Verus

PERSPECTIVES THAT DRIVE ENTERPRISE SUCCESS

DECEMBER 2, 2015

Asset allocation study

Contra Costa County Employees' Retirement Association

Table of contents

Verus

VERUSINVESTMENTS.COM

SEATTLE 206-622-3700
LOS ANGELES 310-297-1777

Plan profile

Plan profile

As of September 30, 2015:

- Total market value of assets = $7,016,433,248

As of December 31, 2014:

- Average monthly Plan cash flows based on the previous 24 months:
  - Total Contributions = $27.7 mil
    - Average annual lump sum employer contribution of $262.6 mil in July
  - Total Benefit Payments & Expenses = $34.0 mil
    - Benefit Payments = $30.8 mil
    - Operating Expenses = $3.2 mil
  - Net Operating Cash *Outflow* = $5.6 mil
  - Total Interest & Dividends = $23.2 mil
  - Net Cash *Inflow* = $17.6 mil

As of December 31, 2014:

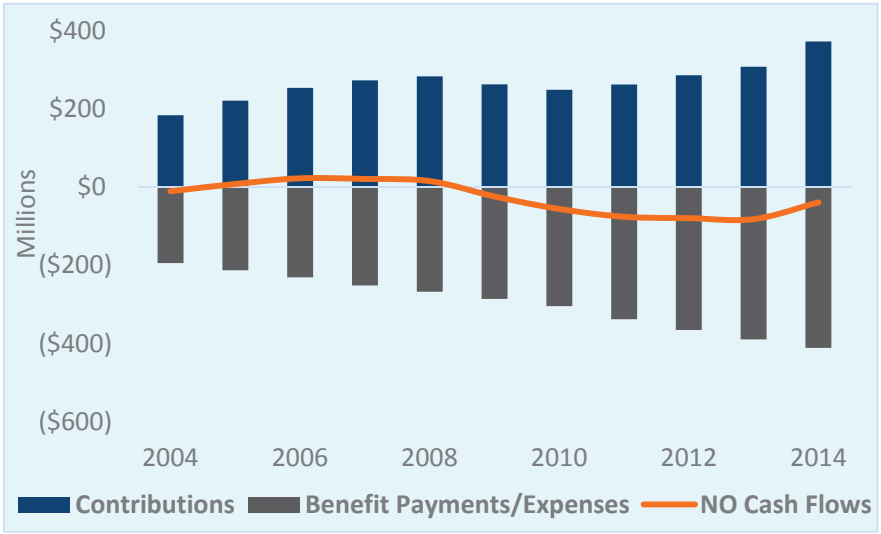
- Open to new participants
- Accrued liability = $8,104,611,627 (based on interest rate of 7.25%)
- Actuarial assumed rate of return = 7.25%
- Funded ratio = 85.9% (actuarial value of assets) and 86.6% (market value of assets)
- Total participants = 20,677 (9,159 or 44.3% active, 2,647 or 12.8% inactive, 8,871 or 42.9% retired)

Cash flows

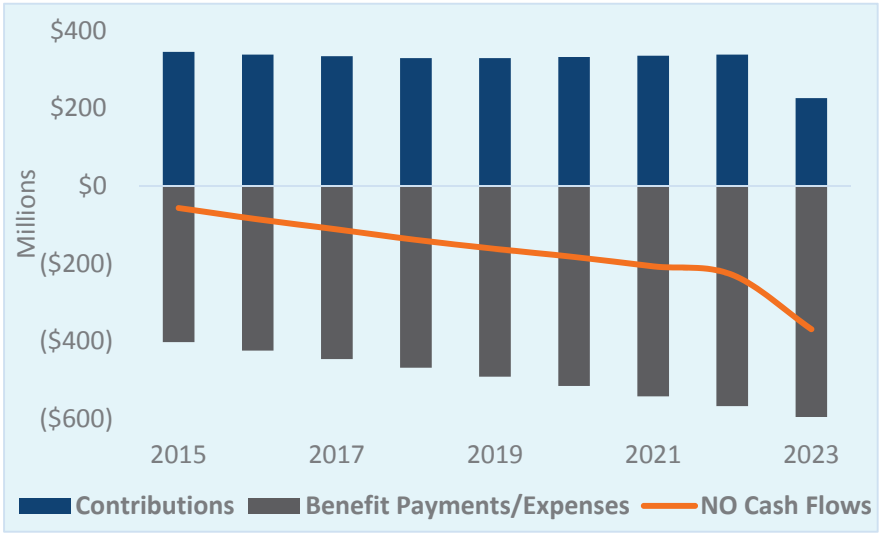
Operating cash flows

- From 2004 to 2014, benefit payments and expenses have increased at an annual rate of 7.8%, while contributions have increased at an annual rate of 7.3%
- From 2015 to 2023, benefit payments and expenses are projected to increase at an annual rate of 5.0%, while contributions are projected to *decrease* at an annual rate of -5.2% (mostly attributable to the decrease in 2023)
- Current projections have net operating cash flows steadily declining to -$369 mil at the end of 2023

HISTORICAL OPERATING CASH FLOWS



PROJECTED OPERATING CASH FLOWS

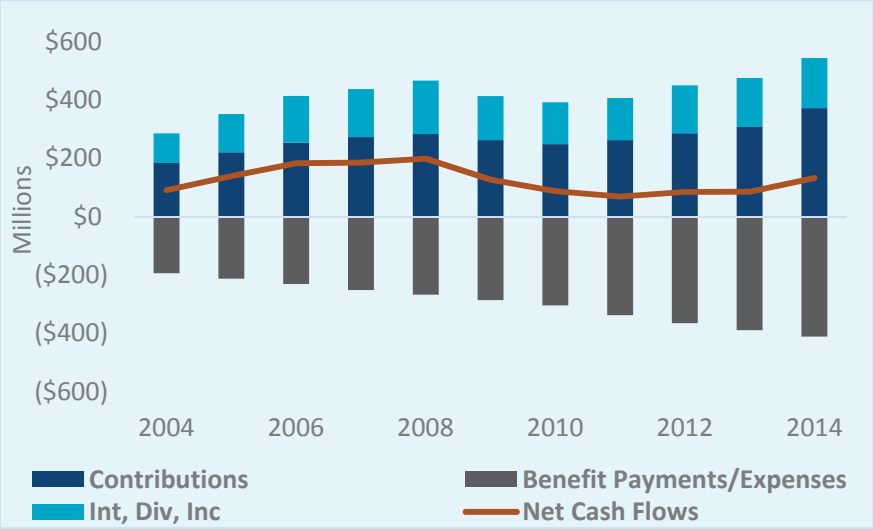


As of December 31, 2014
Sources: CCCERA Comprehensive Annual Financial Reports; Segal Consulting CCCERA GAS 67 Actuarial Valuation Report as of December 31, 2014

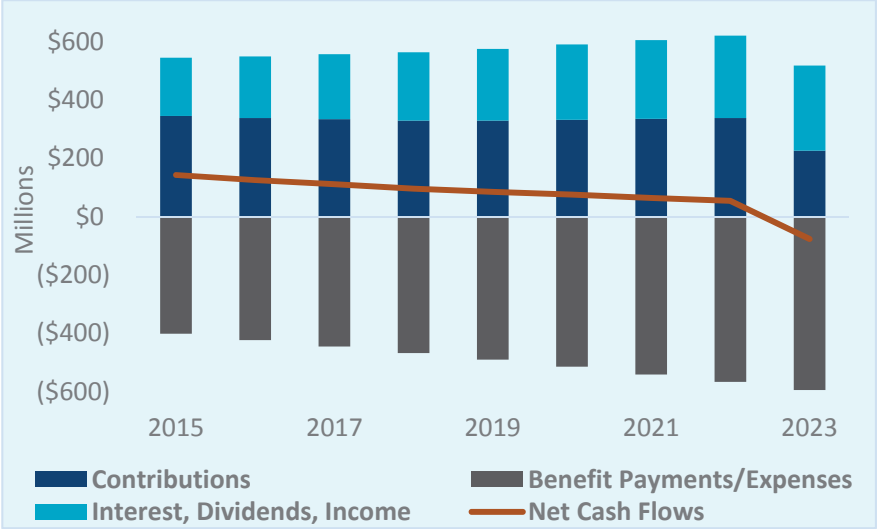
Total cash flows

- Over the last 10 years, net cash flows (taking into account interest, dividends, and real estate income) have remained positive, reaching $132.1 mil at the end of 2014
- Interest, dividends, and real estate income averaged $158.3 mil (2.7% of total assets) from 2010 to 2014
- Using 2.7% of total assets as a projection for future interest, dividends, and real estate income, net cash flows are expected to remain positive through 2022

HISTORICAL CASH FLOWS



PROJECTED CASH FLOWS

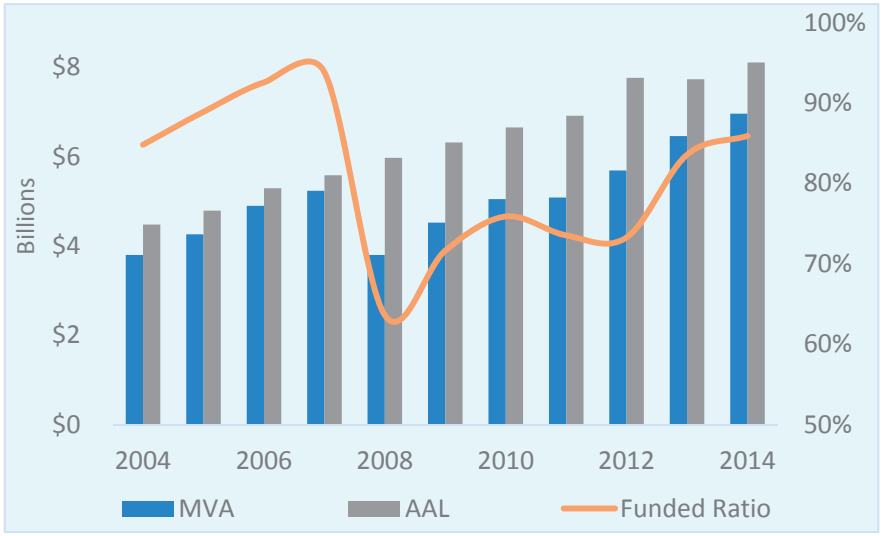


As of December 31, 2014
Sources: CCCERA Comprehensive Annual Financial Reports; Segal Consulting CCCERA GAS 67 Actuarial Valuation Report as of December 31, 2014

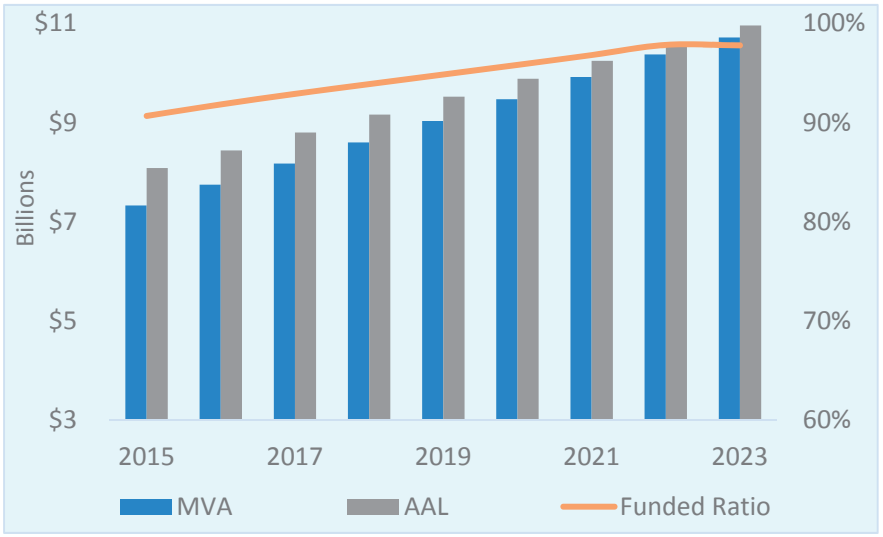
MVA and AAL

- From 2004 to 2014, the market value of assets and actuarial accrued liabilities have grown at an annual rate of 6.1% and 6.2%, respectively
- Based on market value of assets, the Plan's funded ratio at the end of 2014 was 85.9%
- From 2015 to 2023, the actuarial accrued liabilities are projected to grow at an annual rate or 3.9%
- The funded ratio, based on an assumed rate of return of 7.25%, is projected to steadily increase ~1% per year, reaching 97.8% by the end of 2023

HISTORICAL PLAN ASSETS VS. LIABILITIES



PROJECTED PLAN ASSETS VS. LIABILITIES



As of December 31, 2014
Sources: CCCERA Investment Reports, Segal Consulting CCCERA Actuarial Valuation Reports

Benefits & expenses protection

24-month "reserves" model

Assuming annual returns range between 6.0% and 8.5%, 24 month forward projected expenses (as a % of total assets) will range between 10.7% and 12.8% over the next 6 years

	Projected Expenses		Total Assets			Next 2 Year Expenses (% of Assets)		
Year End	Current Year	Next 2 Years	7.25% Return	6.0% Return	8.5% Return	7.25% Return	6.0% Return	8.5% Return
2016	$424	$914	$7,750	$7,571	$7,939	11.79%	12.07%	11.51%
2017	$446	$959	$8,174	$7,890	$8,479	11.73%	12.15%	11.31%
2018	$468	$1,006	$8,599	$8,201	$9,037	11.70%	12.27%	11.13%
2019	$491	$1,057	$9,031	$8,507	$9,618	11.70%	12.43%	10.99%
2020	$515	$1,109	$9,471	$8,806	$10,224	11.71%	12.59%	10.85%
2021	$542	$1,162	$9,918	$9,102	$10,860	11.72%	12.77%	10.70%
2022	$567		$10,373	$9,390	$11,525			
2023	$595		$10,715	$9,554	$12,105			

($ in millions)

As of December 31, 2014
Sources: CCCERA Comprehensive Annual Financial Reports; Segal Consulting CCCERA GAS 67 Actuarial Valuation Report as of December 31, 2014

36-month "reserves" model

Assuming annual returns range between 6.0% and 8.5%, 36 month forward projected expenses (as a % of total assets) will range between 16.7% and 19.4% over the next 5 years

	Projected Expenses		Total Assets			Next 3 Year Expenses (% of Assets)		
Year End	Current Year	Next 3 Years	7.25% Return	6.0% Return	8.5% Return	7.25% Return	6.0% Return	8.5% Return
2016	$424	$1,405	$7,750	$7,571	$7,939	18.13%	18.56%	17.70%
2017	$446	$1,474	$8,174	$7,890	$8,479	18.03%	18.68%	17.38%
2018	$468	$1,548	$8,599	$8,201	$9,037	18.00%	18.88%	17.13%
2019	$491	$1,624	$9,031	$8,507	$9,618	17.98%	19.09%	16.89%
2020	$515	$1,704	$9,471	$8,806	$10,224	17.99%	19.35%	16.67%
2021	$542		$9,918	$9,102	$10,860			
2022	$567		$10,373	$9,390	$11,525			
2023	$595		$10,715	$9,554	$12,105			

($ in millions)

As of December 31, 2014
Sources: CCCERA Comprehensive Annual Financial Reports; Segal Consulting CCCERA GAS 67 Actuarial Valuation Report as of December 31, 2014

48-month "reserves" model

Assuming annual returns range between 6.0% and 8.5%, 48 month forward projected expenses (as a % of total assets) will range between 23.1% and 26.1% over the next 4 years

	Projected Expenses		Total Assets			Next 4 Year Expenses (% of Assets)		
Year End	Current Year	Next 4 Years	7.25% Return	6.0% Return	8.5% Return	7.25% Return	6.0% Return	8.5% Return
2016	$424	$1,920	$7,750	$7,571	$7,939	24.77%	25.36%	24.18%
2017	$446	$2,016	$8,174	$7,890	$8,479	24.66%	25.55%	23.78%
2018	$468	$2,115	$8,599	$8,201	$9,037	24.60%	25.79%	23.40%
2019	$491	$2,219	$9,031	$8,507	$9,618	24.57%	26.08%	23.07%
2020	$515		$9,471	$8,806	$10,224			
2021	$542		$9,918	$9,102	$10,860			
2022	$567		$10,373	$9,390	$11,525			
2023	$595		$10,715	$9,554	$12,105			

($ in millions)

As of December 31, 2014
Sources: CCCERA Comprehensive Annual Financial Reports; Segal Consulting CCCERA GAS 67 Actuarial Valuation Report as of December 31, 2014

Asset allocation

Descriptions of asset allocation approaches

POLICY AND CURRENT PORTFOLIO

—Investment portfolio defined in the investment policy statement

Risk Diversified portfolio

—Model designed to increase risk diversification to the Typical Peer in a way that doesn't markedly increase peer risk

—Does not rely on large allocations to hedge funds or other complex instruments to achieve risk factor diversification

Functionally focused portfolio

—Design based on functional elements, rather than categorizing assets by asset class or risk factors (e.g., liquidity and short term needs, long term growth assets, diversifying strategies)

—By explicitly funding near term benefit payments, additional risk can be assumed throughout the remainder of the portfolio

Asset allocation analysis

	Policy	FFP (ISD)	Risk Div 50/25/25	FFP 2-yr	FFP 3-yr	FFP 4-yr	Unconstrained FFP 2'-yr	Unconstrained FFP 3'-yr	Unconstrained FFP 4'-yr	10-yr Capital Market Assumptions Return	Vol	Sharpe
Total Equity	42.6	25.0	40.0	34.0	32.0	30.0	30.0	30.0	30.0			
Domestic Equity	-	10.0	20.0	15.0	13.0	11.0	10.0	8.0	6.0			
Large Cap US Equity	-	10.0	20.0	15.0	13.0	11.0	10.0	8.0	6.0	5.7	14.7	0.25
International Equity	-	15.0	20.0	19.0	19.0	19.0	20.0	22.0	24.0			
International Large	-	10.0	15.0	14.0	13.0	12.0	10.0	10.0	10.0	9.5	18.2	0.41
Emerging Markets	-	5.0	5.0	5.0	6.0	7.0	10.0	12.0	14.0	11.5	23.7	0.40
Global Equity	42.6	-	-	-	-	-	-	-	-			
Total Fixed Income	30.7	20.0	20.0	25.0	28.0	30.0	18.0	22.0	26.0			
Domestic Fixed Income	28.3	20.0	15.0	25.0	28.0	30.0	18.0	22.0	26.0			
US Core Fixed Income	19.5	-	-	-	-	-	-	-	-	3.1	3.2	0.31
US Treasury	-	10.0	10.0	8.0	6.0	4.0	6.0	4.0	2.0	2.2	6.4	0.01
Short-Term Govt/Credit	-	10.0	-	12.0	18.0	24.0	12.0	18.0	24.0	2.3	1.3	0.17
High Yield Fixed Income	7.4	-	5.0	-	-	-	-	-	-	3.7	10.5	0.30
US TIPS	1.3	-	-	5.0	4.0	2.0	-	-	-	2.6	6.3	0.07
International Fixed Income	2.4	-	5.0	-	-	-	-	-	-			
Global Sovereign ex-US	1.2	-	-	-	-	-	-	-	-	2.5	7.9	0.05
Global Credit	1.2	-	-	-	-	-	-	-	-	1.9	7.4	-0.02
Emerging Market Debt (Hard)	-	-	5.0	-	-	-	-	-	-	5.7	8.9	0.41
Total Real Assets	13.8	15.0	20.0	12.0	9.0	7.0	15.0	11.0	7.0			
Commodities	1.3	-	-	-	-	-	-	-	-	4.1	18.2	0.11
Real Estate	8.0	15.0	20.0	10.0	7.0	5.0	13.0	10.0	7.0	5.1	13.2	0.23
REITs	4.5	-	-	2.0	2.0	2.0	2.0	1.0	-	5.1	26.4	0.11
Total Alternatives	12.4	35.0	20.0	28.0	30.0	32.0	36.0	36.0	36.0			
Risk Diversifying Strategies	-	10.0	5.0	8.0	6.0	4.0	6.0	4.0	2.0	6.0	9.1	0.43
Private Equity	12.4	15.0	10.0	10.0	12.0	14.0	15.0	16.0	17.0	7.7	23.7	0.24
Private Credit	-	10.0	5.0	10.0	12.0	14.0	15.0	16.0	17.0	7.8	10.5	0.55
Cash	0.5	5.0	-	1.0	1.0	1.0	1.0	**1.0**	**1.0**	2.1	0.6	-
Total Allocation	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**			
Allocation to Illiquid Strategies	*20.4*	*40.0*	*35.0*	*30.0*	*31.0*	*33.0*	*43.0*	*42.0*	*41.0*			

Note: Policy portfolio utilizes benchmark constituent weights to determine asset allocation weights for equities and fixed income

Asset allocation by functional role

	Policy	FFP (ISD)	Risk Div 50/25/25	FFP 2-yr	FFP 3-yr	FFP 4-yr	Unconstrained FFP 2'-yr	Unconstrained FFP 3'-yr	Unconstrained FFP 4'-yr	10-yr Capital Market Assumptions Return	Vol	Sharpe
Liquidity	0.5	15.0	-	13.0	19.0	25.0	13.0	19.0	25.0			
Cash	0.5	5.0	-	1.0	1.0	1.0	1.0	1.0	1.0	2.1	0.6	-
Short-Term Govt/Credit	-	10.0	-	12.0	18.0	24.0	12.0	18.0	24.0	2.3	1.3	0.17
Diversifying	-	20.0	15.0	16.0	12.0	8.0	12.0	8.0	4.0			
US Treasury	-	10.0	10.0	8.0	6.0	4.0	6.0	4.0	2.0	2.2	6.4	0.01
Risk Diversifying Strategies	-	10.0	5.0	8.0	6.0	4.0	6.0	4.0	2.0	6.0	9.1	0.43
Growth	99.5	65.0	85.0	71.0	69.0	67.0	75.0	73.0	71.0			
Domestic Large Cap Equity	-	10.0	20.0	15.0	13.0	11.0	10.0	8.0	6.0			
International Equity	-	15.0	20.0	19.0	19.0	19.0	20.0	22.0	24.0			
Developed Markets	-	10.0	15.0	14.0	13.0	12.0	10.0	10.0	10.0	9.5	18.2	0.41
Emerging Markets	-	5.0	5.0	5.0	6.0	7.0	10.0	12.0	14.0	11.5	23.7	0.40
Global Equity	42.6	-	-	-	-	-	-	-	-			
Domestic Fixed Income	28.2	-	5.0	5.0	4.0	2.0	-	-	-			
US Core Fixed Income	19.5	-	-	-	-	-	-	-	-	3.1	3.2	0.31
High Yield Fixed Income	7.4	-	5.0	-	-	-	-	-	-	3.7	10.5	0.30
US TIPS	1.3	-	-	5.0	4.0	2.0	-	-	-	2.6	6.3	0.07
International Fixed Income	2.5	-	5.0	-	-	-	-	-	-			
Global Sovereign ex-US	1.3	-	-	-	-	-	-	-	-	2.5	7.9	0.05
Global Credit	1.3	-	-	-	-	-	-	-	-	1.9	7.4	-0.02
Emerging Market Debt (Hard)	-	-	5.0	-	-	-	-	-	-	5.7	8.9	0.41
Commodities	1.3	-	-	-	-	-	-	-	-	4.1	18.2	0.11
Real Estate	8.0	15.0	20.0	10.0	7.0	5.0	13.0	10.0	7.0	5.1	13.2	0.23
REITs	4.5	-	-	2.0	2.0	2.0	2.0	1.0	-	5.1	26.4	0.11
Private Equity	12.4	15.0	10.0	10.0	12.0	14.0	15.0	16.0	17.0	7.7	23.7	0.24
Private Credit	-	10.0	5.0	10.0	12.0	14.0	15.0	16.0	17.0	7.8	10.5	0.55
Total Allocation	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**			

Note: Policy portfolio utilizes benchmark constituent weights to determine asset allocation weights for equities and fixed income

Asset allocation analysis

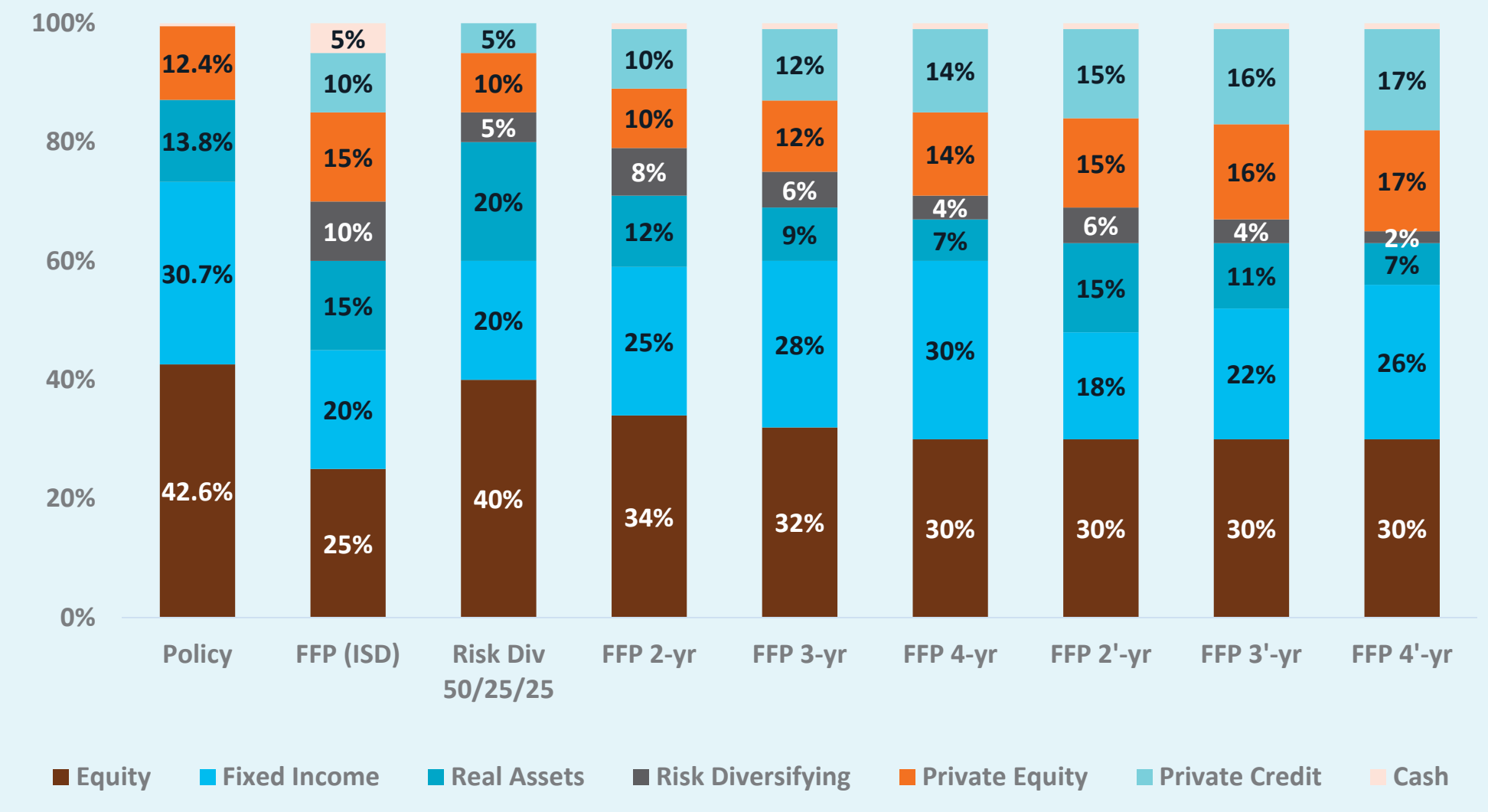
	Policy	FFP (ISD)	Risk Div 50/25/25	FFP 2-yr	FFP 3-yr	FFP 4-yr	Unconstrained 2'-yr	Unconstrained 3'-yr	Unconstrained 4'-yr
Mean Variance Analysis									
Forecast 10 Year Return	**6.4**	**6.5**	***6.9***	***6.5***	***6.5***	***6.6***	***7.1***	***7.2***	***7.2***
Standard Deviation	12.1	9.4	11.0	9.8	9.9	9.9	10.9	10.8	10.8
Return/Std. Deviation	0.5	0.7	*0.6*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
1st percentile ret. 1 year	-33.0	-24.4	*-31.0*	*-25.6*	*-24.8*	*-24.4*	*-27.6*	*-27.1*	*-25.9*
Sharpe Ratio	0.41	0.51	0.49	0.49	0.49	0.50	0.51	0.52	0.52
Verus Economic Scenario Analysis									
10 Year Return Forecast									
Stagflation	5.7	6.5	6.1	6.1	6.0	5.9	6.5	6.3	6.2
Weak Economy	2.3	3.0	2.5	2.6	2.8	3.0	3.2	3.2	3.3
Base CMA	**6.2**	**6.0**	***6.5***	***6.1***	***6.1***	***6.1***	***6.6***	***6.7***	***6.7***
Strong	9.9	9.1	10.2	9.4	9.3	9.2	9.8	9.8	9.8
Range of Scenario Forecast	7.5	6.2	*7.7*	*6.8*	*6.5*	*6.2*	*6.7*	*6.6*	*6.5*
Economic Shock (1 year)	-24.6	-19.4	*-24.2*	*-20.9*	*-20.7*	*-20.6*	*-22.5*	*-22.8*	*-23.1*

Notes:

- Real Estate capital market assumptions are for core real estate
- Verus' assumed inflation rate is 2.1% over the next 10 years (actuarial assumption is 3.25% over 30 years)

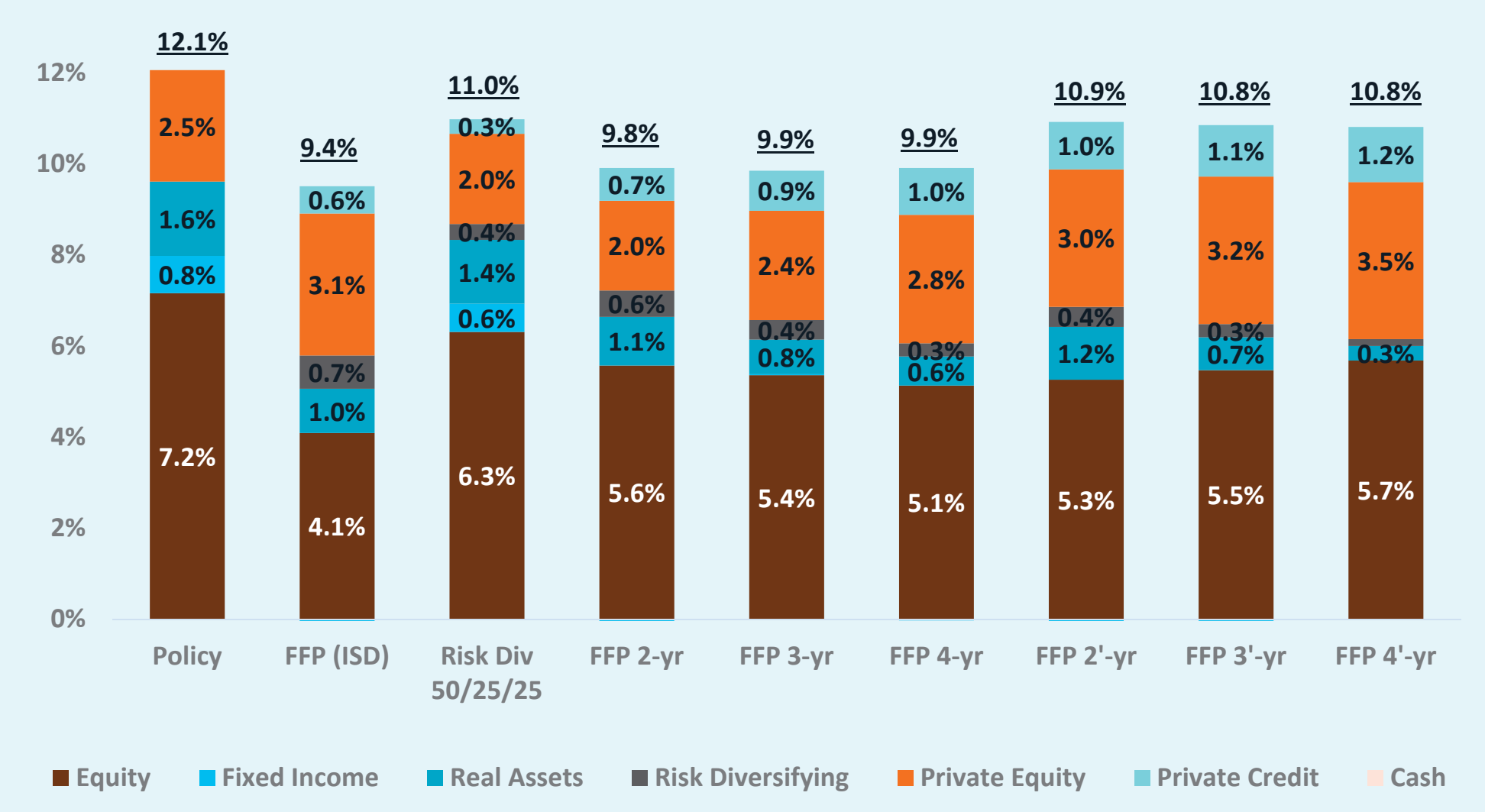
Scenario Analysis utilizes October 2015 Verus Capital Market Assumptions
Note: Policy portfolio utilizes benchmark constituent weights to determine asset allocation weights for equities and fixed income

Allocation by asset class



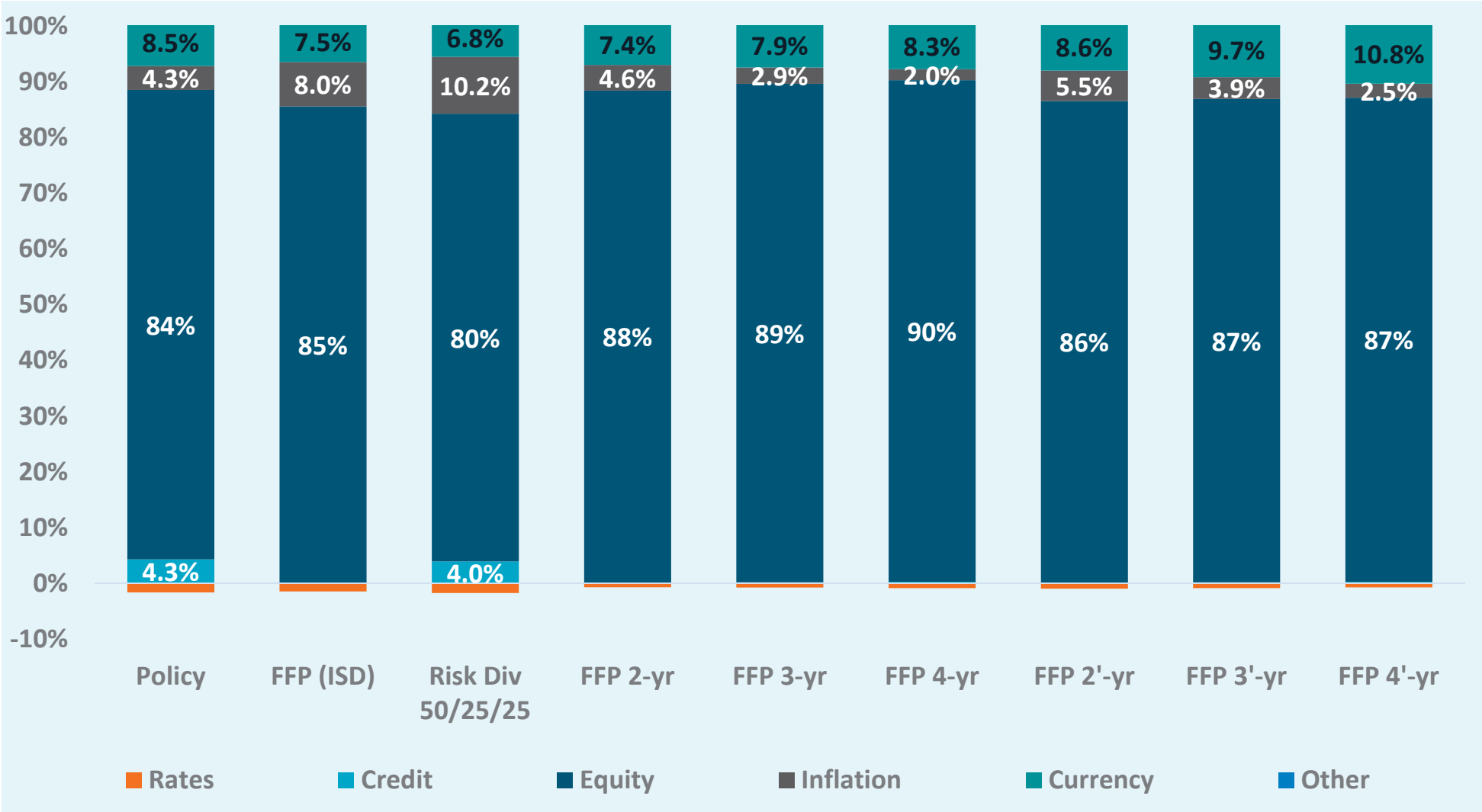
Policy portfolio utilizes benchmark constituent weights to determine asset allocation weights for equities and fixed income

Risk contribution by asset class



Risk contribution based on Verus' Capital Market Assumptions
Policy portfolio utilizes benchmark constituent weights to determine asset allocation weights for equities and fixed income

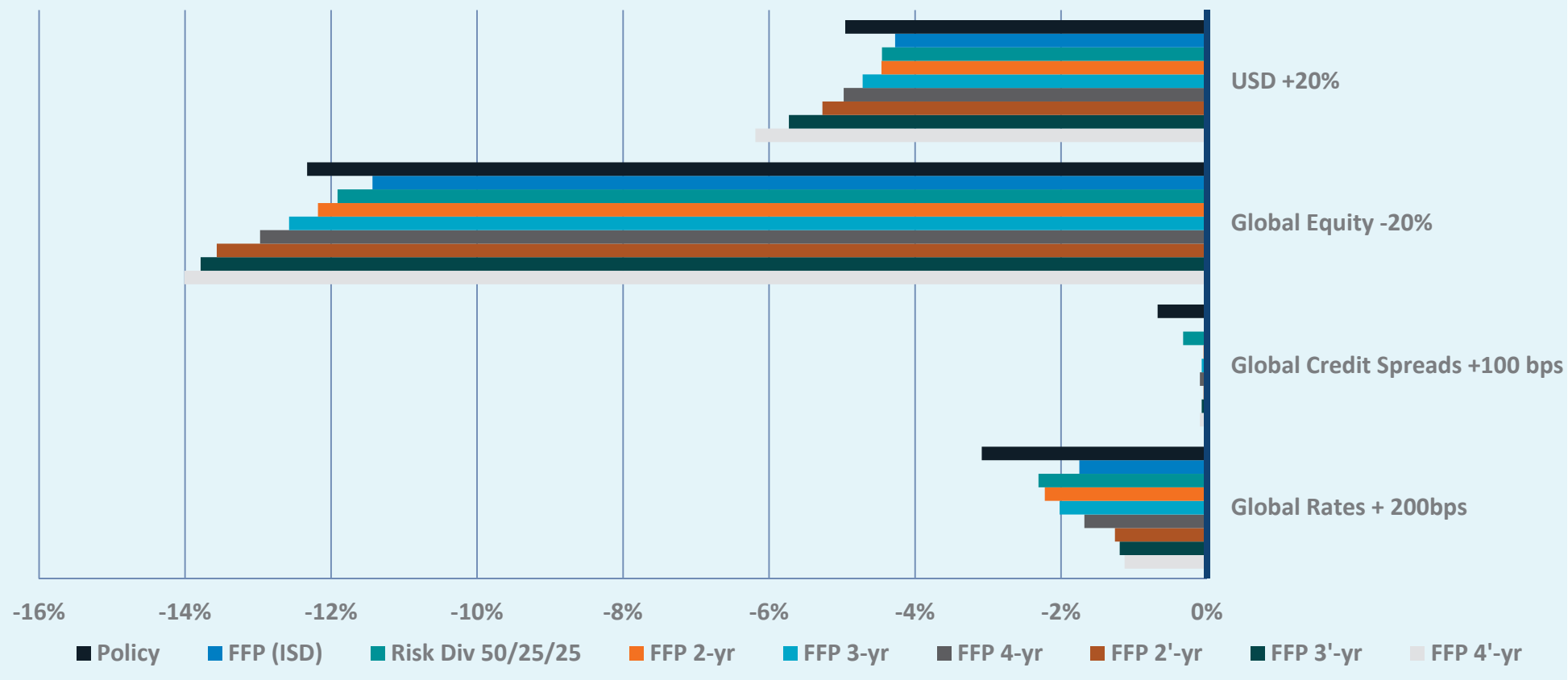
Risk contribution by risk factor



Risk contribution based on BarraOne's Capital Market Assumptions

Stress test

TAIL RISK – STRESS TEST

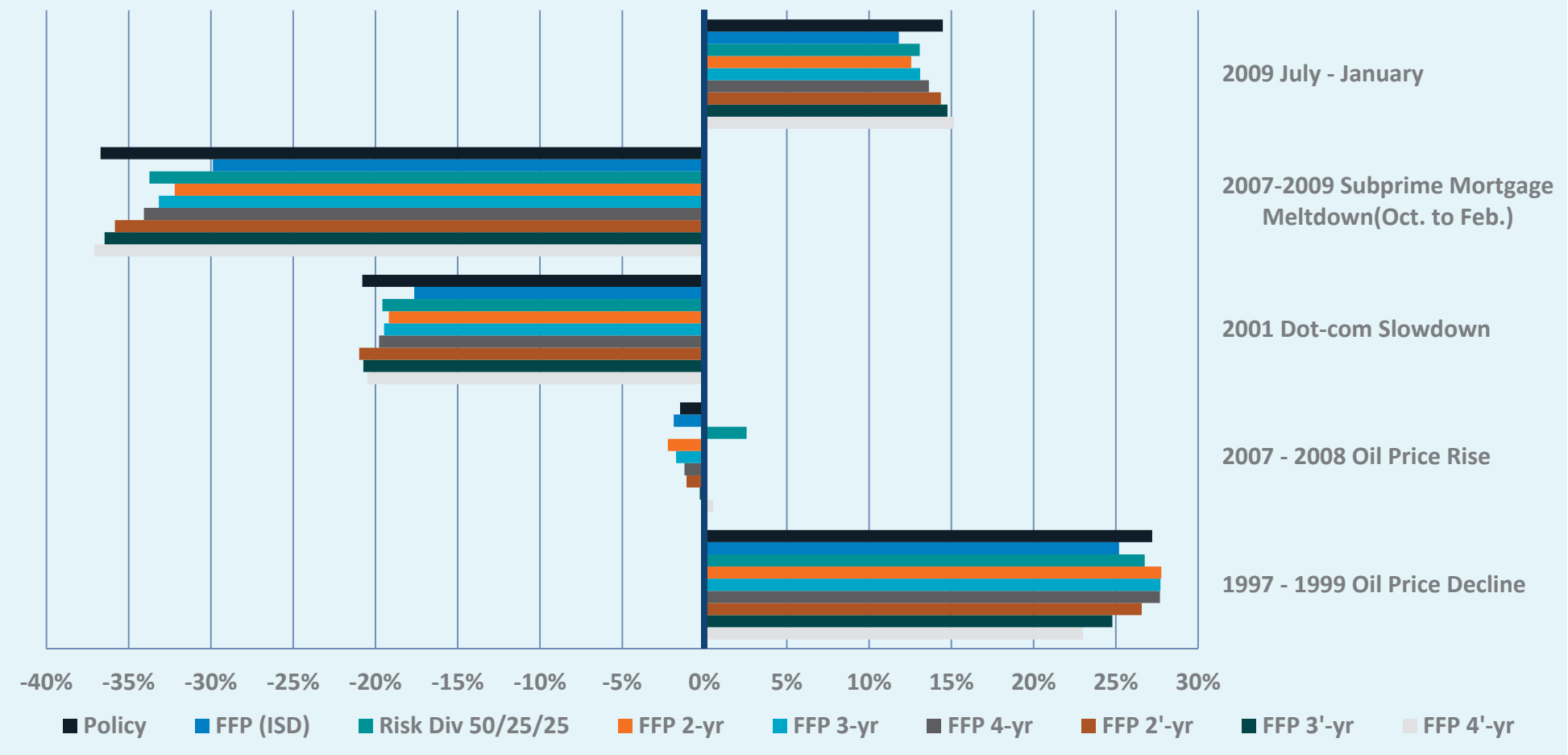


- BarraOne's risk decomposition analysis can hypothesize how the different portfolios would have performed in certain hypothetical stress tests or historical environments.
- This analysis is based on how the risk factors inherent in the current index holdings reacted in those environments.

Scenario analysis based on risk factors in current policy index and computed as hypothetical scenarios using MSCI BarraOne

Historical scenario analysis

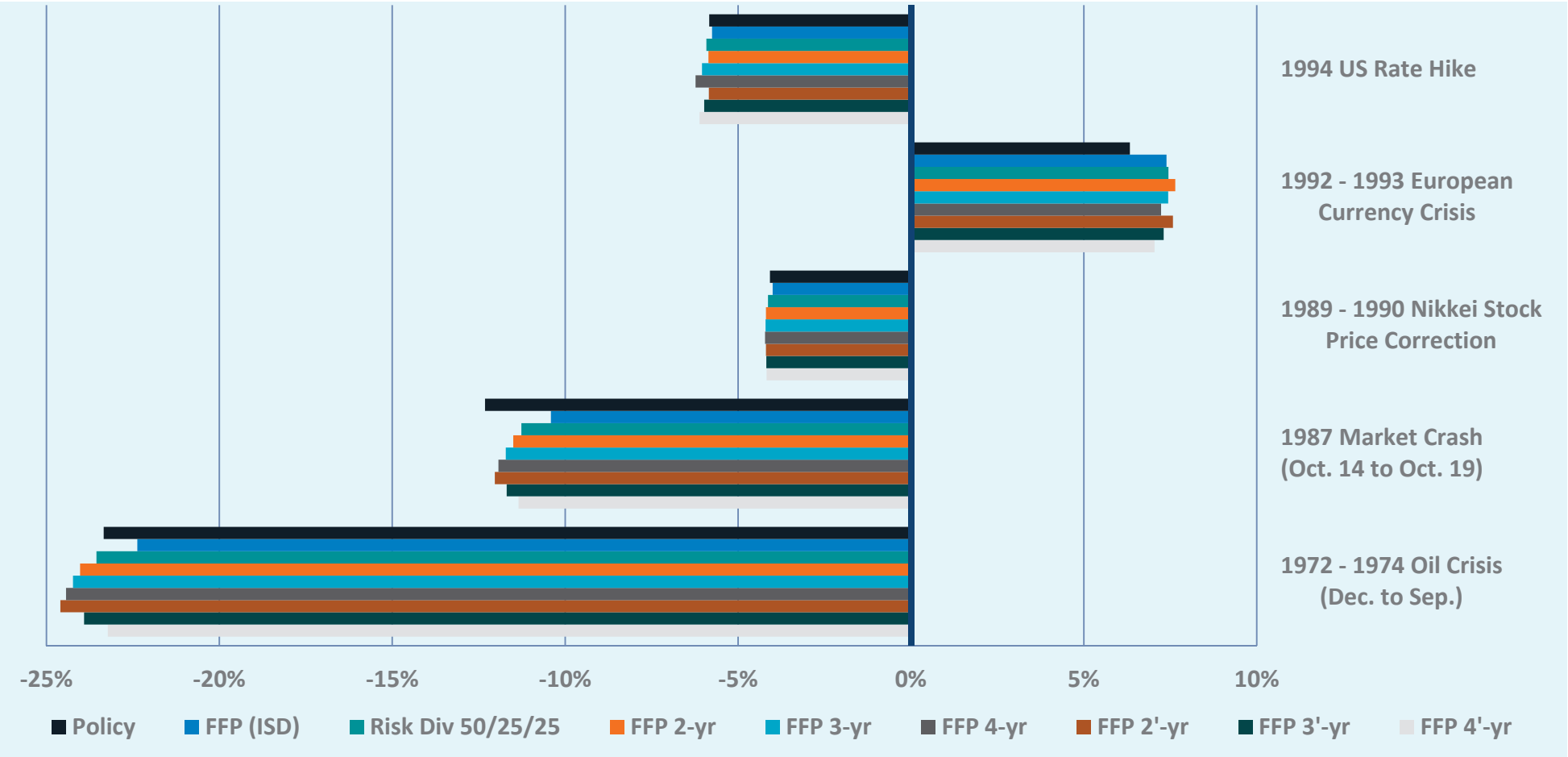
TAIL RISK – SCENARIO ANALYSIS



Scenario analysis based on risk factors in current policy index and computed as hypothetical scenarios using MSCI BarraOne

Historical scenario analysis

TAIL RISK – SCENARIO ANALYSIS



Scenario analysis based on risk factors in current policy index and computed as hypothetical scenarios using MSCI BarraOne

Investment model evaluation summary

Selection Criteria	Policy	FFP (ISD)	Risk Div 50/25/25	FFP 2-yr	FFP 3-yr	FFP 4-yr	FFP 2'-yr	FFP 3'-yr	FFP 4'-yr
Risk/Return Metrics									
Expected Return	6.4%	6.5%	6.9%	6.5%	6.5%	6.6%	7.1%	7.2%	7.2%
Volatility	12.1%	9.4%	11.0%	9.8%	9.9%	9.9%	10.9%	10.8%	10.8%
Sharpe Ratio	0.41	0.51	0.49	0.49	0.49	0.50	0.51	0.52	0.52
% chance of meeting 7.25%	42%	41%	46%	41%	41%	42%	49%	49%	49%
Daily VaR (95% confidence, $MM)	$68.1	$45.0	$58.3	$51.9	$52.4	$53.1	$59.7	$56.8	$54.0
Daily CVaR (95% confidence, $MM)	$108.2	$81.3	$92.9	$89.1	$89.3	$89.1	$92.9	$92.3	$92.0
2007-2009 Drawdown (Simulation)	-36.7%	-29.9%	-33.7%	-32.2%	-33.2%	-34.1%	-35.8%	-36.5%	-37.1%
1st Percentile (1 Year, MVA)	-33.0%	-24.4%	-31.0%	-25.6%	-24.8%	-24.4%	-27.6%	-27.1%	-25.9%
Potential impact on Discount Rate	-0.85%	-0.74%	-0.34%	-0.73%	-0.72%	-0.68%	-0.13%	-0.10%	-0.08%
Risk Factors									
Portfolio Complexity	med	med	high	med	med	med	high	high	high
Leverage	med	med	med	med	med	med	med	med	med
Peer/Headline Risk	low	high	med	med	med	med	high	high	high
Liquidity Risk	med	low	med	low	low	low	low	low	low
Tail Risk	high	low	high	med	low	low	med	med	med
Equity Risk Allocation	high	med	med	med	med	med	med	med	med

Appendix

Date horizon of historical scenario analysis

Scenario	From	To
1972 - 1974 Oil Crisis (Dec. to Sep.)	December 1, 1972	September 30, 1974
1987 Market Crash (Oct. 14 to Oct. 19)	October 14, 1987	October 19, 1987
1989 - 1990 Nikkei Stock Price Correction	December 29, 1989	March 30, 1990
1992 - 1993 European Currency Crisis	September 1, 1992	August 13, 1993
1994 US Rate Hike	January 31, 1994	December 13, 1994
1997 - 1999 Oil Price Decline	January 8, 1997	February 16, 1999
2001 Dot-com Slowdown	March 10, 2001	October 9, 2002
2007 - 2008 Oil Price Rise	January 18, 2007	June 27, 2008
2007-2009 Subprime Mortgage Meltdown(Oct. to Feb.)	October 1, 2007	February 27, 2009
2009 July - January	July 1, 2009	December 31, 2009

Source: MSCI BarraOne

10 year return & risk assumptions

Asset Class	Index Proxy	Ten Year Return Forecast		Standard Deviation Forecast	Sharpe Ratio Forecast	Ten Year Historical Sharpe Ratio
		Geometric	Arithmetic			
Equities						
US Large	S&P 500	5.7%	6.7%	14.7%	0.25	0.47
US Small	Russell 2000	4.7%	6.5%	19.8%	0.13	0.40
International Developed	MSCI EAFE	9.5%	11.0%	18.2%	0.41	0.25
International Small	MSCI EAFE Small Cap	9.2%	11.0%	19.7%	0.36	0.32
Emerging Markets	MSCI EM	11.5%	13.9%	23.7%	0.40	0.40
Private Equity	Cambridge Private Equity	7.7%	10.2%	23.7%	0.24	1.07
Fixed Income						
Cash	30 Day T-Bills	2.1%	2.1%	0.6%	-	-
US TIPS	Barclays US TIPS 5 - 10	2.6%	2.8%	6.3%	0.07	0.47
US Treasury	Barclays Treasury 7 - 10 year	2.2%	2.4%	6.4%	0.01	0.65
Global Sovereign ex US	Barclays Global Treasury ex US	2.5%	2.8%	7.9%	0.05	0.18
Core Fixed Income	Barclays US Aggregate Bond	3.1%	3.2%	3.2%	0.31	0.96
Core Plus Fixed Income	Barclays US Corporate IG	3.8%	4.0%	5.9%	0.29	0.67
Short-Term Gov't/Credit	Barclays US Gov't/Credit 1 - 3 year	2.3%	2.3%	1.3%	0.17	1.09
Short-Term Credit	Barclays Credit 1 - 3 year	2.6%	2.6%	2.3%	0.22	0.88
Long-Term Credit	Barclays Long US Corporate	3.7%	4.3%	11.0%	0.15	0.55
High Yield Corp. Credit	Barclays High Yield	5.2%	5.8%	10.5%	0.30	0.61
Bank Loans	S&P/LSTA	3.7%	4.1%	8.7%	0.19	0.44
Global Credit	Barclays Global Credit	1.9%	2.2%	7.4%	-0.02	0.49
Emerging Markets Debt (Hard)	JPM EMBI Global Diversified	5.7%	6.1%	8.9%	0.41	0.72
Emerging Markets Debt (Local)	JPM GBI EM Global Diversified	6.2%	7.0%	12.9%	0.32	0.46
Private Credit	High Yield + 200 bps	7.8%	8.4%	10.5%	0.55	-
Other						
Commodities	Bloomberg Commodity	4.1%	5.7%	18.2%	0.11	-0.10
Hedge Funds	HFRI Fund of Funds	6.0%	6.4%	9.1%	0.43	0.29
Core Real Estate	NCREIF Property	5.1%	5.9%	13.2%	0.23	0.93
REITs	Wilshire REIT	5.1%	8.1%	26.4%	0.11	0.38
Inflation		2.1%	-	-	-	-

Both geometric and arithmetic return forecasts have been included. It is important that users of this information understand how we derived it. Our forecast process involves the use of a wide range of data inputs (of a variety of different types) to create geometric return forecasts for individual asset classes – this is the process described at length in this document. We use an industry standard formula to convert these to arithmetic return forecasts, and provide both for client use.

Investors wishing to produce expected geometric return forecasts for their portfolios should use the arithmetic return forecasts provided here as inputs into that calculation, rather than the single-asset-class geometric return forecasts. This is the industry standard approach, but requires a complex explanation only a heavy quant could love, so we have chosen not to provide further details in this document – we will happily provide those details to any readers of this who are interested.

More broadly, it is important that the user of these forecasts remembers that return forecasts (whoever provides them) are there to provide a guide to the likely future, no more. While we believe that the approach described in this document is an appropriate one to use for those purposes, and that the forecasts resulting from that approach are meaningful and fit for the uses to which they will be put, users of any such forecasts should always bear in mind the fact that the single most difficult thing to predict is the future, and approach that exercise with appropriate skepticism.

Correlation assumptions

	Cash	US Large	US Small	Developed Large	Developed Small	EM	PE	TIPS	US Treasury	Global Sovereign	US Core	US Core Plus	Short –Term Govt/Credit	Short-Term Credit	Long-Term Credit	US HY	Bank Loans	Global Credit	EMD USD	EMD Local	Commodities	Hedge Funds	Real Estate	REITs	Inflation
Cash	1																								
US Large	-0.1	1																							
US Small	-0.1	0.9	1																						
Developed Large	0.0	0.9	0.8	1																					
Developed Small	0.0	0.8	0.8	1.0	1																				
EM	0.1	0.8	0.7	0.9	0.9	1																			
PE	-0.2	0.7	0.7	0.8	0.8	0.7	1																		
TIPS	0.0	0.2	0.1	0.2	0.3	0.3	0.2	1																	
US Treasury	0.0	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	0.6	1																
Global Sovereign	0.0	0.2	0.2	0.4	0.4	0.4	0.5	0.6	0.5	1															
US Core	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.8	0.9	0.6	1														
US Core Plus	-0.1	0.4	0.3	0.5	0.5	0.5	0.6	0.7	0.5	0.5	0.8	1													
Short –Term Govt/Credit	0.3	-0.1	-0.1	0.1	0.1	0.1	-0.2	0.6	0.6	0.6	0.7	0.6	1												
Short-Term Credit	0.0	0.3	0.3	0.5	0.5	0.5	-0.2	0.6	0.2	0.5	0.6	0.8	0.7	1											
Long-Term Credit	-0.1	0.3	0.2	0.4	0.4	0.4	0.1	0.6	0.5	0.5	0.8	1.0	0.4	0.6	1										
US HY	-0.1	0.7	0.7	0.8	0.8	0.7	0.6	0.4	-0.2	0.3	0.2	0.6	0.1	0.6	0.5	1									
Bank Loans	-0.1	0.6	0.6	0.6	0.6	0.6	0.2	0.2	-0.4	0.0	0.0	0.4	-0.1	0.5	0.3	0.9	1								
Global Credit	-0.1	0.6	0.5	0.8	0.8	0.7	0.7	0.6	0.2	0.8	0.6	0.8	0.5	0.8	0.7	0.7	0.5	1							
EMD USD	-0.1	0.6	0.5	0.7	0.7	0.7	0.5	0.7	0.3	0.5	0.6	0.8	0.4	0.7	0.7	0.8	0.6	0.8	1						
EMD Local	0.1	0.7	0.6	0.8	0.8	0.8	0.6	0.5	0.1	0.6	0.4	0.6	0.3	0.5	0.5	0.7	0.4	0.8	0.8	1					
Commodities	0.1	0.5	0.4	0.6	0.6	0.7	0.2	0.3	-0.2	0.4	0.1	0.3	0.1	0.4	0.2	0.5	0.4	0.6	0.5	0.6	1				
Hedge Funds	0.1	0.7	0.6	0.8	0.8	0.8	0.7	0.2	-0.3	0.1	0.0	0.4	0.0	0.4	0.2	0.6	0.6	0.6	0.5	0.6	0.7	1			
Real Estate	-0.1	0.4	0.3	0.3	0.3	0.3	0.3	0.1	-0.1	0.1	0.0	0.2	-0.1	-0.1	0.1	0.2	0.0	0.2	0.2	0.3	0.0	0.3	1		
REITs	0.0	0.8	0.8	0.7	0.6	0.6	0.6	0.2	-0.1	0.3	0.2	0.4	0.0	0.3	0.4	0.7	0.5	0.6	0.6	0.6	0.3	0.4	0.4	1	
Inflation	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	-0.3	0.0	-0.3	-0.2	-0.2	0.0	-0.3	0.2	0.4	0.0	0.0	0.1	0.3	0.2	0.1	0.1	1

Note: Correlation assumptions are based on the last ten years. Private Equity and Real Estate correlations are especially difficult to model – we have therefore used BarraOne correlation data to strengthen these correlation estimates.

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