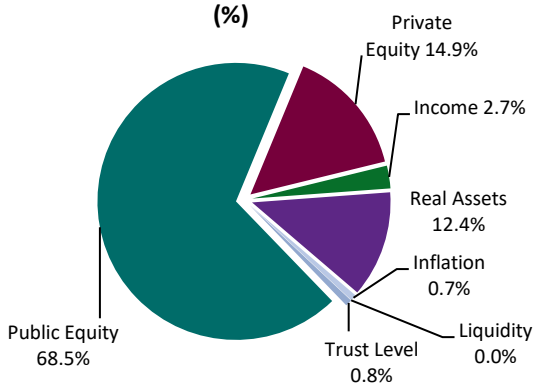
CalPERS Trust Level Review
Risk Management Summary

Period Ending December 31, 2018

Investment Belief 9: *Risk to CalPERS is multi-faceted and not fully captured through measures such as volatility or tracking error. CalPERS shall develop a broad set of investment and actuarial risk measures and clear processes for managing risk. The path of returns matters, because highly volatile returns can have unexpected impacts on contribution rates and funding status.*

Total Fund Forecast Volatility Trends (%)				
	Policy Limit	Current 12/31/2018	Last Qtr 9/30/2018	Last Year 12/31/2017
Total	n/a	8.1	7.2	7.4
Benchmark	n/a	8.0	6.9	7.0
Tracking Error	< 1.5	0.4	0.5	0.6
Allocation	< 0.75	0.0	0.0	0.2
Selection	n/a	0.4	0.5	0.4

Portfolio Volatility Contribution (%)



Comments:

Forecast Total Volatility of the PERF increased by 65 bps over the last year. This increase is primarily a reflection of market volatility recovering from historical lows.

Rapid shifts in volatility regime can occur and would not be predicted by this model. The best interpretation of this estimate is as an indicator of the plan's volatility given the current market environment.

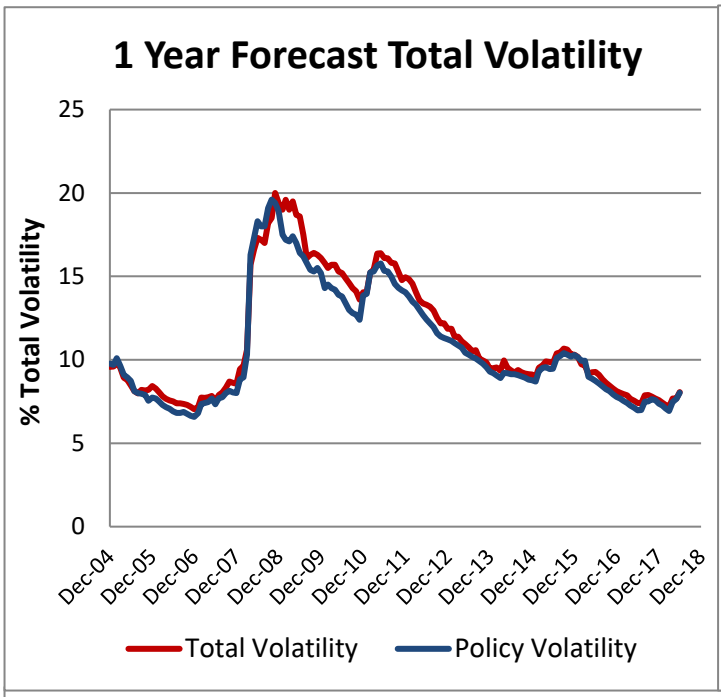
The pie chart above gives a visual representation of portfolio volatility contribution by asset classes (in percent).

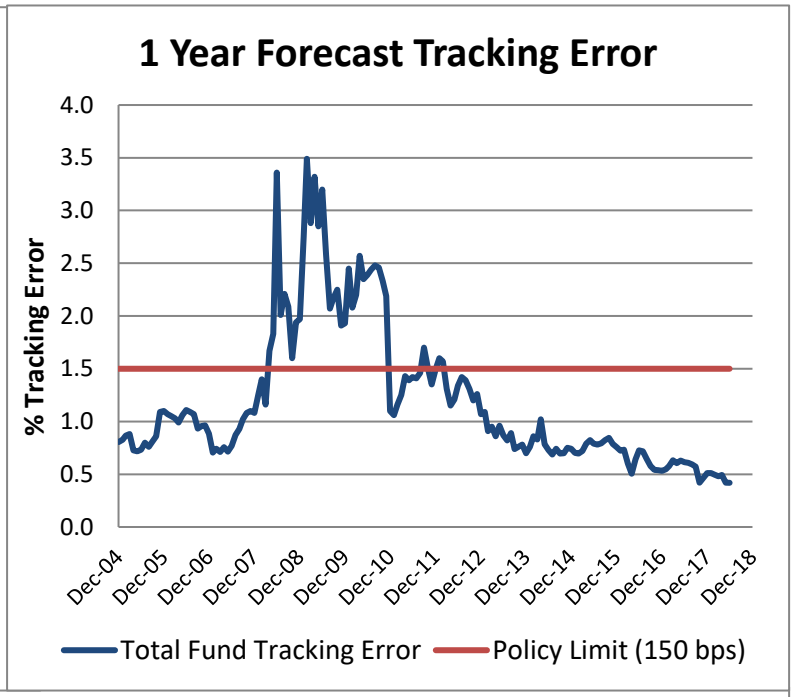
Asset Class		Market Value[1] ($millions)	Total Forecast Volatility (%)	% Contribution to Total Vol	Tracking Error (%)
PUBLIC EQUITY	$	160,469	12.0%	68.5%	0.2%
PRIVATE EQUITY	$	27,698	17.1%	14.9%	4.1%
INCOME	$	94,299	4.5%	2.7%	0.1%
REAL ASSETS	$	39,778	11.2%	12.4%	2.0%
INFLATION	$	7,493	5.7%	0.7%	0.6%
LIQUIDITY	$	3,769	0.1%	0.0%	0.1%
TRUST LEVEL[2]	$	3,640	6.1%	0.8%	2.9%
TOTAL FUND	**$**	**337,147**	**8.1%**	**100.0%**	**0.4%**

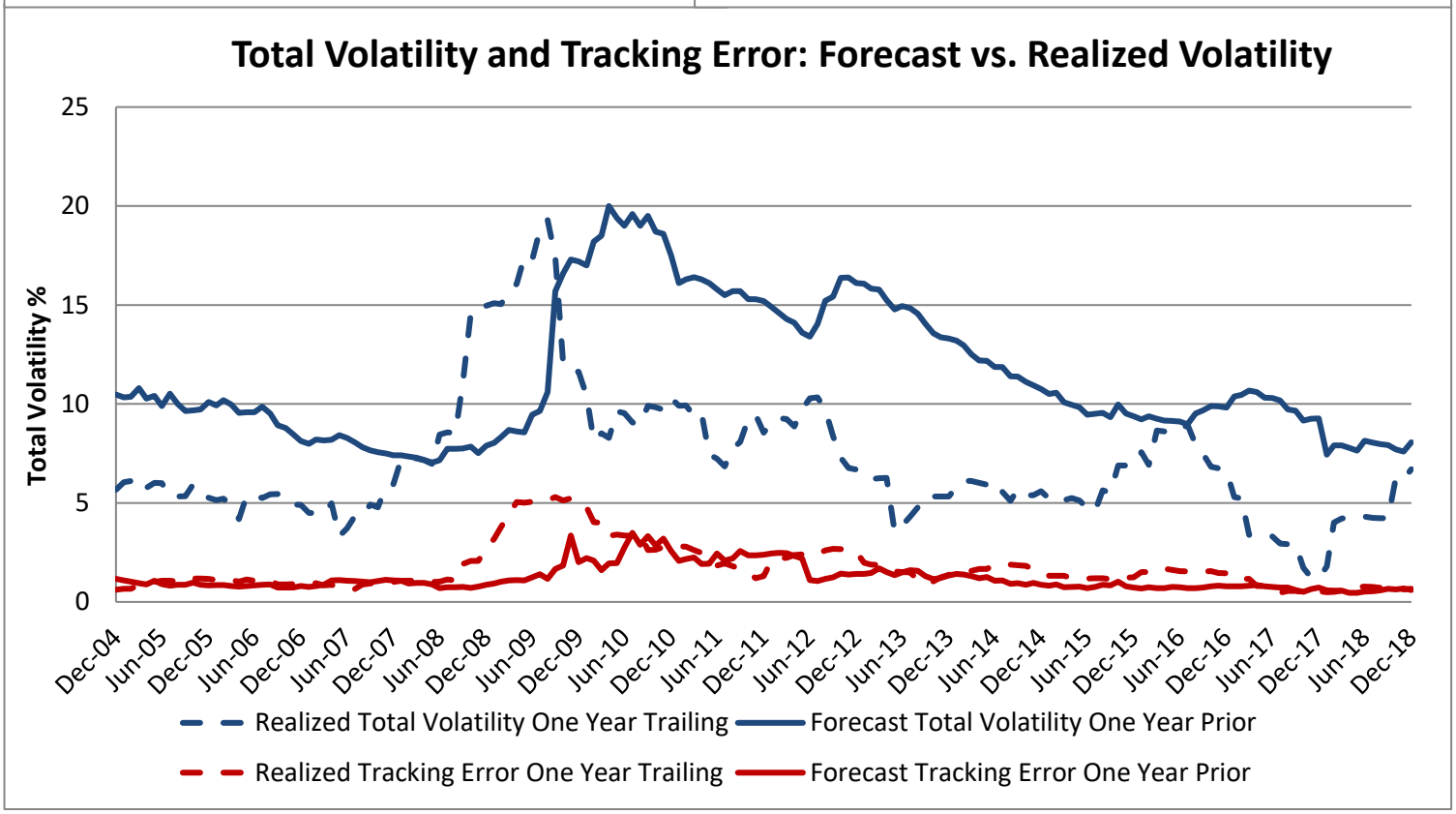
[1]Market values could be different from other documents, due to differences in pricing methods in risk and performance systems.

[2]Trust Level includes Multi Asset Class, Completion Overlay, Risk Mitigation, Transition, Absolute Return Strategies, and other Total Fund level portfolios

Source: BarraOne / CalPERS







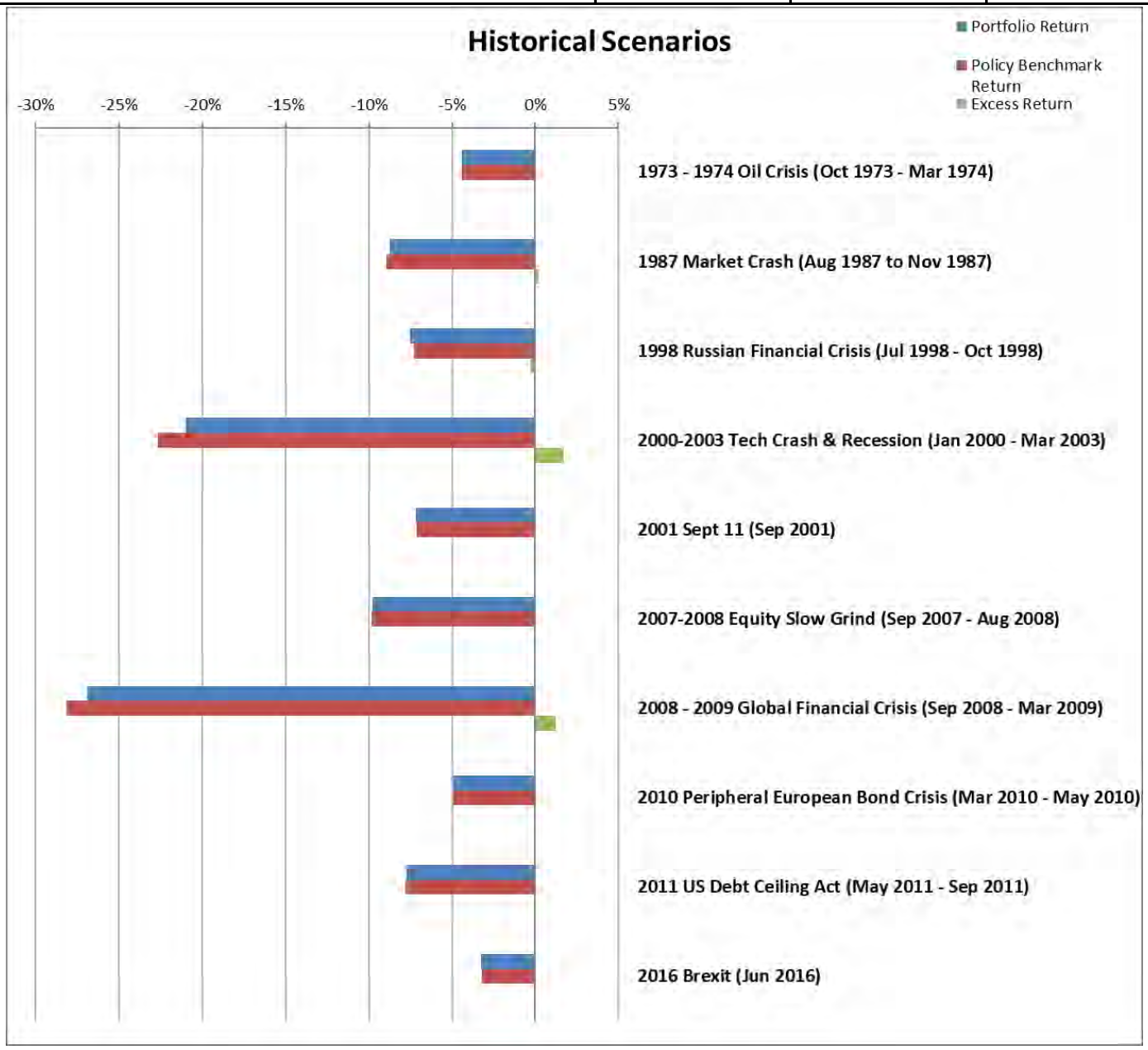
The bottom chart plots the Forecast Total Volatility and Tracking Error for the Total Fund one year prior to each date vs. the Total Volatility and Tracking Error realized for that date. The graph highlights potential deviations between risk model estimates and subsequent realized volatility, due to the lagged and smoothed nature of risk models. In particular, modeled volatility forecasts tend to lag changes in regimes, for example the rapid increase in volatility during the period of the global financial crisis, and similarly the persistent decline in market volatility in the last few years.

Source: BarraOne, SSB, CalPERS

STRESS TESTING

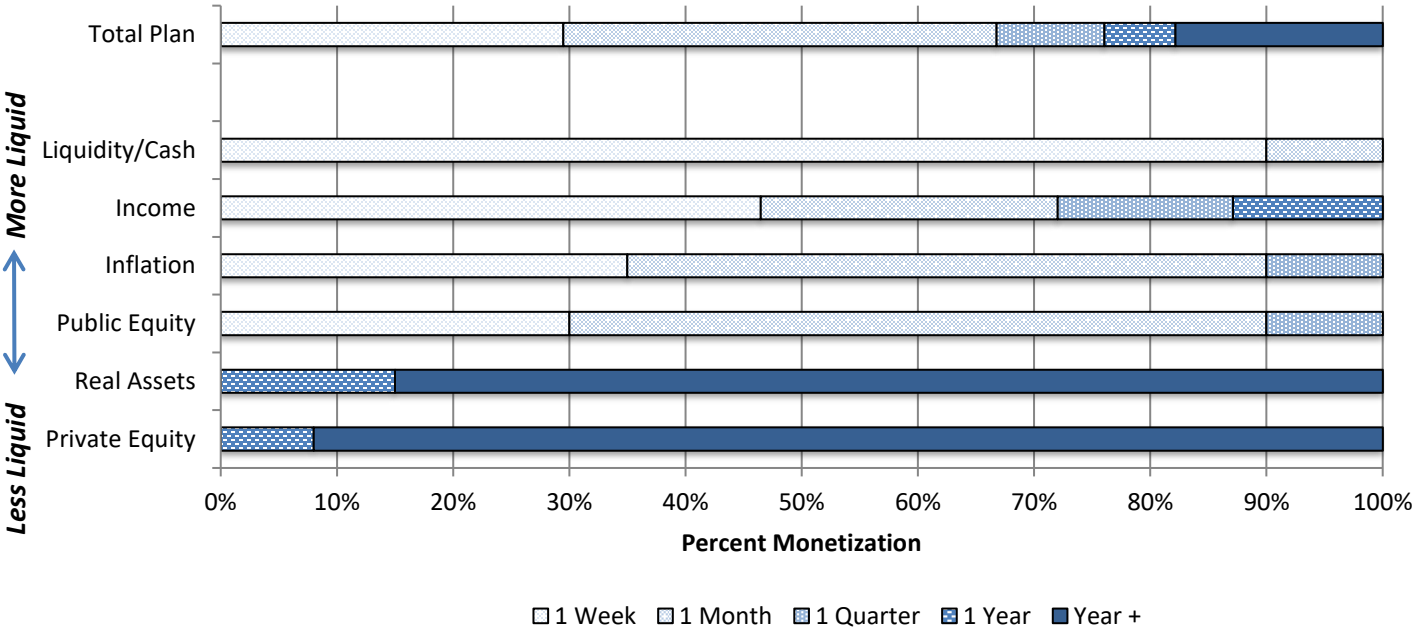
Historical scenarios highlight the sensitivity of the portfolio to past economic regimes or specific events. The scenarios can be used as a "what if" gauge of current portfolio positioning to understand the potential impact if a similar event or regime were to repeat.

Scenario	Portfolio Return	Policy Benchmark Return	Excess Return
2016 Brexit (Jun 2016)	-3.2%	-3.2%	0.0%
1973 - 1974 Oil Crisis (Oct 1973 - Mar 1974)	-4.4%	-4.4%	0.0%
2010 Peripheral European Bond Crisis (Mar 2010 - May 2010)	-4.9%	-4.9%	0.0%
2001 Sept 11 (Sep 2001)	-7.2%	-7.1%	-0.1%
1998 Russian Financial Crisis (Jul 1998 - Oct 1998)	-7.5%	-7.3%	-0.3%
2011 US Debt Ceiling Act (May 2011 - Sep 2011)	-7.8%	-7.8%	0.0%
1987 Market Crash (Aug 1987 to Nov 1987)	-8.8%	-9.0%	0.2%
2007-2008 Equity Slow Grind (Sep 2007 - Aug 2008)	-9.8%	-9.8%	0.0%
2000-2003 Tech Crash & Recession (Jan 2000 - Mar 2003)	-21.0%	-22.7%	1.7%
2008 - 2009 Global Financial Crisis (Sep 2008 - Mar 2009)	-26.9%	-28.1%	1.2%



Source: BarraOne, CalPERS

Liquidity Analysis: Total Plan



Transactional liquidity is estimated for each asset class/strategy based on the current market environment while also accounting for legal structures or other factors that may impact liquidity. *Source: SSB, CalPERS*

	PERF LIQUIDITY SNAPSHOT As of December 31, 2018			
		Expected Cash Flows for 1 Month		
		Normal Conditions	Extreme Stress Scenario	
a	Cash Equivalents in Liquidity Portfolio (< 30 days)*	$1,517,426,300	$1,517,426,300	
b	Sources Total (cash flow in)	$1,655,931,043	$1,554,887,270	
c	Uses Total (cash flow out)	($2,510,686,248)	($2,510,686,248)	
d	Contingency Use**		($3,016,719,810)	
	Expected Cash Equivalents (Period End)	$662,671,095	($2,455,092,488)	
	Liquidity Coverage Ratio	126%	56%	= (a+b)/-(c+d)

* Excludes borrowed liquidity i.e. cash available in asset classes and cash collateral from securities lending
** Contingency Use accounts for potential cash demands and sources from derivatives positions, securities lending, and fund level contingent liabilities. The Extreme Stres Scenario assumes no sales of assets or incremental borrowing

Liquidity Coverage is computed from estimates of future cash inflows and outflows up to a 1-year horizon. In this table, the 1-month forward period is shown with Liquidity Coverage ratios for a normal environment and for a selected stress period (Global Financial Crisis). The Liquidity Coverage ratios could be interpreted as how many times (1.26 times in normal market conditions) available cash / cash equivalents could cover projected cash needs over a 1-month forward period. A ratio of less than one does not imply coverage is inadequate, as there are opportunities to raise cash through asset sales and incremental borrowing.
Source: BarraOne, SSB, CalPERS

Total Fund Leverage Report

as of 12/31/18

Leverage changes a portfolio's risk profile through both impact on liquidity and amplification of returns volatility. As a metric, leverage has the benefit of being relatively straightforward to calculate, making it a good backstop to more nuanced but complex perspectives on risk that could suffer from model errors or flawed assumptions. However, since the leverage metric implicitly treats all assets as equally risky, and because it does not capture the interrelationships between assets (diversification), leverage should always be viewed in conjunction with other perspectives. For example, a low leverage portfolio could easily be more risky than a better-diversified moderate leverage portfolio.

Portfolio View of Plan Leverage:

"L1" captures exposures with full recourse to the total plan, and is most relevant from an immediate liquidity perspective.
"L2" includes non-recourse borrowing, which can amplify risk and returns for a given $ invested.

Company Embedded Leverage:

Some Fund assets embed leverage by their nature (i.e., private and public companies). In this case, leverage is not a result of a portfolio management decision, but does contribute to the assets' inherent riskiness.

Unfunded Commitments:

Represent potential draws on Fund liquidity, but are contingent in nature.

Portfolio View of Plan Leverage

		L1: Portfolio Leverage - Full Recourse						*L2: Portfolio Leverage w/Non-Recourse*		
Asset Class/ Program	Net Market Value ($Billions) (A)	+ Sources of Leverage[1]			- Cash[2]	= Gross Market Exposure (B)	Portfolio Leverage (B/A) - 1	+ Additional Sources of Leverage	= Gross Market Exposure (C)	Portfolio Leverage (C/A) - 1
		Derivatives	Recourse Debt	Other				Non Recourse Debt		
Public Equity	160.5	11.5			1.8	170.2	6.1%		170.2	6.1%
Private Equity	27.7		1.8[3]		0.0	29.5	6.5%		29.5	6.5%
Income	94.3	2.4			1.0	95.7	1.5%		95.7	1.5%
Liquidity	3.8				3.8	0.0	N/M		0.0	N/M
Real Assets	39.8		0.0[4]		0.8	39.0	-1.9%	19.3	58.3	46.6%[5]
Inflation	7.5	2.0			1.8	7.7	2.6%		7.7	2.6%
Securities Lending[6]	0.0			5.6	5.6	0.0	N/M		0.0	N/M
Trust Level	3.6	0.4		0.1	0.6	3.5	-2.9%		3.5	-2.9%
Total Fund	337.1	$16.3	$1.8	$5.7	$15.3	$345.7	**2.5%**	$19.3	$365.0	**8.2%**

Embedded Leverage in Asset Classes

	Implied Leverage[7]
Public Equity	1.53
Private Equity	2.22
Real Estate	1.27

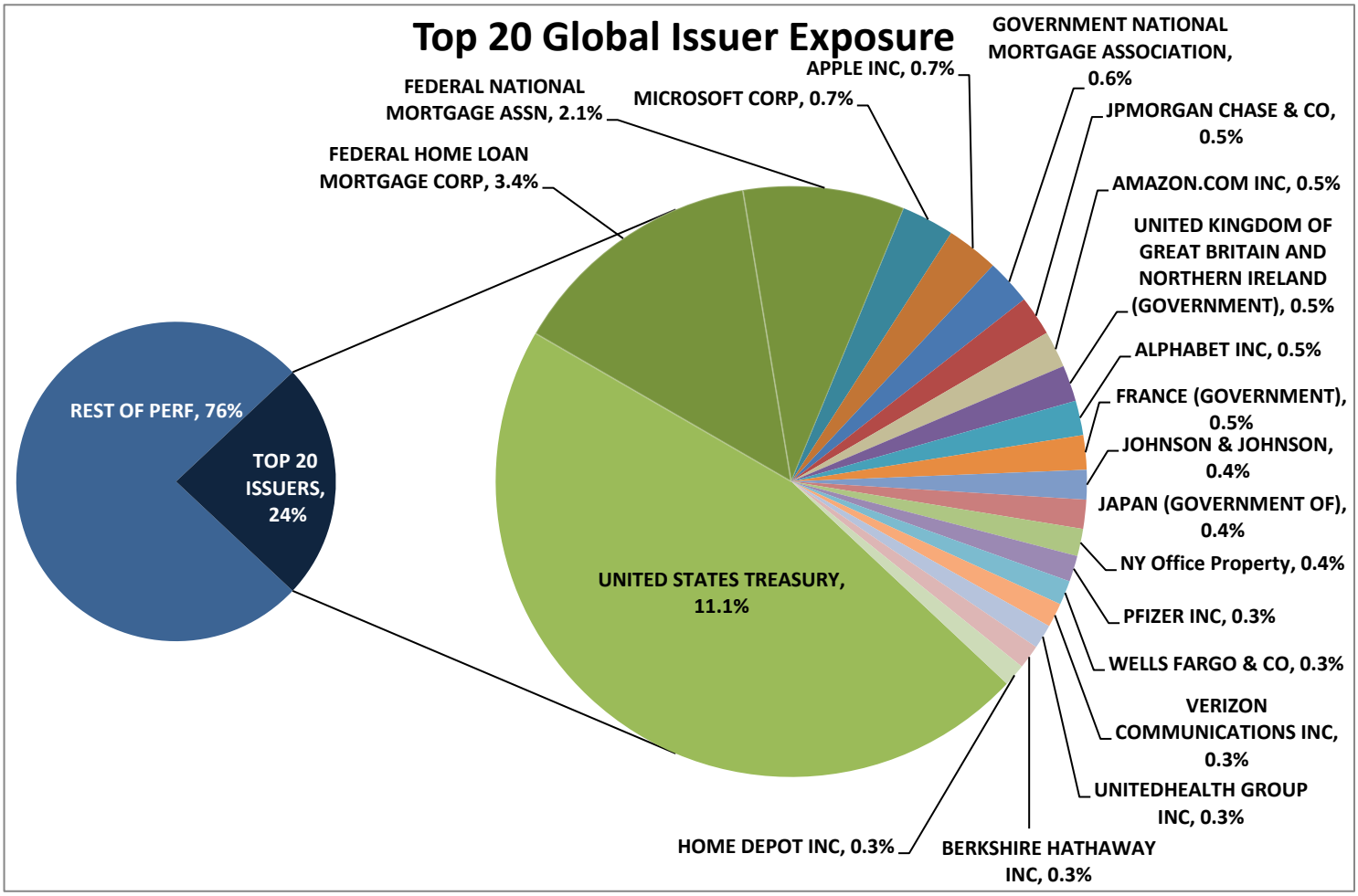
Unfunded Commitments

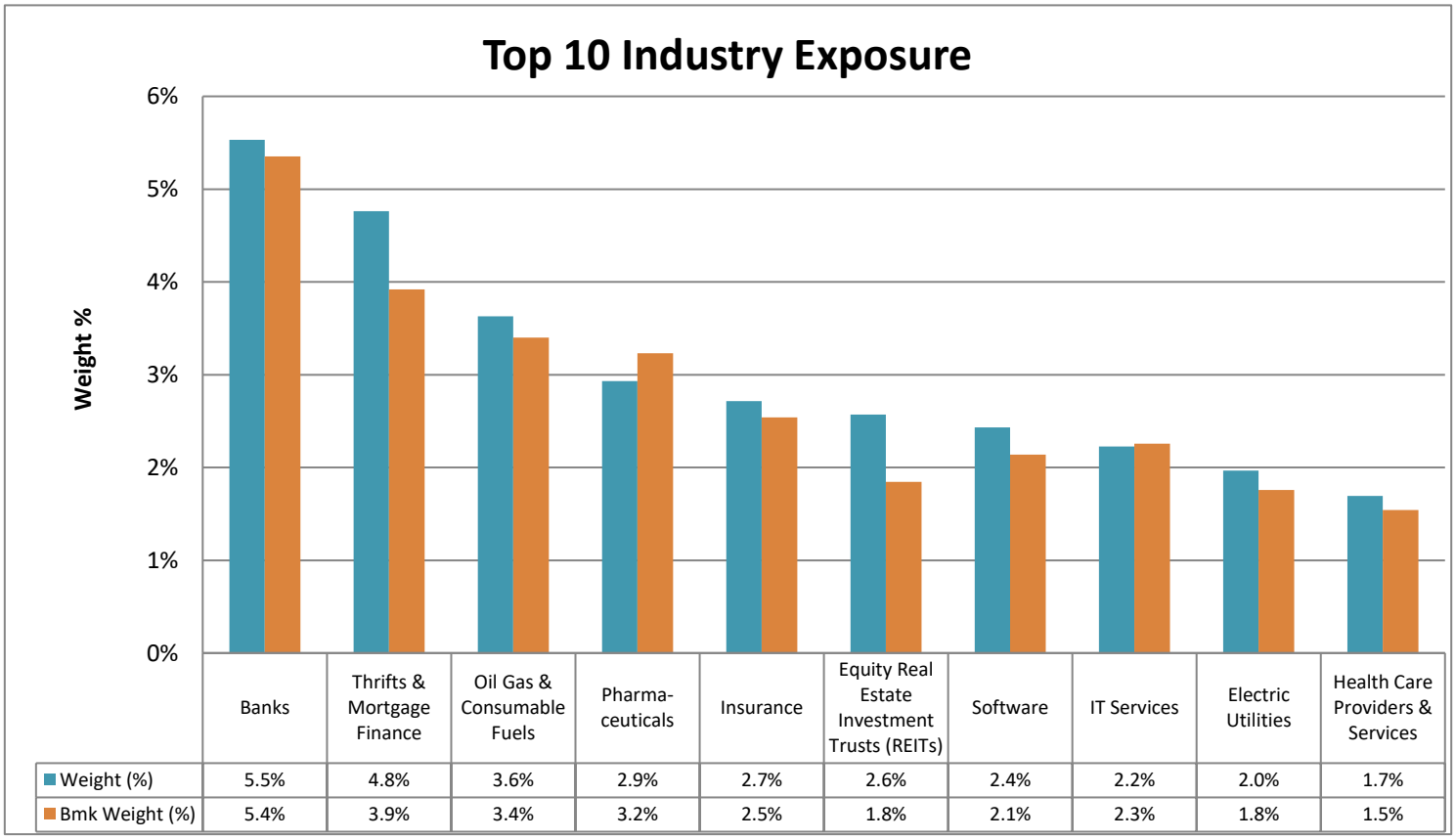
	Net Market Value ($B)	Unfunded Commitments ($B)[8]	% of Total Fund
Private Equity	27.7	17.1	5.1%
Real Assets	39.8	9.5	2.8%

1. FX Forwards used for hedging and fixed income duration shifting are not counted as leverage. Options are included based on delta adjusted notional value.
2. Cash is defined as assets meeting Liquidity program guidelines, and include cash holdings in the Fund.
3. Subscription financing and other liabilities at the fund level (as of Jun 30, 2018) are shown as recourse, while defined non-recourse for policy definition.
4. Recourse Debt in Real Estate is about $4.5m and it has not changed from the prior quarter.
5. Policy leverage for Real Assets is measured as a Loan-to-Value ratio and will differ from figure shown in table. LTV leverage as of 9/30/18 for Real Estate, Infrastructure and Forestland are: 32%, 44%, and 1%, respectively.
6. Securities lending includes only securities lent for cash collateral (which creates a source of financing).
7. Implied leverage is estimated from either asset class benchmark data or industry research. It represents the Enterprise Value to Equity ratio.
8. Unfunded commitments are as of 9/30/18 for Private Equity and 9/30/18 for Real Assets. 97% of Real Asset unfunded commitments are revocable at CalPERS' discretion.

Source: BarraOne, SSB, Factset, CalPERS

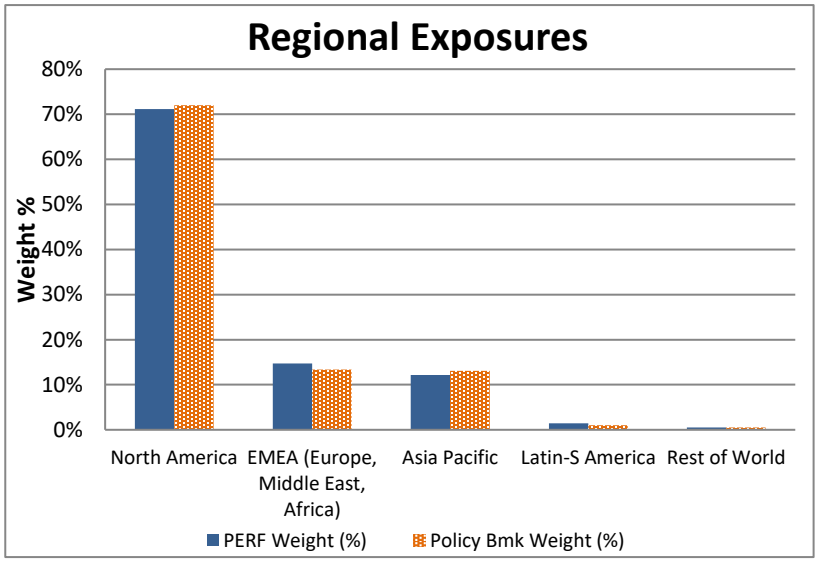
CONCENTRATION REPORT



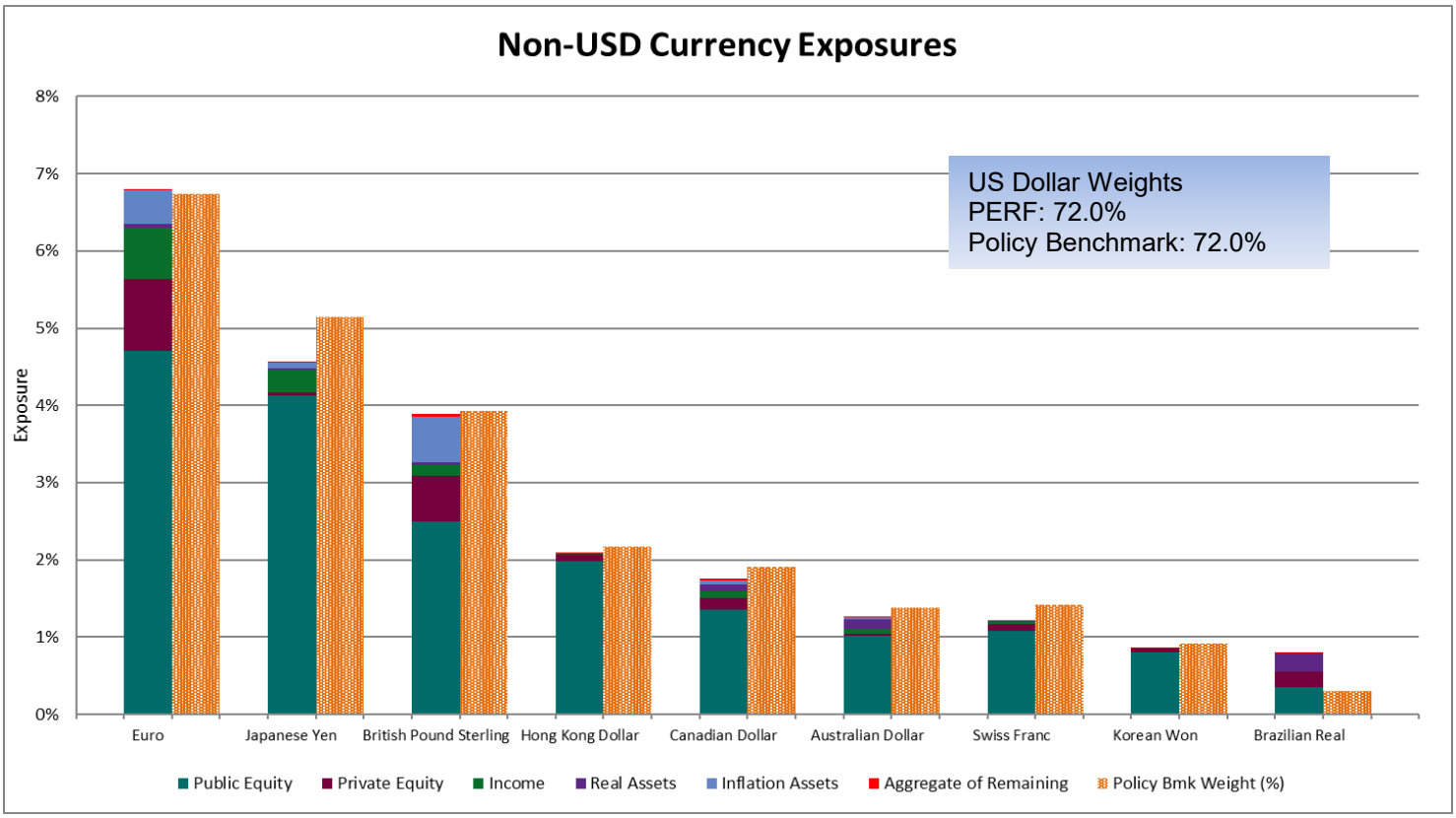


	Banks	Thrifts & Mortgage Finance	Oil Gas & Consumable Fuels	Pharma-ceuticals	Insurance	Equity Real Estate Investment Trusts (REITs)	Software	IT Services	Electric Utilities	Health Care Providers & Services
Weight (%)	5.5%	4.8%	3.6%	2.9%	2.7%	2.6%	2.4%	2.2%	2.0%	1.7%
Bmk Weight (%)	5.4%	3.9%	3.4%	3.2%	2.5%	1.8%	2.1%	2.3%	1.8%	1.5%

Source: BarraOne, CalPERS

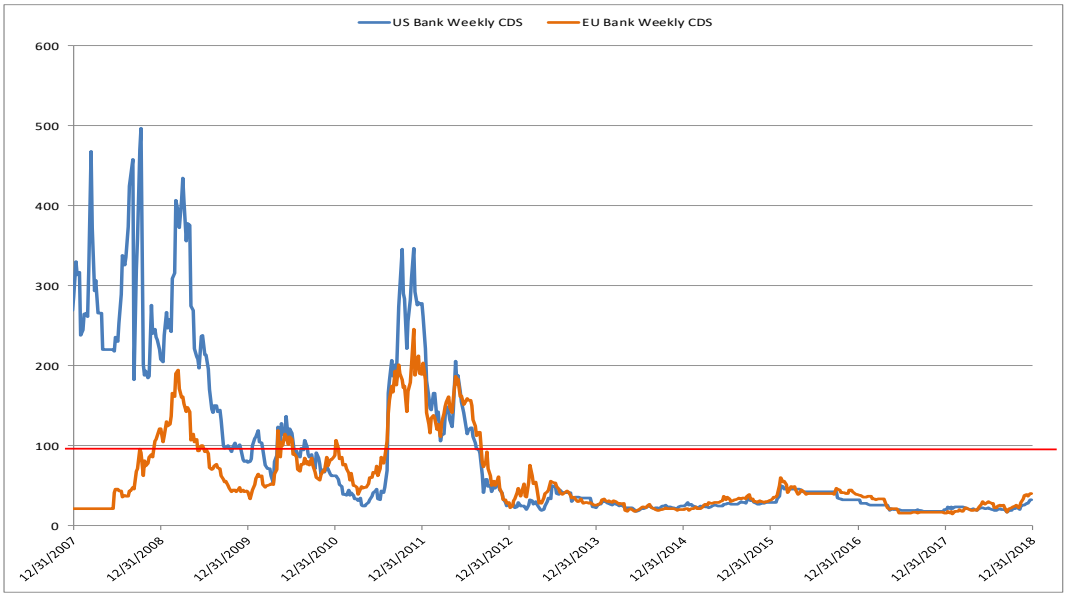


Country	PERF Weight (%)	Policy Bmk Weight (%)	Active Weight (%)
United States	69.8%	70.3%	-0.5%
Japan	4.6%	5.5%	-0.9%
United Kingdom	3.8%	3.4%	0.4%
Canada	2.1%	2.2%	-0.1%
France	2.0%	1.9%	0.1%
Germany	1.7%	1.7%	0.0%
Switzerland	1.4%	1.7%	-0.2%
Australia	1.2%	1.3%	-0.1%
China	1.0%	0.9%	0.1%
Spain	0.9%	0.6%	0.3%



Source: BarraOne, CalPERS

COUNTERPARTY RISK



CDS spreads and other metrics are regularly monitored for individual CalPERS counterparties. In addition, when aggregate spreads rise above 100 bps additional oversight

Counterparty	NET MTM FORWARDS ($)	Net MTM OPTIONS ($)	Net MTM SWAPS ($)	CalPERS Exposure ($)	Counter Party Exposure ($)	Net MTM Total ($)	Collateral Posted ($)*	Net Credit Net Exposure ($)
Bank of America	19,888,932		(41,107,934)	25,852,415	(47,071,417)	(21,219,002)	21,220,000	998
BNP Paribas	2,749,048	(130,656)	(11,015,238)	28,248,336	(36,645,182)	(8,396,846)	8,350,000	(46,846)
Barclays	12,612,093	54,813	(210,435)	13,055,153	(598,682)	12,456,471	(12,500,000)	(43,529)
Citigroup	9,255,075		(61,288,462)	11,008,067	(63,041,454)	(52,033,387)	52,040,000	6,613
Credit Suisse International	19,679		660,943	680,622		680,622	(700,000)	(19,378)
Deutsche Bank	7,842,799		58,913	12,010,360	(4,108,648)	7,901,712	(7,910,000)	(8,288)
Goldman Sachs Intl.	30,376,234	(3,703,733)	(20,420,371)	259,799,960	(253,547,830)	6,252,130	(6,300,000)	(47,870)
HSBC	17,281,430		18,878,675	39,391,258	(3,231,153)	36,160,105	(36,200,000)	(39,895)
JPMorgan Chase Bank	(988,410)	(1,620,611)	(62,158,829)	84,239,405	(149,007,255)	(64,767,850)	64,770,000	2,150
Macquarie			(28,500,619)		(28,500,619)	(28,500,619)	28,510,000	9,381
Morgan Stanley Capital Service	8,100,752	197,546	166,786	14,925,606	(6,460,522)	8,465,084	(8,500,000)	(34,916)
RBC Capital Markets	53,878			5,950,141	(5,896,263)	53,878	(60,000)	(6,122)
Standard Chartered Bank	7,862,879			8,165,388	(302,509)	7,862,879	(7,865,110)	(2,231)
Societe Generale	6,587,046	(293,093)	(2,369,059)	11,405,438	(7,480,544)	3,924,894	(3,930,000)	(5,106)
State Street	8,091,352			9,176,797	(1,085,445)	8,091,352	(8,095,377)	(4,025)
Toronto Dominion	765,481			899,108	(133,627)	765,481	(770,000)	(4,519)
UBS AGG	2,463,386	(9,182)	(40,985,335)	4,798,112	(43,329,243)	(38,531,131)	38,550,000	18,869
WestPac Bank	240,768			319,691	(78,923)	240,768	0	240,768
Grand Total	133,202,422	(5,504,916)	(248,290,965)	529,925,857	(650,519,316)	(120,593,459)	120,609,513	16,054

**As of 12/31/18 CalPERS posted 213mm to Counterparties which includes Internal Collateral*

Above: Total market value exposure and net credit exposures are monitored for all of our OTC (over-the-counter) positions.
Source: Blackrock, CalPERS
Below: FCM (Futures Commission Merchant) exposures are monitored for how much margin we have posted with our FCM. *Source: CalPERS*

FUTURES COMMISSION MERCHANT EXPOSURE	
Futures Commission Merchant	**Collateral Posted***
CITIGROUP GLOBAL MARKETS INC	260,630,527
MERRILL LYNCH PIERCE & SMITH INC	153,074,549

**As of December 31, 2018*

1. How to interpret the OTC Counterparty Risk Exposure section

OTC Derivative Counterparty Exposure Report

Counterparty	NET MTM FORWARDS ($)	Net MTM OPTIONS ($)	Net MTM SWAPS ($)	CalPERS Exposure ($)	Counter Party Exposure ($)	Net MTM Total ($)	Collateral Posted ($)	Net Credit Net Exposure ($)
Counterparty 123	10,386,714.00	(84,745.00)	11,735,283.00	27,147,091.00	(25,475,215.00)	1,671,876.00	(1,525,000.00)	146,876.00

NET MTM BY PRODUCT TYPE

- Columns reflect the net mark to market (MTM) of all OTC trades by product type with a Counterparty
- + amount = CalPERS has a gain on the positions
- - amount = CalPERS has a loss on the positions

Directional Exposure

- The exposure columns reflect an un-net profit or loss (P&L) grouping across product type and is equivalent to the directional unwind exposure at a point in time
- Trades with positive P&L are bucketed together = CalPERS Exposure
- Trades with negative P&L are bucketed together = Counterparty Exposure

NET CREDIT EXPOSURE

- The net credit exposure column reflects the open uncollateralized credit exposure risk if a Counterparty were to default with no change in mark to market prices
- + amounts reflect open credit risk where CalPERS is owed money

NET MTM TOTAL

- The net market to market column reflects the total current net profit or loss position across all open OTC trades with a Counterparty
- + amount = CalPERS is owed money
- - amount = CalPERS owes money

COLLATERAL POSTED

- The collateral posted column reflects the dollar amount of collateral that is either posted to CalPERS or that CalPERS has posted to a Counterparty to offset credit risk
- + amount = CalPERS has posted money out
- - amount = Counterparty has posted money to CalPERS

*Net mark to market (MTM): positions are adjusted to reflect current market values and then summed