TWO SIGMA

Street View

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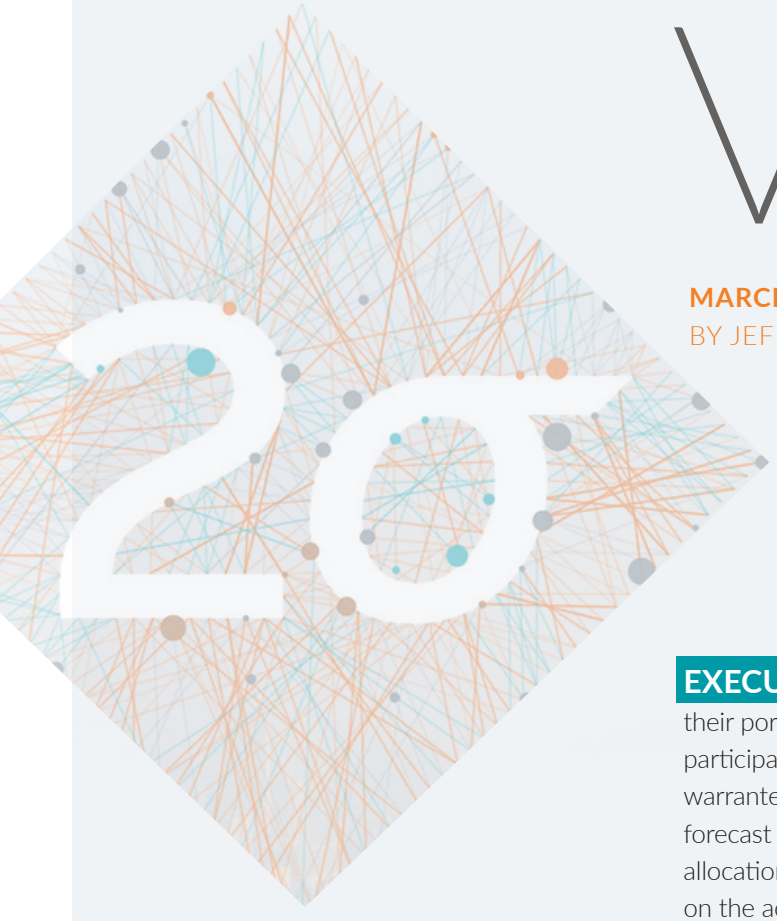
BY JEFFREY N. SARET & SUBHADEEP MITRA



EXECUTIVE SUMMARY US public pension plans publish their portfolio return expectations and asset class allocations. Market participants may try to mine wisdom from this crowd, but caution seems warranted. There exists an inverse relationship between a plan's return forecast and its funded ratio, even after controlling for the plan's risk factor allocation. This inverse relationship may stem from a structural bias based on the accounting rules that dictate the plan's discount rate.

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Inside:
Structural Optimism in Public Pension Plan Return Forecasts

Relatively few asset allocators share their point forecasts and investment strategies, but US public pension plans offer a notable exception. These plans annually publish their portfolio return expectations and asset class allocations, generating a large data set. The Public Plans Data (PPD) from Boston College's Center for Retirement Research conveniently makes this data accessible.[1]

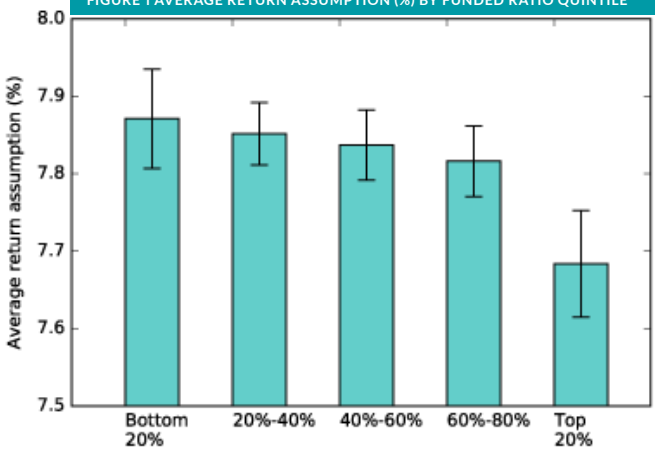
Market participants may try to mine wisdom from this crowd, but caution seems warranted. An analysis of the data highlights an inverse relationship between pension plans' funded ratios and return assumptions. In other words, the pension plans with the worst historical track record in meeting their funding obligations tend to maintain the loftiest expectations for future returns. Across the 160 plans in the data set, a 20 percent decrease[2] in the funded ratio[3] tends to increase return expectations by approximately 7.4 basis points. Lower funding status also appears associated with lower propensity to reset expectations.

Evaluating appropriate return expectations for individual pension plans remains a topic for policy makers and outside the scope of this market commentary. However, helping identify insights and potential biases embedded in the aggregate pension plan data may help market participants trying to tackle the hard problem of asset allocation.

INVERSE RELATIONSHIP BETWEEN FUNDED RATIOS AND RETURN EXPECTATIONS

Figure 1 shows the average return assumptions of US pension plans from 2001 to 2015, grouped by funded-ratio quintiles. As funded ratios increase, average return assumptions decrease. The plans in the lowest 20 percentile for funding ratio hold return expectations 19 basis points higher than plans in top quintile for funding ratio, and this difference is statistically different from zero. Given that long-term return expectations of public pension funds have declined approximately 40 basis points since 2001,[4] the differences in return assumptions among the most and least adequately funded pensions also appear economically meaningful.

FIGURE 1 AVERAGE RETURN ASSUMPTION (%) BY FUNDED RATIO QUINTILE



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

More rigorous statistical testing supports the intuition from Figure 1—pension plan funding status and return assumptions appear inversely related. Table 1 (Panel A) reports the results of a panel regression of the investment return assumption on four factors (controlling for time fixed-effects for a cross-section of US public pensions from 2001 to 2015): funded ratio, 10-year investment return, logarithm of actuarial assets, and the allocation made to risky assets.[5] The table indicates that a 20 percent decrease in funded ratio increases the return expectations of pensions by 7.4 basis points.

1 http://publicplansdata.org/public-plans-database/ The Public Plans Data sample spans from fiscal year 2001 to 2015 and includes 160 plans, which collectively account for approximately 95 percent of the public pension assets and members in the US.

2 A 20 percent decrease in funded ratio is approximately a one-standard deviation move.

3 Funded ratio under GASB standards is equal the actuarial assets divided by the actuarial liability.

4 Two Sigma Street View: *Investment Return Assumptions of Public Pension Funds*, February 2017.

5 Time fixed-effects help address year-specific effects on return assumption levels.

TABLE 1		
	Panel A: Regression with time fixed-effects	Panel B: Logistic regression with time fixed-effects
	Change in return assumption (basis points)...	Change in probability of not reducing return expectations...
20 percent decrease in funded ratio	7.42***	2.66**
2 percent increase in 10-year historical investment return	4.12	3.04%*
1 unit decrease in log (assets)	1.69	-0.03%
10 percent increase in allocation to risky assets (Equities, Real Estate & Alternatives)	13.51***	-1.69%
0.5 percent decrease in current level of expected investment returns		6.18%***

Notes: Column 1 reports the effect on public pension plans' investment return assumptions from approximately one-standard deviation moves in funded ratio, 10-year investment return, logarithm of assets, and allocation to risky assets based on a panel regression with time fixed-effects. Column 2 reports the effect on the probability of changing investment returns assumptions from approximately one-standard deviation moves in funded ratio, 10-year investment return, logarithm of assets, allocation to risky assets and the level of investment return expectations from their respective means (keeping all other variables at their means) based on a panel logistic regression with time fixed-effects. Data from Public Pensions Database spans 2001-2015. *, ** and * denote that the corresponding regression coefficients are statistically significant based on heteroskedastic consistent standard errors at 99 percent, 95 percent, and 90 percent confidence respectively.**

This inverse relationship exists even after controlling for potentially confounding factors like historical return levels, pension plan size and allocation made to risky assets. The historical returns and size of the pension plan have a positive relationship to return expectations, but the result is not significant. Not surprisingly, the risk tolerance of the pension plan, proxied by the allocation to factors like equity and real estate, has a positive and statistically significant coefficient. A 10 percent increase[6] in allocation made to risky assets (Equities, Real Estate, and Alternatives) increases the return expectations of pensions by 13.5 basis points. In sum, the results show that two plans with similar allocations will have different return assumptions if their funded status levels vary.[7]

Not only do pension plans with lower funding ratios make relatively more optimistic forecasts about future returns, they have historically proven less willing than their peers to lower their forecasts over time. Table 1 (Panel B) also shows the results of a panel logistic regression of the probability of not reducing investment return assumptions on funded ratio, 10-year investment return, logarithm of actuarial assets, and the current level of expected investment returns. A 20 percent decrease in funded ratio (accounting for time fixed-effects and controlling for the other variables) makes it 2.7 percent less likely the fund will reduce its return assumption.[8] Similarly, plans with relatively low expectations for future returns seem less likely to reduce their expectations further. Plans with 0.5 percent[9] lower return expectations appear 6.2 percent less likely to reduce their return assumptions than otherwise comparable plans. Since only 15 percent of plans reduced their return expectations in any given year between 2001 and 2015, the magnitude of these estimated probabilities appears economically meaningful.

POTENTIAL IMPLICATIONS

The return forecasts of US public pension plans offer another example of hope triumphing over experience. The average pension plan expects to generate 7.6 percent per year, even though the average plan only realized a 5.7 percent return per year from 2001-2015. The low levels of returns over this period reduced the funding status for many plans from 99 percent in 2001 to 74 percent in 2015. However, the plans with the largest shortfalls still tend to have the highest expected future returns and the lowest willingness to reduce those expectations.

Accounting rules may explain some of this apparent inconsistency. Public pensions discount their liabilities based on their expected rates of return, so reducing those expectations would negatively affect funded ratios. These assumptions embody structural optimism. This optimism is persistent across time, as pensions with lower funded ratios appear less likely to reduce their investment return assumptions each year than their more successful counterparts. Market participants trying to glean insights from the crowd of public pension plans might want to keep this bias in mind.

6 A 10 percent increase in allocation made to risky assets is approximately a one-standard deviation move.

7 One might argue that the relationship between return assumptions and risk allocations are endogenous. A separate regression (not reported) estimates the model but omits the allocation variable. The coefficient on funded ratio still appears negative and statistically significant.

8 Assuming a 20% move from mean funded ratio and all other variables are fixed at their mean levels.

9 A 0.5 percent decrease in return expectations is approximately a one-standard deviation move.

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.

"Cars Now Talk to Other Cars, if You're Into That Sort of Thing" by Aarian Marshall

https://www.wired.com/2017/03/cars-now-talk-cars-youre-sort-thing/

In December 2016, the National Highway Traffic Safety Administration proposed making short-range communications mandatory in all cars by 2020. Thus far, the Cadillac 2017 CTS sedan is the first-mover on this trend. Engineers call the technology vehicle to vehicle communication, or V2V, which allows vehicles to transmit information to other vehicles nearby to reduce collisions. Cadillac's Vehicle-to-Vehicle communications technology can share data like location, speeds, and traffic conditions from about 1,000 feet away. Currently, the 2017 Cadillac CTS can only communicate with other cars of the same model, but interest in V2V from other companies makes this likely to change in the near future.

"Quantum computer learns to 'see' trees" by Jane C. Hu

http://www.sciencemag.org/news/2017/03/quantum-computer-learns-see-trees

A team of scientists from St. Mary's College of California have trained a quantum computer to recognize trees using pattern recognition and computer vision. They used a D-Wave 2X computer, created by the company that produced the world's first quantum computer back in 2007. Quantum computers differ from regular computers because rather than storing data in binary form using 0 or 1, quantum computers can use quantum bits, or qubits, that can represent both 0 and 1 at the same time. A quantum computer could solve computationally expensive problems more quickly than a traditional computer. This allowed the team of scientists to consider dozens of features in pictures of California, including hue, saturation, and light reflectance, to classify clumps of pixels as trees rather than buildings or other geographical objects. Although this classification exercise using a quantum computer did not improve upon the speed of traditional computers for classification, quantum computers will continue to improve in the future.

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