

CALSTRS

2017 Review of Funding Levels and Risks

Presented November 3, 2017

EXECUTIVE SUMMARY

The purpose of this report is to assist the CalSTRS board, stakeholders, policymakers and the public to better understand and assess the risks inherent in the funding of the pension system. Understanding and accounting for these risks is critical to CalSTRS mission to secure the financial future of California's educators. This year's report investigates various risks faced by CalSTRS and measures their impact on the Defined Benefit Program.

Over the last fiscal year, CalSTRS has taken steps to strengthen the funding of the system by adopting new actuarial assumptions. Financial markets have also provided better than assumed returns, positively impacting projected funding levels and contribution rates. Even with these changes, improvements in funding levels are expected to be minimal over the next decade, as anticipated by the funding plan, while contribution rates from both employers and the State continue to increase.

In April of 2017, the board voted to increase the State's contribution rate by 0.5 percent of payroll. This marked the first time the board exercised its authority granted by the funding plan, which was enacted through Assembly Bill 1469 in June 2014. The employer contribution rate also continues to increase as detailed by the plan. The report finds that the authority granted in the funding plan has considerably reduced the risk of a low funded status or even running out of money. However, there is still the possibility that the contributions may not be sufficient to fully fund the benefits by the year 2046, especially if investment returns significantly fall short of expectations. Significant improvements in life expectancies above current assumption and declines in membership could also prevent full funding.

The report illustrates that, due to the gradual nature of the contribution rate increases, it will be several years before the unfunded actuarial obligation is expected to decrease. Consequently, improvements in funding levels are expected to occur slowly over time. As a result, large drawdowns like the one experienced in the 2008-09 fiscal year continue to pose a significant risk to the long-term funding of the system.

Key results and findings of this report are:

- Recent changes to the actuarial assumptions have put the System on a more sustainable funding path despite lowering funding levels in the short term.
- A strong investment performance in the 2016-17 fiscal year has mitigated some of the impact of the assumption changes resulting in expected lower contribution requirements for the State.
- Significant risk remains in CalSTRS ability to achieve full funding by 2046.
- The State contribution rate is highly sensitive to investment experience.
- As the System continues to mature over time, investment losses will have a greater impact on the contribution requirements needed to ensure full funding, especially for the State.

INTRODUCTION

This is the second annual report on CalSTRS' funding levels and risk. This report is intended to assist the board in assessing the soundness and sustainability of the System. To better understand the risks associated with funding the System, this report examines a range of potential negative outcomes, both economic and demographic, that could endanger the long-term funding of the System and prevent the System from reaching full funding.

This report is based on the June 30, 2016 Annual Valuation and reflects the changes that have occurred over the past year including the changes to actuarial assumptions adopted by the board in February 2017 and the 13.4 percent net investment return reported for the 2016-17 fiscal year. In this report, the focus is on:

- The changing pension environment, including the plan maturity and volatility.
- Significant changes to the System and funding levels in the past year.
- Negative amortization and its impact on long-term funding.
- Risks to long-term funding, including investment volatility, longevity risk, and risks of membership decline.
- Funding risk measures based on stochastic projections.

CHANGING PENSION ENVIRONMENT

This section examines the environment in which CalSTRS operates. Like other pension systems across the nation, CalSTRS continues to mature. The maturity of the System is examined in the context of the number of actives to retirees, the projected cash flows, and the so-called volatility ratios which measure the volatility in contribution rates in response to the volatility in investment returns. The section concludes with a discussion of the evolving economic environment and its impact on future expected returns.

Maturing of the System

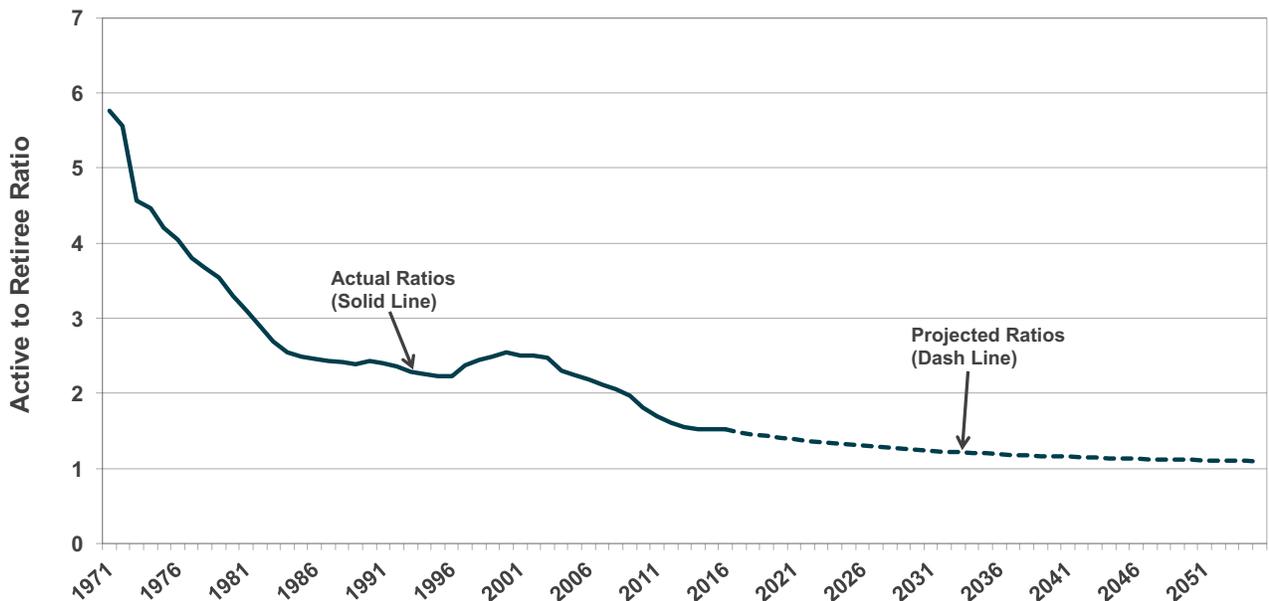
The aging of the population and the retirement of the baby boomers has been felt by all retirement systems across the nation. This demographic shift has long been predicted by actuaries and taken into account in the funding of the

System. Even though it was anticipated, this demographic shift is impacting the System and has increased the amount of risk faced by the System which will be demonstrated throughout this report.

There are various ways to assess the maturity level of a retirement system. One way is to look at the ratio of active members to retirees. In the early years of a retirement system, the ratio of active to retired members will be very high as the system will be mostly comprised of active members. As the system matures, the ratio starts declining. A mature system will often have a ratio near or below one. For CalSTRS and other retirement systems in the US, these ratios have been steadily declining in recent years.

The chart below illustrates CalSTRS historical and projected actives to retirees ratio. As can be seen on the chart below, the ratio of active to retired members for CalSTRS was almost 6 back in 1971 and has steadily decreased over time. Today the ratio is about 1.5. The ratio is projected to drop to close to one over the next 40 years but it is not expected to go below one over that time period.

CalSTRS Historical and Projected Actives to Retirees Ratio



CHANGING PENSION ENVIRONMENT

The above chart reflects the new actuarial assumptions adopted by CalSTRS in February 2017. At that time, the board adopted new assumptions including mortality assumptions that assume life expectancy will continue to improve in the future. If improvements in life expectancy end up being greater than the improvements currently built into the actuarial assumption, it would impact the active to retiree ratio and potentially bring the ratio closer to one over a shorter time period, even possibly below one.

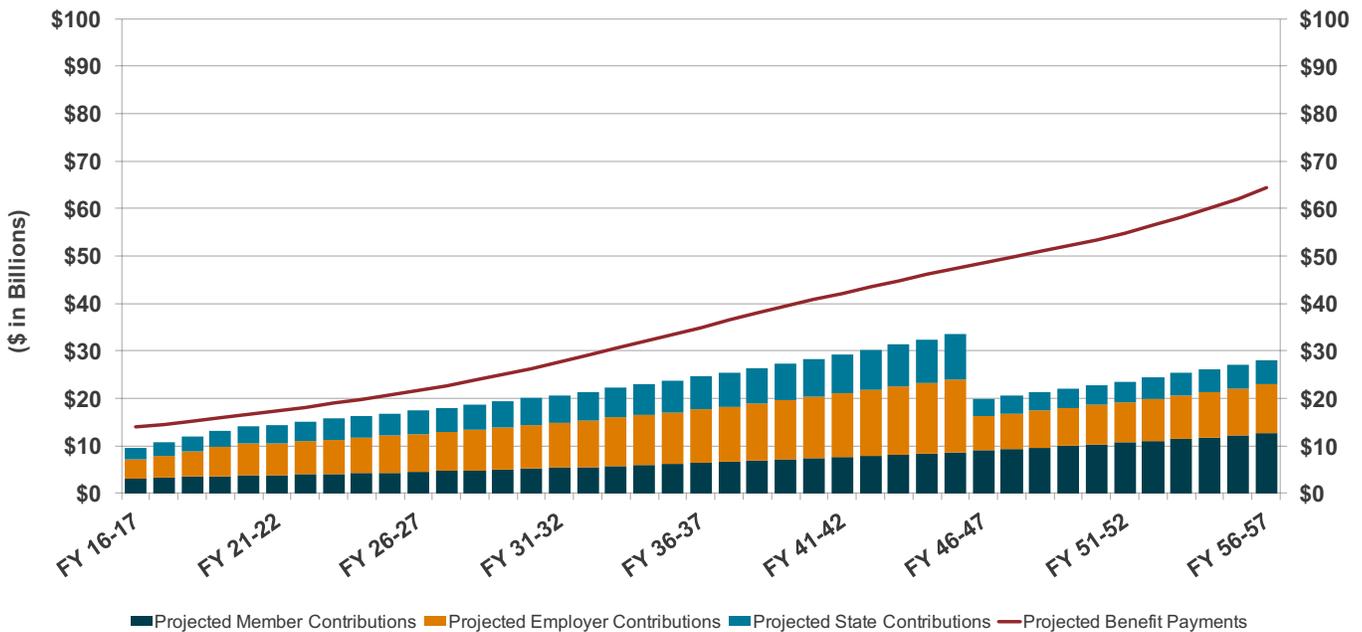
Note that the actives to retirees ratio chart was prepared assuming the number of active members would remain constant in the future. A decline in the CalSTRS active population could accelerate this trend and also push the ratio below one.

Projected Cash Flows

The cash flows for a retirement system are another good indicator of the maturity level. As a pension plan matures, it is normal for benefit payments to exceed contributions coming into the System. CalSTRS first experienced negative cash flows (simply measured as contribution revenue less benefit payment expense) in 1999, and since then, the gap between contributions coming in and the benefits being paid out has increased. In the 2016-17 fiscal year, the benefit payments exceeded the contributions by about \$5 billion. Negative cash flows are a natural state for any pension fund and are expected, but nonetheless need to be taken into account as part of the asset liability management process of a pension plan.

Next is a chart showing the projected cash flows for CalSTRS Defined Benefit and Supplemental Benefit Maintenance Account programs combined. As can be seen on the chart, the gap between contributions and benefit payments is expected to remain fairly stable over the next 10 years as contributions from both the State and employers increase per the funding plan. Beyond 10 years, the gap will start to widen and will increase further, especially after 2046 when contribution rates for both the State and employers will be reverting back to pre-funding plan levels.

Projected Cash Flows for CalSTRS
Reflecting 13.4% Return in FY 16-17 and Assuming 7.0% Return Thereafter



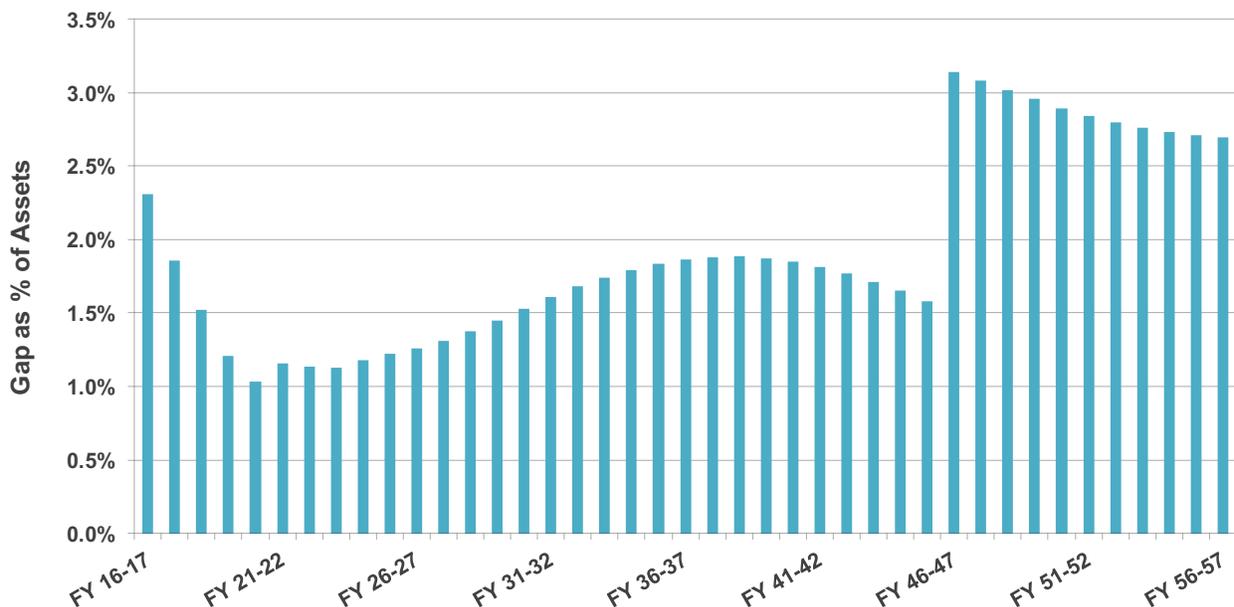
CHANGING PENSION ENVIRONMENT

Although negative cash flows need to be taken into account as part of the asset allocation decision process, negative cash flows do not necessarily imply the System will have to sell assets to make benefit payments. Cash generated from investments have to be considered as well as the relative size of the cash flows compared to the total assets in the fund.

Today, enough cash is being generated from investment income to cover the gap. The gap between projected benefit

payments and future contributions is expected to represent between 1 percent and 2 percent of the assets for the next 30 years. Cash generated by assets would have to be at least 2 percent of assets to avoid having to sell assets to pay benefits. Over the last 20 years, cash generated by investments has been between 1.8 percent and 3.7 percent of assets, with an average of 2.7 percent. The chart below illustrates the projected gap between contributions and benefit payments expressed as a percentage of assets.

**Projected Gap Between Contributions and Benefit Payments
(as a Percentage of Assets)**



Increasing Volatility

As retirement systems become more mature, these systems are subject to increased volatility in the contributions needed to fully fund the benefits. The drop in the active to retiree ratio over the last decade has increased the contribution volatility risk for CalSTRS and this volatility risk will continue to increase as the ratio continues to drop in the future.

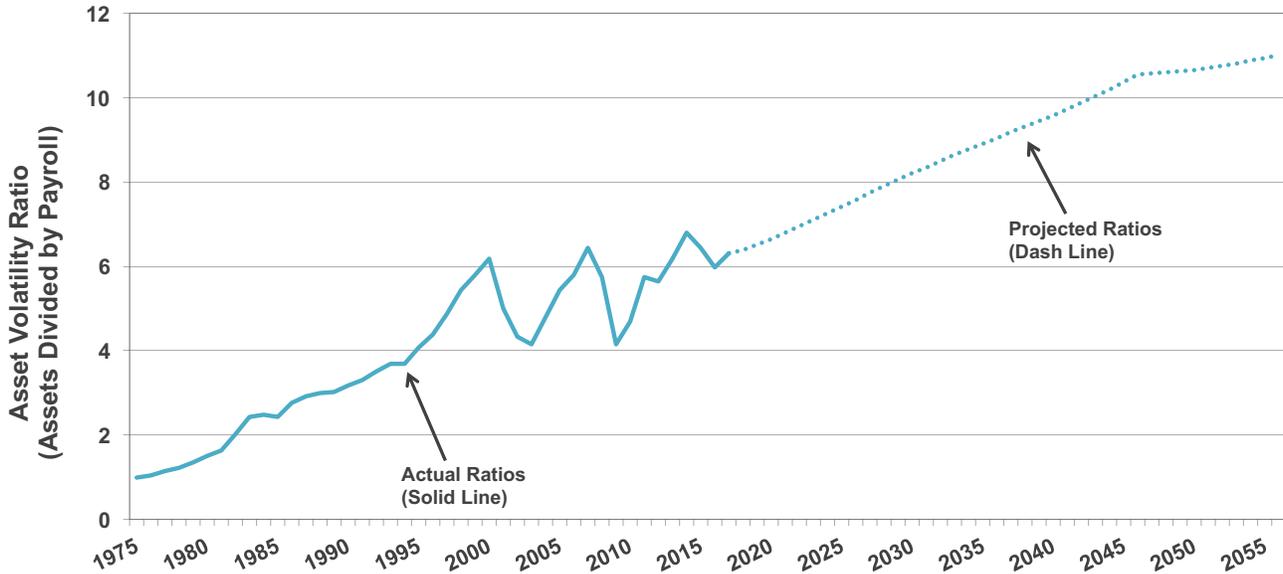
One indicator of the contribution volatility is the Asset Volatility Ratio (AVR). The AVR is the ratio of the market value of assets over the total payroll for active members. Plans with a high ratio will be subject to higher contribution volatility.

The AVR for CalSTRS has increased significantly over the last 40 years. Back in 1975 the AVR was at about 1 and has steadily increased ever since. As of the most recent actuarial valuation, the AVR was 6. This is typical for a mature System like CalSTRS. This means that the contribution volatility is currently 6 times higher than it was back in 1975. The AVR is expected to continue to increase over time, reaching 11 over the next 40 years.

CHANGING PENSION ENVIRONMENT

Below is a chart showing the historical AVR for CalSTRS along with a projection of the AVR for the next 40 years.

CalSTRS Asset Volatility Ratios



There are various reasons why the AVR is projected to increase over time. One reason is expected improvements in funding levels. Today the System is about 64 percent funded. If the System was 100 percent funded today, the AVR would be close to 9. As additional contributions flow into the System as per the funding plan, the funded ratio will improve and move toward the target of being 100 percent funded. As a result, the AVR will increase over time. In addition, the System has not yet reached its full maturity stage and as more members retire, we expect the AVR to continue to increase slightly.

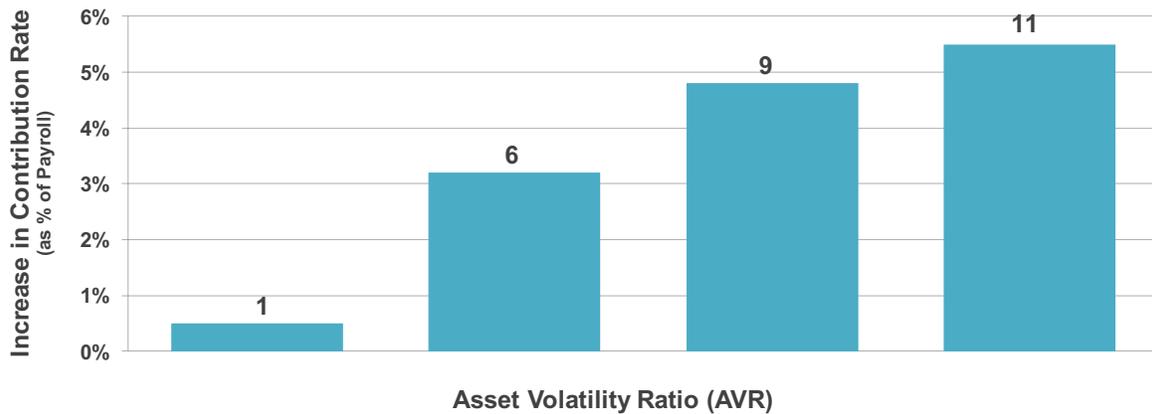
It is important to keep in mind that there is nothing to “fix” if the AVR is high. A high AVR simply indicates that there is more money invested for the plan—a good thing in the overall scheme of a pension plan. It should, however, serve as a reminder that the more money invested, the more of an impact investment gains and losses will have on the contribution levels needed to fully fund the System.

With the expected increases in AVR over time, the funding risk of the System will be greater in 20-30 years than it is today, resulting in greater volatility in the level of contributions that would be needed to ensure the plan remains 100 percent funded over the long term.

CHANGING PENSION ENVIRONMENT

To help demonstrate this increased contribution volatility, below is a chart showing the necessary increase in contribution rates to fund a 10 percent investment loss for various AVR assuming a funding target of 30 years. Note that a 10 percent investment loss represents a return of -3.0 percent, i.e. a return 10 percent less than the assumed 7.0 percent investment return. Over the last 20 years, the System has experienced a 10 percent investment loss on four occasions.

Estimated Increase in Contribution Rates to Fund a 10% Investment Loss (-3% Investment Return) (Assuming 30 Year Funding Period)



It is important to also mention that the System will face additional contribution rate volatility going forward due to the fixed time frame for paying down the unfunded actuarial obligation by 2046. Today, the existing shortfall is amortized over 30 years. In 10 years, any remaining shortfall will be amortized over 20 years. If markets were to fall short of expectations in 20 years, the shortfall would have to be paid over a 10 year period, requiring higher contributions than would normally be needed if the funding period was still 30 years. This additional contribution rate volatility could be eliminated if the funding plan was amended to allow for funding shortfalls over set periods of time rather than by a specific date.

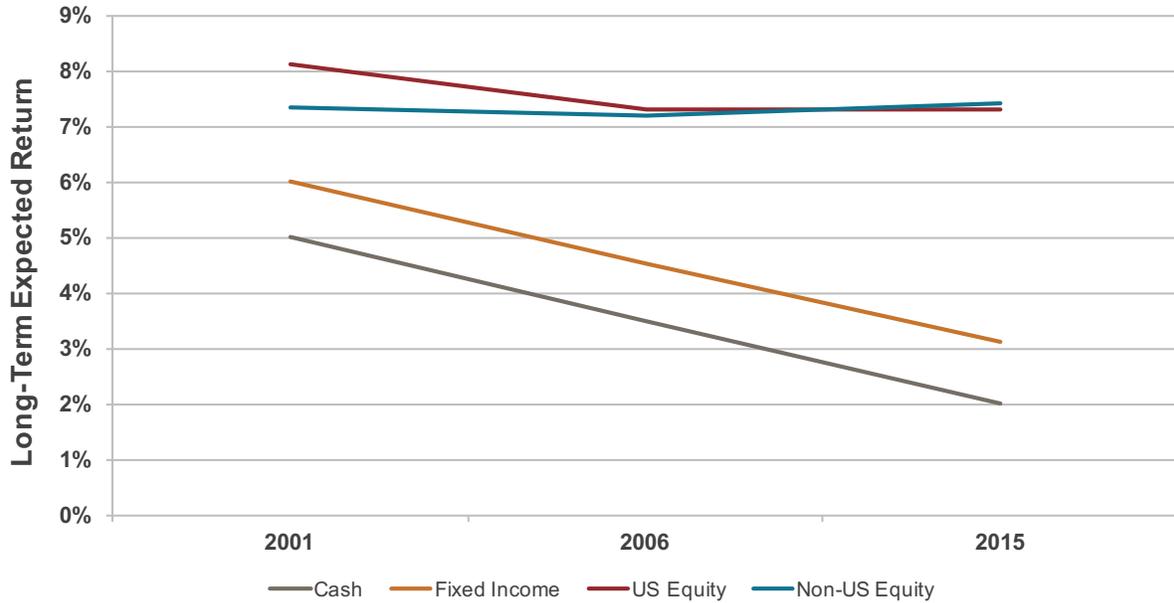
To ensure the long-term financial integrity of the fund and ensure members receive the benefits they were promised, the board has to be able to adjust contribution rates to levels necessary to eliminate the existing unfunded liability. With the expected increases in volatility combined with the shortening of the amortization period, there is a risk the rate setting limitations imposed by statute combined with a decline in financial markets could prevent the board from being able to set contribution rates to the levels necessary to ensure full funding. This will be analyzed further in the report.

CHANGING PENSION ENVIRONMENT

Changing Market Environment

Over the past 15 years, returns have been strong for many asset classes. During the same time, economic conditions have resulted in continuing declines in long-term government bond interest rates that serve as the foundation of capital market returns. The chart below provides snapshots of

expected returns for some of the major public asset classes from previous CalSTRS asset allocation studies. As can be seen, as interest rates fell, forward-looking expected returns on fixed income investments fell as a result. Over the same time period, expected returns for US Equity also fell, while expectations for Non-US Equity remained relatively stable.



These declines in expected returns for the various asset classes have resulted in a lowering of the expected returns that CalSTRS expects to earn each year on its investments. The environment means that for systems to expect to earn the same returns, they will have to accept a higher level of investment risk. In 2015, the board adopted Risk Mitigation Strategies to help address some of the increased risk while retaining some ability to achieve higher returns. To reflect changes in financial markets and anticipated returns from the new asset allocation, the board took action in February 2017 by adopting new actuarial assumptions, including the adoption of a long-term investment return assumption of 7 percent, 50 basis points lower than the previously assumed return.

CalSTRS is not alone in facing the changed expectations of what can be achieved in the capital markets. Information compiled by the National Association of State Retirement Administrators shows that among the 127 plans measured in the Public Fund Survey, more than half have reduced their investment return assumption since 2012.

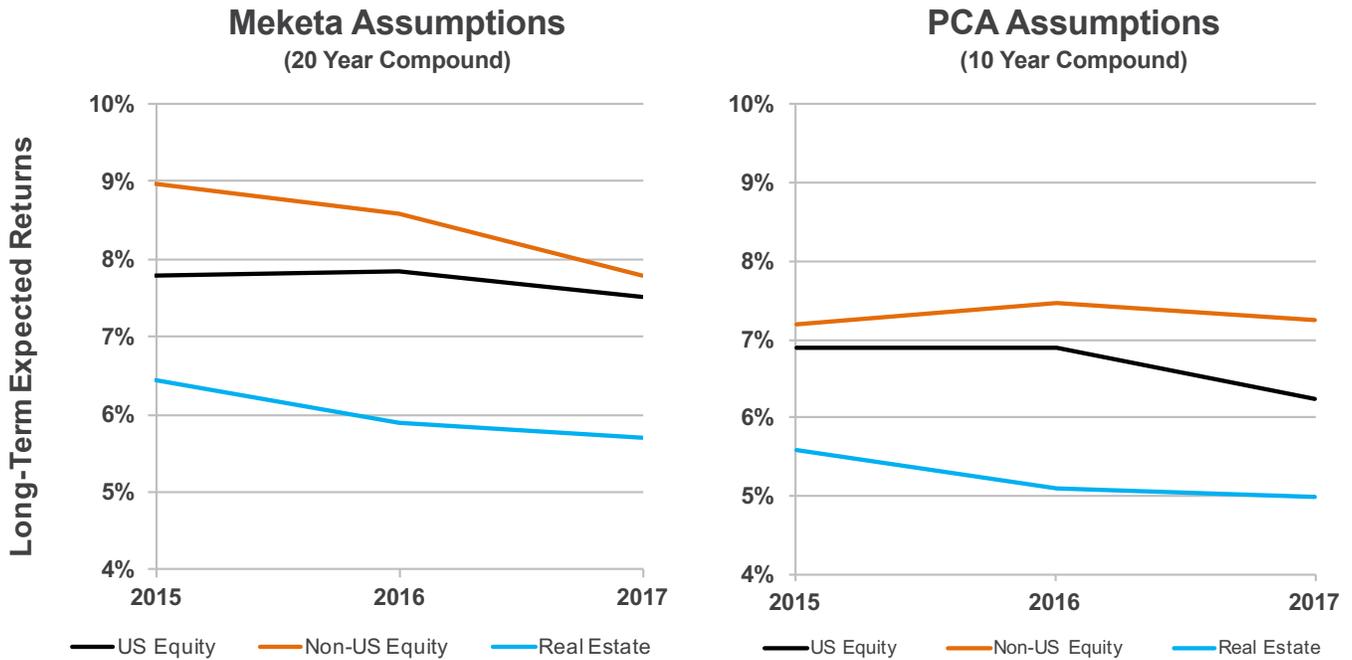
Long-term assumptions for the investment portfolio are updated every four years during the strategic asset allocation study. The last time they were updated and adopted by the board was in June 2015. The board will update long-term expected returns for the portfolio during the next asset allocation study in 2019. Between now and the 2019 study, CalSTRS will complete two important initiatives from the 2015 study designed to enhance long-term portfolio performance:

- Implementing a full allocation to the new Risk Mitigating Strategies class; and
- Transition in public equity from a US bias to global market weights.

During the 2019 study, the Investment Committee, consultants, and staff will again seek ways to secure long-term performance of the fund. Even if the board will not be adopting new capital market assumptions until 2019, the Investment Committee's General Investment Consultants (PCA and Meketa) publish long-term expected returns

CHANGING PENSION ENVIRONMENT

annually. Since 2015, expected returns for Fixed Income and Cash have remained relatively stable but low compared to historical levels. At the same time, expected returns for US Equity, Non-US Equity and Core Real Estate have generally fallen.



Although the charts above are for a different time period, both firms expect lower returns today than they did two years ago. Based on this trend, the likelihood of the system experiencing a sustained period of low returns in the short term is higher today than it was a decade ago. Later in this report, the impact and risk of sustained low returns on funding and contribution levels is examined in more detail.

One of CalSTRS' strategic goals is to ensure a financially sound retirement system for California educators. Over the last fiscal year, the board has taken steps to strengthen the funding of the system to ensure meeting this goal by adopting new actuarial assumptions. Financial markets have also provided better than assumed returns, positively impacting projected funding levels and contribution rates. Even with these changes, improvements in funding levels are expected to be minimal over the next decade as contribution rates from both employers and the State continue to increase. This section discusses the impact recent changes had on projected funding and contribution levels. We conclude by reviewing negative amortization and discussing the board rate setting limitations and their impact on long-term funding.

Significant Changes in the Past Year

In February 2017, the board adopted a new set of actuarial assumptions in order to strengthen the funding of the system and better align assumptions with expected future experience. Key assumption changes included longer life expectancies for members, lower inflation and lower expected investment returns over the long term. For more details on the new actuarial assumptions, please refer to the February 2017 board [item](#). The changes in actuarial assumptions were reflected in the June 30, 2016 actuarial valuations that were presented to the board in April 2017.

As indicated in the April 2017 actuarial valuation, the funded status was lower following the adoption of the new assumptions. It is important to understand that despite the decrease in the funded status as of result of the new assumptions, the new assumptions have put the system on

a more sustainable path towards full funding. By recognizing the shifting demographic and economic trends early the system can better plan and adjust contributions in advance.

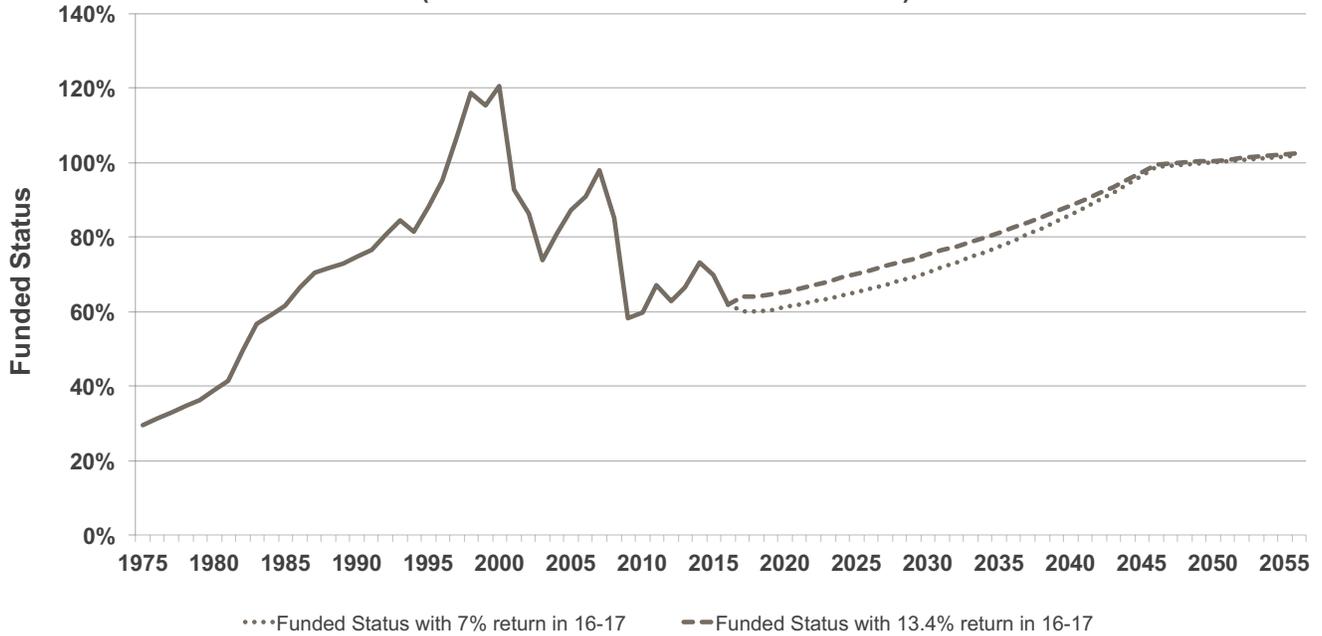
Another significant change since the prior report was the 13.4 percent investment return reported for the 2016-17 fiscal year. This return is greater than the long-term assumed rate of return of 7 percent. This better than assumed return will have a positive impact on the projected funding levels as well as reducing projected increases to the State contribution rate.

The next page displays a chart showing the historical and projected funded status for the Defined Benefit program and the impact of the 13.4 percent return in the 2016-17 fiscal year. Note that the projected funded status reflects the additional lowering of the investment return assumption from 7.25 percent to 7.00 percent that will be implemented with the June 30, 2017 actuarial valuations.

Throughout this report, the funded status displayed is calculated as the ratio of the market value of assets to the actuarial obligations since the market value of assets reflect the amount of assets in the fund at any given time that are available to pay benefits. For purposes of setting contribution rates, the CalSTRS board has adopted a rate smoothing method involving the use of an actuarial value of assets that recognizes investment experience over a three year period. This approach results in a funded status measured using the actuarial value of assets that differs from the funded status on a market value of assets, sometime higher and sometime lower, depending on past investment performance.

PATH TO FULL FUNDING

CalSTRS Historical and Projected Funded Status (Based on the Market Value of Assets)

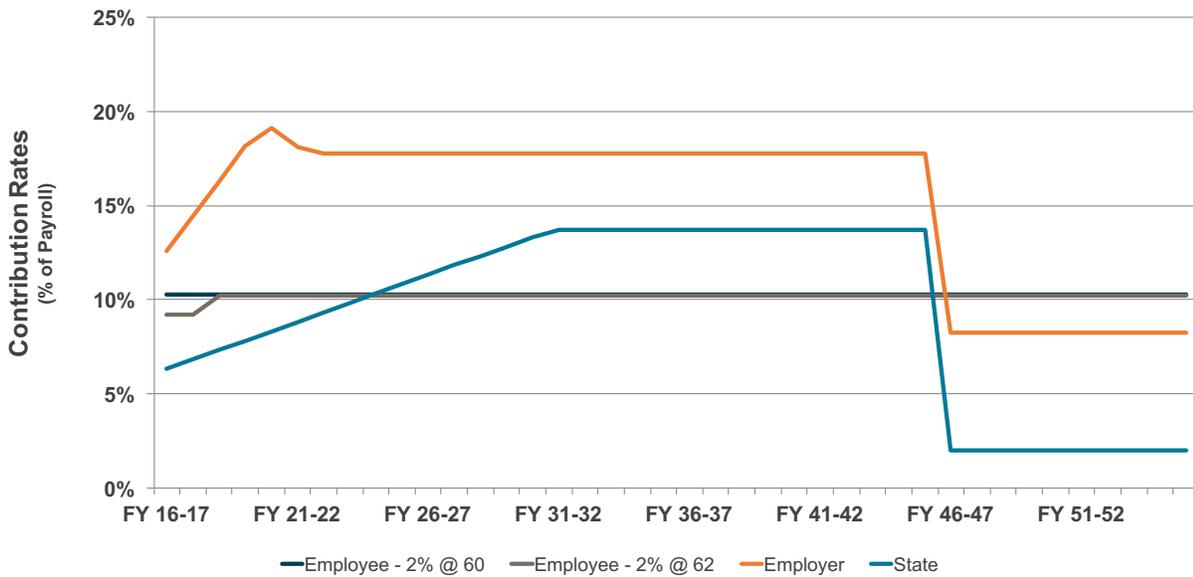


As can be seen on the above chart, the 13.4 percent investment return for fiscal year 2016–17 is expected to increase funding levels by almost 4 percent as of June 30, 2017. As a result, contribution rates for the State, will not have to increase as high as previously estimated. Note that member contribution rates are unaffected by investment performance. As was indicated to the board last April, the member contribution rate for the 2 percent at 62 members is expected to increase by 0.5 percent of salary on July 1, 2018 following the lowering of the investment return assumption to 7 percent in the June 30, 2017 actuarial valuation.

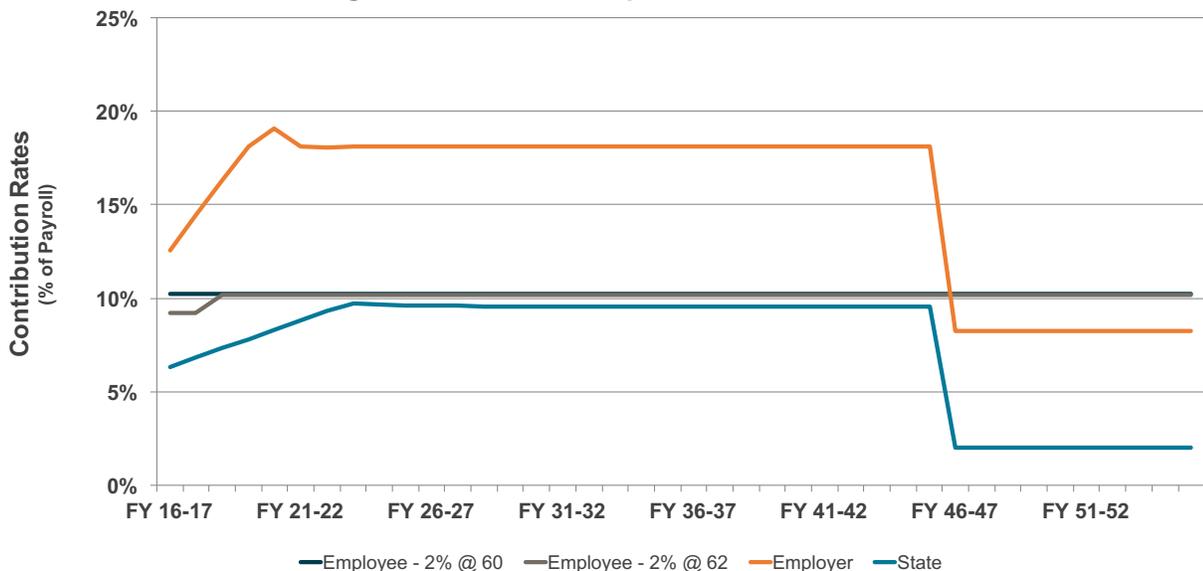
PATH TO FULL FUNDING

Below are two charts showing projected contribution rates. The first one shows the projected contribution rates that were provided to the board last April as part of the annual actuarial valuation. The projected rates assumed the investment return for fiscal year 2016-17 would be 7 percent. The second chart shows the projected rates reflecting the 13.4 percent return in fiscal year 2016-17. As can be seen in the two charts, the state contribution rate is now projected to increase and reach a level just below 10 percent of payroll. Last April, based on an assumed return of 7 percent for the fiscal year, the state contribution rate was expected to increase to about 13.7 percent of payroll. The significant reduction in projected contribution rates illustrates once again how investment volatility directly impacts contribution rate volatility, especially for the State.

Projected Contribution Rates Reflecting New Actuarial Assumptions



Projected Contribution Rates Reflecting New Actuarial Assumptions and 13.4% Return in 16-17



PATH TO FULL FUNDING

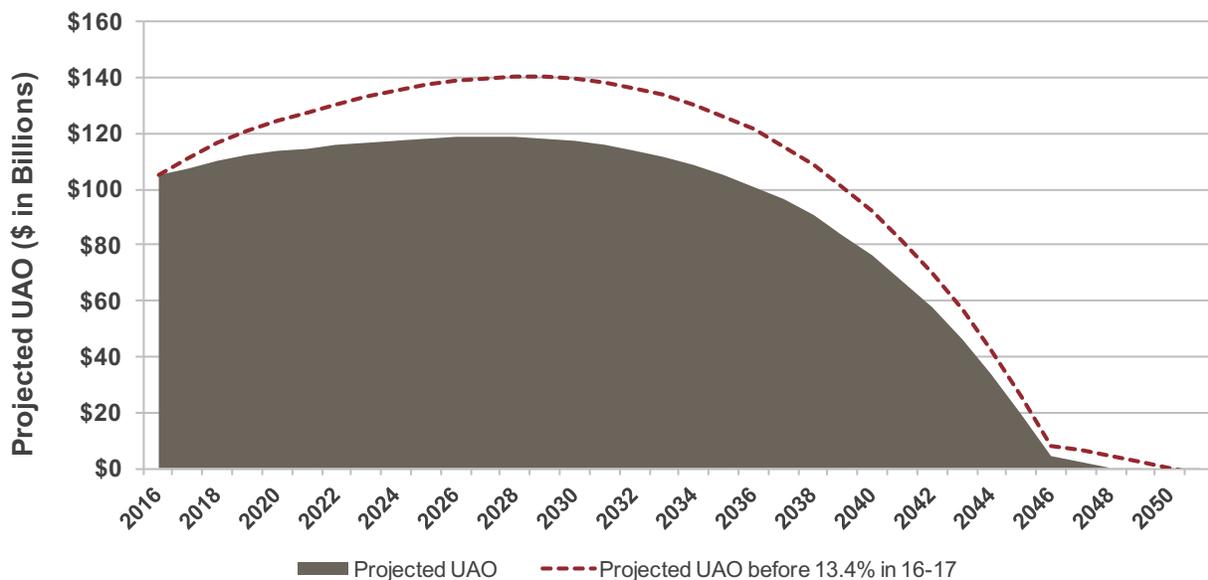
Note that due to rules and parameters set in statute for the CalSTRS funding plan, the State's nominal share of the assets actually exceeds the total assets. Since the employers' share of assets act as a balancing item, they effectively have negative assets. Therefore, the State's contribution rate experiences far greater volatility as a result of investment volatility and the employer's contribution rate tends to move, in most cases, in opposite direction of the State contribution rate. This can be seen by comparing the two charts on the previous page. As per the schedule set in the CalSTRS funding plan, the employer contribution rate is currently scheduled to increase each year until reaching 19.1 percent of payroll in fiscal year 2020–21. Based on projections performed last April, the employer rate was expected to decrease to about 17.6 percent in fiscal year 2021–22. Although the employer contribution rate is still expected to decrease in 2021-22, the employer contribution rate is now expected to decrease to 18.0 percent of payroll effective in fiscal year 2021–22.

Negative Amortization

Although the System is currently on a path to full funding, it is important to understand how the unfunded actuarial obligation (UAO) is expected to change over time. When pension plans are less than 100 percent funded, contributions in excess of the normal cost are needed in order to pay down the UAO and to make progress toward being 100 percent funded. In order to ensure the UAO does not increase on a year to year basis, the payments toward the UAO have to be greater than the interest that will be accrued on the UAO. Failing to contribute an amount in excess of the interest will result in the UAO increasing from year to year. This is referred to as negative amortization. For CalSTRS, in order to avoid negative amortization, the payment toward the unfunded actuarial obligation has to be more than 7 percent of the UAO.

In the 2017–18 fiscal year, the contributions toward paying down the UAO are expected to represent only 3.1 percent of the total UAO. As contribution rates for the State and employers continue to increase over the next few years, contributions will increase but they are not projected to exceed 7 percent of the total UAO until the 2028-29 fiscal year. As a result, the UAO is expected to increase until 2028 when it will start decreasing. The next chart shows the projected UAO in dollars reflecting both the impact of the new actuarial assumptions and the 13.4 percent investment return in fiscal year 2016-17. The projected UAO includes the impact of lowering the investment return assumption to 7 percent in the upcoming actuarial valuation. For comparison, the chart contains a red dash line which illustrates the total UAO before the 13.4 percent return in 2016–17, i.e. assuming the return had been 7 percent.

Projected Unfunded Liability



PATH TO FULL FUNDING

As can be seen, the better than expected return in 2016–17 resulted in a decrease of about \$20 billion in the projected UAO. The UAO is now projected to increase to about \$120 billion by 2028 upon which it will start to decrease.

Note that negative amortization is fairly common among public plans and is generally the result of the funding practice. For most public plans, contribution requirements are expressed as a percentage of the payroll. This has long been the preferred approach to provide budget stability to employers. Because payroll is expected to increase over time, contribution amounts will increase as well. For CalSTRS, payroll is assumed to increase annually at a rate of 3.5 percent. This means that payments toward the UAO will be larger in 20 years than they are today even if the contribution rates remain the same. In a way, payments to eliminate the existing UAO are back loaded. As a result, the UAO is expected to increase for the next decade and start declining starting in 2028. 20 years from now, the UAO is expected to be back to about \$100 billion, the current level today. Note however that the funded status at that point is expected to be about 80 percent.

The risk of not seeing a decrease in the size of the UAO could be exacerbated in the future due to the limited ability of the board to adjust contribution rates, especially if the System were to experience consecutive years of return below the assumed 7.0 percent.

Unallocated UAO

Although the funding plan has helped improve the long-term sustainability of the System, it is still not a perfect setup. The board now has limited rate setting authority to allow the system to reach full funding by 2046. The funding plan however did not grant the board authority to adjust contribution rates to pay for the entire UAO in place today.

As per current Statute, the State is responsible for any UAO related to all service but limited to benefits that were in effect prior to 1990. The board can increase, if necessary, the State contribution rate by 0.5 percent of payroll each year to pay down their share of the UAO.

The employers are responsible for any UAO that can be attributed to the new benefit structure i.e. any benefit changes on or after 1990 but that responsibility is limited to service accrued by teachers before July 1, 2014. Effective with fiscal year 2021–22, the board will be able, if necessary, to adjust the employer contribution rate by no

more than 1 percent of payroll each year, never to exceed 20.25 percent of payroll, to pay down the employer's share of the UAO.

Since the employer's share of the UAO is limited to service earned prior to July 1, 2014, this in effect means that the board cannot adjust contribution rates for any UAO that may develop for the new benefit structure and service accrued on or after July 1, 2014. The UAO related to post 1990 benefits and post July 1, 2014 service is referred as the "unallocated UAO".

Since the start of the funding plan, a small unallocated UAO has developed resulting mostly from a combination of investment experience and the new actuarial assumptions adopted by the board in February 2017. The size of the unallocated UAO, currently just under one billion dollars, is very small relative to the overall UAO since it is only for service post July 1, 2014. However, since the Board cannot adjust contribution rates to pay for the unallocated UAO, it is projected to increase five fold by the end of the funding plan due to interest alone. Because of the unallocated UAO and the board's inability to adjust contribution rates to eliminate it, the system is projected to be just short of 100 percent funded by 2046.

The current unallocated UAO could be eliminated in a number of ways. For example, if investment returns were to exceed the expected return, the gains would offset some or all of the unallocated UAO. We estimate that a return of 13.5 percent in a single year would be sufficient to completely eliminate the unallocated UAO. Similarly, a return of 9 percent in each of the next 3 years or 8.5 percent in each of the next 5 years would also be sufficient. Alternatively, if the board were given authority to increase contribution rates for the unallocated portion, we estimate the contribution rate would need to be about 0.15 percent of payroll over the next 30 years in order to pay down the unallocated UAO.

If the unallocated UAO is not eliminated by the time the funding plan ends, it is still projected to be paid down over time based on information and assumptions as of today, as long as both the employer and state's share of the UAO have been fully eliminated by 2046. This is due to the fact that once the State and employers have paid their share of the UAO, the base contribution rates set in statute for members, employers and the State are projected to be larger than the annual cost of the benefits referred to as the

PATH TO FULL FUNDING

normal cost by about 2.7 percent of payroll. These excess contributions will help improve the funded status and help mitigate funding risks once the State and employers' shares have been fully paid.

There is a risk that going forward these excess contributions may disappear since the normal cost is determined based on actuarial assumptions adopted by the board. The most recent changes in assumptions increased the normal cost by about 2 percent of payroll, reducing the anticipated excess contributions. Future changes in assumptions that increase the normal cost will further reduce the excess contributions available for funding the system, including funding the unallocated UAO.

The risk related to the unallocated UAO will increase over time as the size of the actuarial obligation related to the unallocated UAO is expected to represent a growing share of the total actuarial obligation. Today, it represents about 2 percent of the total actuarial obligation. Over the next 20 years, it is expected to approach 10 percent. To eliminate this risk, laws would have to be changed to grant authority to the CalSTRS board to adjust the contribution rates to pay down any unallocated UAO that may exist. The risk related to the unallocated UAO and how it may impact full funding going forward has been included in all the work performed for this report and is reflected in the risk measures provided later in the report.

THE RISK ENVIRONMENT

This section examines several risks that could pose challenges to CalSTRS ability to reach full funding by 2046. In order to understand the extent of the risks faced, several stress tests were performed to determine to what extent each risk would need to manifest itself in order to threaten the funding of the system. It is important to note that although each risk was examined in isolation, in reality the system has the potential to face these challenges in combination which could have a compounding effect. The following risks are considered in this section:

- Investment Risk
- Longevity Risk
- Membership and Payroll Growth Risk

Throughout this section, an emphasis is placed on the funding levels of the system. For these analyses, the funded status used is the one based on the fair market value of assets rather than the actuarial value of assets since the market value of assets reflects the actual amount of assets available to pay benefits.

Investment Risk

Investment return volatility is the greatest risk facing CalSTRS today. As the System continues to mature over time, investment returns will have a greater impact on the funding of the system than they do today. When investment returns are below expectation, the unfunded actuarial obligation increases and additional contributions are needed to bridge the gap. With the passage of the funding plan, the board has limited authority to increase contribution rates for the State and employers in order to pay down the unfunded liability by 2046. However the plan limits both the level of rates that can be imposed and the increases allowed from one year to the next. Additionally, this authority is set to expire in 2046.

A series of stress tests related to investment return volatility were performed to determine to what extent the funding plan can be expected to achieve its goal of full funding by 2046.

Risk of Sustained Low Returns

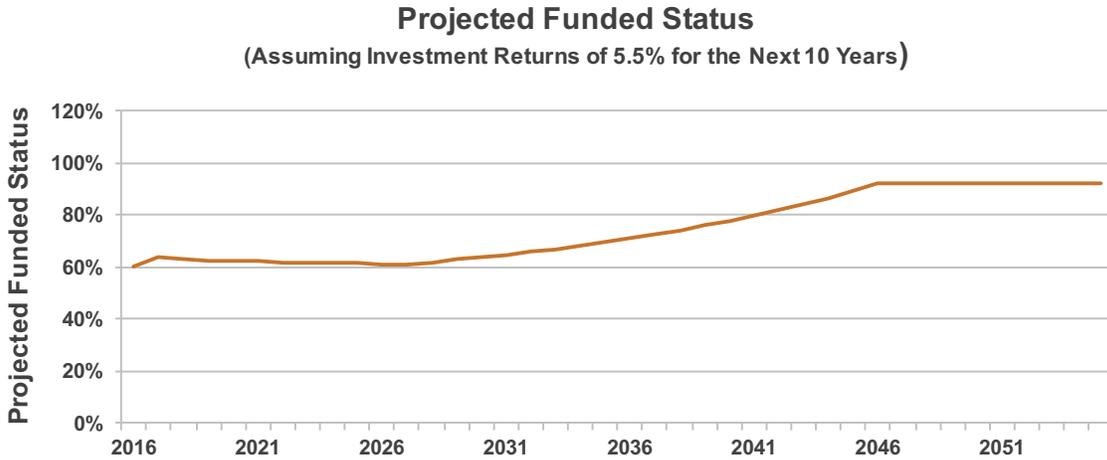
For many in the economic and investment fields, the consensus view is that a low return environment may persist for some time into the near future. The purpose of this section is not to validate whether this view is correct or incorrect but to determine the minimum investment return the system could sustain over the next 5, 10 and 15 years and still recover and reach funding levels that are expected to remain stable by the end of the funding plan.

Because of the rate setting limitations imposed by statute, a sustained period of low returns could prevent the System from reaching full funding. For this report, thresholds were identified as the lowest returns that could be sustained over a short period of time to allow CalSTRS to reach funding levels that would be high enough to remain stable and not decline over time, following the end of the funding plan. Although the goal is to reach 100 percent funded, the System should avoid situations where funding levels are once again expected to decline following the end of the funding plan. It was determined that as long as the funded status reached about 90 percent by 2046, the statutory contribution rates of 8.25 percent of payroll for employers and 2.017 percent of payroll for the State would be enough, along with member contributions, to keep the funded status at stable levels beyond 2046.

Over a 10 year period, the funding plan would be able to absorb the impact of returns of 5.5 percent each year. Assuming the board exercises its authority to increase contribution rates, funding levels would be about 90 percent in 2046 and remain stable beyond the end of the funding plan.

THE RISK ENVIRONMENT

Below is a projection of the funded status under this scenario.



Below is a table showing the lowest returns that could be sustained over 5, 10 and 15 years with the System reaching funding levels that are expected to remain stable by the end of the funding plan. The table also shows the probability of seeing returns either equal or lower over the given period. In all three scenarios, funding levels would end up about 90 percent in 2046 and would remain stable beyond that point, once the funding plan has ended. Anything lower than these rates of return over the specified period would result in funding levels slowly declining following the end of the funding plan.

Period	Return	Probability
5 Years	4.25%	33%
10 Years	5.50%	34%
15 Years	6.00%	37%

In all these scenarios, the state bears most of the responsibility when it comes to having to contribute more following investment performance below expectations. This is a direct result of the fact that today the State is responsible for about 80 percent of CalSTRS overall actuarial obligation and the assets that support them. In all three scenarios, the State rate would have to increase each year by the maximum allowed of 0.5 percent of payroll to a peak rate of 20.8 percent in fiscal year 2045-46 at which point the funding plan ends and the rate drops back down to pre-funding levels of 2.017 percent. To allow the system to reach full funding, the funding plan would have to be extended to provide more time to operate or more

flexibility to increase the rates faster in order to pay down the resulting unfunded liability.

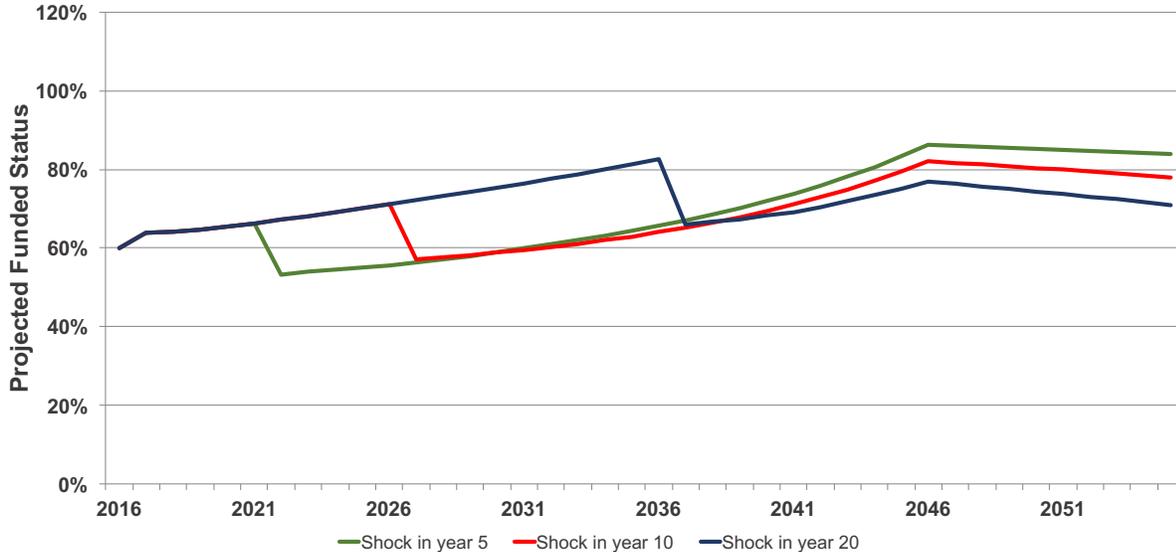
Risk of a “Shock” in a Single Year

In 2008-2009, financial markets crashed around the world resulting in the worst investment annual performance on record for CalSTRS. This single event caused the funded status of the System to drop by more than 30 percent in a single year, resulting in the need for the funding plan to avoid a future depletion in assets.

Even with the current funding plan in place, the system remains at risk if another return “shock” were to occur in a single year. The impact of a decline would also be different depending on the timing. As the System continues to mature, investment declines will be harder to absorb the later they occur, especially when considering the scheduled ending of the funding plan in 2046. In addition, over the next decade with funding levels expected to remain below 70 percent, a large shock could have a drastic impact on the long term funding of the system. There are also political risks associated with low funding levels.

Based on the current asset allocation and capital market assumptions adopted by the board, there is a 5 percent probability that in any given year the investment return will be minus 13 percent or worse. The next chart shows the impact a minus 13 percent investment return in a single year would have on the system if it were to occur in 5, 10 or 20 years from now. To conduct this stress test, it was assumed that the fund would earn 7 percent in every year

Projected Funded Status Impact of a -13% Investment Shock



except for the year of the shock. Once again, the funded status was projected assuming the board exercises its authority to increase contribution rates.

As can be seen, the timing of the shock influences the projected funded status at the end of the funding plan. For example, if the shock occurs five years from now, funding levels would drop to close to 50 percent but would have time to increase back to almost 90 percent by 2046. If the shock were to occur 20 years from now when funding levels are about 80 percent, funding levels would drop close to 60 percent but would not have time to recover as much and still be below 80 percent by 2046. The chart also shows that in all three cases, following the end of the funding plan, the

funding levels would be expected to slightly decline each year in the future. To avoid this situation, the funding plan would have to be extended to provide more time to operate or amended to provide more flexibility to increase the rates faster in order to pay down the resulting unfunded liability.

The impact of shocks with a 1 percent and 10 percent probability were also analyzed. Based on the current asset allocation, there is a 10 percent probability that returns in a single year will be minus 8 percent or lower and a 1 percent probability the returns will be minus 25 percent, the return experienced in 2008–09. Below is a table showing the projected funded status in the year following the shock as well as the projected funded status in 2046.

Timing of Shock	-8 % Shock Return		-25% Shock Return	
	Funded Status After Shock	Funded Status in 2046	Funded Status After Shock	Funded Status in 2046
In 5 Years	57%	90%	45%	74%
In 10 Years	61%	86%	48%	68%
In 20 Years	70%	83%	55%	62%

Once again, the above projections assumed financial markets would provide a return of 7 percent in all other years. It is also worth highlighting that if funding levels are at or below 70 percent in 2046, the System would once again be projected to run out of assets over the next 30 to 40 years. To avoid this situation, the funding plan would have to be extended to provide more time to operate.

THE RISK ENVIRONMENT

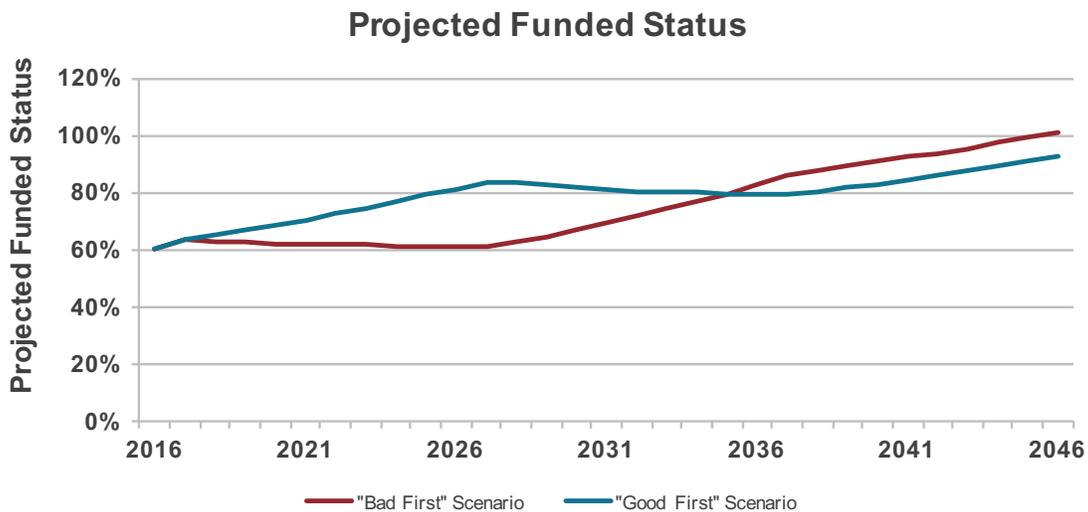
Risk due to “Path Dependence”

The concept that outcomes depend not only on the level of returns but also the order in which they occur is called path dependence. Because of the board’s limited ability to set contribution rates, the timing of returns will play a significant role in the success of the funding plan. As the system continues to mature, the funding of the system will be more affected by investment volatility and poor investment returns if they occur later rather than sooner.

To illustrate this point, two scenarios were analyzed:

- Returns of 5.50 percent for 10 years followed by 8.50 percent for 10 years followed by 7.00 percent returns every year thereafter; this is the “bad first” scenario.
- Returns of 8.50 percent for 10 years followed by 5.50 percent for 10 years followed by 7.00 percent returns every year thereafter; this is the “good first” scenario.

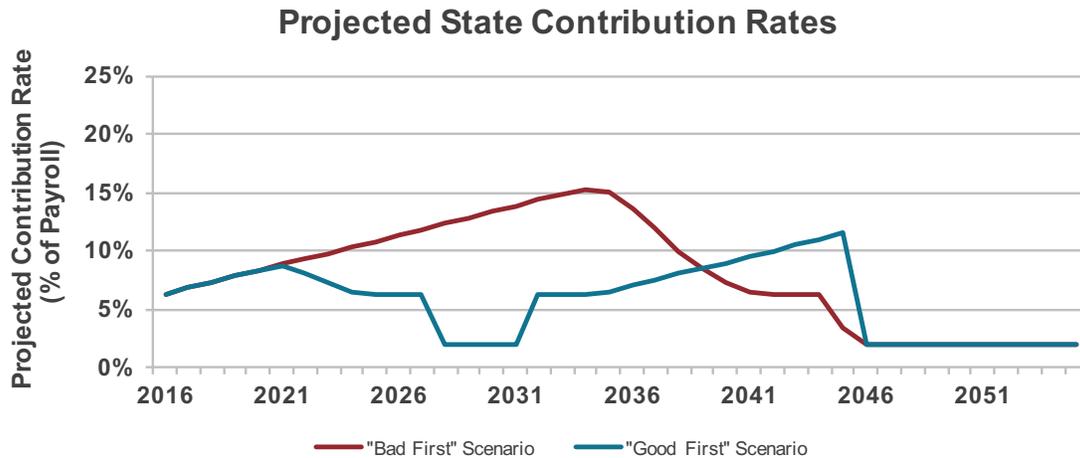
Both of the above scenarios are expected to earn an average compounded return of about 7 percent over a 30-year period. As the following charts illustrate, each scenario results in different outcomes for the System. Below is a chart showing the projected funded status under both scenarios.



In the “bad first” scenario, despite remaining around 60 percent funded for the first 10 years, the fund recovers once the good returns are realized and eventually reaches 100 percent funding by 2046. In contrast, the “good first” scenarios sees a quick initial improvement in funded status as the system is experiencing the good returns, however it starts dropping once the bad return period starts and never quite recovers, ending at a funded status of about 93 percent in 2046.

THE RISK ENVIRONMENT

To better understand the disparity in outcomes, it helps to analyze the projected state contribution rates under each scenario. Under the terms of the funding plan set by statute, the state's contribution rate is far more sensitive to investment volatility than the employer contribution rate. The chart below illustrates the state's projected contribution rate in each scenario.



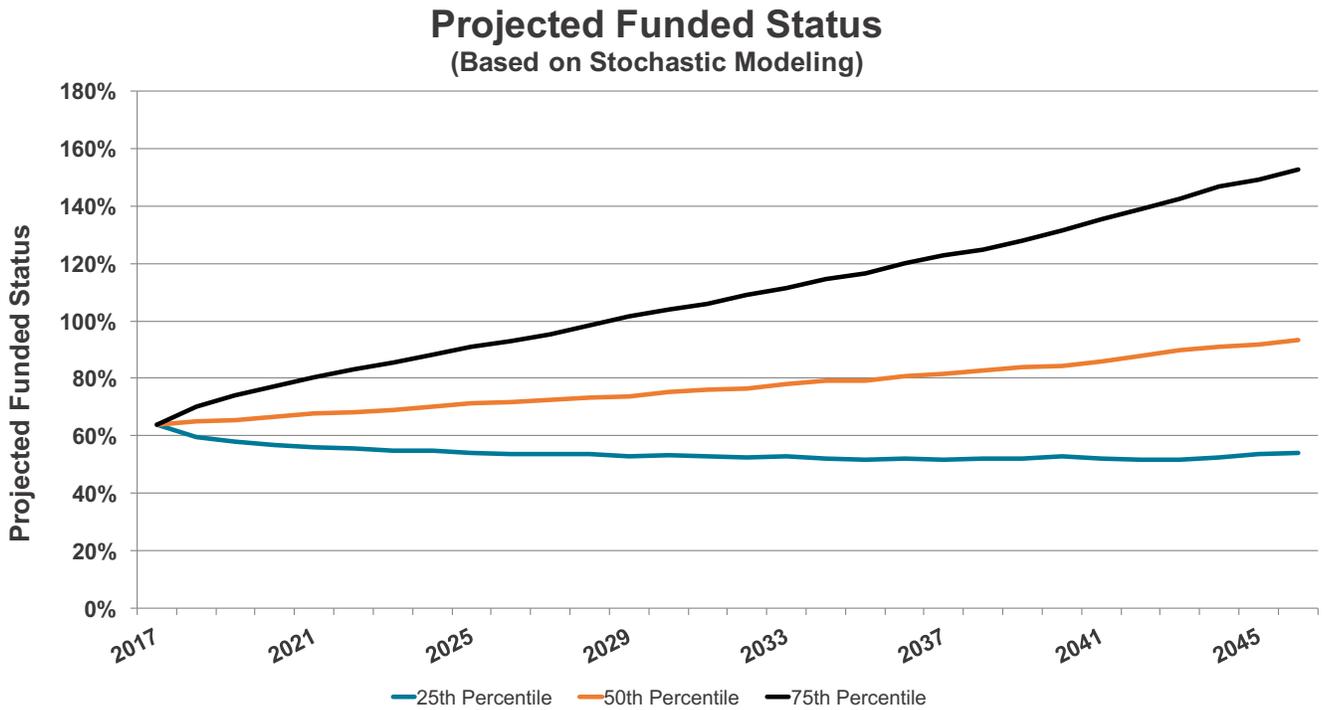
The board is limited to increasing the states rate by only 0.5 percent in a given year however the rate can be decreased without limit down to pre-funding plan levels if there is no remaining pre-1990 UAO. This is exactly what happens in the good return first scenario, by 2028 the states contribution rate has dropped back to pre-funding level as their share of the UAO is fully paid by that time. However once the poor returns start accumulating and the rate begins increasing again, there is not enough time to increase the rate sufficiently to pay down the State's share of the UAO before the end of the funding plan. In contrast, for the bad return first scenario the system is at a higher initial rate when the losses start to occur and has more time to increase the rates in order to pay down the resulting UAO.

Impact of Long-Term Investment Performance

The analyses above focused on deterministic scenarios in which the expected return of 7 percent was met in most years. In reality, it is unlikely that the system will have a return of exactly 7 percent in any year due to volatility around the mean. A stochastic model was used to assess the impact of long term investment performance on the funding levels. 5,000 sets of Monte Carlo simulations were performed based on the most recent asset allocation adopted by the board in November 2015 and further adjusted to reflect the recent change to the actuarial assumptions. For each simulation, the assets and liabilities for the System were projected for the next 30 years.

THE RISK ENVIRONMENT

Below is a chart showing the 25th, 50th and 75th percentile of the projected funded status for the DB program. Note that the compounded investment return over the 30 year period was just under 5.5 percent for the 25th percentile and just above 8.5 percent for the 75 percent percentile.



As can be seen above, under the 50th percentile, the System is expected to reach a funded status of 93.3 percent by 2046. This expected funded status as of 2046 represents a decrease from the previous funding levels and risk report in which we were expected to reach 100 percent funding in the 50th percentile. This decrease is a consequence of the change in actuarial assumptions adopted in February 2017. As expected and illustrated earlier in this report, if extremely long periods of low investment return were to persist, the System would not be able to achieve full funding by 2046 as shown by the 25th percentile line.

Risk Measures

The previous funding levels and risk report introduced a series of risk measures that focus on risks related to funding levels and contribution levels. As discussed previously, for funding levels, the funded status used for risk measures is the one based on the fair market value of assets rather than the actuarial value of assets since the

market value of assets reflects the actual amount of assets available to pay benefits.

Using the same 5,000 Monte Carlo simulations described earlier, several probability based risk measures were developed to illustrate the various areas of risk.

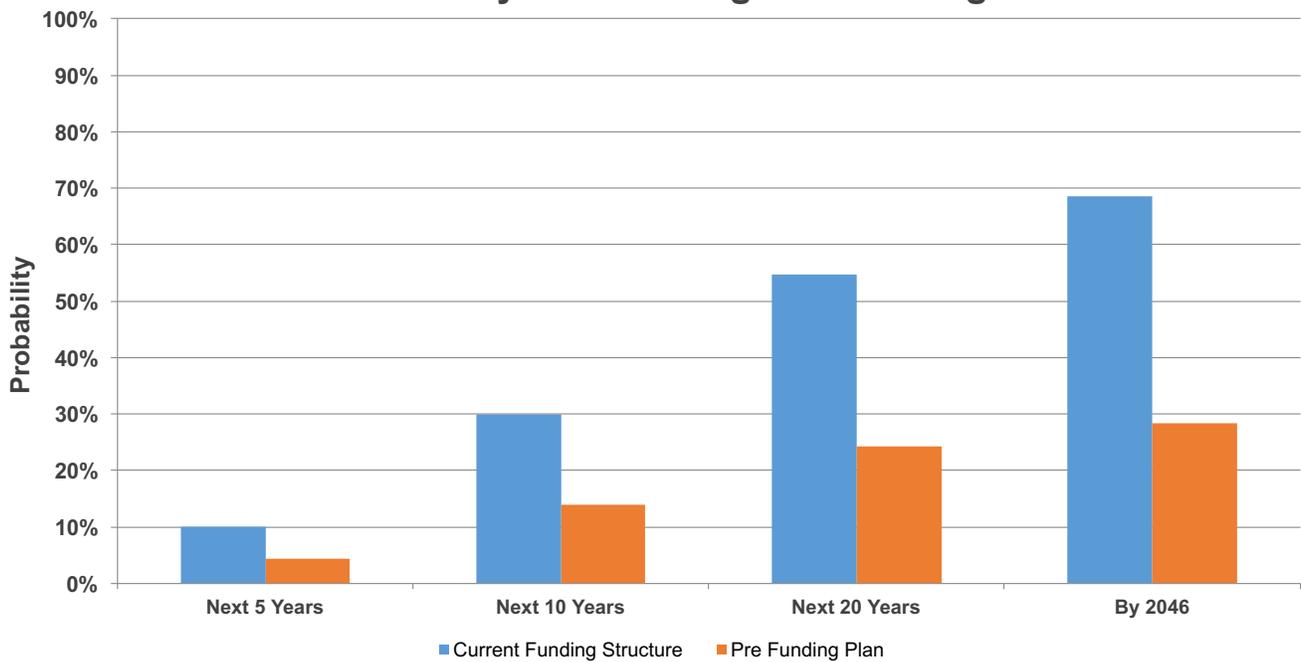
Probability of Achieving Full Funding

As a System, CalSTRS has come a long way when it comes to funding risk. Prior to the passage of the funding plan, the System was projected to run out of money in about 30 years. The System is now on track to be fully funded by 2046. However, full funding is projected under the assumption the fund will earn 7.0 percent each year until 2046. Due to the uncertainties and volatility associated with the current asset allocation, better than expected investment experience could allow us to reach full funding prior to 2046 while returns lower than expected may prevent us from ever achieving full funding.

THE RISK ENVIRONMENT

The first risk measure studied in this report is the probability of achieving a 100 percent funded status over the next 5, 10, 20 years or anytime on or before 2046, the target set in the funding plan. As a result of the volatility inherent in our asset allocation, there is a chance that the System may achieve full funding before 2046 if we get better than expected investment returns. Similarly, we cannot guarantee we will reach 100 percent funded by or before 2046 mostly due to the possibility of having long-term investment performance below the assumed 7 percent. The impact of investment volatility on the ability for the System to achieve full funding is illustrated in the chart below. As a comparison, the chart shows the probabilities of achieving full funding assuming the funding plan had not been enacted in 2014.

Probability of Achieving Full Funding



Although achieving 100 percent funding over the long term is our funding goal, we want to ensure we make progress toward being fully funded. With the board's limited ability to adjust contribution rates annually, we expect the System to make progress toward full funding, even if investment returns are below expectations. In fact, the system has a 75 percent chance of reaching 90 percent funded between now and 2046 and almost 85 percent chance of reaching 80 percent funded.

The funding plan has greatly reduced the funding risk facing the System. Probabilities of reaching higher funding levels have more than doubled with the passage of the funding plan. Although the probabilities have improved greatly, the probabilities are less than 100 percent. It is important to

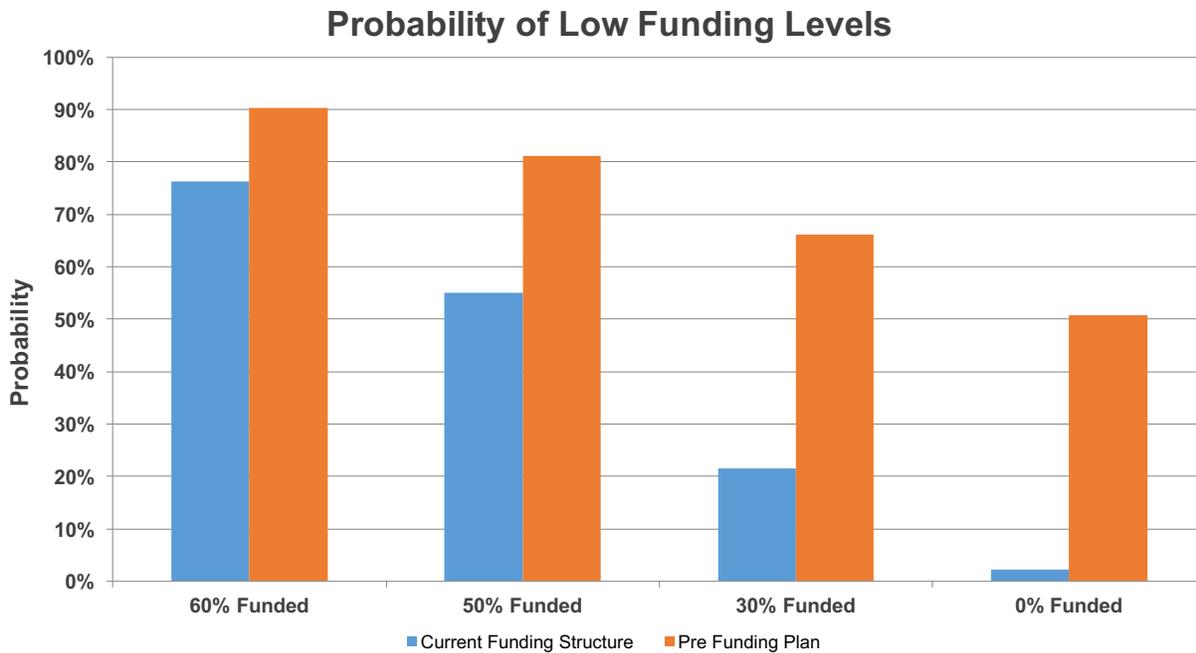
realize these probabilities are not expected to ever reach 100 percent as a result of the investment volatility inherent in an asset allocation with an expected return of 7 percent and the board's limited rate setting ability.

Probability of Low Funding Levels

The second risk measure being studied is the probability of the System reaching low funding levels or even running out of money. The risk of low funded status or even running out of money has been reduced considerably over the last few years with the adoption of the funding plan. However, that risk has not been completely eliminated and may never be fully eliminated as a result of the maturity level of the System, investment volatility and the board's limited rate setting ability.

THE RISK ENVIRONMENT

Below is a chart showing the probability of the System reaching lower funding levels over the next 30 years.



The bars on the right hand side of the chart show the probability of the System to run out of money. Three years ago this was an almost inevitable scenario. Today, that probability is very low. Of the 5,000 simulations that were performed, the System ran out of assets in only 2 percent of these simulations. Prior to the funding plan, the probability of running of assets was about 50 percent.

The probability of falling below 60 percent or even 50 percent funded however is still quite large. This is driven mostly by the current funding level of the System and the fact that short-term contributions toward the UAO are not expected to be sufficient to cover the interest on the UAO as was discussed earlier in the report. The recent change of assumptions reduced the funded status to 62 percent as of the June 30, 2016 actuarial valuation, and although the 13.4 percent return in fiscal year 2016-17 has increased our projected June 30, 2017 funded status, it is still expected to only be about 64 percent. It would take only one or two more years of lower than expected returns in the near term to push the funded status below 60 percent or even below 50 percent.

Probability of High Contribution Rates

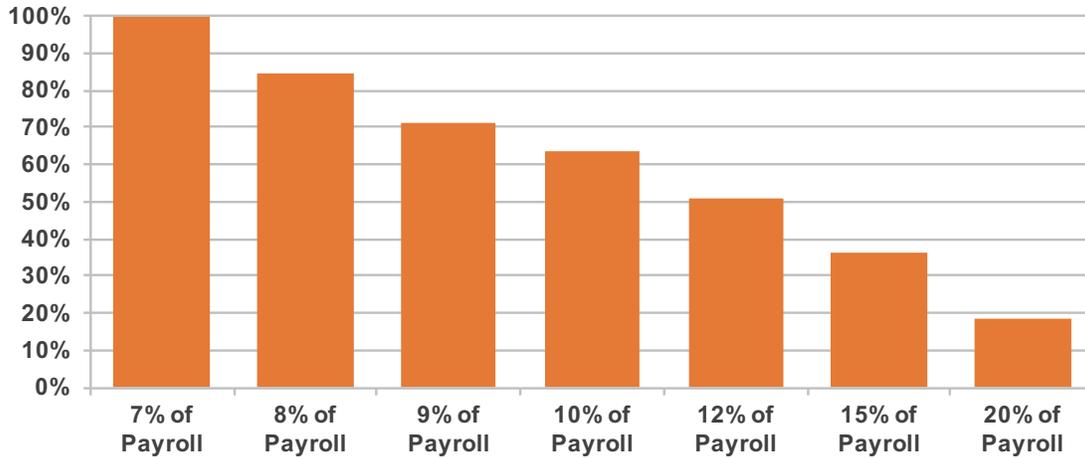
The last risk measure relates to the probability of seeing high contribution rates for the State. Because of the 20.25 percent cap in the employer contribution rate, only the State contribution rate is being analyzed in this section.

The State contribution rate can increase each year by no more than 0.5 percent of payroll with no limit on the actual rate. In April 2017, the board exercised their authority to increase the state's rate by 0.5 percent for the first time. For the 2017-18 fiscal year, the state pays a supplemental contribution of 4.811 percent of payroll to fund the portion of the UAO related to benefits in effect prior to 1990 in addition to a fixed base rate of 2.017 percent of payroll to fund DB benefits and 2.5 percent of payroll to fund the SBMA Program. Therefore, the State currently pays 6.828 percent of payroll to fund the DB benefits in fiscal year 2017-2018. For each fiscal year between 2018-19 and 2045-46, the board will have the ability to adjust that rate but never by more than 0.5 percent each year. As a result, the highest rate the State could be required to pay is a rate of 20.828 percent of payroll in fiscal year 2045-46. Note that the State supplemental contribution rate will never be less than 4.311 percent of payroll as long as there is an unfunded actuarial obligation related to benefits that were in effect prior to 1990.

THE RISK ENVIRONMENT

The chart below provides probabilities for the State contribution rate to reach certain levels as a percentage of payroll over the next 30 years. Because the State contribution rate is currently expected to reach almost 10 percent of payroll, the probability that it exceeds 7 percent, 8 percent, or 9 percent of payroll is very high today.

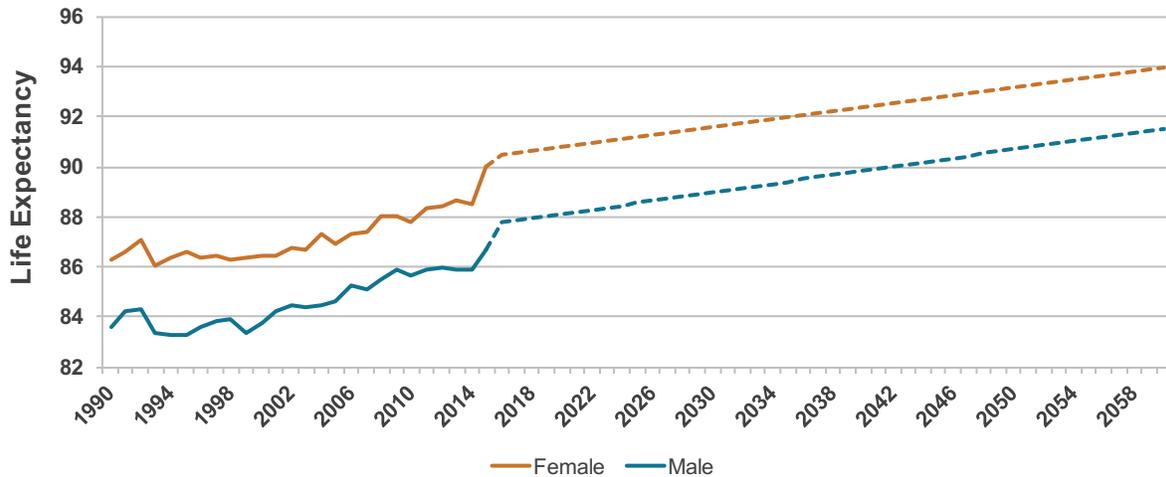
Probability of State Contribution Rate to Exceed Certain Rate Thresholds Over the Next 30 Years



Longevity Risk

In February of 2017 the CalSTRS board adopted new assumptions reflecting longer life expectancies and the anticipation life expectancies will continue to increase in the future. The following chart shows both the historical life expectancy for a CalSTRS member retiring at age 62 as well as the projected future life expectancy based on the assumptions adopted by the board in February 2017. To project mortality, actuaries use mortality improvement factors. CalSTRS currently uses a mortality improvement factor of 1.1 percent in each year for most ages.

Historical and Projected Life Expectancy for CalSTRS Age 62 Retiree

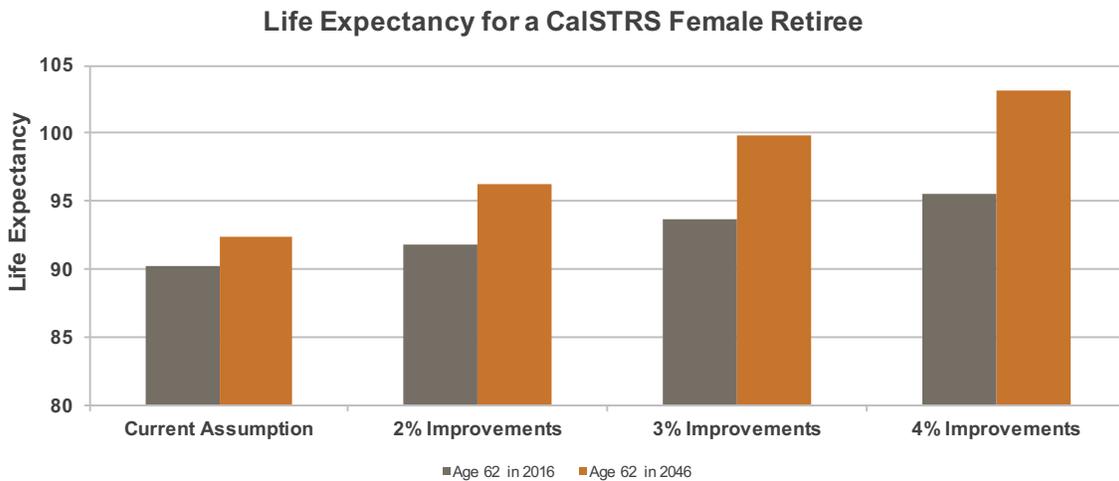


THE RISK ENVIRONMENT

Although the board has adopted more robust mortality assumptions, there is still a risk that mortality rates could improve faster than currently projected, especially if significant medical advancements were to quickly impact the life expectancy of CalSTRS members. It is hard to quantify the likelihood of seeing faster improvements than currently assumed. Over the last century, mortality rates have improved on average at a rate of about 1 percent

per year, consistent with the assumption adopted by the board earlier this year. For this report, longevity risk was analyzed by estimating the impact faster improvements in life expectancies would have on the funding of the system. Improvement factors of 2 percent, 3 percent, and 4 percent per year for most ages were selected to determine the impact such improvement factors would have on funding levels and contribution rates.

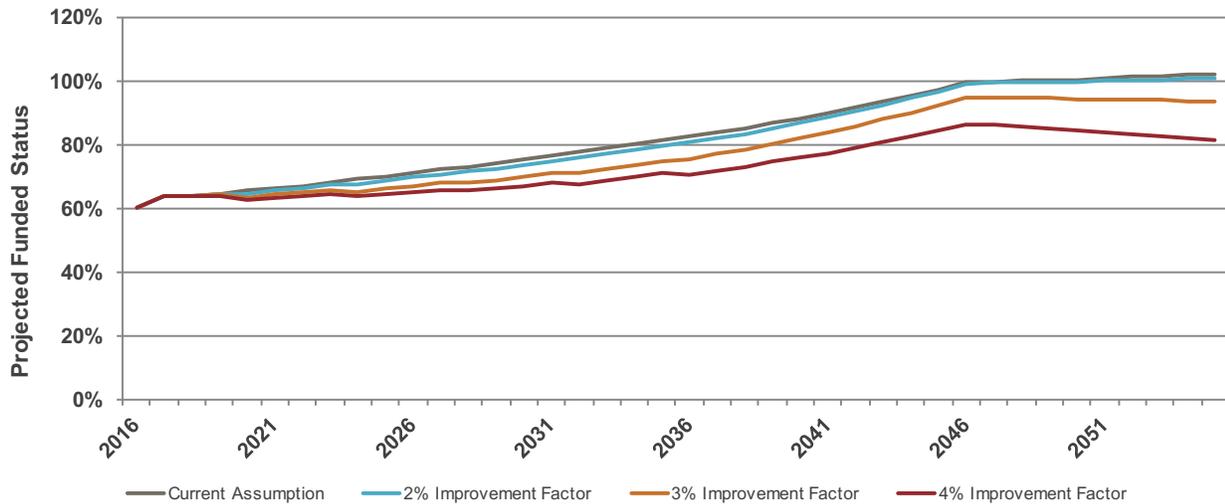
To help illustrate what these improvement factors mean in terms of life expectancy, the chart below provides life expectancy for a CalSTRS female retiree at age 62 in 2016 and projected to 2046.



As the chart illustrates, increasing the improvement factor greatly increases life expectancy over time. CalSTRS currently assumes a female member retiring at age 62 today will live to about age 90, collecting about 28 years of benefit. Current assumptions also assume that a female member retiring at age 62 in 2046 will be expected to live until about age 92, collecting 30 years of benefits. If improvement rates were 2 percent per year going forward, double what they have been historically, it would add about 2 and 3 years to projected life expectancies. If mortality improved at a 4 percent rate, a female retiring at age 62 in 2046 would be expected to live to about 103 years old. This means the System would be paying the typical retiree for over forty years after retirement, ten more than we are currently funding for. It's important to realize this is a fairly extreme example and it would take significant medical advances to sustain a 4 percent improvement in mortality over a long period of time.

THE RISK ENVIRONMENT

Impact of Mortality Improvements on Funded Status



The chart illustrates that the system would still be projected to reach full funding by 2046 if the mortality improvement factor were as high as 2 percent annually. However, there would be very little room left in the funding plan if financial markets failed to deliver investment returns in line with the assumed return of 7 percent. If improvement were 3 or 4 percent per year on average, it would not be possible to reach full funding. The above projections assume the board will exercise its authority to adjust contribution rates to improve funding levels. If the improvement factor increased to 3 percent or more on average per year, the contribution rate for the State would be projected to increase by the maximum amount possible of 0.5 percent of payroll in each future year, reaching a peak of 20.8 percent by fiscal year 2045-46. The employer's contribution rate would be minimally impacted, increasing about 1 percent above the levels currently projected.

Membership and Payroll Growth Risk

When the actuarial valuation is performed each year, it determines the funded status of the plan as of the valuation date, the unfunded actuarial obligation and the contributions needed to fully fund the system. The needed contributions are expressed as a percentage of payroll consistent with the way contributions are collected each year.

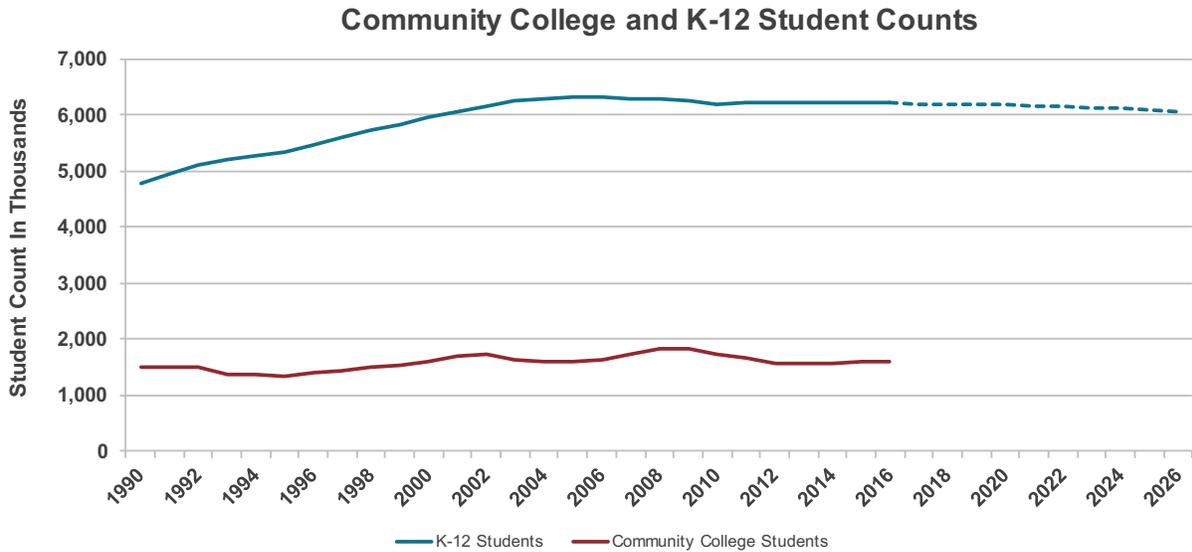
One of the key actuarial assumptions in the funding of the system is the assumed growth in payroll. The current payroll growth assumption adopted by the board is 3.5 percent annually. This assumption assumes that the number of active members in the system will remain stable over time. The funding of the system could be impacted if there was a sudden material shift in CalSTRS active membership.

To understand how a reduction in membership and payroll could impact the long-term funding of the system, one has to remember the board was given limited authority to set contribution rates to achieve full funding by 2046. The authority is limited by restrictions imposed in statute. When the payroll of CalSTRS covered members declines, it requires increases in contribution rates to ensure full funding, even if the unfunded actuarial obligation has remained the same. One has to keep in mind that the overall cost to fund retirement benefits is not increasing. In fact, the contributions required to eliminate the unfunded liability are still the same. Since contributions are collected as a percentage of payroll, the contribution rates have to increase to collect the same amount. There is a risk that the rate setting limitations combined with declines in payroll could prevent the board from being able to set contribution rates to the levels necessary to ensure full funding.

THE RISK ENVIRONMENT

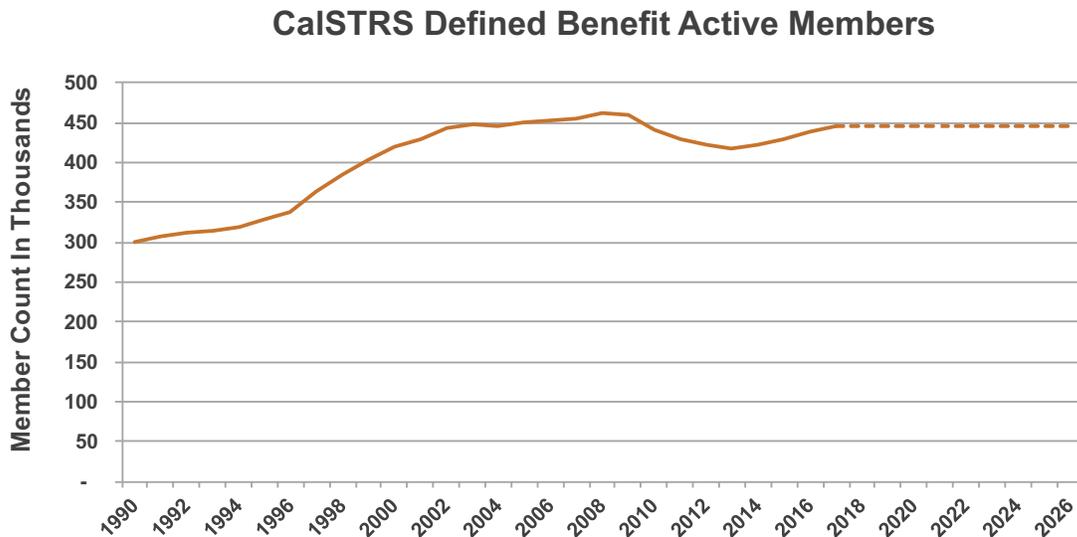
Historical and Projected Trends in Membership

Before considering specific scenarios, it is informative to examine past trends in California's student and teacher populations. Below is a chart showing historical counts of students in both K–12 and community colleges. Also included is a 10 year projection of K–12 students performed by the California Department of finance. As the chart illustrates, while the counts of community college students have remained relatively stable, the K–12 population saw a steady increase throughout the 1990s followed by a slow but steady decline starting in the mid-2000s. The Department of Finance projects a continued slow decline for the next 10 years.



Sources: Community College student count - CA Community Colleges Chancellor's Office
 K-12 student count - CA Department of Education
 K-12 enrollment projection - CA Department of Finance

The next chart shows the corresponding count of active members in the CalSTRS Defined Benefit program as well as a 10 year projection based on CalSTRS current assumptions.



THE RISK ENVIRONMENT

Similar to the count of students above, CalSTRS saw a steady increase in membership throughout the 1990s followed by a leveling off in the mid-2000s. Following the global financial crisis when the State experienced budget difficulties, the number of active members decreased by about 45,000 over a five year span. The chart also illustrates that, as mentioned above, CalSTRS projects the active population to remain stable over time.

Risk of a Decline in Active Membership

A decline in CalSTRS active membership could occur for a number of reasons. If the state experiences severe and prolonged fiscal troubles, staffing levels might be reduced as occurred between 2009 and 2013. Alternatively, the state might experience a faster decline in the student population, reducing the necessity for as many teachers. Another possibility is a shift in technology and the way education is delivered in California. Massively open online courses could potentially decrease the need for teachers in the classroom, especially at the community college level.

Charter schools also pose a risk to the long-term funding of the system. When a charter school is created, it must decide as part of the chartering process whether or not to provide CalSTRS benefits to its employees. Recent trends indicate that charter schools are increasingly choosing not to participate in CalSTRS. Today, the number of charter school employees not covered by CalSTRS is just above 3,000. Although numbers are low today compared to the overall CalSTRS population, a drastic shift in the number of charter schools could impact the long term funding of the system. CalSTRS has been actively monitoring the growth of charter schools and will continue to do so going forward. This risk is analyzed in greater details as part of a separate item on charter schools at the November 2017 board meeting. Regardless of the cause, any substantial decline in the active membership could pose a risk to the funding of the system.

To illustrate this risk, several scenarios in which the system experiences a decline in membership over a period of time were studied. The following table details the specific scenarios studied, the resulting decrease in active membership, and the projected funded status in 2046. The number of members was then assumed to remain stable following the initial decline.

Scenario	Decrease in Membership	2046 Funded Status
No reduction in active population	0	99%
3% reduction in actives per year for 5 years	62,000	98%
4% reduction in actives per year for 5 years	81,000	94%
5% reduction in actives per year for 5 years	99,000	90%
2% reduction in actives per year for 10 years	80,000	96%
3% reduction in actives per year for 10 years	115,000	89%

As the table above illustrates, the system is sensitive to declines in membership. Over a five year period, the system would be able to sustain a decline of 3 percent per year and still get near full funding. This is equivalent to losing about 62,000 active members over the period. Over a 10 year period, the System would be able to sustain a decline of 2 percent per year and still get near full funding. This is equivalent to losing about 80,000 active members over the period.

In each of the above scenarios, the cap placed on the employer supplemental contribution rate is the primary

factor impacting long-term funding. The employer rate cannot increase above a total of 20.25 percent of payroll as specified in the funding plan. Because of this cap, significant payroll decreases would prevent the board from setting the employer contribution rate to levels necessary to pay down their share of the unfunded liability. The same issue does not exist for the State since the state contribution rate does not have an upper bound and had sufficient flexibility in each of the scenarios to increase to a level high enough to eliminate the state's share of the unfunded liability, despite the decreases in payroll.

THE RISK ENVIRONMENT

It is important to emphasize that, if the membership were to decline significantly as illustrated above, it would not increase the unfunded actuarial obligation; it would simply reduce CalSTRS' ability to fund that obligation. Thus if the system were to experience a significant decrease in membership, discussions would need to occur with the legislature on options which might include either modifying the funding plan or allowing CalSTRS to begin collecting required contributions as a dollar amount rather than as a percentage of payroll.

CONCLUSION

This report discussed a variety of risks associated with the funding of the System. When looked at together, it is clear that even though the System is on a path to reach full funding; significant risks remain and could impact the funding of the System. Although the risks related to longevity and decline in membership are real and important, the fact remains that the largest risk facing CalSTRS is risk from investment volatility and this risk will continue to increase over time simply due to the natural progression of the maturity of the System.

In order to address these risks going forward, CalSTRS has undertaken steps to create an asset liability management team and an asset liability management framework, as detailed in the 2017-2018 CalSTRS business plan. The goal of this team is to bring together the actuarial, investment, and financial areas of CalSTRS to better manage and assess funding risk as well as guide future board decisions related to investment strategy and actuarial policies. Starting in 2018, the asset liability management team will begin work on the next asset allocation study to be completed in 2019.

As illustrated in this report, the funding plan has greatly helped to improve the long-term sustainability of the System. However, it is still not a perfect setup. The rate setting ability provided to the board is limited and the board does not have the authority to adjust contribution rates to pay for the entire UAO in place today.

When the funding plan was enacted by the California Legislature in July 2014, it contained a provision requiring CalSTRS to return to the Legislature every five years with a report on the progress of the plan. The first report to the Legislature is required on or before July 1, 2019. In preparation for this progress report, and in light of the risks highlighted in this report, CalSTRS has begun analyzing adjustments that could be made to further strengthen the plan and increase its chance of success. Potential changes being analyzed include:

- Provide the board with the authority, even limited, to set contribution rates to pay down the unallocated UAO.
- Limiting reductions to the state's supplemental contribution rate to no more than 0.5 percent of payroll in a single year.
- Change the limit for state contribution rate increases from 0.5 percent of payroll to 1.0 percent of payroll in a single year. This would allow the system to improve funding levels more quickly and reduce risk following a large drawdown.

It is important to emphasize that, although improvements could be made, the funding plan as currently implemented is working. The risk of low funded status or even running out of money has been reduced considerably with the adoption of the funding plan. The board has also taken steps to strengthen the funding of the system to ensure meeting this goal by adopting new actuarial assumptions. Financial markets have also provided better than assumed returns, positively impacting projected funding levels and contribution rates putting the System in a stronger financial position for the long term.



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