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Street View

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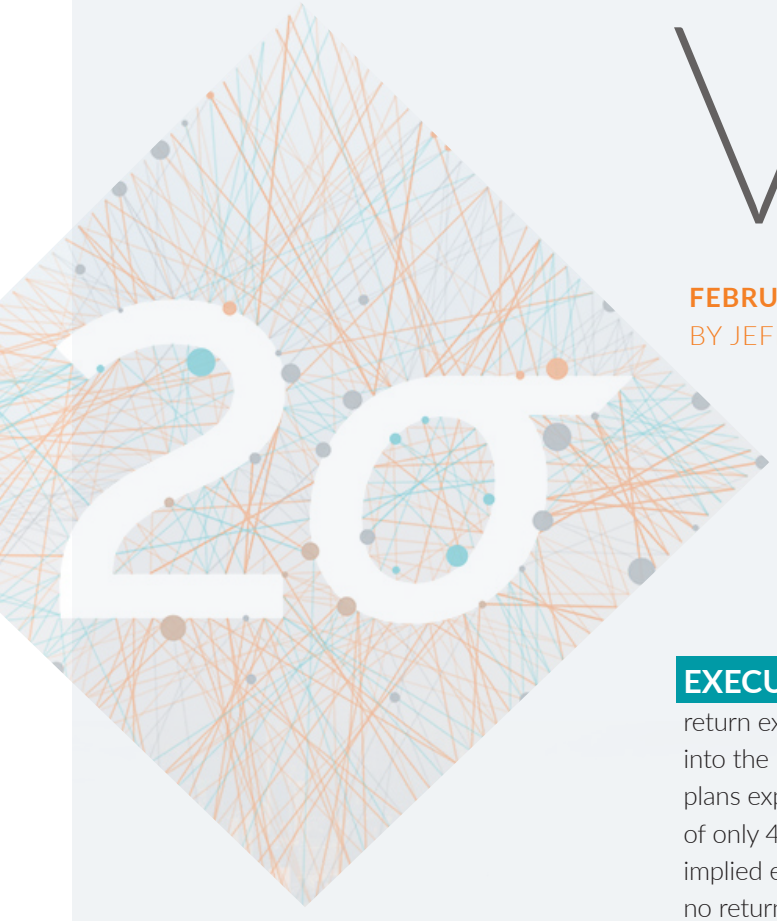

EXECUTIVE SUMMARY Data on US public pension plan portfolio return expectations and asset allocations offer market participants insights into the long-term views of these asset owners. First, US public pension plans expect to earn on average 7.6 percent over the long-term, a decline of only 40 basis points since 2001. Second, plan allocations suggest an implied expectation of ten percent for US and global equities but little to no returns from fixed income and alternatives. The historical performance, among other reasons, suggests these forecasts may prove too optimistic.

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INVESTMENT RETURN ASSUMPTIONS OF PUBLIC PENSION FUNDS

A second California appeals court ruled on December 30, 2016 that the state can reduce or eliminate pension benefits as long as employees still receive a pension that is "substantial" and "reasonable."[1] This ruling capped off a tough 2016 for CalPERS members, the largest public pension fund in the United States. CalPERS saw its funded status fall four percentage points to 69 percent. At the same time, CalPERS reduced its assumed investment rate of return from 7.5 percent to 7 percent. Given CalPERS' ten-year annualized return of 5.1 percent, however, even this return assumption may prove overly optimistic.[2]

Evaluating what constitutes "substantial" and "reasonable" pension benefits remains a topic squarely in the public policy realm and outside the scope of this market commentary. However, data describing pension plan expectations, performance, and allocations may offer insights to market participants trying to tackle the hard problem of asset allocation.

The Public Plans Data (PPD) produced by the Center for Retirement Research at Boston College[3] contains detailed annual data spanning from fiscal year 2001 to 2015 for CalPERS and other large US state and local pension funds. The sample includes 160 plans, which collectively account for approximately 95 percent of the public pension assets and members in the US. An analysis of the data highlights two interesting findings. First, the average public pension plan reports a long-term return expectation of 7.6 percent as of 2015 (the last year available), a forecast that has declined approximately 40 basis points since 2001. Second, pension plans seem to expect to earn ten percent per year from equities over the long term but little to no return from their fixed income and alternatives investments. Other asset owners might have reason to doubt these forecasts. Those who oversee state pension plans, for example, may have an incentive to proffer optimistic forecasts, most of which have not matched the reality of the past five and ten years.

AVERAGE PUBLIC PENSION PLAN REPORTS A LONG-TERM RETURN EXPECTATION OF 7.6 PERCENT

The 160 public pension plans in the data set report a wide range of expected long-term returns. For 2015, the most optimistic plans expected a nine percent return, and the most conservative plans forecasted less than six percent return. Figure 1a reports the time series of these scattered assumptions.

Across all plans in the data, the average return assumptions of pensions has declined from 8.02 percent in 2001 to 7.60 percent in 2015[4]. The decline in the average reflects small changes across most individual plans since 2008 (Figure 1b), not large changes for only a few plans. The average change differs statistically from zero for most years following the financial crisis, but only by five basis points per year. Since 2001, the average annualized return for these plans was approximately 5.7 percent.[5]

FIGURE 1A TARGET RETURN ASSUMPTIONS

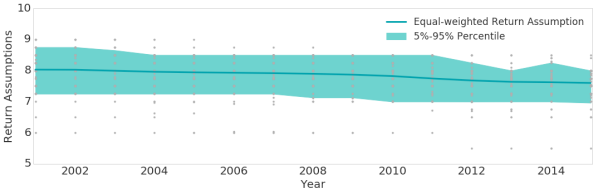
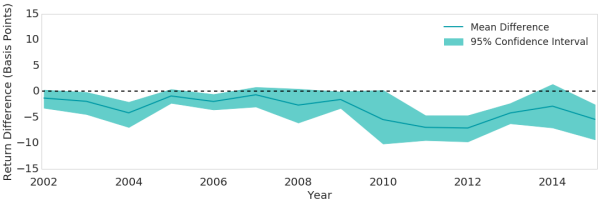


FIGURE 1B RETURN ASSUMPTION YEAR ON YEAR DIFFERENCE



Notes: Data from The Public Plans Data (PPD) produced by the Center for Retirement Research at Boston College.

1 http://www.pionline.com/article/20170103/ONLINE/170109974/second-california-appeals-court-rules-pension-benefits-can-be-reduced

2 Based on data from CalPERS: https://www.calpers.ca.gov/docs/forms-publications/cafr-2016.pdf

3 http://publicplansdata.org/public-plans-database/

4 Actuarial asset weighted return assumptions across the cross-section of pensions has declined from 8.04 percent in 2001 to 7.56 percent in 2015.

5 Average computed for funds which reported trailing 1-year investment return for every year from 2001 to 2015 (134/160 funds in the PPD database). Funds report fiscal year results, but since the time series spans 15 years, the calendar year results will likely not differ significantly.

PUBLIC PENSION PLANS ASSUME APPROXIMATELY TEN PERCENT RETURNS FROM EQUITIES AND LITTLE TO NO RETURNS FROM FIXED INCOME OVER THE LONG-TERM

Identifying where pension plans expect to generate these returns requires some algebra. If most plans operate with a mean-variance utility framework, it is relatively straightforward to calculate their implied asset-class return expectations given their portfolio-level return and volatility expectations, asset-class allocations, and historical asset-class volatility and covariance (see technical appendix for details).

For example, during 2015 CalPERS assumed a 7.5 percent annualized return and a 13.0 percent target volatility.[6] CalPERS allocated approximately 24 percent to US equities.[7] Based on the long-term covariance across asset classes, this suggests CalPERS implied US equity returns equal 10.3 percent (see appendix).[8]

Figure 2a reports these implied asset class returns across the cross-section of pension funds based on their fiscal year 2015 allocations. On average, the implied returns suggest an approximately ten percent return to equities (US and international) and fifteen percent to real estate. The implied expectation for fixed income returns is approximately zero. Return expectations for alternatives also remains low. This may be a reason why several pensions announced their decision to cut their hedge fund allocations.[9]

FIGURE 2A AVERAGE IMPLIED RETURN ASSUMPTION:2015

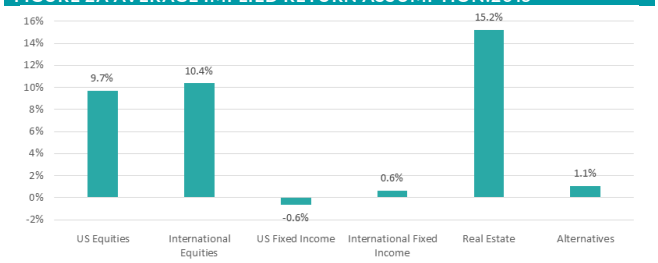
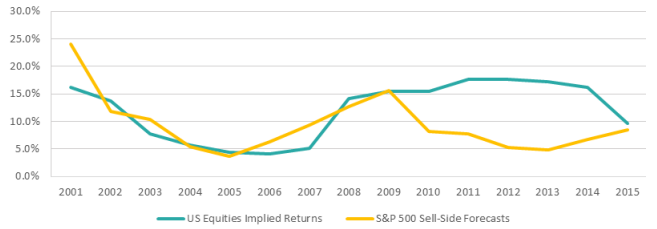


FIGURE 2B IMPLIED US EQUITIES RETURNS VS. S&P 500 SELL-SIDE FORECASTS



Notes: Pensions data from the Public Plans Data (PPD) produced by the Center for Retirement Research at Boston College, S&P 500 sell-side forecast data from Bloomberg

Whether these return expectations prove realistic remains an open question. Figure 2b compares US equity implied returns with published S&P forecasts from leading sell-side banks.[10] From 2010 to 2014, a chasm of more than five percentage points separated the expectations of pension plans and banks. It seems that public pension funds did not adjust their allocations to US equities to account for the higher volatility following the financial crisis, leading to significantly higher implied returns from US equities compared to sell-side analysts' forecasts. Since 2014, that gap has narrowed and fallen more in line with sell-side forecasts.

6 http://www.pionline.com/article/20161128/PRINT/311289986/calpers-balancing-risks-in-review-of-lower-return-target

7 https://www.calpers.ca.gov/docs/forms-publications/annual-investment-report-2016.pdf

8 "Cash" and "Other" categories were left out of PPD allocation data, and remaining asset weights were normalized to sum to 100%.

9 https://www.bloomberg.com/news/articles/2016-08-15/hedge-funds-are-losing-endowments-after-exodus-by-large-pensions

10 Source: Bloomberg

POTENTIAL IMPLICATIONS

At first glance, lofty investment return assumptions may seem unreasonably optimistic, but pension plans have a potential rationale. Certain accounting rules for public pensions foster optimism, because public pensions discount their liabilities based on their assumed rate of return instead of an appropriate-duration credit rate.[11] This potentially encourages pensions to report high return assumptions, even while the markets may not reflect the same beliefs. When CalPERS cut its long term forecast to seven percent, it phased in its official forecast over the next three years. One might wonder whether that implies a higher degree of confidence in generating returns for 2017 and 2018 than in subsequent years.

Looking at pension performance through an actuarial lens reflects a grimmer outlook. The Public Plans Data indicates that the average funded ratio across pension funds has declined from 99 percent in 2001 to 74 percent in 2015.[12] During this period, the average year-over-over growth in liabilities of 5.5 percent across public pension funds outpaced the average growth in assets of 3.2 percent.

Without meeting their target returns or additional funding, pension funds will not keep pace with their liability growth rates, posing potential hazards to employee benefits and potentially straining government budgets in the future. In January, CalPERS benefitted from an additional $5.3 billion contribution from the state of California, an increase of 11 percent from last year.[13] Other funds may not be as lucky.

11 http://www.pionline.com/article/20150429/ONLINE/150429853/estimating-future-costs-at-public-pension-plans-setting-the-discount-rate

12 Actuarial assets often differ from market assets in a given year because actuarial assets are calculated using techniques that smooth out fluctuations in the level of assets that arise from investment gains and losses.

13 http://www.pionline.com/article/20170112/ONLINE/170119952/state-contribution-to-calpers-to-rise-by-524-million-next-year

BRIEF TECHNICAL APPENDIX

Computing implied returns by asset class involves the following steps:[14]

1) Assume a simple mean-variance utility function:

Given a target or expected Sharpe ratio S, a risk free rate r_f and a risk aversion k, the mean-variance utility function U as a function of expected fund volatility σ, simplifies to:

$$U(\sigma) = S\sigma + r_f - (\tfrac{1}{2})\, k\sigma^2$$

2) Compute risk aversion:

The mean-variance utility maximizing volatility is given by $\sigma = (s/k)$, which yields the risk aversion

$$k = (s/\sigma)$$

3) Compute implied returns:

Suppose implied returns for asset classes are denoted by vector f. Assuming the expected fund volatility (given asset weights vector w and realized return covariance matrix Σ) is equal to historically realized fund volatility, i.e., $\sigma = \sqrt{w'\Sigma w}$, the mean-variance utility function U can be rewritten as $U(w) = f'w - (\tfrac{1}{2})kw'\Sigma w$. The utility maximizing asset weights must then satisfy $w = (1/k)\,\Sigma^{-1}f$, which yields the implied returns

$$f = k\Sigma w = (s/\sigma)\,\Sigma w$$

Assuming a risk aversion based on CalPERS' most recently reported investment return and volatility target of 7.5% and 13% respectively[6] and a 7-year historical covariance for major asset classes,[15] each pension fund's asset allocation weights give rise to corresponding implied returns per asset class. It is important to point out that using 7 years of trailing returns to estimate the historical covariance brings the realized and expected fund volatilities of CalPERS closer, making the assumption in step 3 more realistic. Although pension funds such as CalPERS reported that their short-term realized volatility tends to be lower than their longer-term volatility forecasts, which rely on a longer period of lagging returns.[16]

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14 https://corporate.morningstar.com/ib/documents/MethodologyDocuments/IBBAssociates/BlackLitterman.pdf

15 Covariance matrix arises from historical returns of broad market indices that serve as proxies for major asset classes, namely, S&P 500 (Equities-US), Vanguard Total International Stock Index Fund (Equities-International), Vanguard US Total Bond Market Index Fund (Fixed Income-US), Barclays Global Aggregate ex-USD Total Return Index Value Unhedged (Fixed Income-International), Dow Jones US Select Equal Weight REIT Index (Real Estate), HFRX Global Hedge Fund Index (Alternatives). The covariance matrix is shrunk using top principal 3 components which retain about 92 percent of the co-movement on average to make the mean-variance estimation more stable.

16 https://www.calpers.ca.gov/docs/forms-publications/leg-report-cio-total-fund-2016.pdf

INTERESTING TECHNOLOGY-RELATED ARTICLES

Two Sigma views itself as a technology company that applies a rigorous, scientific method-based approach to investment management. Our technology is inspired by a diverse set of fields including artificial intelligence and distributed computing. Occasionally, we read articles in the popular press that describe applications of technology that we find interesting, thought-provoking, and relevant for people thinking about improving the investment management process. Below is a subset of the articles we read this month. Please do not view the inclusion of these articles as an endorsement by Two Sigma of their viewpoints or the companies discussed therein. Two Sigma welcomes discussions (and contributions) about these and other such technology-related articles.

"What Happens When Algorithms Design a Concert Hall? The Stunning Elbphilharmonie" by Lix Stinson

https://www.wired.com/2017/01/happens-algorithms-design-concert-hall-stunning-elbphilharmonie/

The newly opened philharmonic concert hall in Hamburg, Germany, called the Elbphilharmonie, is built on the foundation of algorithms, just like Two Sigma. Each of the 10,000 gypsum fiber acoustic panels lining the auditorium walls are shaped uniquely, to help distribute sound around the auditorium based on the room's geometry. Not only did the algorithms have to accommodate the acoustic quality of the auditorium, the panels also had to be designed to be beautiful and respect audience members (ones near seats had to be less sharp for safety purposes). The Elbphilharmonie may open doors for other designers to collaborate with algorithms and create intricate, scalable designs in other venues in the future.

"The Infinite Promise of DNA-Based Data Encryption" by George I. Seffers

http://www.afcea.org/content/?q=Article-infinite-promise-dna-based-data-encryption

Scientists at Sandia National Laboratory are exploring ways to encrypt data within synthetic DNA, which is more compact and durable than traditional information storage. Sandia officials pointed out that readable DNA can be extracted from prehistoric fossils, while the same cannot be said about tape and disk-based data storage. Furthermore, cloud and server-based storage require vast amounts of physical space and electricity that bacterium storing DNA-encrypted data do not. DNA-storing bacteria also lend themselves easily to replication, able to make hundreds of millions of copies of the data they house. Besides Sandia, Microsoft and other companies are also working on DNA data storage, though both are still far from producing a commercially viable product.

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