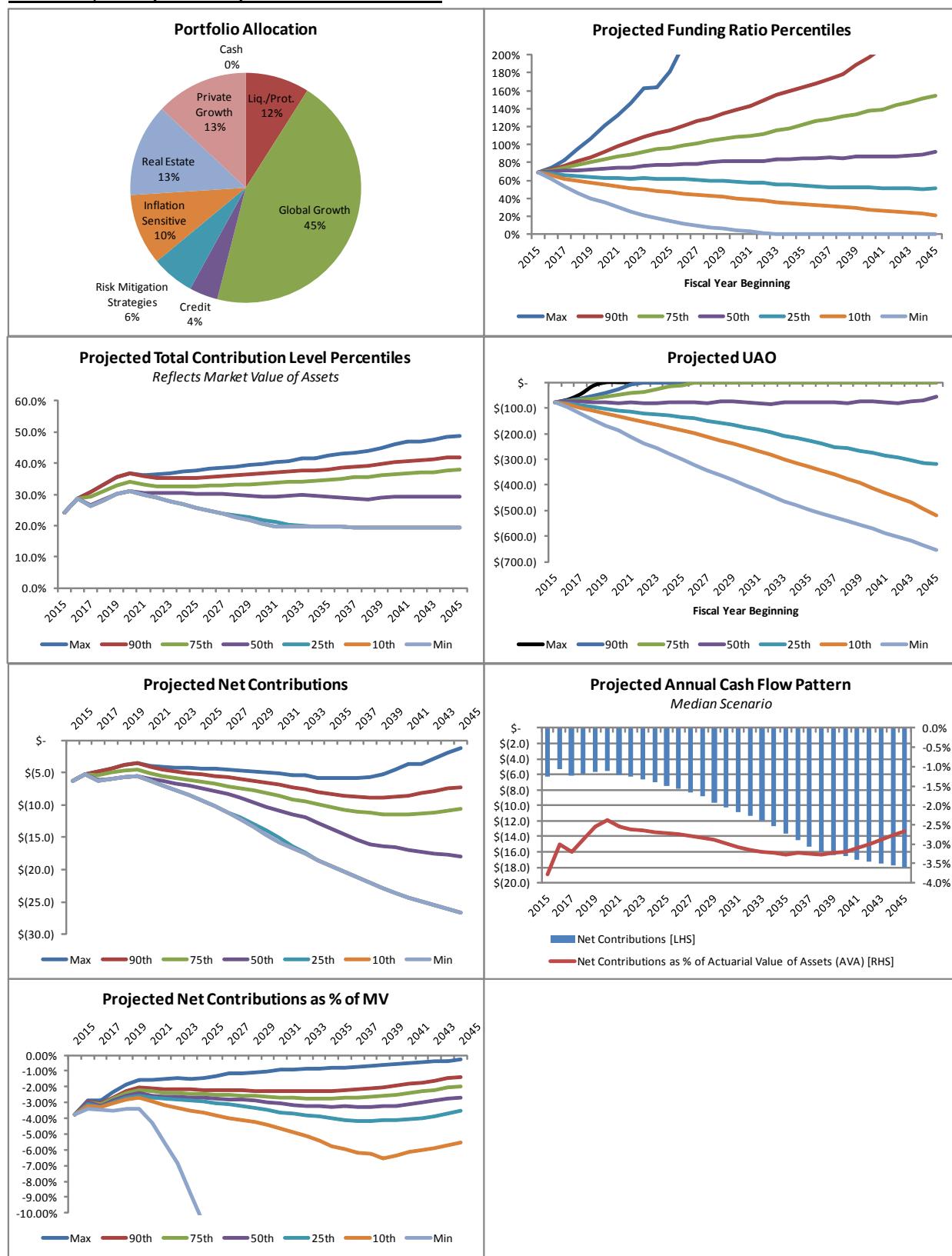
| Strategic Class Percentages | Current | MID | Diff. |
|-----------------------------------|---------------|---------------|---------------|
| Cash | 1.9% | 0.0% | -1.9% |
| Liquidity/Protection | 9.8% | 9.0% | -0.8% |
| Interest Rates | 5.3% | 4.8% | -0.5% |
| Securitized | 4.5% | 4.2% | -0.2% |
| Global Growth | 57.9% | 45.0% | -12.9% |
| US Equity | 38.0% | 16.9% | -21.1% |
| Non-US Equity | 19.5% | 16.9% | -2.7% |
| Developed Non-US Equity | 16.4% | 13.2% | -3.2% |
| Emerging Markets Equity | 3.1% | 3.7% | 0.6% |
| Fundamental Low Vol | 0.3% | 3.6% | 3.3% |
| Non-Market Cap Indexing | 0.0% | 3.6% | 3.6% |
| Option-writing Strategies | 0.1% | 4.1% | 3.9% |
| Credit | 6.1% | 4.0% | -2.1% |
| US Credit | 4.4% | 2.2% | -2.2% |
| Non-US Credit | 0.1% | 0.5% | 0.4% |
| US High Yield | 1.2% | 0.7% | -0.6% |
| Non-US High Yield | 0.0% | 0.2% | 0.2% |
| Bank Loans | 0.4% | 0.3% | -0.1% |
| Emerging Markets Debt | 0.0% | 0.2% | 0.2% |
| Risk Mitigation Strategies | 0.9% | 6.0% | 5.1% |
| Treasury Duration | 0.0% | 2.1% | 2.1% |
| Trend Following | 0.2% | 2.4% | 2.2% |
| Alternative Premia | 0.2% | 0.6% | 0.4% |
| Global Macro | 0.5% | 0.9% | 0.4% |
| Inflation Sensitive | 0.9% | 10.0% | 9.1% |
| TIPS | 0.3% | 3.0% | 2.7% |
| Timber | 0.0% | 1.0% | 1.0% |
| Infrastructure | 0.5% | 3.0% | 2.5% |
| Agriculture | 0.0% | 1.0% | 1.0% |
| Commodities/MLPs | 0.1% | 1.5% | 1.4% |
| Bank Loans | 0.0% | 0.5% | 0.5% |
| Real Estate | 12.5% | 13.0% | 0.5% |
| Private Growth | 10.1% | 13.0% | 2.9% |
| Total | 100.0% | 100.0% | 0.0% |

| Strategic Class Dollar Amounts | Current | MID | Diff. |
|-----------------------------------|--------------------|--------------------|--------------------|
| Cash | \$3,564.5 | \$0.0 | -\$3,564.5 |
| Liquidity/Protection | \$18,610.8 | \$17,178.9 | -\$1,431.8 |
| Interest Rates | \$10,114.2 | \$9,104.8 | -\$1,009.4 |
| Securitized | \$8,496.5 | \$8,074.1 | -\$422.4 |
| Global Growth | \$110,612.1 | \$85,894.6 | -\$24,717.5 |
| US Equity | \$72,557.4 | \$32,210.5 | -\$40,346.9 |
| Non-US Equity | \$37,282.9 | \$32,210.5 | -\$5,072.4 |
| Developed Non-US Equity | \$31,308.5 | \$25,156.4 | -\$6,152.1 |
| Emerging Markets Equity | \$5,974.4 | \$7,054.1 | \$1,079.7 |
| Fundamental Low Vol | \$564.0 | \$6,871.6 | \$6,307.6 |
| Non-Market Cap Indexing | \$0.0 | \$6,871.6 | \$6,871.6 |
| Option-writing Strategies | \$207.8 | \$7,730.5 | \$7,522.7 |
| Credit | \$11,627.2 | \$7,635.1 | -\$3,992.2 |
| US Credit | \$8,360.5 | \$4,122.9 | -\$4,237.6 |
| Non-US Credit | \$148.7 | \$916.2 | \$767.5 |
| US High Yield | \$2,350.8 | \$1,298.0 | -\$1,052.8 |
| Non-US High Yield | \$0.0 | \$381.8 | \$381.8 |
| Bank Loans | \$695.9 | \$534.5 | -\$161.4 |
| Emerging Markets Debt | \$71.3 | \$381.8 | \$310.5 |
| Risk Mitigation Strategies | \$1,704.4 | \$11,452.6 | \$9,748.2 |
| Treasury Duration | \$0.0 | \$4,008.4 | \$4,008.4 |
| Trend Following | \$372.5 | \$4,581.0 | \$4,208.5 |
| Alternative Premia | \$359.9 | \$1,145.3 | \$785.4 |
| Global Macro | \$972.0 | \$1,717.9 | \$745.9 |
| Inflation Sensitive | \$1,685.9 | \$19,087.7 | \$17,401.8 |
| TIPS | \$554.0 | \$5,726.3 | \$5,172.3 |
| Timber | \$0.0 | \$1,908.8 | \$1,908.8 |
| Infrastructure | \$985.2 | \$5,726.3 | \$4,741.1 |
| Agriculture | \$0.0 | \$1,908.8 | \$1,908.8 |
| Commodities/MLPs | \$146.7 | \$2,863.2 | \$2,716.5 |
| Bank Loans | \$0.0 | \$954.4 | \$954.4 |
| Real Estate | \$23,765.9 | \$24,814.0 | \$1,048.1 |
| Private Growth | \$19,306.0 | \$24,814.0 | \$5,508.0 |
| Total | \$190,876.8 | \$190,876.8 | \$0.0 |

| Strategic Class - Fees % | Current | MID | Diff. |
|----------------------------|--------------|--------------|--------------|
| Cash | 0.01% | 0.00% | -0.01% |
| Liquidity/Protection | 0.08% | 0.08% | 0.00% |
| Global Growth | 0.11% | 0.13% | 0.02% |
| Credit | 0.08% | 0.10% | 0.02% |
| Risk Mitigation Strategies | 1.27% | 0.53% | -0.74% |
| Inflation Sensitive | 0.78% | 0.72% | -0.06% |
| Real Estate | 0.75% | 0.75% | 0.00% |
| Private Growth | 1.67% | 1.67% | 0.00% |
| Total | 0.36% | 0.49% | 0.13% |

| Strategic Class - Fees \$ | Current | MID | Diff. |
|----------------------------|----------------|----------------|----------------|
| Cash | \$0.4 | \$0.0 | -\$0.4 |
| Liquidity/Protection | \$14.0 | \$13.2 | -\$0.8 |
| Global Growth | \$122.4 | \$113.8 | -\$8.6 |
| Credit | \$9.1 | \$7.8 | -\$1.2 |
| Risk Mitigation Strategies | \$21.6 | \$61.3 | \$39.6 |
| Inflation Sensitive | \$13.1 | \$136.6 | \$123.5 |
| Real Estate | \$178.2 | \$186.1 | \$7.9 |
| Private Growth | \$322.4 | \$414.4 | \$92.0 |
| Total | \$681.2 | \$933.2 | \$252.0 |

CalSTRS A/L Study Summary Statistics: MID Portfolio



MSCI Emerging Markets Index Country Membership as of 6/30/2015

| Region | Country | Percentage of Index | |
|---|----------------------|----------------------------|---------------|
| Americas | Brazil | 7.5% | 14.3% |
| | Chile | 1.2% | |
| | Colombia | 0.6% | |
| | Mexico | 4.5% | |
| | Peru | 0.4% | |
| Europe, Middle East & Africa | Czech Republic | 0.2% | 17.2% |
| | Egypt | 0.2% | |
| | Greece | 0.3% | |
| | Hungary | 0.2% | |
| | Poland | 1.5% | |
| | Qatar | 1.0% | |
| | Russia | 3.8% | |
| | South Africa | 7.9% | |
| | Turkey | 1.5% | |
| | United Arab Emirates | 0.7% | |
| Asia | China | 24.8% | 68.5% |
| | India | 7.7% | |
| | Indonesia | 2.3% | |
| | Korea | 14.3% | |
| | Malaysia | 3.2% | |
| | Philippines | 1.4% | |
| | Taiwan | 12.6% | |
| | Thailand | 2.3% | |
| | Total | 100.0% | 100.0% |

Endnotes

- ⁱⁱ Treasury duration is a measure of the interest rate sensitivity of a fixed income instrument. U.S. Treasuries are considered to be default-risk free. Therefore, the cash flows of the instrument are known with certainty, and for a given level of interest rates, can be priced with certainty. Treasury securities are issued regularly by the United States Treasury, with over \$12 trillion in securities currently outstanding. They are traded in a market that transacts over \$800 billion a day. <http://www.bloomberg.com/news/articles/2014-11-18/flash-boys-invade-treasury-bond-market-in-new-era-of-volatility> Duration is a mathematical description of the degree of price change that will occur if the level of interest rates change instantaneously by 100 basis points across the entire interest rate curve. For example, if a Treasury note has a duration of 7 and there is a 100 basis point shift down in interest rates (from say 3% to 2%), the price of the Treasury note will rise by 7%. This type of shift may occur if there is a sudden change in growth expectations as experienced in 2008. For a further explanation of Treasury duration, please follow this link: http://treasurydirect.gov/apps/fip/news/dfimarket_valuations_duration.ppt Treasury portfolios of virtually any duration can be constructed and maintained at very low cost, given the size and liquidity of the market. In addition, excellent historical data goes back over 60 years.
- ⁱⁱ Trend following – to construct the time series for any trend following strategy and the position taken in each market is determined by assessing the past return in that market over the relevant look-back horizon. A positive past return is considered an “up trend” and leads to a long position; a negative past return is considered a “downtrend” and leads to a short position. Therefore, each strategy always holds either a long or short position in every market. The look-back horizon (one month, 3 months, 6 months, 1 year, etc.) and the markets traded (rates, equity indexes, commodities, currencies), can vary by strategy. Data that we used to construct the historical series used to model strategy behavior is described in *A Century of Trend Following*, Fall 2012, Hurst, Ooi, Pedersen. See this paper for a description of underlying data, methods. https://www.efficient.com/pdfs/A_Century_of_Evidence_on_Trend-Following_Investing.pdf Trend following is one of the oldest trading strategies practiced. “As one example, consider the economist and trader David Ricardo, who flourished in the London markets from the 1790s until about 1818. A large trader in Consols (bonds) and stocks, he accumulated a large fortune from his speculations, which afforded him the leisure to focus on his primary interest in life, economics. Exactly what his methodologies were is not known, but it is to him that one of the most famous sayings in all of trading history is attributed: ‘Cut short your losses; let your profits run on.’” <http://www.michaelcovel.com/pdfs/stig-ostgaard.pdf> Furthermore, in 1949, in an article by Alfred Winslow Jones, “Fashions in Forecasting”, *Fortune* (March 1949), page 180, Jones, the originator of the hedge fund concept and founder of the first hedge fund, coined the term “Trend Following.” Currently, trend following is one of the largest hedge fund sub-strategies. Systematic trend following represents over \$250 billion in unlevered assets, representing almost 10% of total hedge fund industry assets under management. (HFR Global Hedge Fund Industry Report – Year End 2014).
- ⁱⁱⁱ Alternative premia strategies are defined relative to the market risk premium, which is often referred to as market “beta”. Additional premia are often the base of well-established hedge fund trading strategies. Alternative premia typically exist as compensation for identified risks or structural trading imbalances, and can be captured with systematic, rules-based (i.e. nondiscretionary) trading strategies. Such trading strategies are “market neutral,” meaning that they do not have market risk premium exposure. Thus, structuring exposure to these risk premia often requires the use of derivatives and leverage in a long-short portfolio. Below is academic literature documenting such premia, and is the data from which we modeled the historical series.
- Ilmanen & Kizer, *The Death of Diversification Has Been Greatly Exaggerated*, The Journal of Portfolio Management, Vol.38, Number 3, Spg 2012.
- Asness, Ilmanen, Israel and Moskowitz, *Investing with Style, The Case for Style Investing*, 2012.
- Carhart, Cheah, De Santis, Farell, and Litterman, *Exotic Beta Revisited*, FAJ Volume 70, Number 5, 2014. Page 24.
- ^{iv} Portfolio of CRO Strategies – The portfolio of Crisis Risk Offset (CRO) strategies is constructed using a weighted risk contribution of modeled return series of 30% Treasury duration, 40% Trend Following, and 30% Alternative Premia. This is one of many possible portfolios that could have been used. It is not optimized to any particular attribute, but rather is an example of a portfolio that might be constructed. Nevertheless, the impact of the addition of similar portfolio are robust in their diversifying attributes to a traditional portfolio.

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