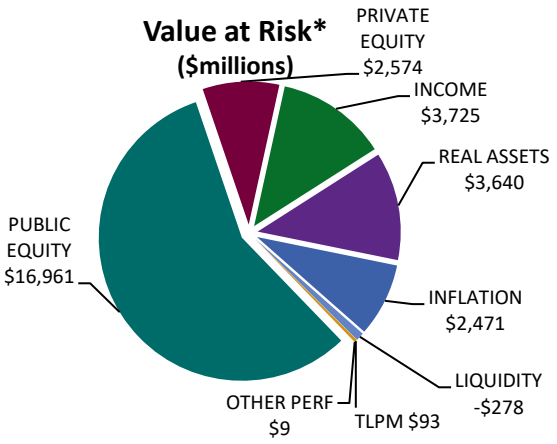
CalPERS Trust Level Review
Risk Management Summary

Period Ending December 31, 2017

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 Target	Current 12/31/2017	Last Qtr 9/30/2017	Last Year 12/31/2016
Total	n/a	7.4	7.7	9.2
Benchmark	n/a	7.0	7.2	8.7
Tracking Error	< 1.5	0.6	0.7	0.7
Allocation	< 0.75	0.2	0.2	0.1
Selection	n/a	0.4	0.4	0.6



Comments:

Forecast Total Volatility of the PERF decreased by 179 bps over the last year. This change is primarily a reflection of historically low recent market volatility. Recent conditions carry higher weight in risk model calibration.

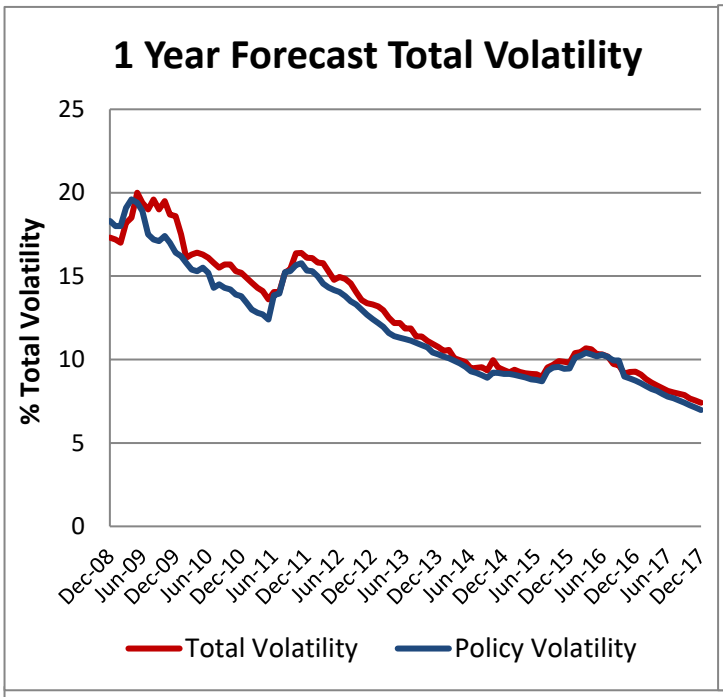
Rapid shifts in volatility regime can occur and would not be predicted by this model. The best interpretation of this estimate is as an indicator of the plan's volatility given the current market environment.

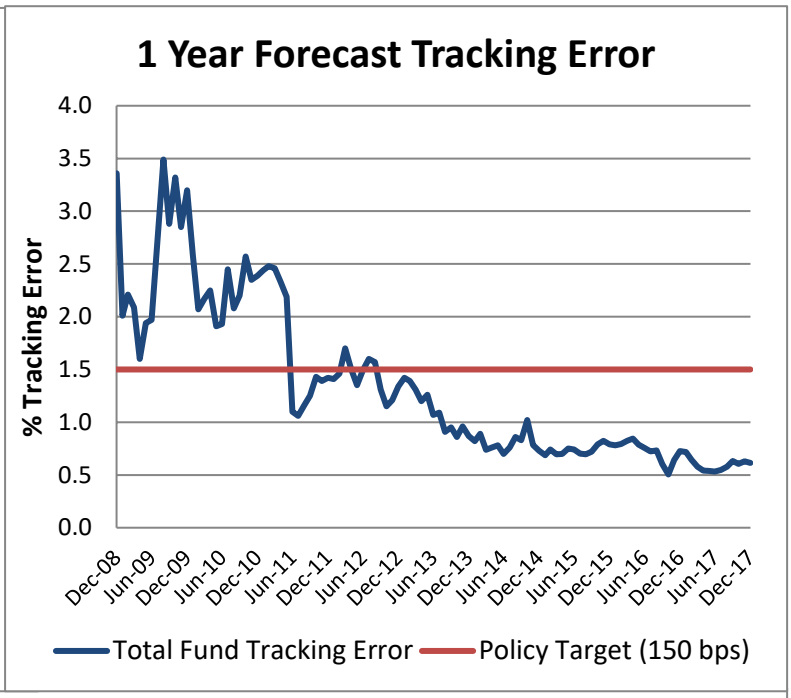
Asset Class	Market Value ($millions)	Total Forecast Volatility (%)	% Contribution to Total Vol	Tracking Error (%)	Value at Risk* ($millions)	Conditional VaR* ($millions)
PUBLIC EQUITY	$ 176,440	10.8%	71.4%	0.2%	$ 16,961	$ 24,918
PRIVATE EQUITY	$ 26,710	12.7%	11.6%	3.3%	$ 2,574	$ 3,991
INCOME	$ 65,583	5.4%	1.7%	0.3%	$ 3,725	$ 5,208
REAL ASSETS	$ 36,829	10.0%	10.7%	2.3%	$ 3,640	$ 5,172
INFLATION	$ 27,422	7.4%	4.0%	0.3%	$ 2,471	$ 3,313
LIQUIDITY	$ 14,660	0.1%	0.0%	0.1%	$ (278)	$ (273)
TLPM	$ 2,063	6.7%	0.5%	6.7%	$ 93	$ 150
OTHER PERF	$ 278	5.9%	0.0%	5.9%	$ 9	$ 16
TOTAL FUND	**$ 349,986**	**7.4%**	**100.0%**	**0.6%**	**$ 19,936**	**$ 30,769**

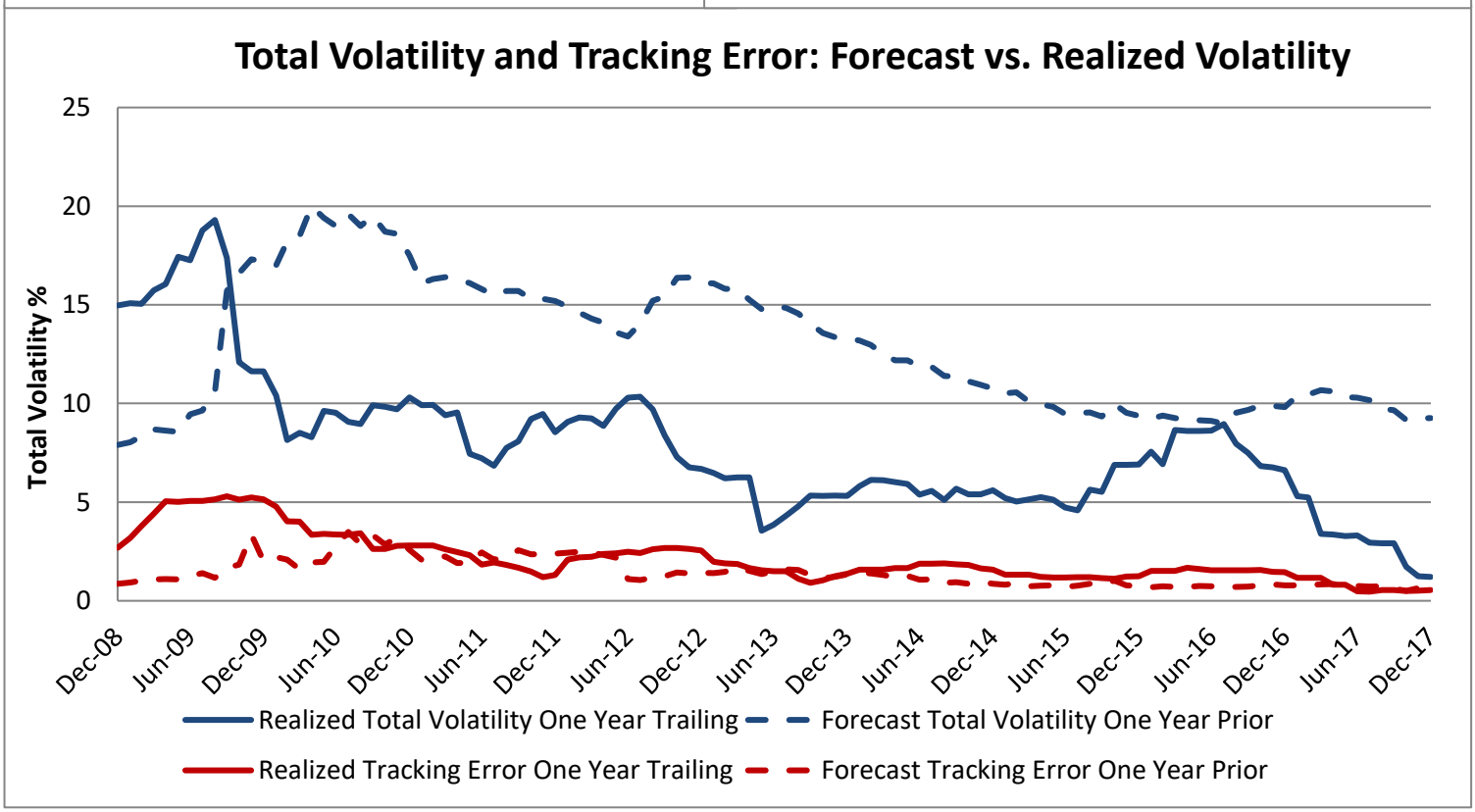
*1-year, 95% confidence Value at Risk. Conditional Value at Risk measures the mean of the tail distribution beyond the 95% confidence level. Both are adjusted to account for 1 year of expected returns of each asset class and the PERF using June 2017 Capital Market Assumptions.

Source: BarraOne / CalPERS

RISK MANAGEMENT TIME SERIES



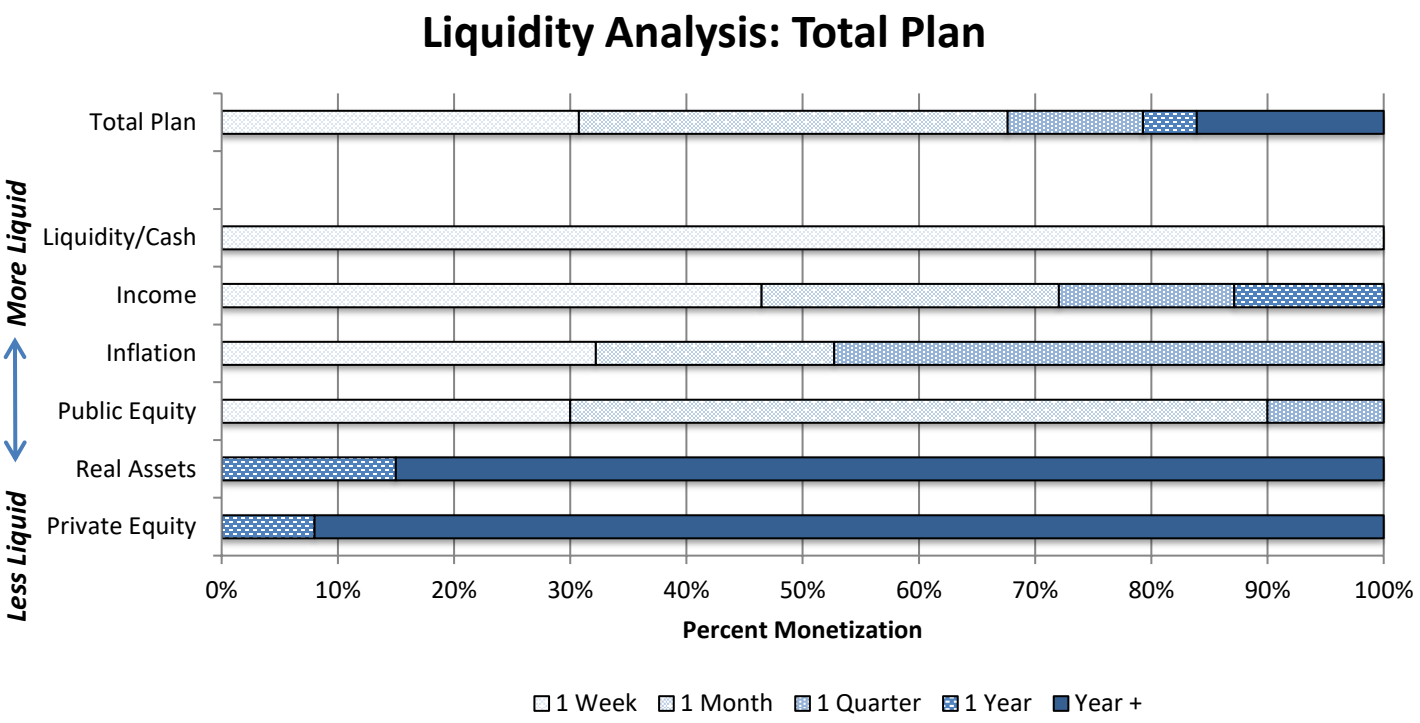




The bottom chart plots the Forecast Total Volatility and Tracking Error for the Total Fund one year prior to each date vs. the Total Volatility and Tracking Error realized for that date. The graph highlights potential deviations between risk model estimates and subsequent realized volatility, due to 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

LIQUIDITY

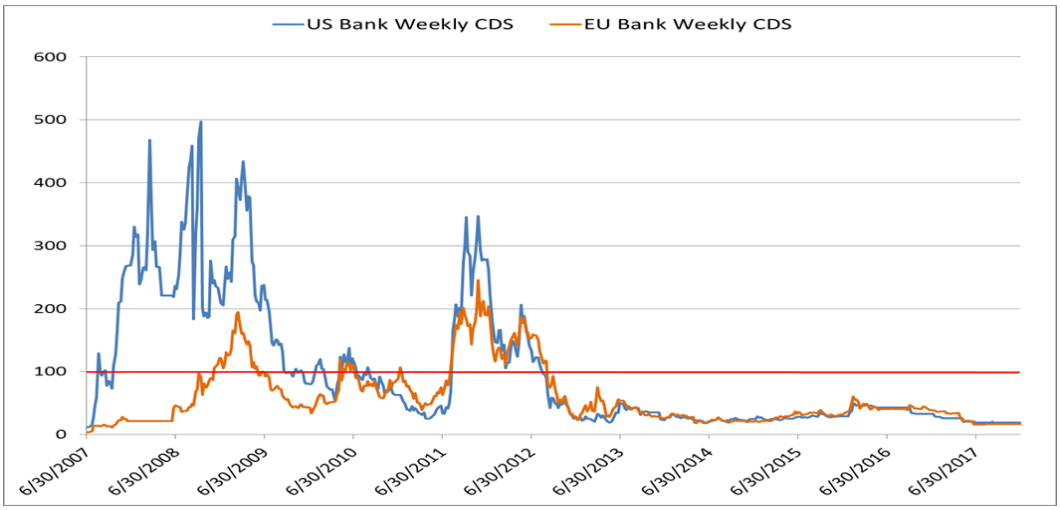


Transactional liquidity is estimated for each asset class /strategy based on the current market environment while also accounting for legal structures or other factors that may impact liquidity. *Source: SSB, CalPERS*

	PERF LIQUIDITY SNAPSHOT As of January 1, 2018			
		Expected Cash Flows for 1 Month		
		Normal Conditions	Stress Scenario	
a	**Cash Equivalents in Liquidity Portfolio (< 30 days)***	$6,336,098,254	$6,336,098,254	
b	**Sources Total (cash flow in)**	$3,709,861,488	$3,408,712,219	
c	**Uses Total (cash flow out)**	($2,090,496,332)	($2,090,496,332)	
d	**Contingency Use****		($2,546,737,405)	
	Expected Cash Equivalents (Period End)	$7,955,463,411	$5,107,576,737	
	Liquidity Coverage Ratio	**481%**	**210%**	**= (a+b)/-(c+d)**
	* Excludes borrowed liquidity i.e. cash available in asset classes and cash collateral from sec lending ** Contingency Use accounts for potential cash demands from derivatives positions, sec lending, and fund level contingent liabilities			

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 (4.81 times in normal market conditions) available liquid cash /cash equivalents could cover projected cash needs over a 1 month forward period. *Source: BarraOne, SSB, CalPERS*

COUNTERPARTY RISK



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

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	(18,227,443)	(54,636)	14,105,897	(18,530,179)	14,353,997	(4,176,182)	4,180,000	3,818
BNP Paribas	(8,830,000)		50,810,811	(11,992,364)	53,973,175	41,980,811	(42,025,000)	(44,189)
Barclays	(9,499,162)			(10,201,047)	701,885	(9,499,162)	9,500,000	838
Citigroup	(11,931,747)	(181,299)	14,192,872	(12,969,933)	15,049,759	2,079,826	(2,080,000)	(174)
Canadian Imperial Bank of Commerce	(110,551)		13,430,910	(110,551)	13,430,910	13,320,359	(13,330,000)	(9,641)
Credit Suisse International			168,044		168,044	168,044	0	168,044
Deutsche Bank	(4,661,685)	(10,883)	391,336	(4,830,821)	549,589	(4,281,232)	4,290,000	8,768
Goldman Sachs Intl.	(45,023,604)	114,464,493	184,891,137	(157,171,820)	411,503,846	254,332,026	(254,350,000)	(17,974)
HSBC	9,208,979		315,319	(564,858)	10,089,156	9,524,298	(9,550,000)	(25,702)
JPMorgan Chase Bank	(5,100,734)	(35,341)	107,412,868	(22,915,459)	125,192,252	102,276,793	(102,280,000)	(3,207)
Morgan Stanley Capital Group			13,947,617		13,947,617	13,947,617	(13,950,000)	(2,383)
Morgan Stanley Capital Service	(9,266,916)	(64,876)	1,988,653	(12,426,442)	5,083,303	(7,343,139)	7,350,000	6,861
RBC Capital Markets	22,521				22,521	22,521	0	22,521
Standard Chartered Bank	(5,029)			(5,029)		(5,029)	0	(5,029)
Societe Generale	(774,402)	(1,079,700)	22,603,023	(8,286,787)	29,035,708	20,748,921	(20,750,000)	(1,079)
State Street	(102,319)			(110,854)	8,535	(102,319)	110,000	7,681
Toronto Dominion	(3,347,705)			(4,040,179)	692,474	(3,347,705)	3,350,000	2,295
UBS AGG	(663,397)			(990,382)	326,985	(663,397)	700,000	36,603
Wells Fargo			12,458,411		12,458,411	12,458,411	(12,460,000)	(1,589)
	(108,313,194)	113,037,758	436,716,898	(265,146,705)	706,588,167	441,441,462	(441,295,000)	146,462

**As of 12/31 CalPERS posted 471mm to Counterparties which includes Internal and External 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 CLEARING MERCHANT EXPOSURE	
Futures Commission Merchant	**Collateral Posted**
CITIGROUP GLOBAL MARKETS INC	160,987,112
MERRILL LYNCH PIERCE FENNER & SMITH INCORPORATED	53,662,371

**As of December 31, 2017*

Total Fund Leverage Report

as of 12/31/17

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)	Additional + Sources of Leverage	= Gross Market Exposure (C)	Portfolio Leverage (C/A)
		Derivatives	Recourse Debt	Other				Non Recourse Debt		
Public Equity	176.4	8.1			1.8	182.8	1.04		182.8	1.04
Private Equity	26.7		1.6[3]		0.0	28.3	1.06		28.3	1.06
Income	65.6	4.7			2.1	68.2	1.04		68.2	1.04
Liquidity	14.7				14.7	0.0	0.00		0.0	0.00
Real Assets	36.8		0.0[4]		0.6	36.2	0.98	17.6	53.8	1.46[5]
Inflation	27.4	7.1			6.3	28.2	1.03		28.2	1.03
Securities Lending[6]	0.0			5.8	5.8	0.0	N/M		0.0	N/M
Credit Enhancement	0.0			0.1		0.1	N/M		0.1	N/M
Other Trust Level[7]	2.3			0.5	1.5	1.3	0.55		1.3	N/M
Total Fund	$350.0	$19.9	$1.6	$6.4	32.8	$345.1	**0.99**	$17.6	$362.6	**1.04**

Embedded Leverage in Asset Classes

	Implied Leverage[8]
Public Equity	1.53
Private Equity	2.22
Real Estate	1.27

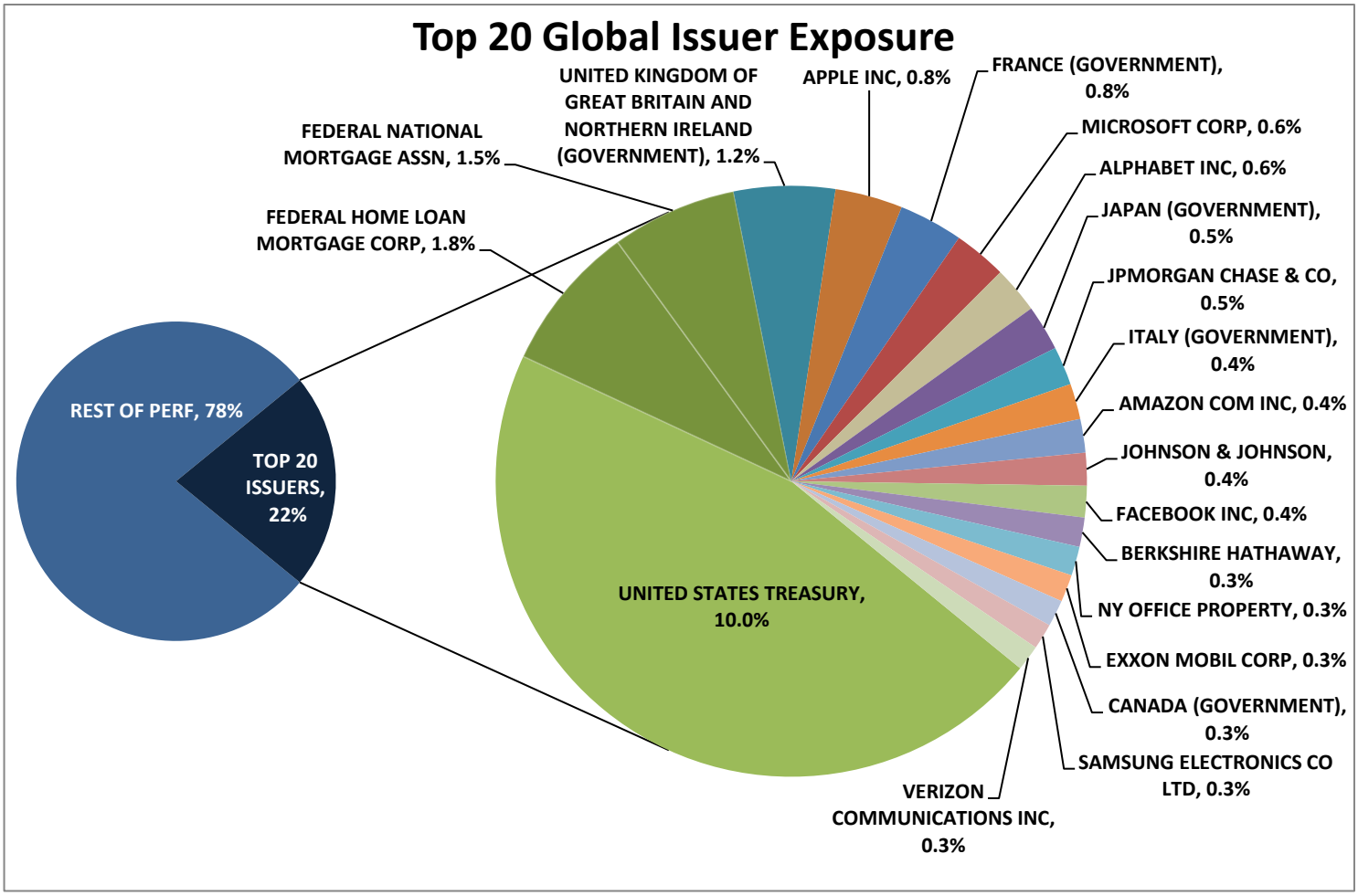
Unfunded Commitments

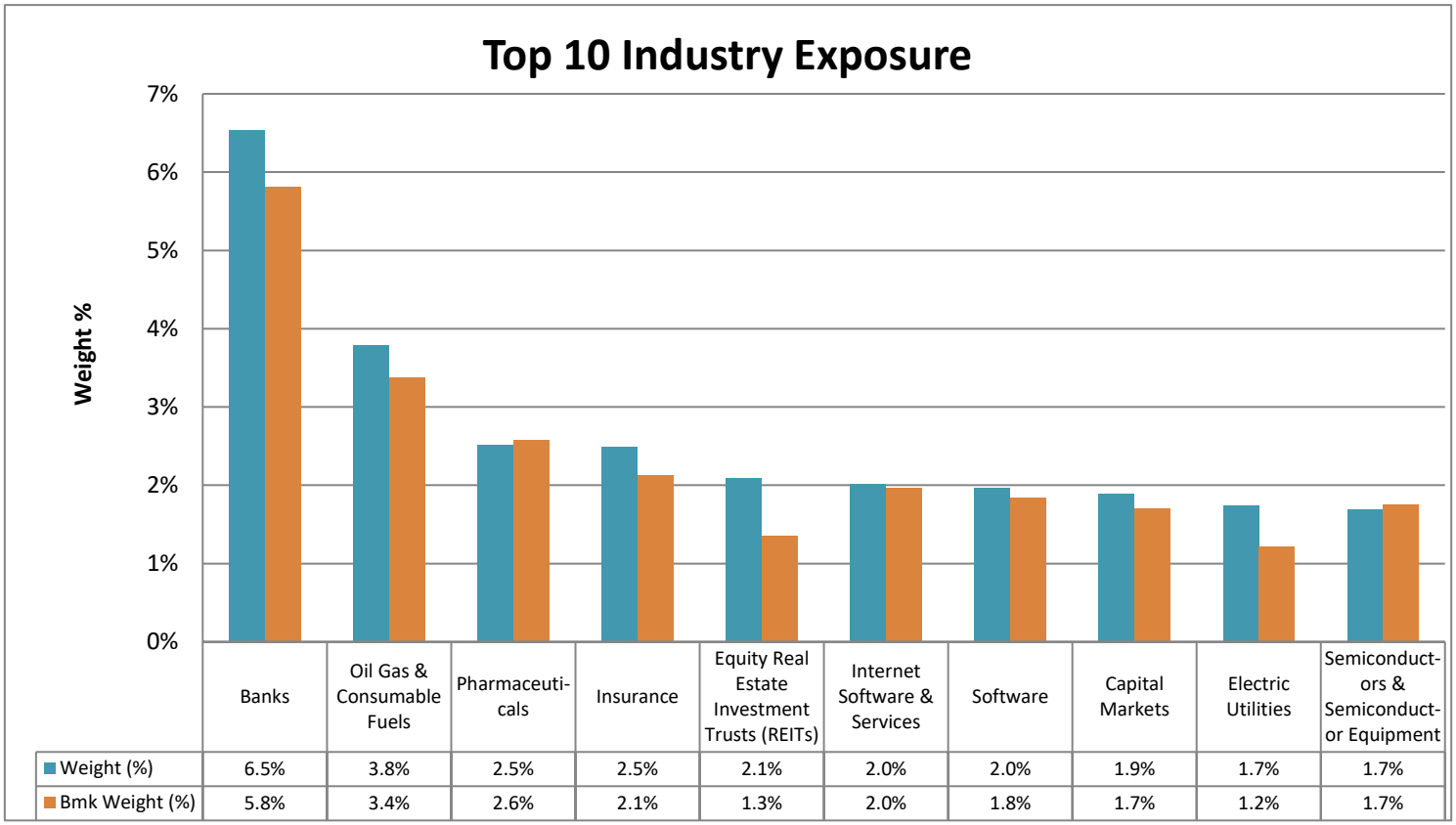
	Net Market Value ($B)	Unfunded Commitments ($B)[9]	% of Total Fund
Private Equity	26.7	14.2	4.1%
Real Assets	36.8	9.2	2.6%

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, 2017) 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 9/30/17 for Real Estate, Infrastructure and Forestland are: 31%, 43%, and 22%, respectively.
6. Securities lending includes only securities lent for cash collateral (which creates a source of financing).
7. Other Trust Level includes: Absolute Return Strategies and other Plan Level Portfolios.
8. Implied leverage is estimated from either asset class benchmark data or industry research. It represents the Enterprise Value to Equity ratio.
9. Unfunded commitments are as of 12/31/17 for Private Equity and 9/30/17 for Real Assets. 96% of Real Asset unfunded commitments are revocable at CalPERS' discretion.

Source: BarraOne, SSB, Factset, CalPERS

CONCENTRATION REPORT

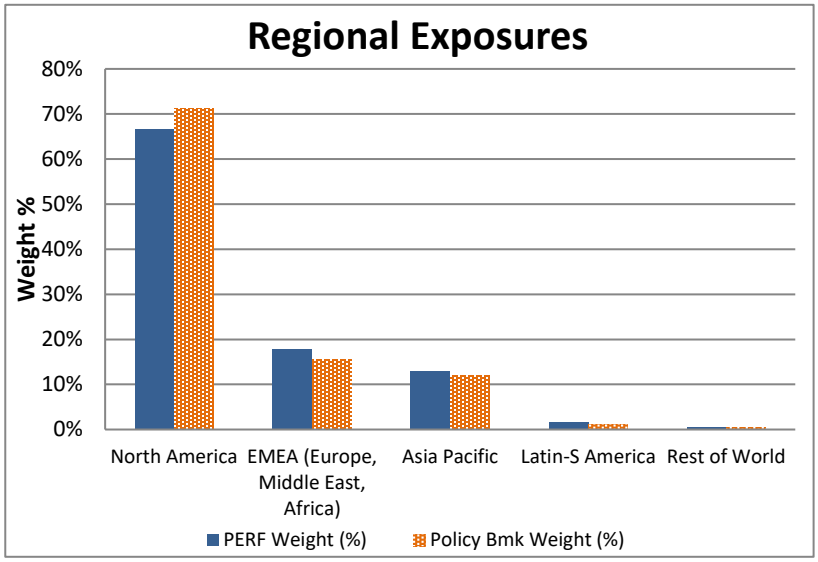




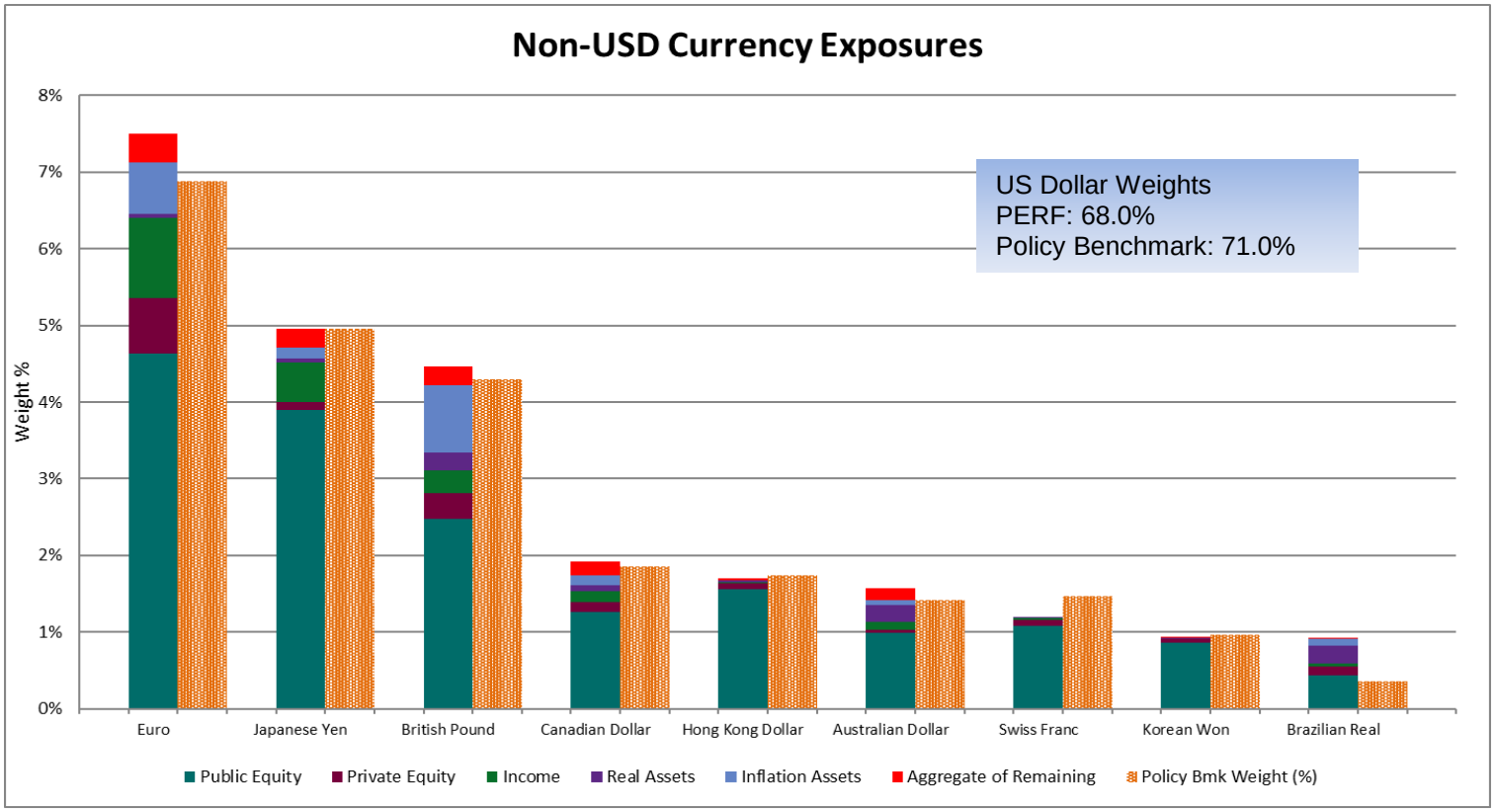
	Banks	Oil Gas & Consumable Fuels	Pharmaceuti-cals	Insurance	Equity Real Estate Investment Trusts (REITs)	Internet Software & Services	Software	Capital Markets	Electric Utilities	Semiconduct-ors & Semiconduct-or Equipment
Weight (%)	6.5%	3.8%	2.5%	2.5%	2.1%	2.0%	2.0%	1.9%	1.7%	1.7%
Bmk Weight (%)	5.8%	3.4%	2.6%	2.1%	1.3%	2.0%	1.8%	1.7%	1.2%	1.7%

Source: BarraOne, CalPERS

CONCENTRATION REPORT



Country	PERF Weight (%)	Policy Bmk Weight (%)	Active Weight (%)
United States	64.5%	69.1%	-4.6%
Japan	5.0%	5.0%	-0.1%
United Kingdom	4.6%	4.4%	0.2%
France	2.5%	2.2%	0.3%
Canada	2.2%	2.1%	0.1%
Germany	1.9%	2.0%	-0.2%
Australia	1.7%	1.4%	0.2%
China	1.5%	1.3%	0.2%
Switzerland	1.3%	1.5%	-0.2%
Italy	1.0%	0.8%	0.2%

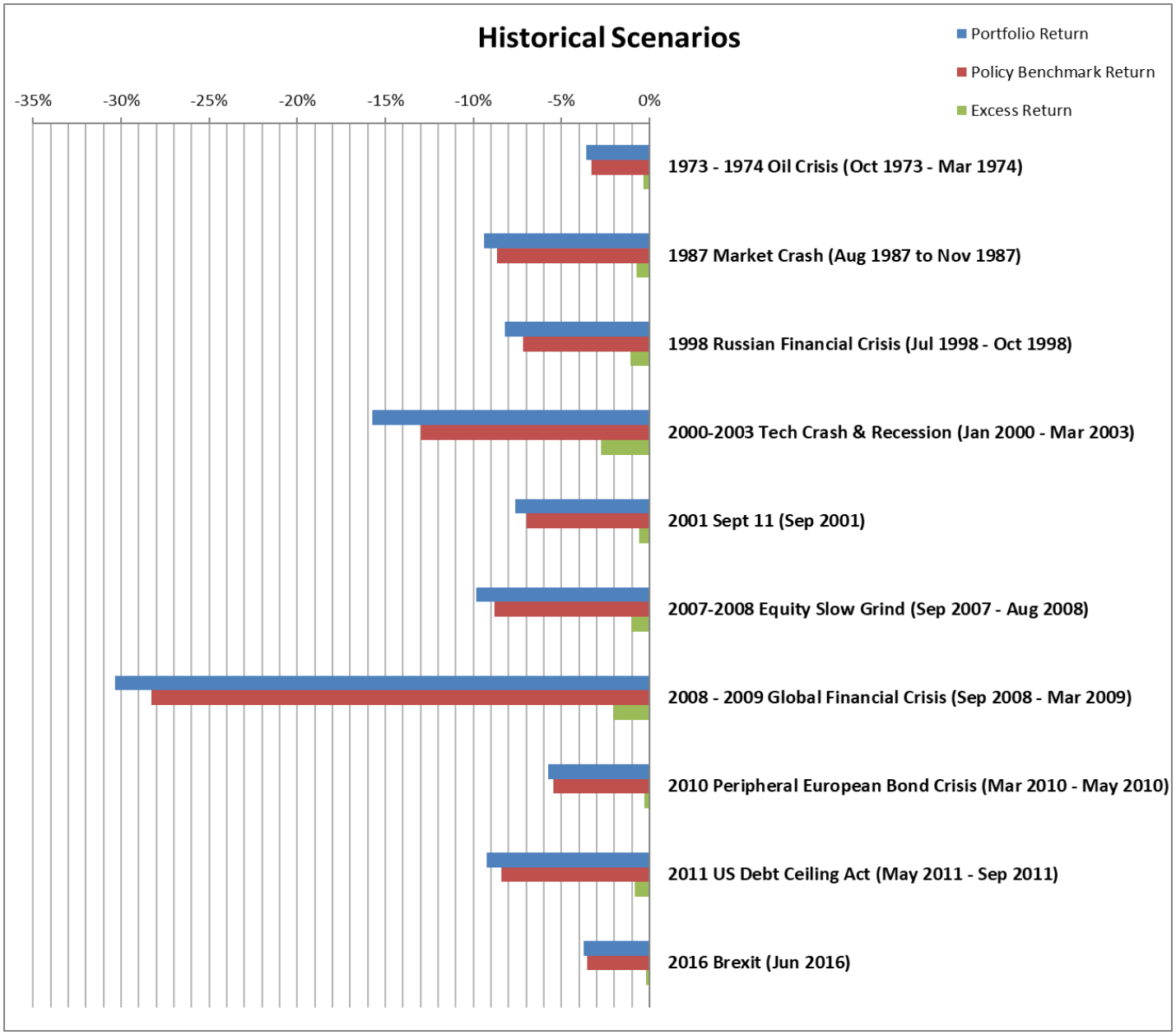


Source: BarraOne, CalPERS

STRESS TESTING

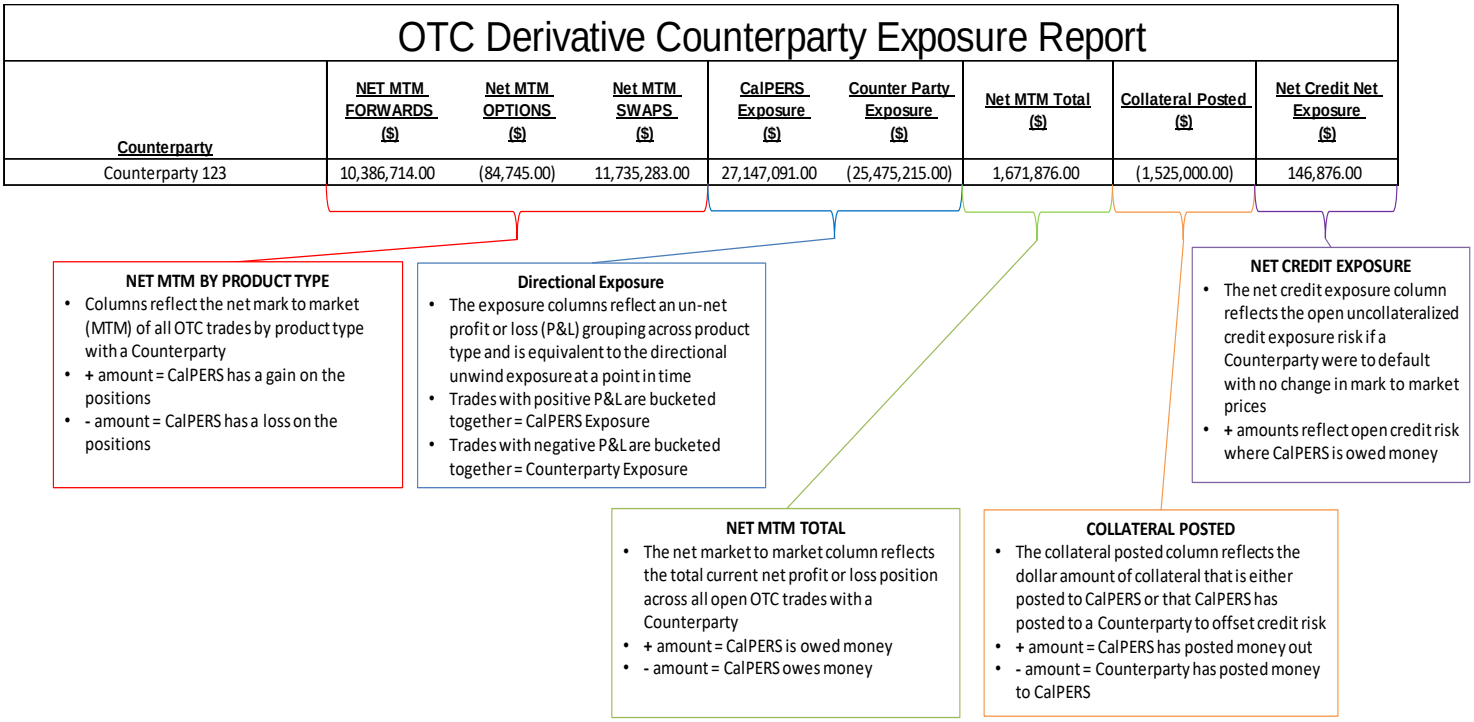
Historical scenarios highlight the sensitivity of the portfolio to past economic regimes or specific events. The scenarios can be used as a "what if" gauge of current portfolio positioning to understand the potential impact if a similar event or regime were to repeat.

Scenario	Portfolio Return	Policy Benchmark Return	Excess Return
1973 - 1974 Oil Crisis (Oct 1973 - Mar 1974)	-3.6%	-3.3%	-0.3%
2016 Brexit (Jun 2016)	-3.7%	-3.5%	-0.2%
2010 Peripheral European Bond Crisis (Mar 2010 - May 2010)	-5.7%	-5.4%	-0.3%
2001 Sept 11 (Sep 2001)	-7.6%	-7.0%	-0.6%
1998 Russian Financial Crisis (Jul 1998 - Oct 1998)	-8.2%	-7.2%	-1.1%
2011 US Debt Ceiling Act (May 2011 - Sep 2011)	-9.2%	-8.4%	-0.8%
1987 Market Crash (Aug 1987 to Nov 1987)	-9.4%	-8.6%	-0.7%
2007-2008 Equity Slow Grind (Sep 2007 - Aug 2008)	-9.8%	-8.8%	-1.0%
2000-2003 Tech Crash & Recession (Jan 2000 - Mar 2003)	-15.7%	-13.0%	-2.8%
2008 - 2009 Global Financial Crisis (Sep 2008 - Mar 2009)	-30.3%	-28.3%	-2.0%



Source: BarraOne, CalPERS

1. How to interpret the OTC Counterparty Risk Exposure section



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