

Asset Allocation

South Dakota Investment Council

June 3, 2021

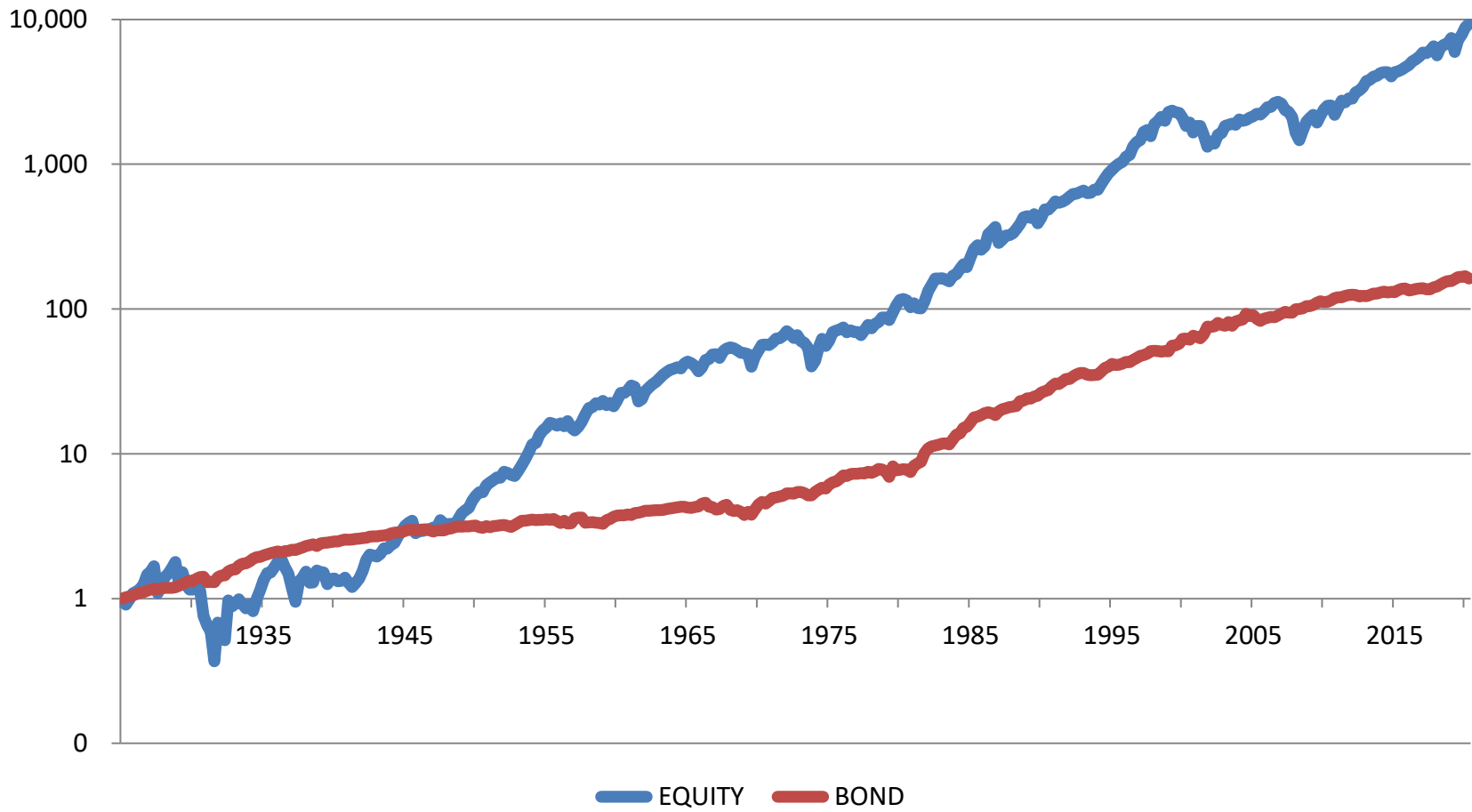
Discussion topics

- Recommended benchmark equity-like and bond-like risk and ranges
- Equity-like and bond-like risk embedded in other categories
- Recommended benchmark asset category allocation and ranges
- Expected return and standard deviation
- Asset category valuation
- Allocation movement within ranges

Benchmark equity and bond risk

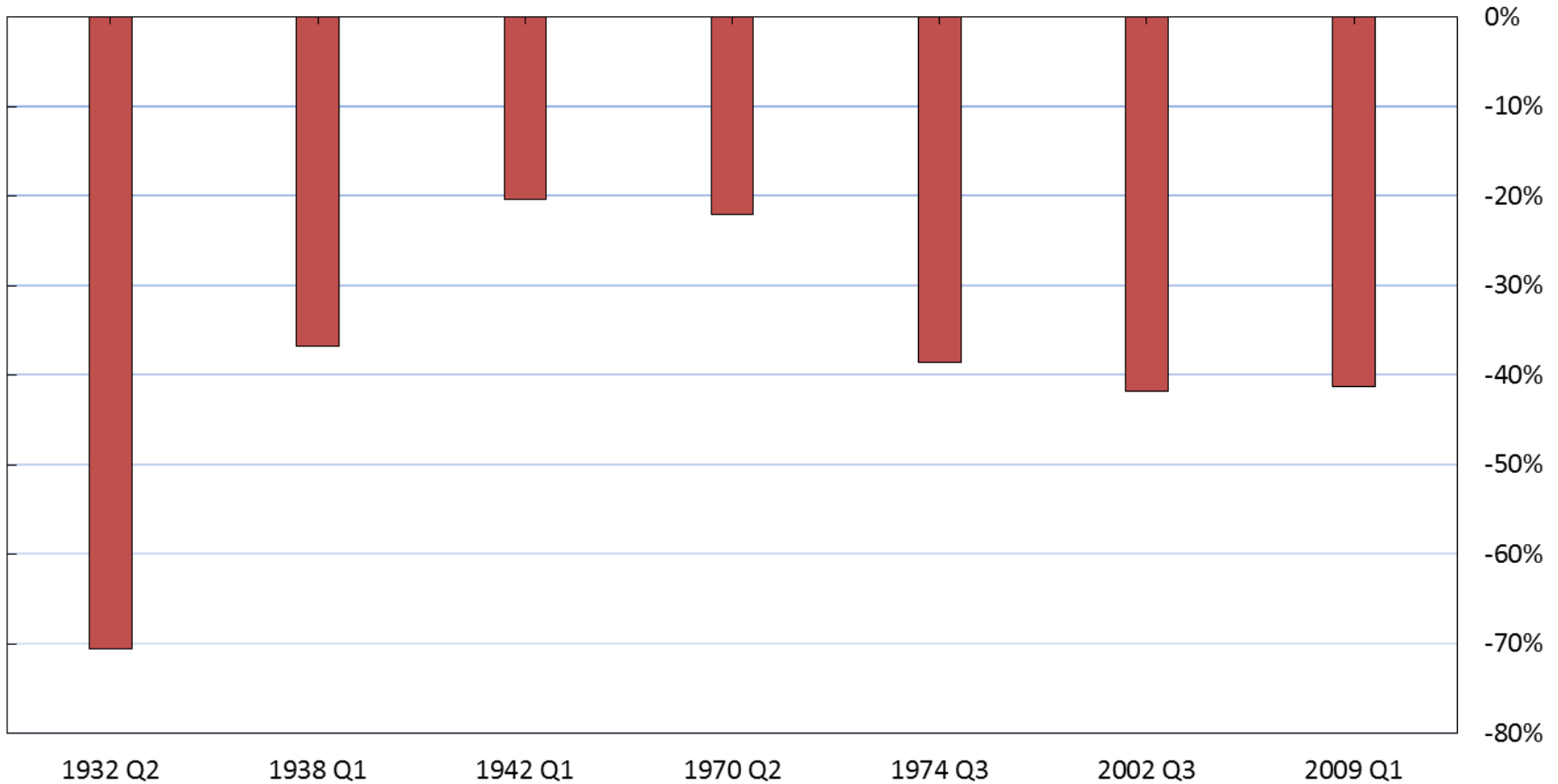
- Historical outcomes are helpful in relating to impact of risk
- Long-term return history is available only for equity, bonds, and cash
- Equity returns are best over the very long term, but are volatile
- Bonds returns are lower over the long term, but provide diversification
- Return/risk tradeoff depends on willingness to endure volatility

Equity long-term returns much higher



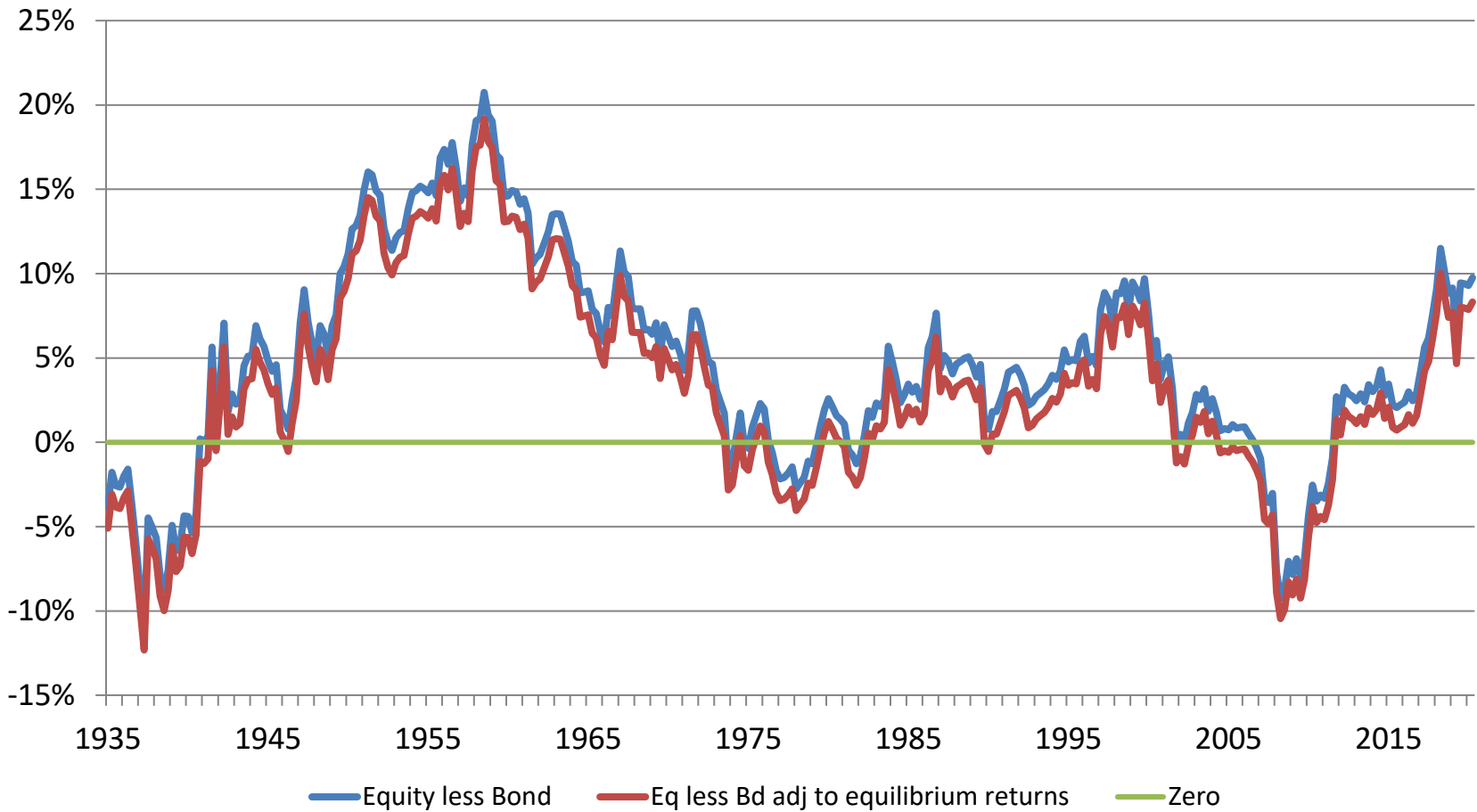
Equity downturns can be brutal

two-year periods with equity returns below negative 20%



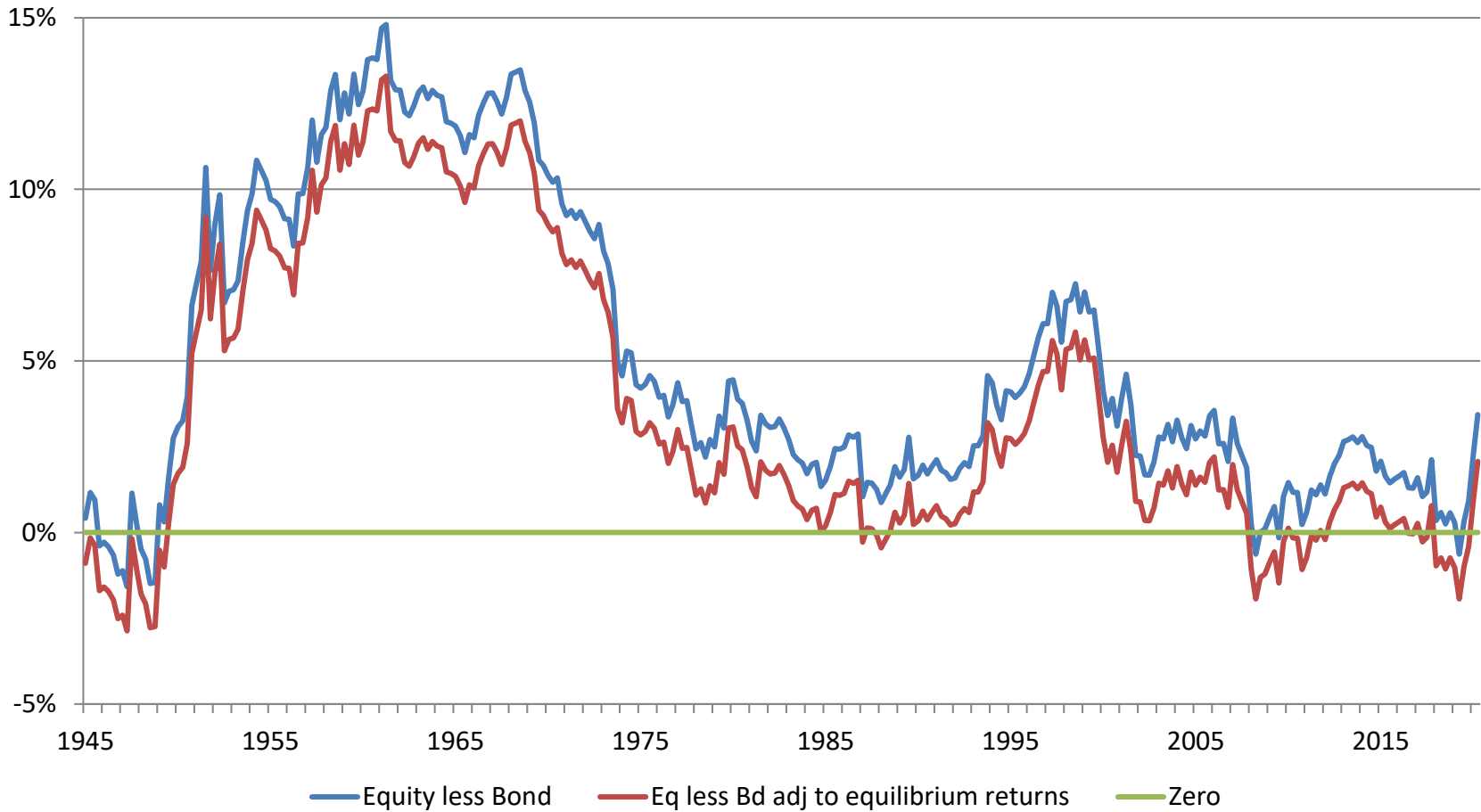
Equity less bond return rolling 10-year periods

red line adjusted to impose future equilibrium returns on past



Equity less bond return rolling 20-year periods

red line adjusted to impose future equilibrium returns on past

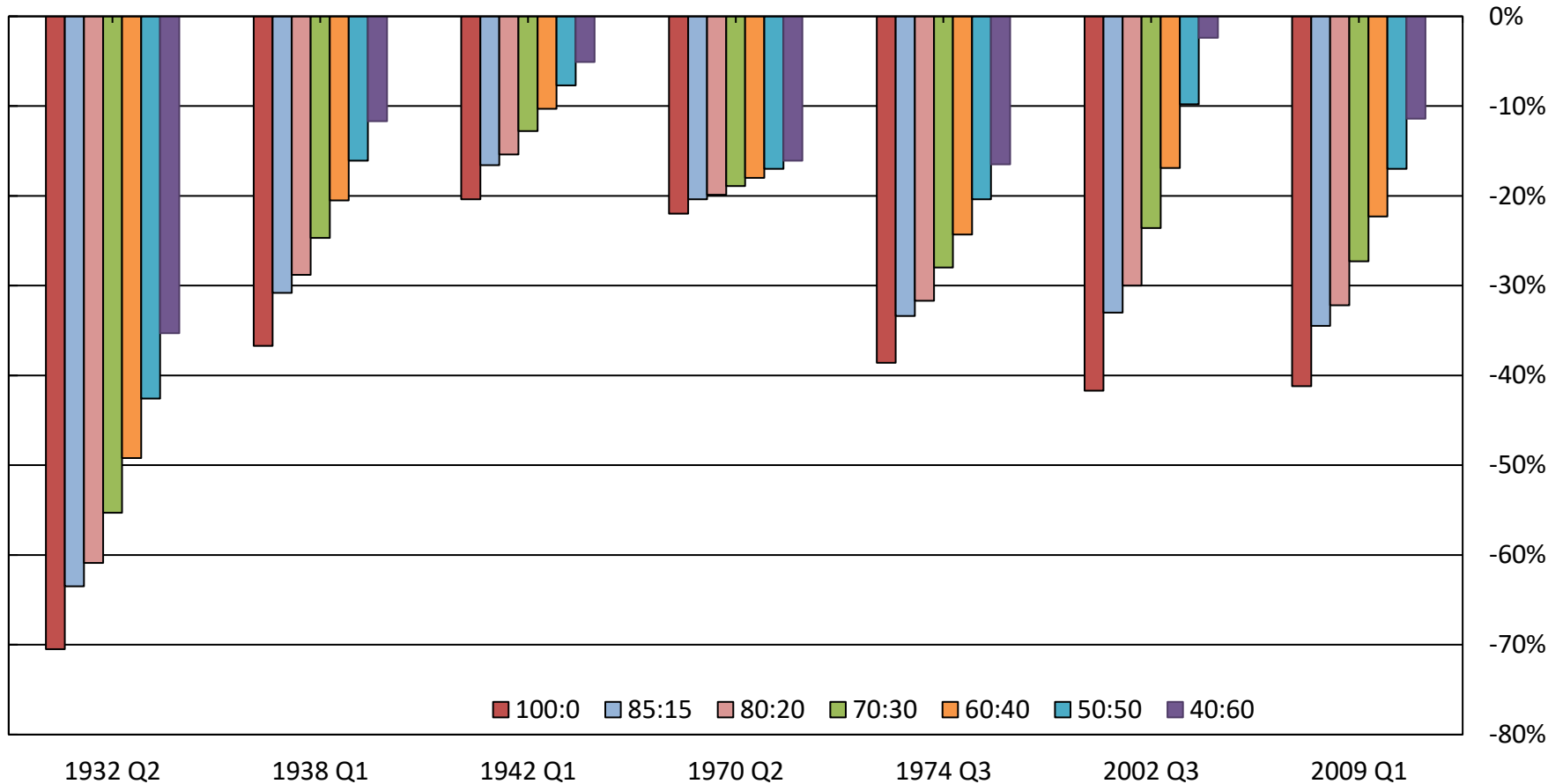


Equity-like and bond-like risk benchmark and ranges

- Recommend benchmark equity-like risk of 70%, bond-like risk 27%, cash-like 3%
 - 70% Equity / 30% bonds and cash balances long term returns with drawdown risk remembering benchmark should represent what can be adhered to through thick and thin.
- Recommend 40% to 85% equity-like range, 15% to 60% bond-like range
 - 40% equity-like risk minimum is believed appropriate when markets extremely expensive using our valuation measures. Was 50% prior to 2019. 50% reached in late 1990's, fall '18, fall '19, & now.
 - The minimum provides still meaningful exposure if wrong or a decade early.
 - New low steps of 45% and 40% are for when markets are extremely expensive such as 1999.
 - 40% minimum is significantly below the benchmark and would increase underperformance risk but also reduce absolute risk when markets extremely expensive (and likely after big gains).
 - 85% believed appropriate for when markets are very cheap using our valuation measures. The cheapness would suggest much or most of a potential decline had already occurred.
 - 85% maximum approximate peak during financial crisis. Seems appropriate having experienced.
 - Goal is to enter market downturns with near minimum benchmark risk then increase toward maximum during downturn to benefit from eventual rebound.
 - Markets typically continue to rise or fall further after reaching thresholds to move to our minimum or maximum risk position. Essential to be patient for 5 years or more.

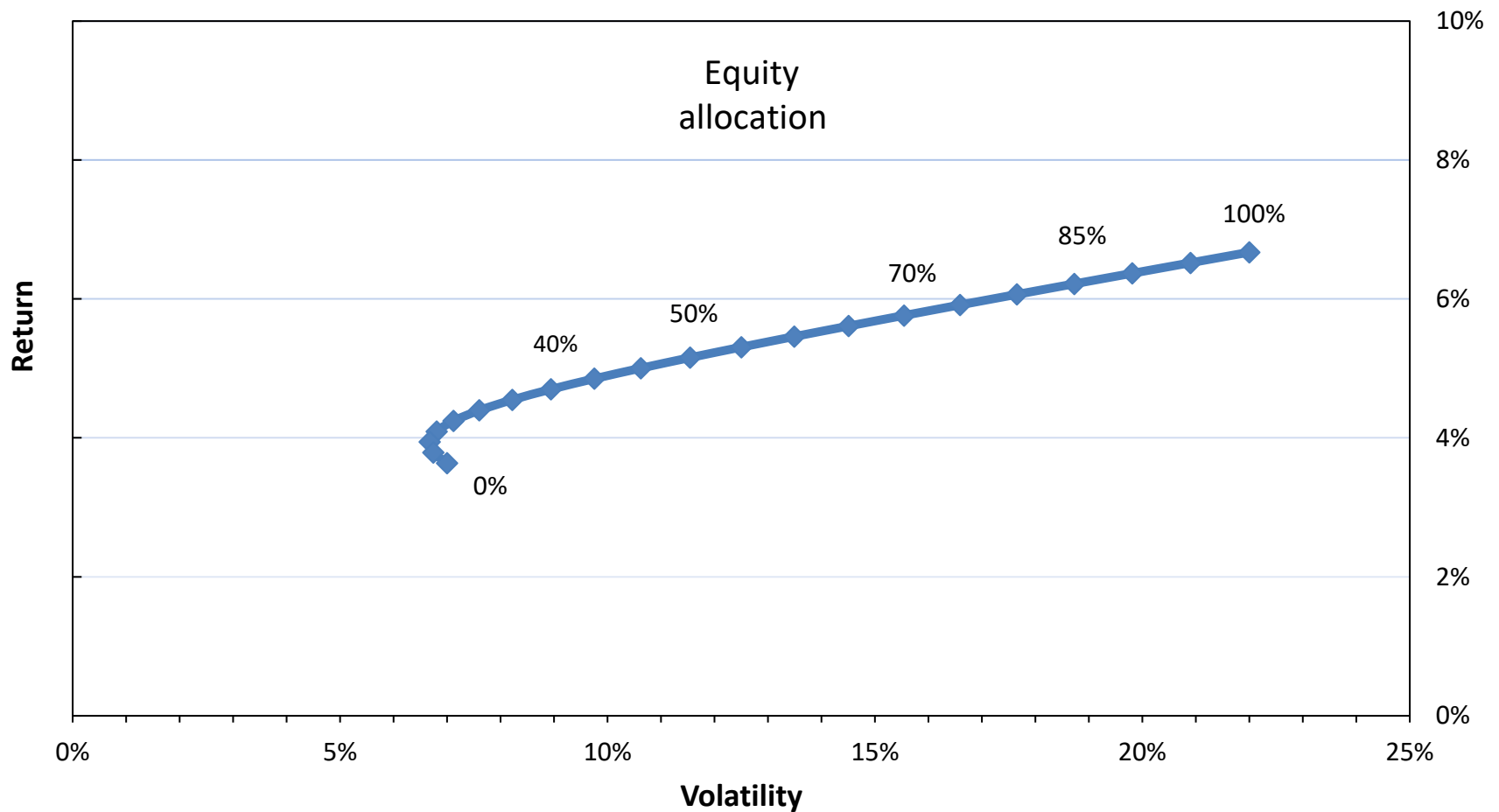
Risk of various equity allocations

two-year periods with equity returns below negative 20%



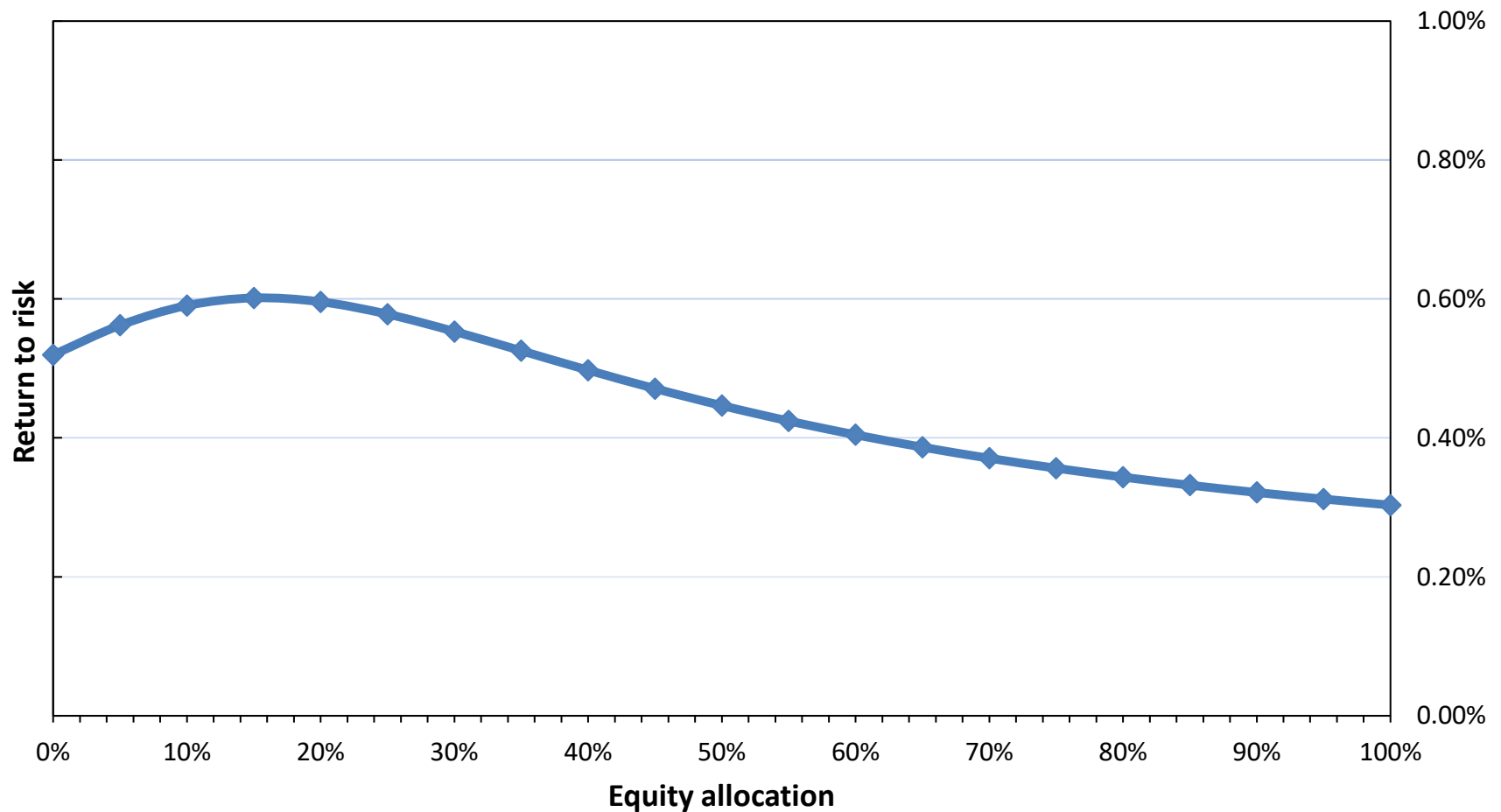
Return and risk for stock/bond allocations

using SDIC long term expected returns and fat tail adjusted volatility



Reward for assuming additional equity risk

increase in expected return per unit increase in volatility



Equity-like and bond-like risk for other categories

- Other categories are mapped to equivalent equity/bond/cash risk
 - REITS mapped primarily to equity with remainder mapped to short duration bonds
 - High yield mapped to equity and short duration bonds depending on credit quality
 - Private equity treated as leveraged equity
 - Opportunistic RE treated as leveraged REITs
- Exposures embedded in other categories is accounted for when targeting overall equity-like / bond-like / cash-like risk

Benchmark construction

- Categories in benchmark are significant and passively implementable
 - equity, bonds, real estate (REITS), high yield, and cash
- Skill/niche categories excluded from benchmark, but have permitted range
 - private equity, opportunistic real estate, arbitrage and hedge funds, commodities
 - equivalent stock/bond/cash risk is accounted for and offset if invest in these
- Benchmark constructed to achieve 70% equity-like, 27% bond-like, and 3% cash-like risk exposures

SDRS Capital Market Benchmark

allocations, indexes, min max ranges, and equity-like risk

		Public Equity	Real Estate REIT/Core	HY Corp Debt	Investment Grade Debt	Cash	Private Equity	Opportunistic Real Estate	HY Real Estate Debt	Aggressive Absolute Return	TIPS	Commodities	Merger Arb	Convert Arb	Equity Like Risk
Maximum	1	75%	20% ²	15%	50%	50%	12%	15% ²	10%	5%	5%	5%	10%	5%	85%
2022 Benchmark (proposed)		58%	10%	7%	23%	2% ³	0% ⁴	0% ⁴	0% ⁴	0% ⁴	0% ⁴	0% ⁴	0% ⁴	0% ⁴	70%
Minimum	1	20%	2%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%
Index		<i>MSCI AC IMI (3/4) + MSCI IMI US (1/4)</i>	<i>MSCI REIT</i>	<i>FTSE High Yield</i>	<i>FTSE BIG</i>	<i>FTSE 3 mo. Tsy bill</i>									

Benchmark history

2021 Benchmark	58%	10%	7%	23%	2%	3	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	70%
2020 Benchmark	58%	10%	7%	23%	2%	3	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	70%
2019 Benchmark	58%	10%	7%	23%	2%	3	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	70%
2018 Benchmark	58%	10%	7%	23%	2%	3	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	70%
2017 Benchmark	58%	10%	7%	23%	2%	3	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	0%	4	70%
2016 Benchmark	58%	10%	7%	23%	2%		0%			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	70%
2015 Benchmark	60%	10%	7%	19%	2%		0%			0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	70%
2014 Benchmark	56%	8%	7%	18%	2%		7%			0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	70%
2013 Benchmark	56%	8%	7%	18%	2%		7%			0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	70%

1. Buffer for market drift of 1% for Equity and 1/2% for debt (example: Investment Grade debt minimum of 13% can drift to 12.5%)

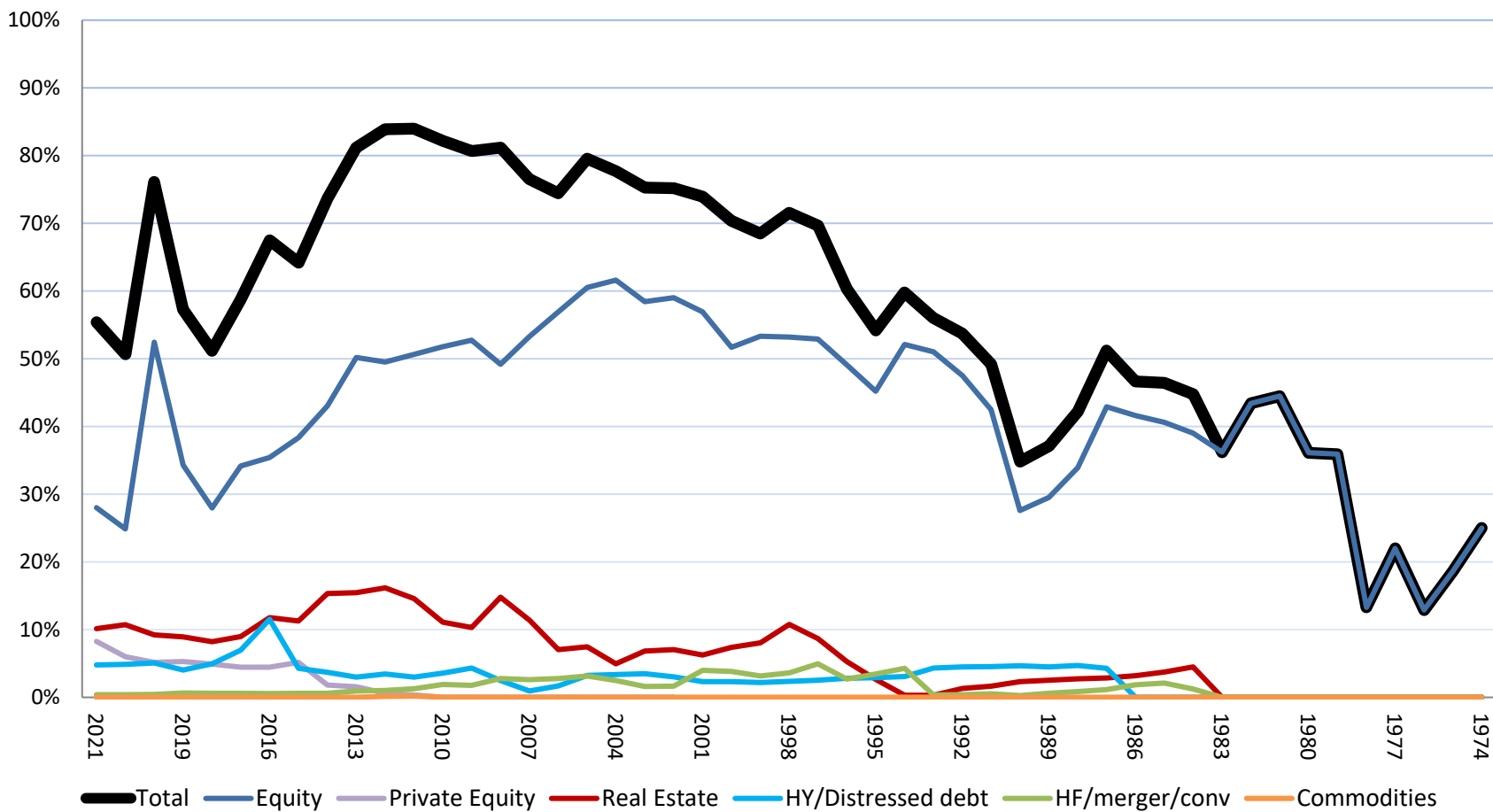
2. Real Estate (RE) maximum applies to REITS/Core RE and Opportunistic combined. Opportunistic RE counts 1.3x against RE max. Projected case allocation used for partnerships

3. Cash to provide liquidity for benefits payments and rebalancing

4. Skill and niche categories are not included in benchmark but do have a permitted range to invest in opportunistically

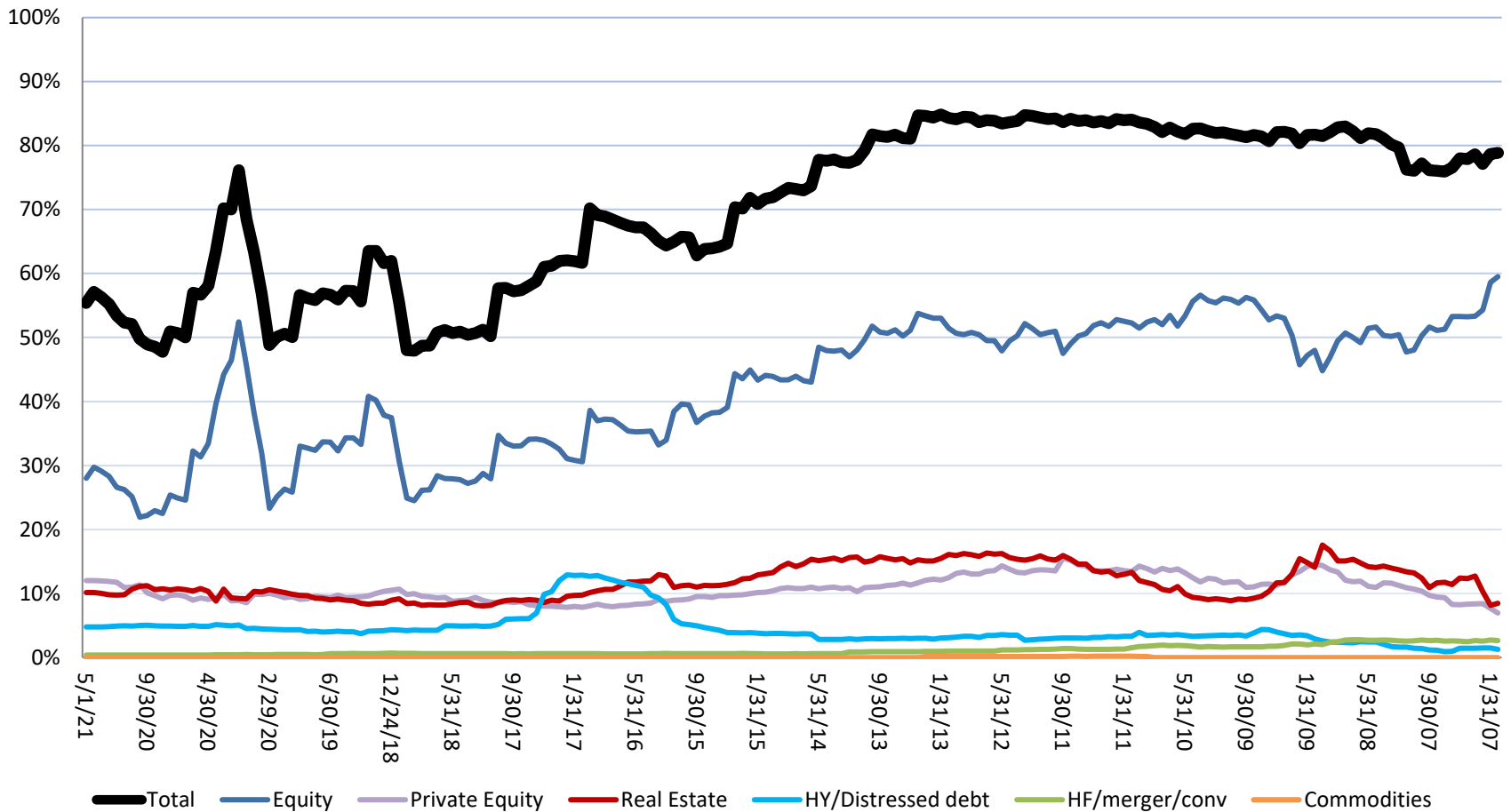
Equity-like risk (equity and embedded equity from other categories)

total and contribution of each component 5/1/2021 back to 1974



Equity-like risk (equity and embedded equity from other categories)

total and contribution of each component 5/1/2021 back to 12/31/2006



Additional risk measures and control

- Risk measurement
 - Focus on equity-like and bond-like risk - easier to relate to historical returns for stocks and bonds
 - Statistical measures of risk, such as standard deviation and correlation, are also calculated but are adjusted to reflect higher real-world frequency and magnitude of adverse outlier events
 - Behavior of some assets in a crisis can vary depending on if an inflation or deflation rooted crisis
- Risk control
 - Risk managed by broad diversification and reducing amounts invested in expensive assets
 - Adequate liquidity maintained to avoid liquidations of depressed assets and allow rebalancing
- Need to participate in economic system
 - Participation in free enterprise economic system provides highest long-term rewards
 - To get the long-term rewards, must endure the short-term ebbs and flows
 - Faith in the long term despite periodic bumps in the road and potentially rockier future
- Strength and determination to handle tough markets
 - Strong funding and benefit design helpful to managing downside volatility
 - In very difficult circumstances, benefits may require further adjustment to maintain funding

SDRS expected return and standard deviation

using J.P. Morgan inputs as proxy for conventional inputs

	Expected Standard		Correlation Matrix										Mean Expected Return	1 year Standard Deviation	5 year Standard Deviation	10 year Standard Deviation	20 year Standard Deviation	
	Return	Deviation*	US Eq	Intl	Hedge	Debt	Cash	HY	Comd	RE	Priv Eq	RE Opp						Tips
Domestic (US) Equity	4.1%	15%	100%															
International Equity	6.5%	17%	88%	100%														
Hedge Funds	3.1%	9%	81%	83%	100%													
Investment Grade debt	2.1%	3%	0%	7%	-5%	100%												
Cash	1.1%	0%	-7%	-3%	-4%	10%	100%											
High Yield Debt	4.8%	8%	71%	75%	79%	18%	-11%	100%										
Commodity Index	2.3%	16%	47%	57%	60%	0%	6%	50%	100%									
REITs	6.5%	15%	73%	67%	54%	28%	-5%	64%	30%	100%								
Private Equity	7.8%	19%	74%	78%	80%	-22%	7%	67%	59%	45%	100%							
Real Estate Opportunistic	8.1%	18%	51%	44%	55%	-20%	-8%	50%	38%	60%	50%	100%						
Tsy Inflation Protected Sec(TIPS)	1.5%	5%	9%	16%	11%	74%	8%	33%	26%	25%	5%	2%	100%					

* Standard deviation is a measure of volatility. There is a 66% chance of being within plus or minus 1 standard deviation, a 95% chance of being within 2 standard deviations.

	U.S. Equity	Intl Equity	Hedge Funds	Inv Gr Debt	Cash	HY Debt	Comm -odity	REITs	Private Equity	RE Opport	TIPS	Mean Expected Return	1 year Standard Deviation	5 year Standard Deviation	10 year Standard Deviation	20 year Standard Deviation
100:0 Equity/Debt	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4.10%	14.8%	6.6%	4.7%	3.3%
70:30 Equity/Debt	70%	0%	0%	30%	0%	0%	0%	0%	0%	0%	0%	3.50%	10.4%	4.7%	3.3%	2.3%
add International EQ	47%	23%	0%	30%	0%	0%	0%	0%	0%	0%	0%	4.05%	10.6%	4.7%	3.4%	2.4%
add REITs	42%	20%	0%	28%	0%	0%	0%	10%	0%	0%	0%	4.26%	10.6%	4.7%	3.4%	2.4%
add High Yield Debt	40%	19%	0%	24%	0%	7%	0%	10%	0%	0%	0%	4.37%	10.6%	4.7%	3.3%	2.4%
add Cash	40%	19%	0%	22%	2%	7%	0%	10%	0%	0%	0%	4.35%	10.6%	4.7%	3.3%	2.4%
add Private Equity	32%	17%	0%	22%	4%	7%	0%	10%	8%	0%	0%	4.53%	10.3%	4.6%	3.2%	2.3%
add RE Opportunistic	31%	16%	0%	22%	6%	7%	0%	2%	8%	8%	0%	4.58%	9.8%	4.4%	3.1%	2.2%
Benchmark FY22 (proposed)	39%	19%	0%	23%	2%	7%	0%	10%	0%	0%	0%	4.33%	10.4%	4.7%	3.3%	2.3%
SDRS Current AA	19%	9%	1%	12%	29%	11%	0%	0%	10%	9%	0%	4.01%	7.5%	3.4%	2.4%	1.7%

Return Ranges	Mean	1 Year Horizon			5 Year Horizon			10 Year Horizon			20 Year Horizon		
		Exp Ret	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd
Benchmark FY22 (proposed)	4.33%	14.8%	-6.1%	-16.6%	9.0%	-0.3%	-5.0%	7.6%	1.0%	-2.3%	6.7%	2.0%	-0.3%

SDRS expected return and standard deviation

using SDIC expected returns and fat-tail adjusted risk measures

	Expected Standard		Correlation Matrix										
	Return	Deviation*	US Eq	Intl Eq	Hedge	Debt	Cash	HY	Comd	RE	Priv Eq	RE Opp	TIPS
Domestic (US) Equity	6.7%	22%	100%										
International Equity	6.7%	22%	100%	100%									
Hedge Funds	5.0%	12%	73%	73%	100%								
Investment Grade debt	3.7%	7%	0%	0%	-10%	100%							
Cash	3.3%	1%	0%	0%	0%	0%	100%						
High Yield Debt	5.1%	12%	75%	75%	35%	23%	0%	100%					
Commodity Index	3.7%	22%	50%	50%	35%	-20%	0%	20%	100%				
REITs	7.0%	24%	75%	75%	30%	0%	0%	50%	30%	100%			
Private Equity	7.4%	30%	88%	88%	30%	0%	0%	55%	40%	70%	100%		
Real Estate Opportunistic	7.6%	32%	75%	75%	25%	2%	0%	60%	25%	90%	60%	100%	
Tsy Inflation Protected Sec(TIPS)	3.7%	7%	0%	0%	0%	100%	0%	24%	0%	0%	0%	0%	100%

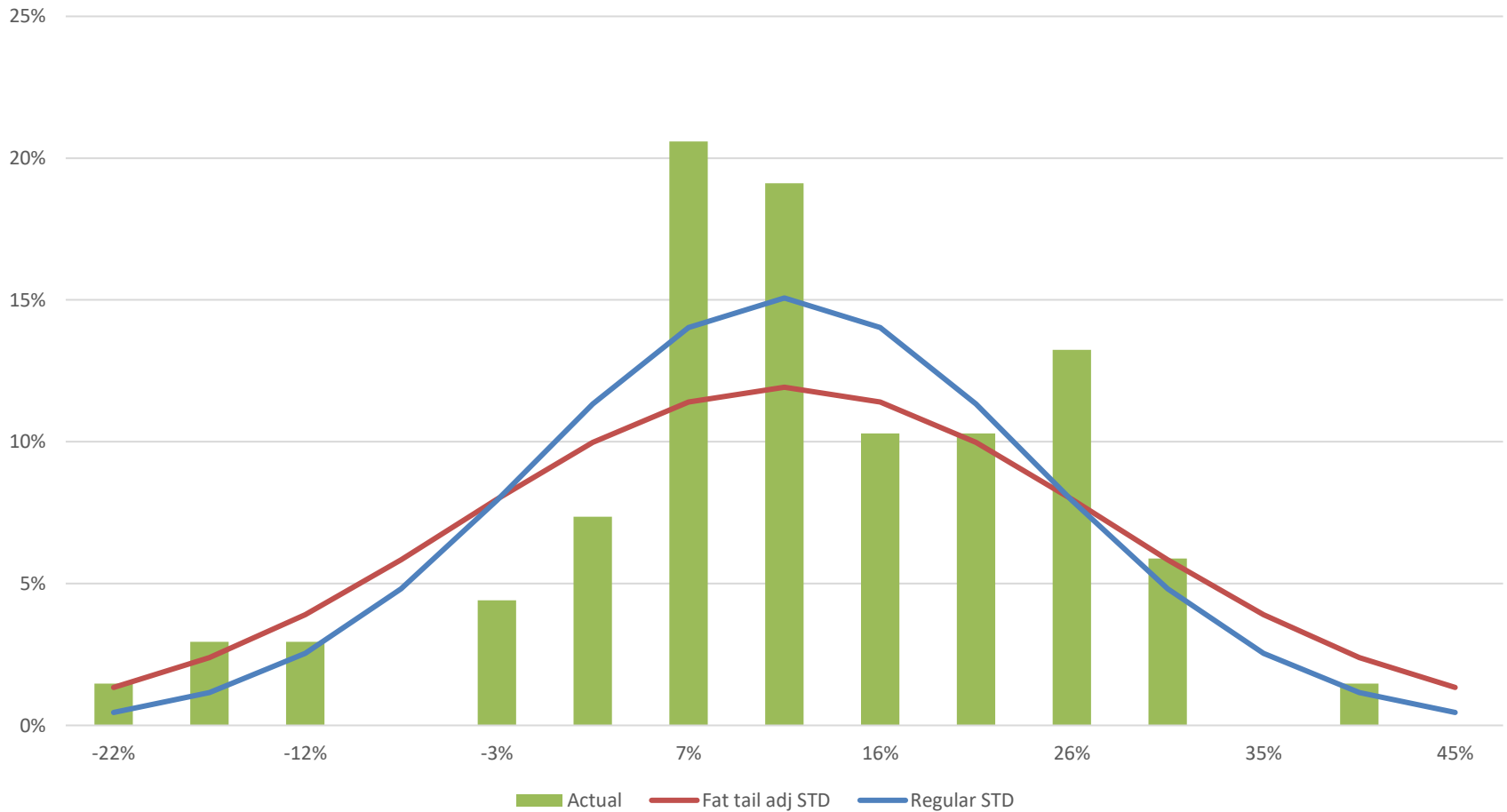
* Standard deviation is a measure of volatility. There is a 66% chance of being within plus or minus 1 standard deviation, a 95% chance of being within 2 standard deviations.

	U.S. Equity	Intl Equity	Hedge Funds	Inv Gr Debt	Cash	HY Debt	Comm -odity	REITs	Private Equity	RE Opport	TIPS	Mean Expected Return	1 year Standard Deviation	5 year Standard Deviation	10 year Standard Deviation	20 year Standard Deviation
100:0 Equity/Debt	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6.69%	22.0%	9.8%	7.0%	4.9%
70:30 Equity/Debt	70%	0%	0%	30%	0%	0%	0%	0%	0%	0%	0%	5.78%	15.5%	7.0%	4.9%	3.5%
add International EQ	47%	23%	0%	30%	0%	0%	0%	0%	0%	0%	0%	5.78%	15.5%	7.0%	4.9%	3.5%
add REITs	42%	20%	0%	28%	0%	0%	0%	10%	0%	0%	0%	5.87%	15.6%	7.0%	4.9%	3.5%
add High Yield Debt	40%	19%	0%	24%	0%	7%	0%	10%	0%	0%	0%	5.88%	15.6%	7.0%	4.9%	3.5%
add Cash	40%	19%	0%	22%	2%	7%	0%	10%	0%	0%	0%	5.88%	15.6%	7.0%	4.9%	3.5%
add Private Equity	32%	17%	0%	22%	4%	7%	0%	10%	8%	0%	0%	5.86%	15.5%	7.0%	4.9%	3.5%
add RE Opportunistic	31%	16%	0%	22%	6%	7%	0%	2%	8%	8%	0%	5.84%	15.6%	7.0%	4.9%	3.5%
Benchmark FY22 (proposed)	39%	19%	0%	23%	2%	7%	0%	10%	0%	0%	0%	5.85%	15.4%	6.9%	4.9%	3.4%
SDRS Current AA	19%	9%	1%	12%	29%	11%	0%	0%	10%	9%	0%	5.30%	12.3%	5.5%	3.9%	2.7%

Return Ranges	Mean	1 Year Horizon			5 Year Horizon			10 Year Horizon			20 Year Horizon		
		Exp Ret	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd	dn 2 sd	up 1sd	dn 1 sd
Benchmark FY22 (proposed)	5.85%	21.2%	-9.5%	-24.9%	12.7%	-1.0%	-7.9%	10.7%	1.0%	-3.9%	9.3%	2.4%	-1.0%

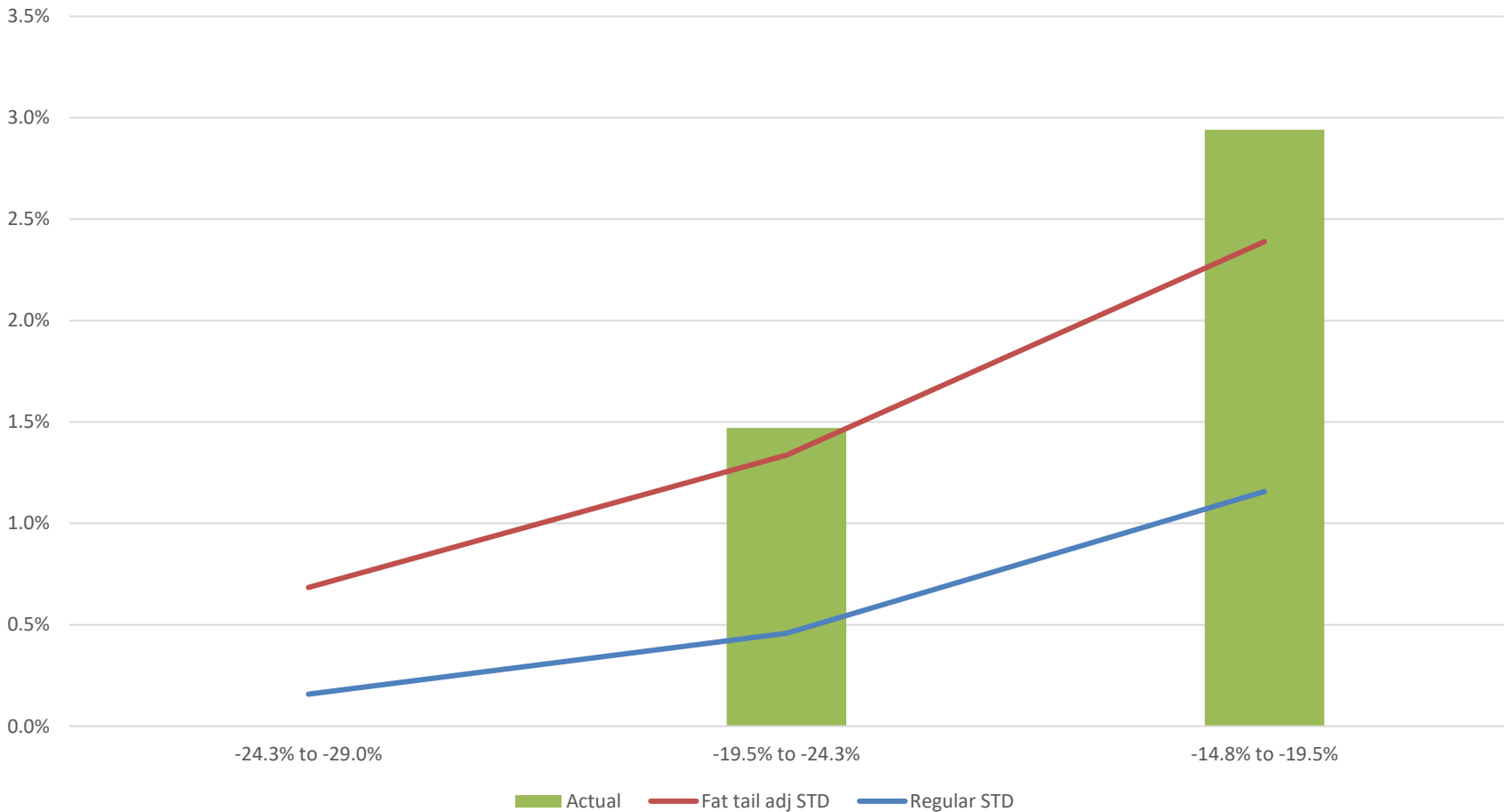
Actual vs expected with fat tail adjusted volatility

two-year annualized equity returns



Focus on severe adverse outcomes

two-year annualized equity returns actual versus expected



SDRS expected long-term return recap

- Benchmark asset allocation expected return is 5.85%.
- Use of contribution margin to buffer adverse investment experience could support a higher expected return.
- Negative dollar cost averaging effect may lower by .25%.
- Expected returns are the midpoint of a wide distribution with a 50% chance of being higher and a 50% chance of being lower.
- Standard deviation is 15.4% adjusted to reflect real world frequency of severe negative returns and correlations during severe periods. Conventionally measured standard deviation is 10% to 11%.

Asset category valuation

- Equity-like and bond-like risk
 - Equity and bond valuation processes
- Real estate (REITS)
 - REIT valuation versus underlying equity and bond components
- High yield
 - High yield valuation versus underlying equity and bond components
- Private equity
 - Subjective and data assessment of risk adjusted added value versus equity
- Opportunistic real estate
 - Subjective and data assessment of risk adjusted added value versus REITS
- Arbitrage and other strategies
 - Monitor for signs of distress and bottom-up underwriting of proxy transactions

Equity valuation

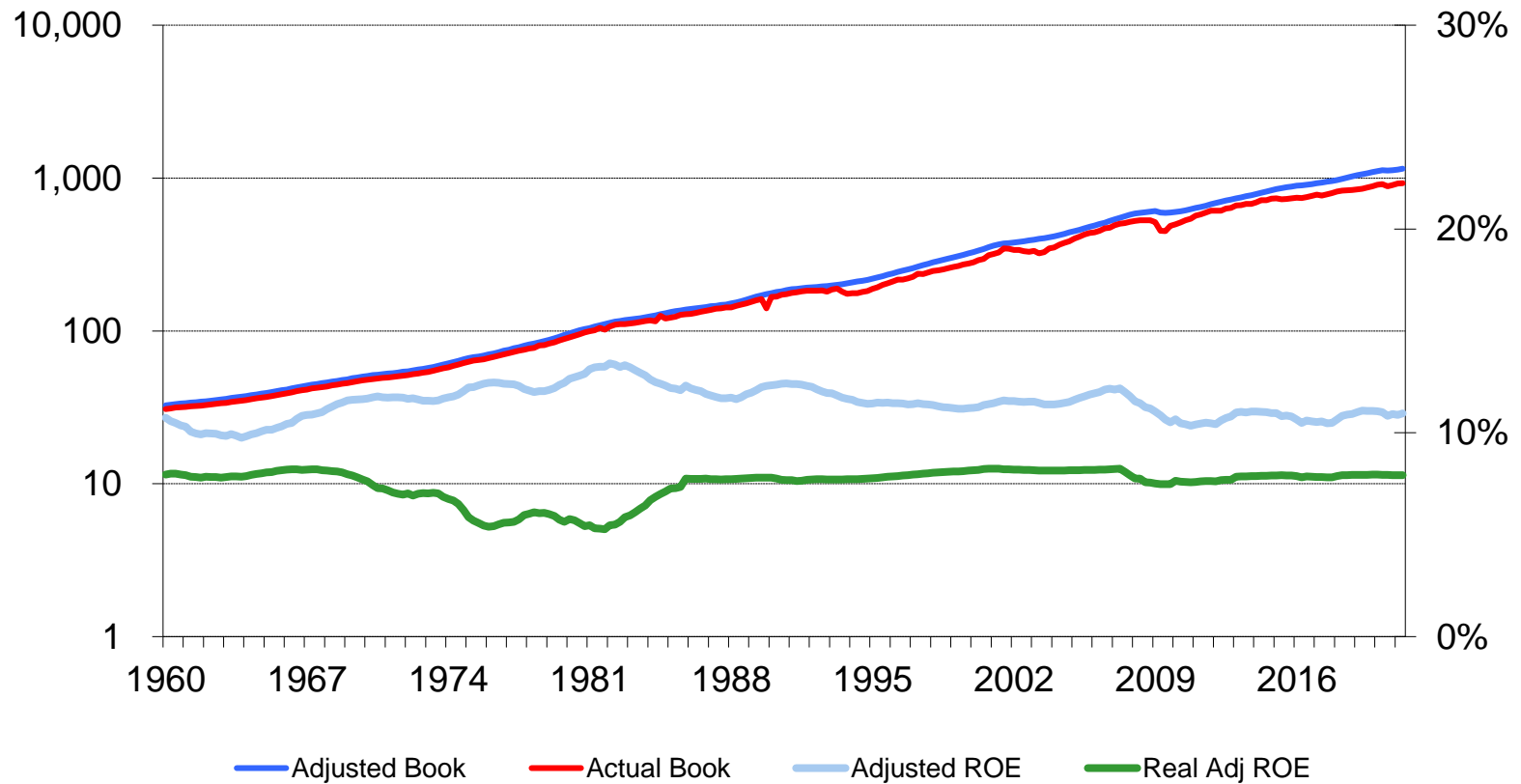
- Estimated future cash flows
 - Normal earnings
 - Growth rate
- Discount rate based on risk
 - Inflation + real cash yield + term premium + equity risk premium
- Value is discounted value of future cash flows
- Adjustments to value
 - Monetary stimulus/restraint
 - Earnings strength

Normal earnings

- Normal earnings
 - Adjusted book value multiplied by normal return on equity
- Adjusted book value
 - Book value is balance sheet reported value of assets net of liabilities
 - Book value may not track retained earnings due to index changes, mergers, and buybacks. These leakages must be addressed.
 - Book value write-downs are smoothed
- Normal return on equity = Historic Real ROE + Expected Inflation + ROE Adjustments
 - Return on equity is earnings divided by adjusted book value
 - Real ROE is return on equity less inflation
 - Historic Real ROE is the historic average Real ROE
 - Expected inflation is drawn from long term and recent history
- ROE Adjustments
 - Inflation can impact the level of real ROE
 - Governance can also impact real ROE

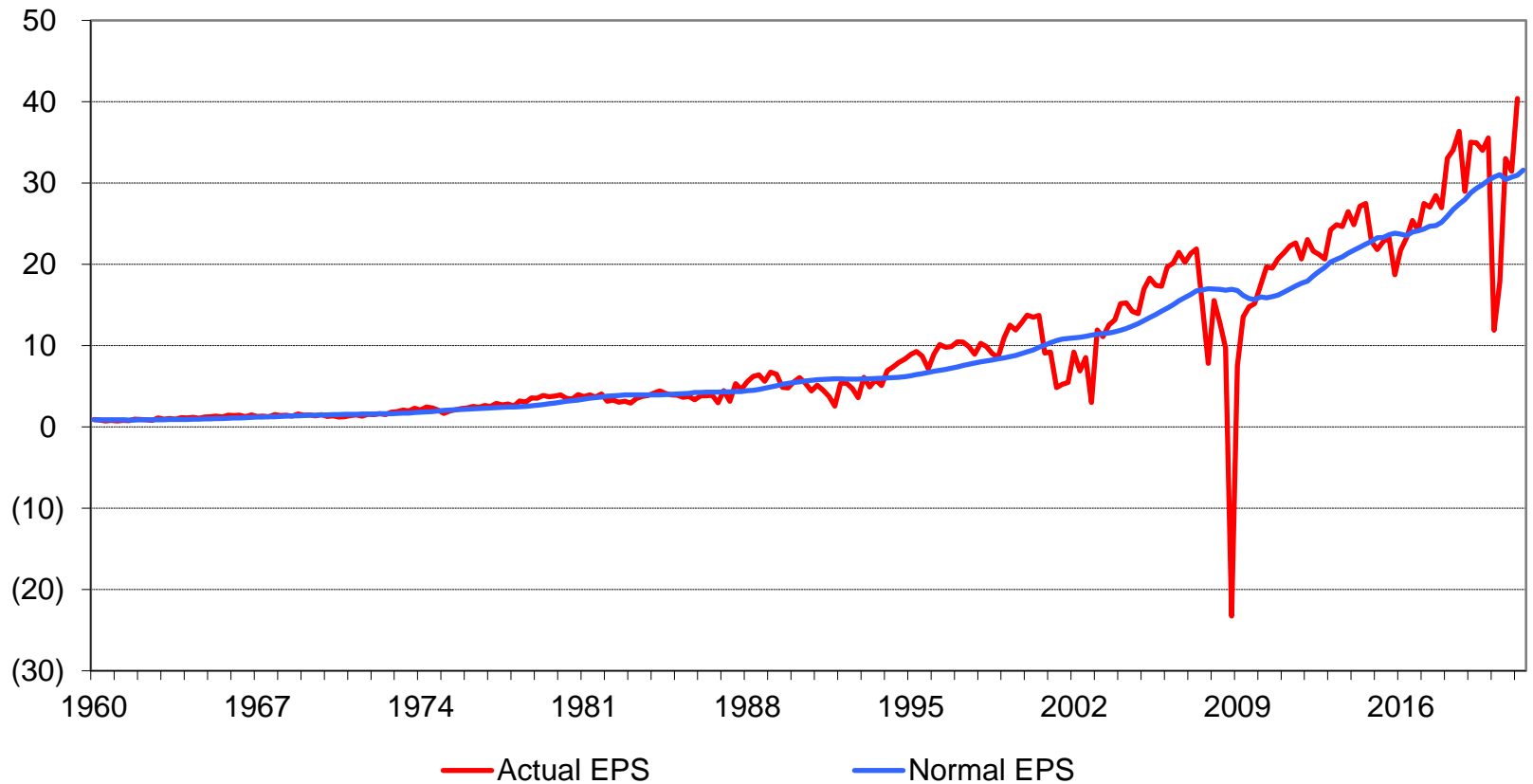
Book value and return on equity (RHS)

Incorporates book value adjustments



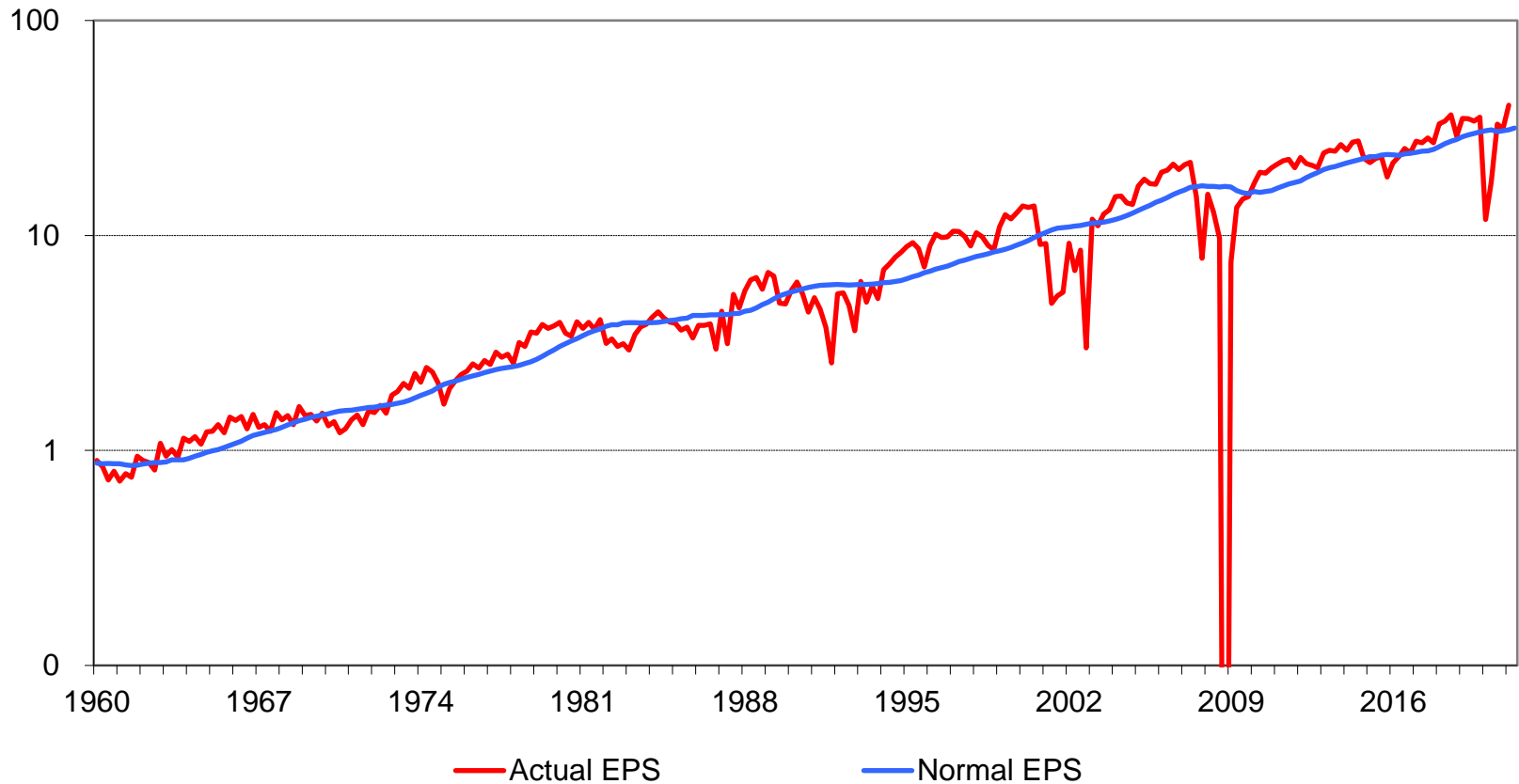
Normal EPS (regular scale to better see recent levels)

Book value multiplied by adjusted ROE



Normal EPS (Log scale to better see historic levels)

Book Value multiplied by adjusted ROE

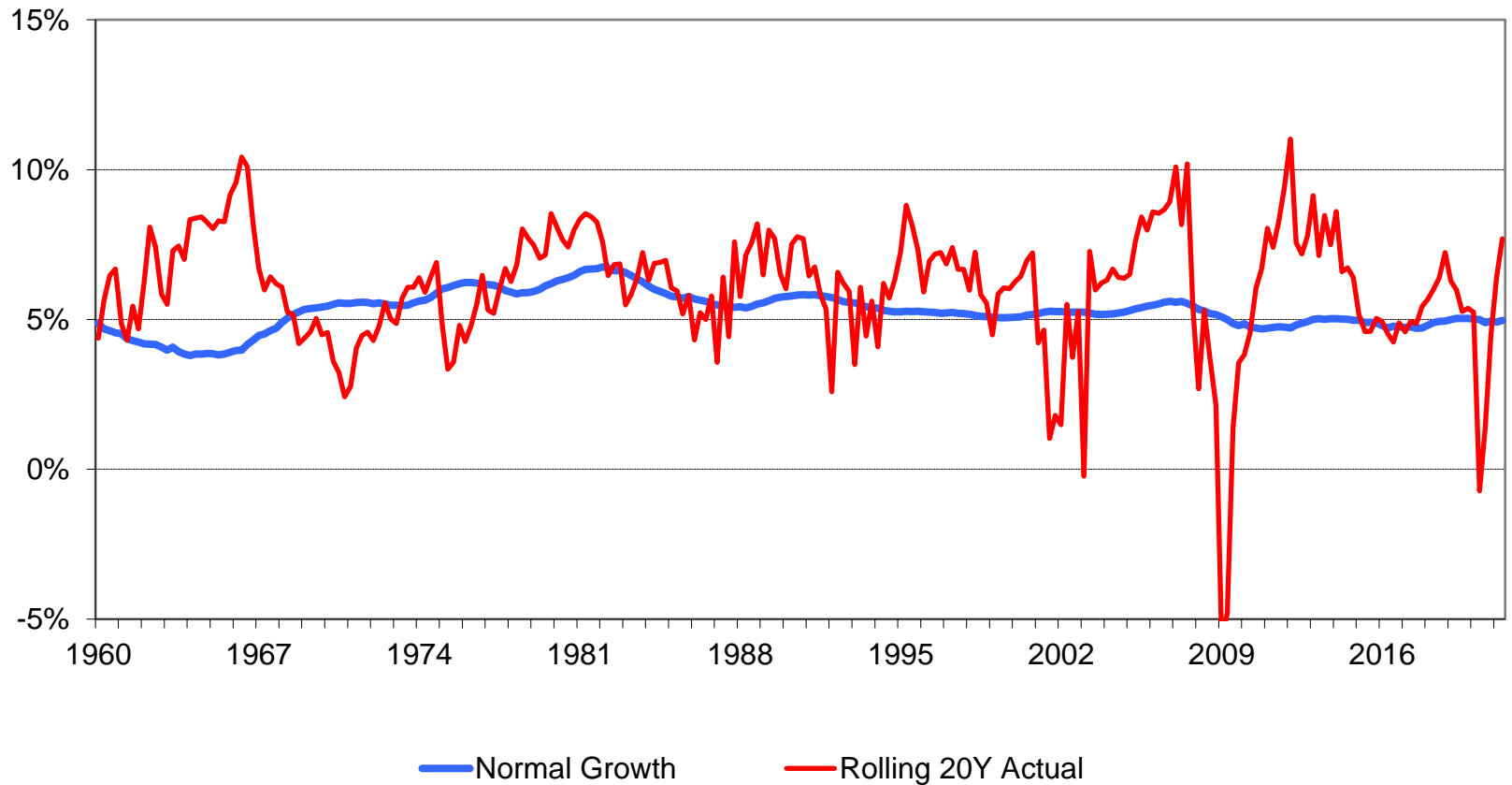


Normal growth

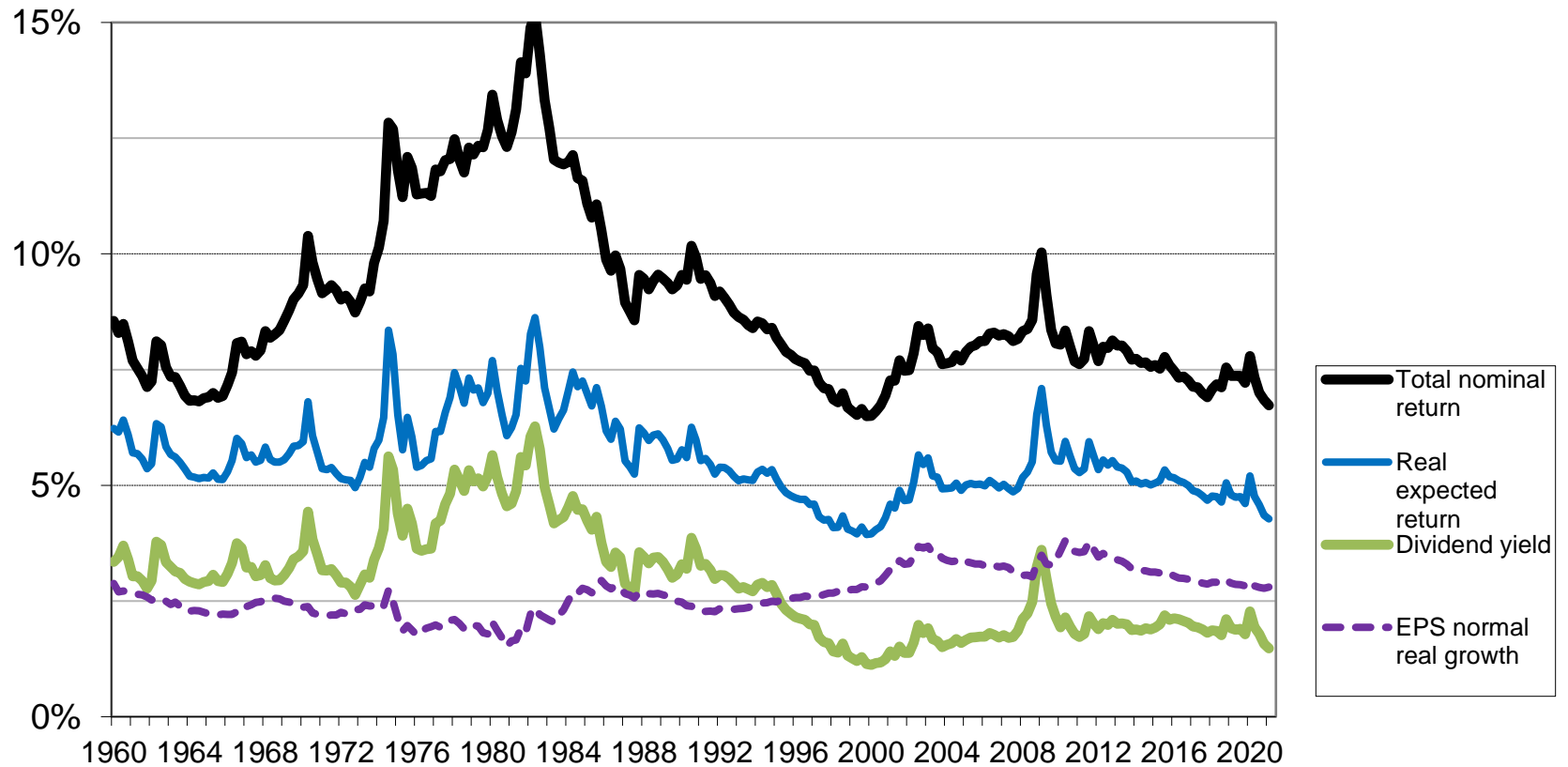
- Normal Growth = organic + acquisition + inflation pass through – attrition
 - Organic growth = organic reinvestment times normal ROE
 - Organic reinvestment = portion of earnings reinvested excluding acquisitions
 - Normal ROE adjusted to avoid double counting of inflation pass-through effect
 - Acquisition growth = acquisition investment times cost of capital
 - Acquisition investment = portion of earnings invested in acquisitions
 - Return of acquisitions based on cost of capital
 - Inflation pass through = expected inflation x pass-through percentage
 - Expected Inflation = same as used for Normal ROE
 - Pass-through percentage = percent of expected inflation estimated to pass through as an increase in normal earnings
 - Attrition = estimated mortality rate of normal earnings
 - Adjust for bias of earnings power (absent further investment) to be at risk of erosion
 - Attrition rate helps reconcile historic actual growth with the growth otherwise expected

EPS growth

Normal versus 20 year actual

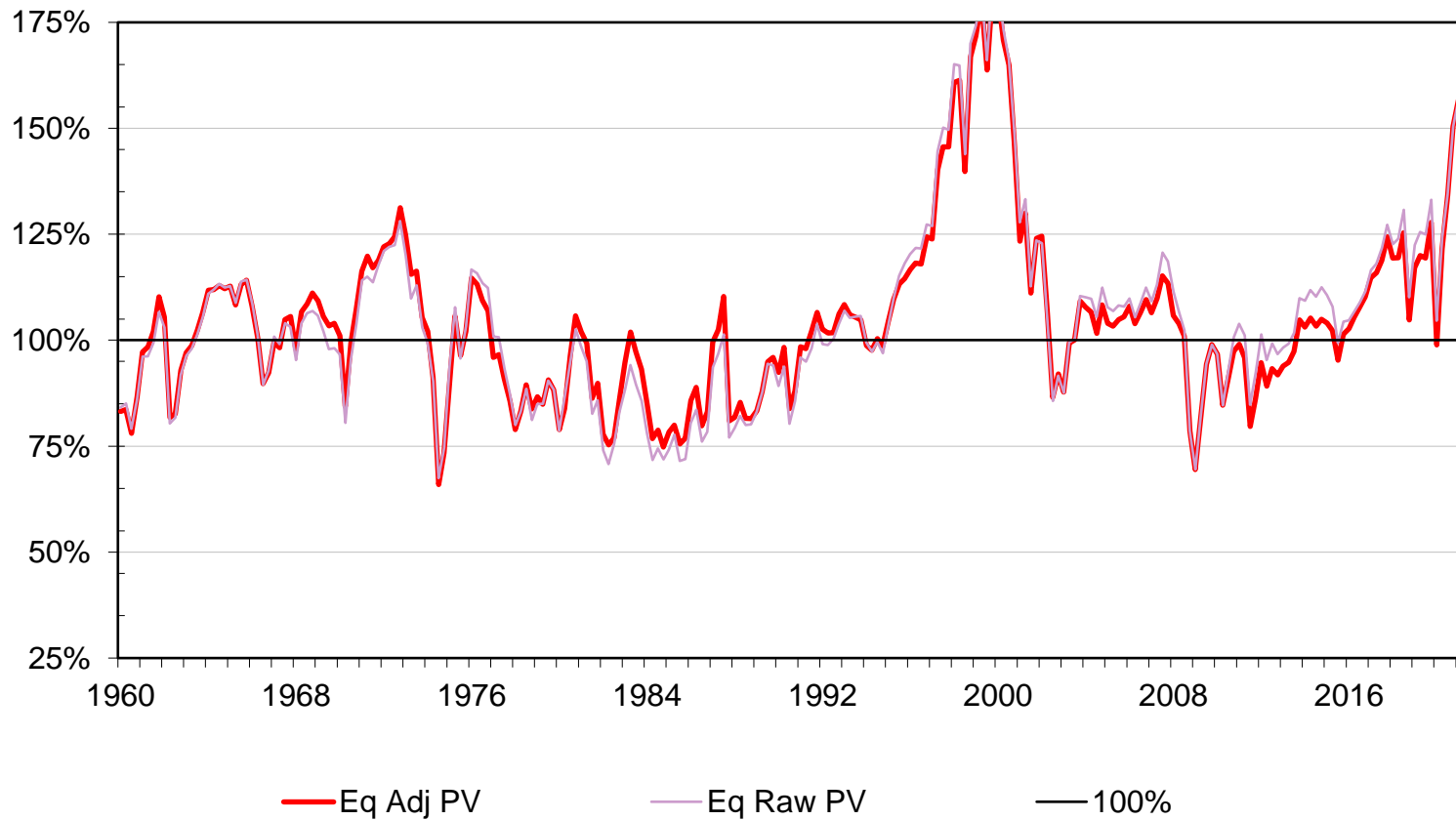


Equity expected return – nominal and real



Equity price to value

raw and with monetary and earnings adjustments

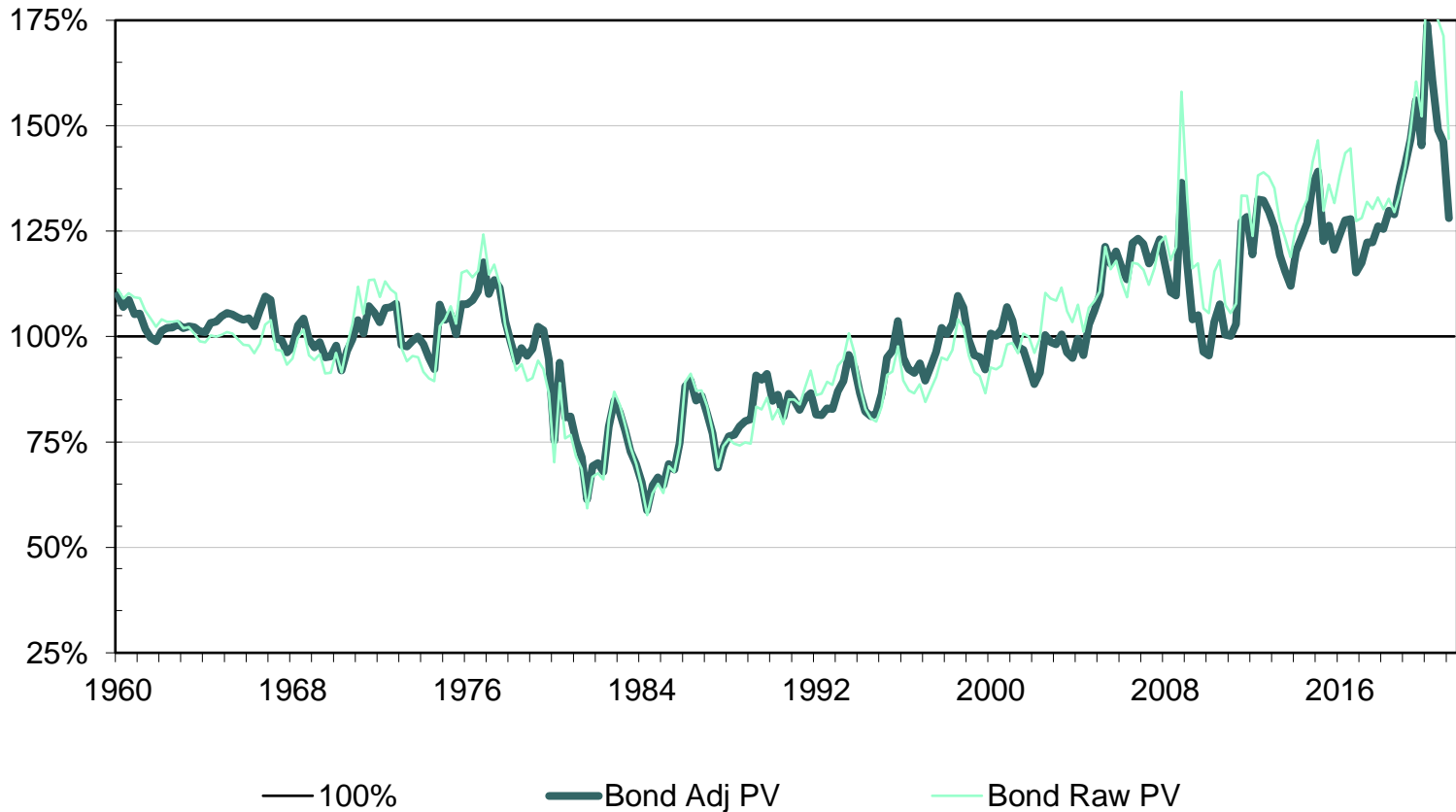


Bond valuation

- Equilibrium yield estimated
 - Inflation
 - Real cash yield
 - Term premium
- Bond value based on equilibrium yield
- Adjustments to value
 - Monetary stimulus/restraint
 - Earnings strength

Bond price to value

raw and with monetary and earnings adjustments



Real Estate valuation

- Real estate capitalization rate is adjusted to a typical equity/debt structure
- Discount rate is linked to the equity discount rate
- Difference between leverage adjusted cap rate and discount rate is converted into price to value

High Yield spread model

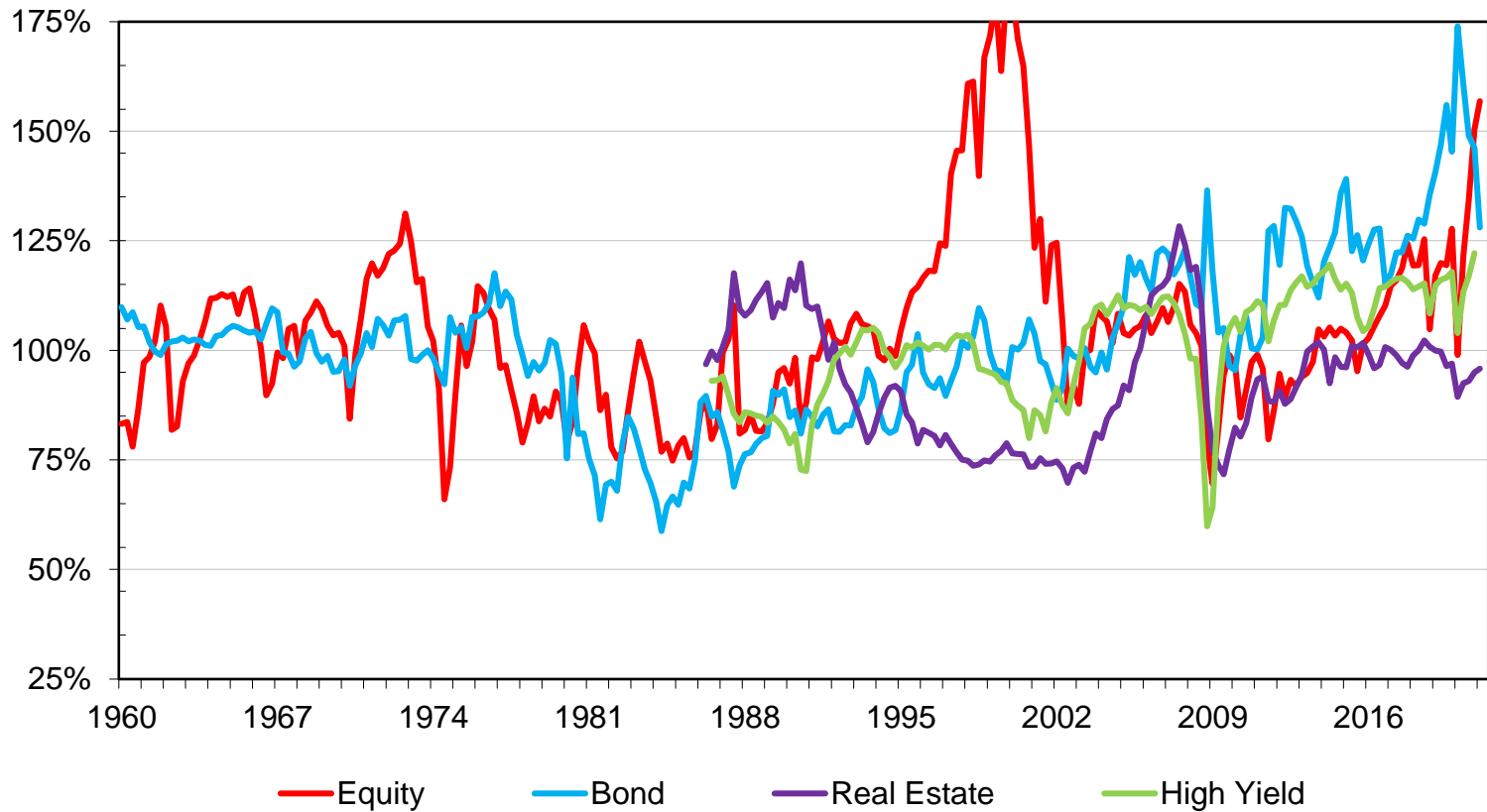
- Fair spread to treasuries based on long-term average spread and internal credit modeling research
- Difference between current spread and fair spread is converted into price to value

High Yield valuation model

- Fair yield
 - Fair yield of similar duration treasuries plus
 - Fair yield spread to treasuries
- Current yield is compared to fair yield
- Yield difference is converted to price to value

Price to value

equity, bond, real estate, high yield



Allocation over and under-weights based on valuation

- **Thresholds to adjust equity-like and bond-like risk**
 - Meaningfully cheap or expensive to initiate over or under-weight
 - Move back toward fair value to remove over or under-weight
 - Several steps between the benchmark and minimum and maximum levels
- **Other categories over and under-weights depend on valuation relative to valuation of risk mapped blend of stock/bonds/cash**
 - Equity-like, bond-like, and cash-like risk from other categories is offset by adjusting weight of stocks, bonds, or cash

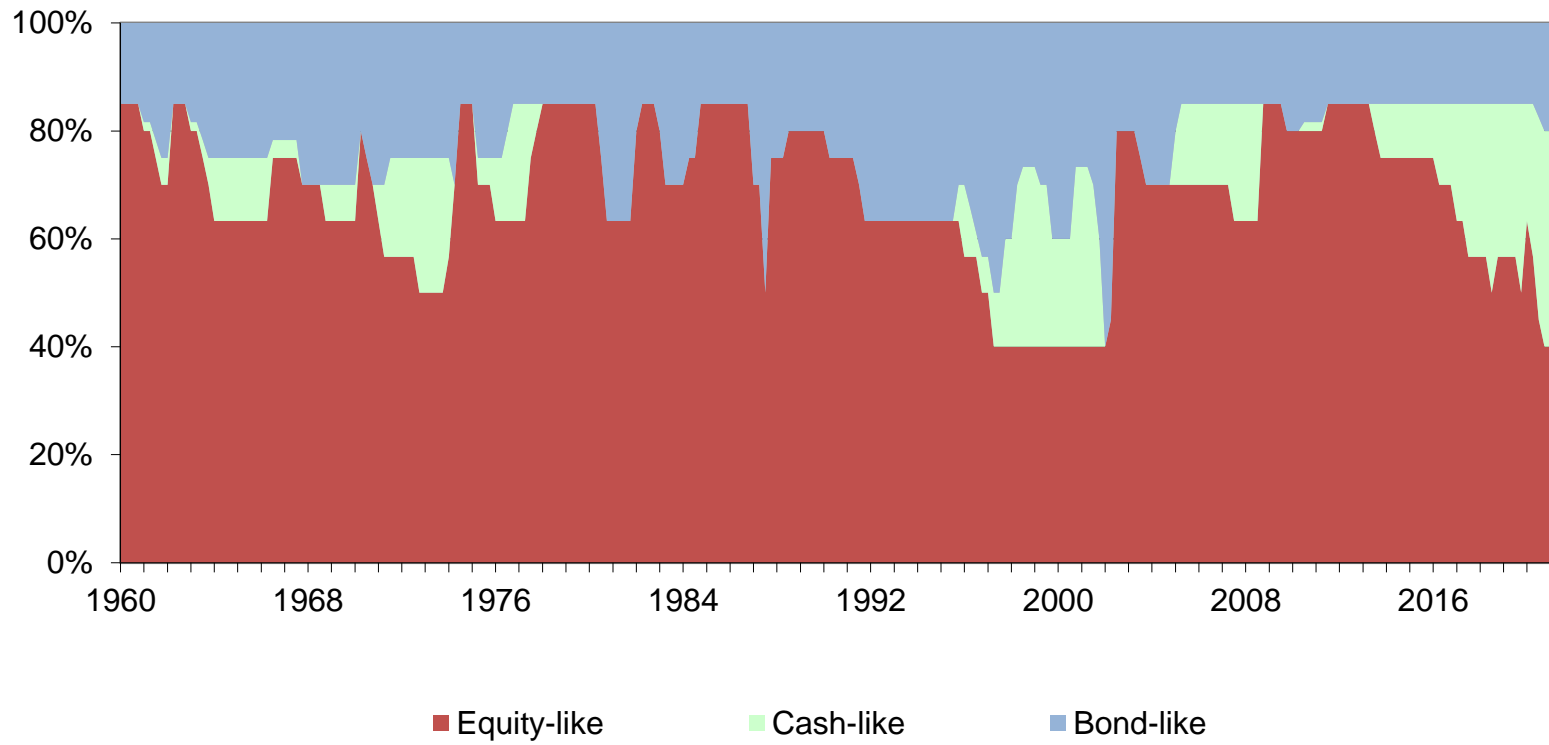
Allocation table example

equity-like risk and bond-like risk (entry and exit levels not shown)

Equity	Eq	Eq	Equity-like	Bond	Bond	Bond	Bond-like weight if equity-like weight is								
Position	Entry	Exit	Weight	Position	Entry	Exit	85%	80%	75%	70%	63.3%	56.7%	50%	45%	40%
3			85%	3			15%	20%	25%	30%	36.7%	43.3%	50%	55%	60%
2			80%	2			15%	20%	25%	30%	34.4%	38.9%	43.3%	46.7%	50%
1			75%	1			15%	20%	25%	30%	32.2%	34.4%	36.7%	38.3%	40%
0			70%	0			15%	20%	25%	30%	30%	30%	30%	30%	30%
-1			63.3%	-1			15%	18.3%	21.7%	25%	25%	25%	25%	25.8%	26.7%
-2			56.7%	-2			15%	16.7%	18.3%	20%	20%	20%	20%	21.7%	23.3%
-3			50%	-3			15%	15%	15%	15%	15%	15%	15%	17.5%	20%
-4			45%	-4											
-5			40%	-5											

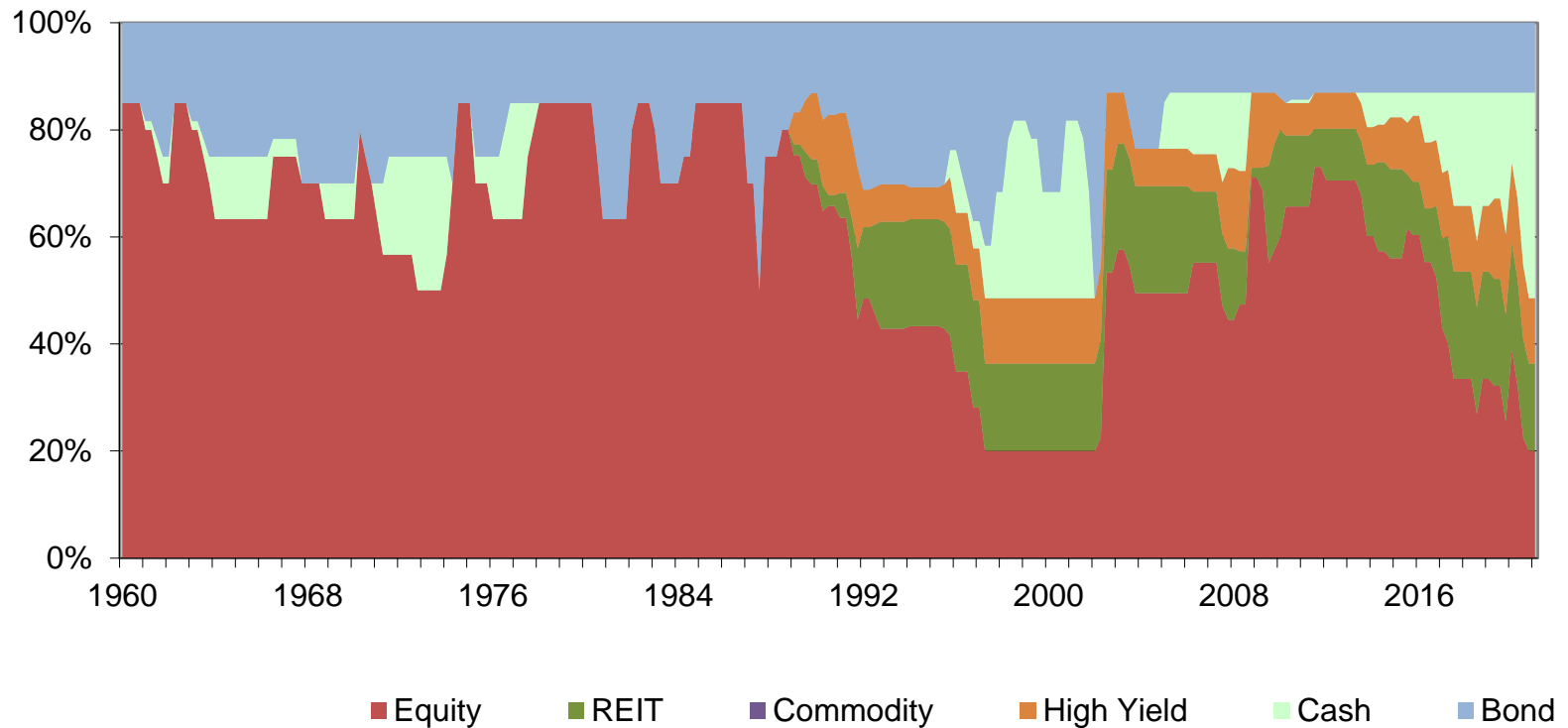
Model suggested allocations

Equity-like, bond-like, cash-like



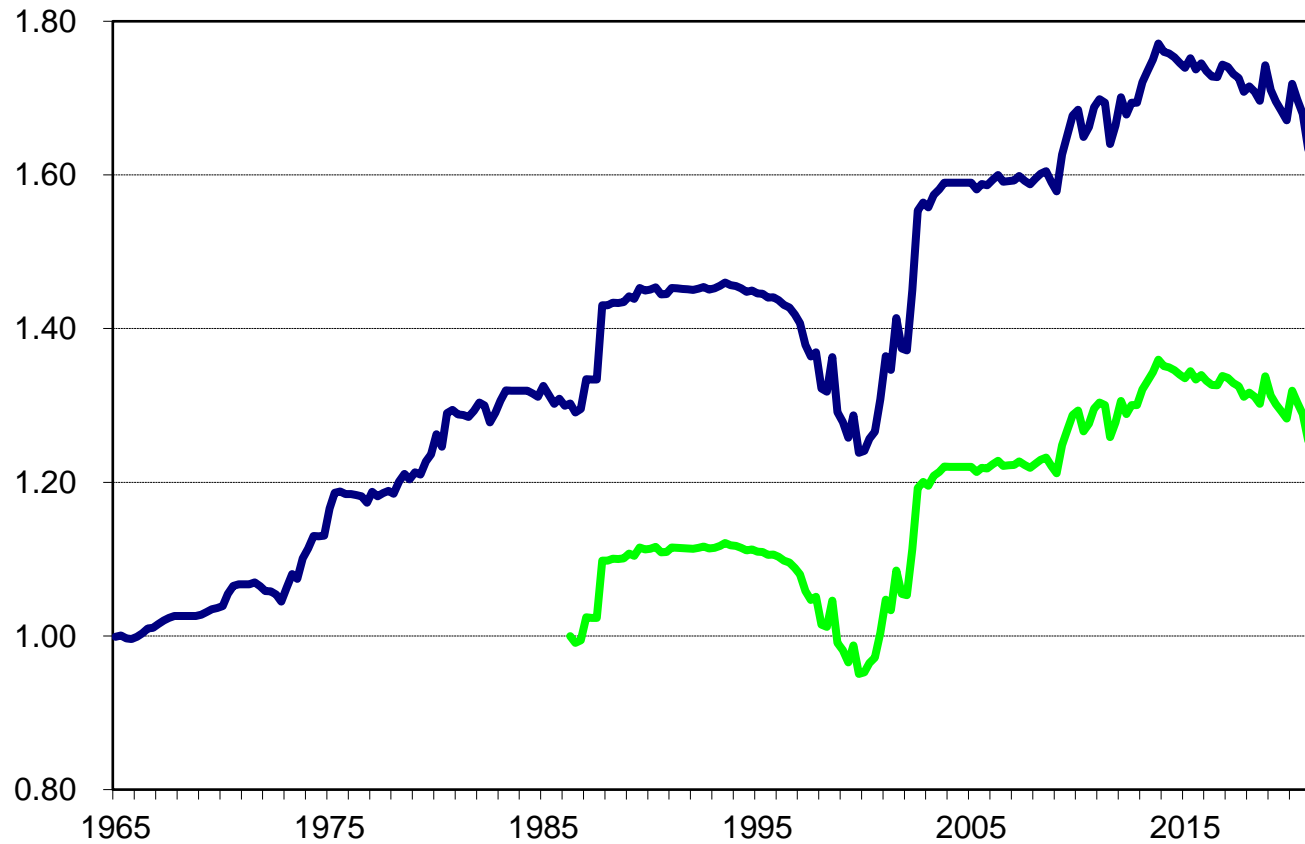
Model suggested allocations

including REITS and high yield



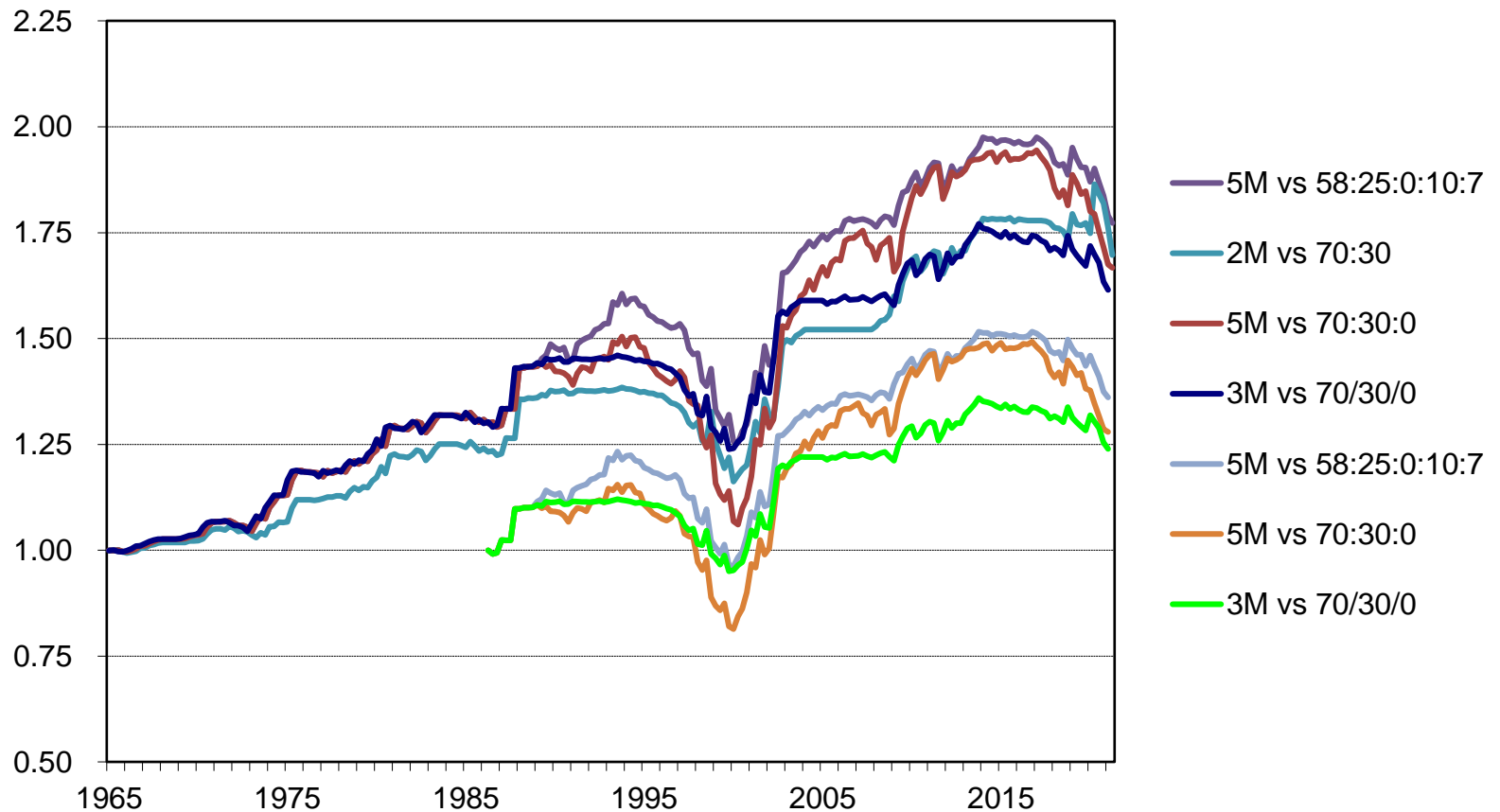
Model return versus 70/30 stock/bond

from 1965 to now and from 1986 initial use



Model return from 1965 and from 1986 initial use

Eq/Bd/Ca vs 70:30:0, Eq/Bd vs 70:30, and Eq/Bd/Ca/REIT/HY vs 58/25/0/10/7

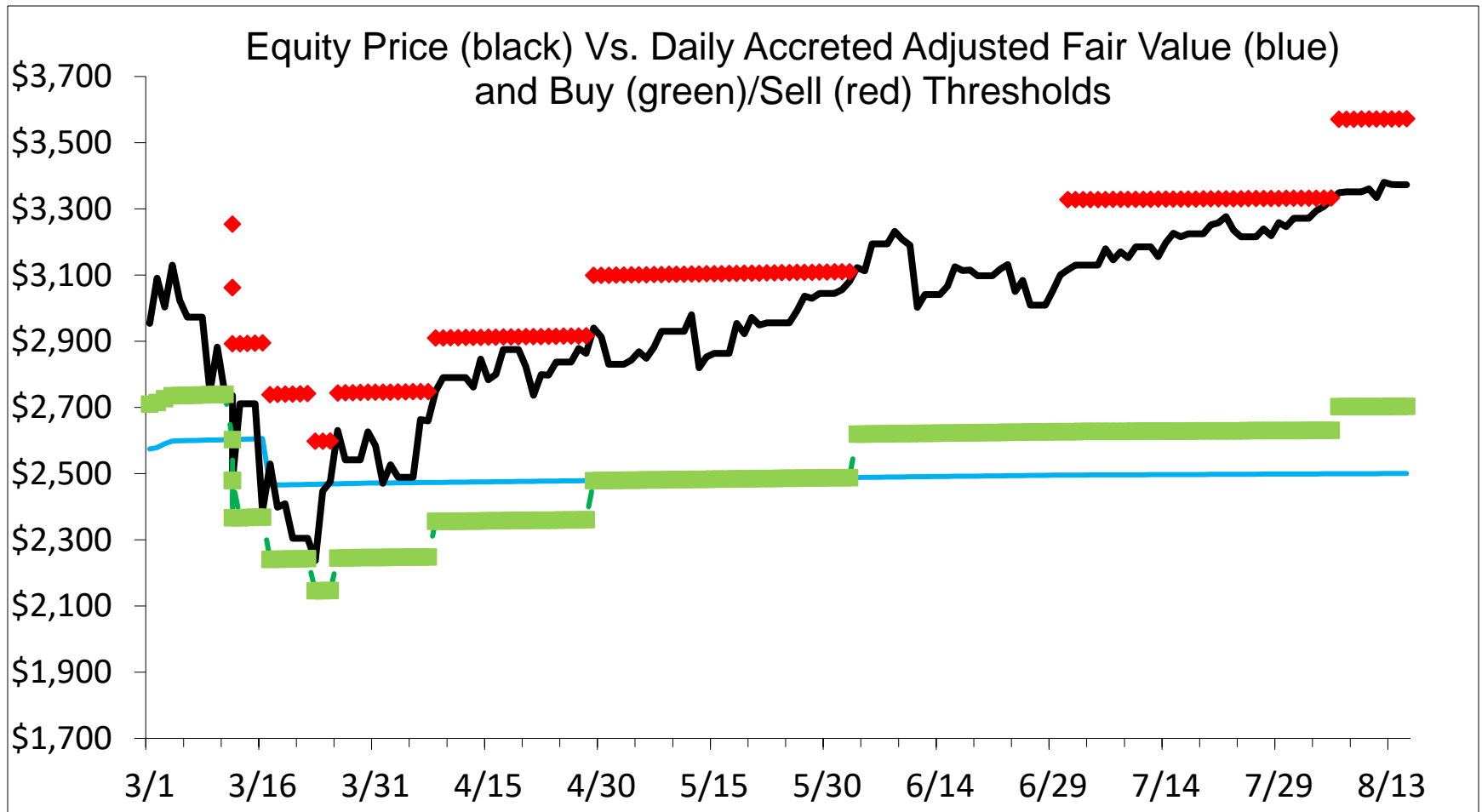


Daily asset allocation valuation and thresholds

Date	S&P500 Price	Equity Position	Next Buy Price	Next Sell Price
8-Mar-20	2972.37	-3	2,734.21	At Min
9-Mar-20	2746.56	-3	2,734.82	At Min
10-Mar-20	2882.23	-3	2,735.43	At Min
11-Mar-20	2741.38	-3	2,736.03	At Min
12-Mar-20	2480.64	-1	2,476.01	3,058.60
13-Mar-20	2711.02	-1	2,476.55	3,059.27
14-Mar-20	2711.02	-1	2,477.10	3,059.95
15-Mar-20	2711.02	-1	2,477.65	3,060.63
16-Mar-20	2386.13	0	2,365.55	2,891.23
17-Mar-20	2529.19	0	2,238.23	2,735.61
18-Mar-20	2398.1	0	2,238.67	2,736.15
19-Mar-20	2409.39	0	2,239.11	2,736.69
20-Mar-20	2304.92	0	2,239.55	2,737.23
21-Mar-20	2304.92	0	2,240.00	2,737.77
22-Mar-20	2304.92	0	2,240.44	2,738.32
23-Mar-20	2237.40	1	2,143.45	2,594.71
24-Mar-20	2447.33	1	2,143.88	2,595.22
25-Mar-20	2475.56	1	2,144.30	2,595.73
26-Mar-20	2630.07	0	2,242.21	2,740.48
27-Mar-20	2541.47	0	2,242.65	2,741.02

Illustration of Asset Allocation Model

3/1/2020 through 8/15/2020



Equity-like risk

3/1/2020 through 8/15/2020

