



# Arizona Permanent State Land Fund

Asset Allocation Review

January 2012

**Stephen P. McCourt, CFA**  
Managing Principal

**Laura B. Wirick, CFA, CAIA**  
Vice President

M E K E T A I N V E S T M E N T G R O U P  
5796 ARMADA DRIVE SUITE 110 CARLSBAD CA 92008  
760 795 3450 fax 760 795 3445 [www.meketagroup.com](http://www.meketagroup.com)

---

## Table of Contents

- 1. Introduction**
- 2. Asset Allocation Overview**
- 3. Proposed Policy Options**
- 4. Risk/Return Analysis**
  - Mean-Variance Optimization
  - Deterministic Economic Scenario Analysis
  - Risk Analytics
  - Liquidity Analysis
- 5. Analysis of Distribution Policy**
- 6. Analysis of Fiscal Year Change**
- 7. Conclusions**
- 8. Appendices**
  - Detail of Deterministic Scenario Analysis
  - Additional Risk Analytics
  - Asset Class Definitions
  - Risk/Return Analysis Assumptions

# Introduction

## Introduction

- This document presents a range of asset allocation options for the Fund, on both a restricted and unrestricted basis.
- We provide various approaches to assessing the risk in each policy option in order to provide a “mosaic” of the risks faced by the Fund.
- The goal of this review is not to declare one portfolio the “right” choice or the only prudent choice, but to highlight the risk and return tradeoffs of different policy portfolios.
- Over long periods of time, riskier assets, such as equities, are likely to produce relatively high rates of return. Consequently, higher allocations to risky assets increase the likelihood of the Fund maintaining and improving the real value of its corpus over the long term. However, riskier assets increase volatility in the short term.
- The asset allocation review process highlights the natural tension between long term goals and short term risks, and should allow the Trustees to make more informed decisions regarding portfolio positioning.
- This document also reviews the current distribution policy of the Fund, and evaluates two alternative distribution policies.
- A brief analysis of the historical relevance of different fiscal year end dates is provided.

## **Asset Allocation Overview**

## Asset Allocation

### ***What is Asset Allocation?***

Asset allocation refers to the distribution of assets across a number of asset classes that exhibit modest or low correlations with each other. Each asset class exhibits a unique combination of risk and reward. The expected and realized long-term returns vary by asset class, as do the interim volatility of those returns. Some asset classes, like equities, exhibit high degrees of volatility, but also offer high returns over time. Other asset classes, like cash, experience very little volatility, but offer limited return potential.

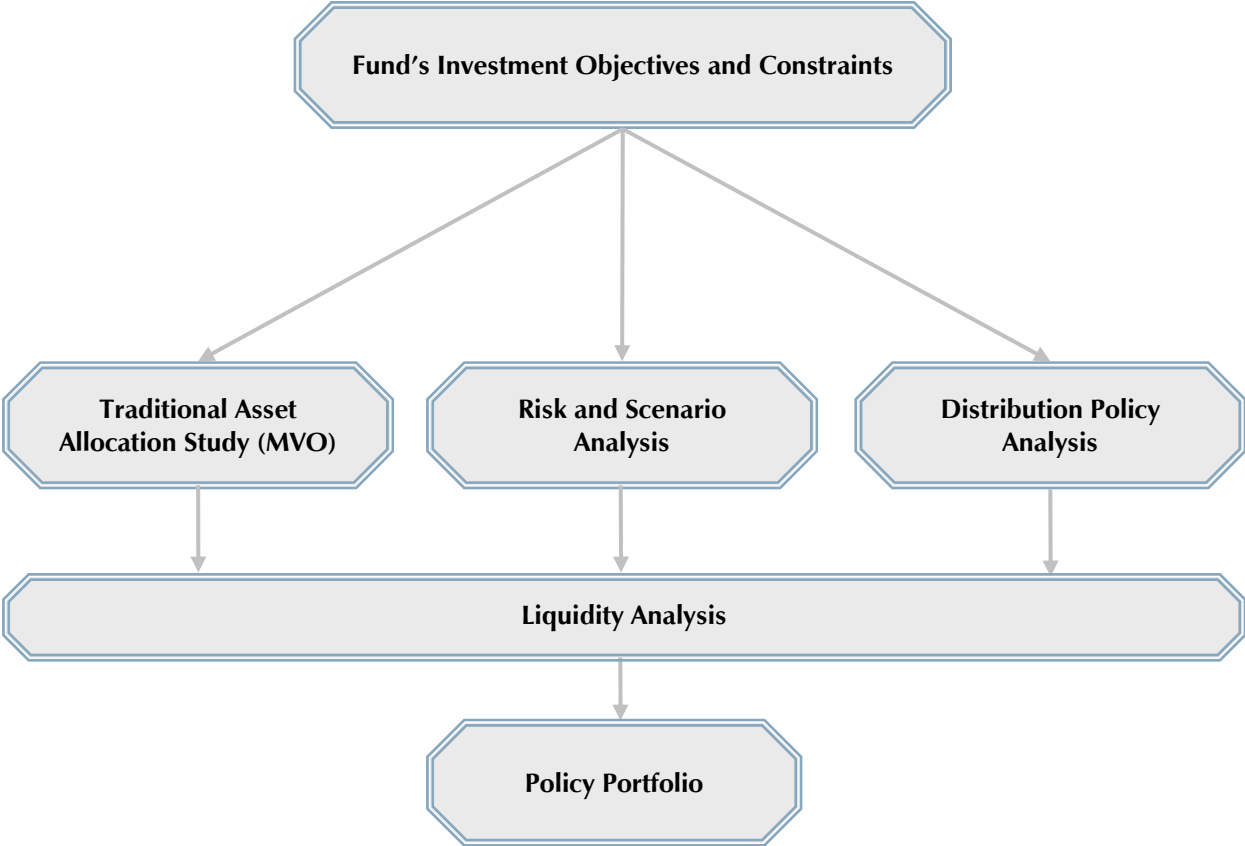
### ***Why is Asset Allocation important?***

The distribution of assets across various asset classes exerts a major influence on the return behavior of the aggregate pool over short and long time periods.

### ***How does Asset Allocation affect aggregate performance?***

In addition to exhibiting unique characteristics, each asset class interacts differently with other asset classes. Because of low correlations, the likelihood that any two asset classes will move together in the same direction is limited, with the movement of one asset class often partially offsetting another's. Combining asset classes allows investors to control more fully the aggregate risk and return of their portfolio, and to benefit from the reduction in volatility that stems from diversification.

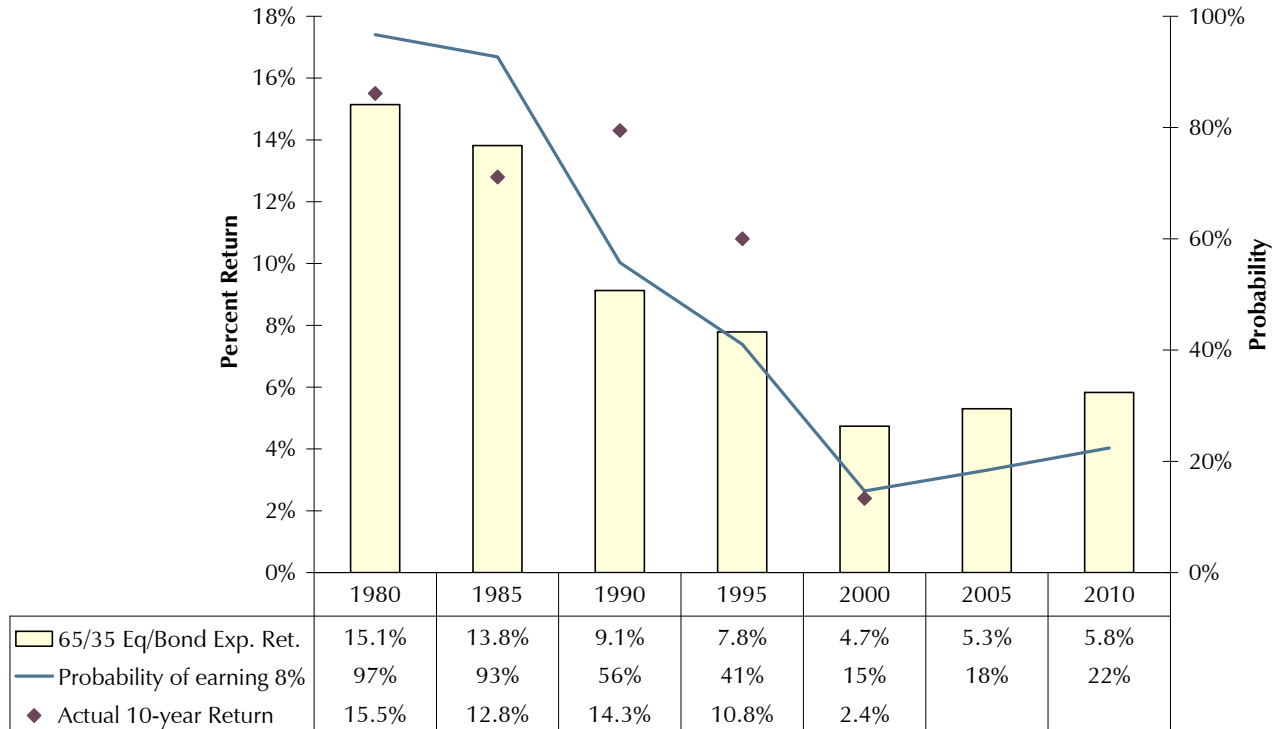
Asset Allocation Review Process



### Current Investment Constraints

- What is the overall time horizon for the State Land Fund?
  - Perpetual.
- What are the liquidity needs of the State Land Fund?
  - The current annual distribution is the average total rate of return for the previous five fiscal years less the average of the annual percentage change in the GDP price deflator for the previous five fiscal years, multiplied by the trailing 60-month average market value of the Fund.
- What are the legal and regulatory constraints under which the Fund operates?
  - Constitutional Constraints
    - No more than 60% of the Fund (at cost) may be invested in equities.
    - No more than 5% of equity securities may be invested in any one firm.
    - All equities purchased must be listed on a national exchange (no private equity).
    - Fixed income securities must be rated investment grade (BBB or higher).
    - Exchange-traded funds ("ETFs") are allowed, but only if their underlying holdings are allowed by state law.
  - Limitations by Statute
    - Fixed income securities are limited to firms organized to do business in the United States.
    - ETFs are allowed, but are classified based on their underlying holdings.

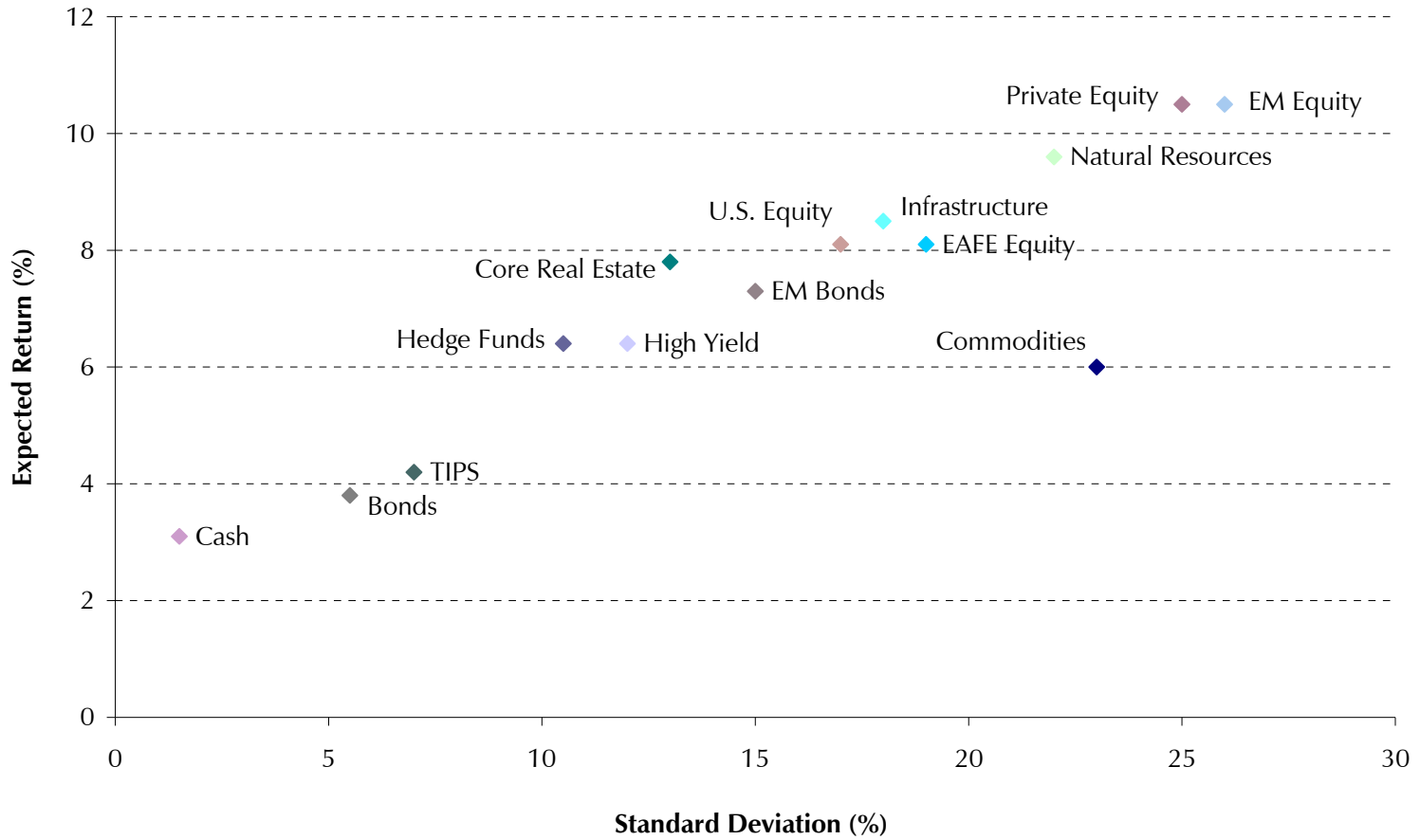
The Secular Decline in Investment Returns<sup>1</sup>



- A portfolio comprised of 65% domestic stocks (Russell 3000) and 35% investment grade bonds (Barclays Aggregate) has produced diminishing returns over the past twenty years (along with diminished forward-looking expected returns), as interest rates have declined, equity valuations have inflated, and equity market returns have disappointed.

<sup>1</sup> Expected return assumptions for 1) Bonds equals the yield of the ten-year Treasury plus 100 basis points, and 2) Equities equals the dividend yield plus the earnings yield of the S&P 500 index (using the inflation-adjusted trailing 10-year earnings). Probability calculation is for the subsequent ten years.

Expected Return and Volatility for Major Asset Classes<sup>1</sup>



- A positive correlation exists between long-term return expectations and the level of risk accepted.

<sup>1</sup> Expected return and standard deviation are based upon Meketa Investment Group's 2011 Annual Asset Study.



## **Proposed Policy Options**

### Review of Proposed Asset Allocation Policies

- We reviewed three alternative policy portfolios that conform with current restrictions, as well as three policy portfolios that would require changes to current investment restrictions.
- In the case of both the Unrestricted and Restricted Policies, we recommend that the Trustees consider reducing domestic equity exposure, while increasing developed foreign and emerging markets equity exposure. We also recommend considering the addition of dedicated Treasury Inflation-Protected Securities ("TIPS") exposure.
- In the case of Unrestricted Policy U-1, we added a target allocation to investment grade non-U.S. fixed income, in addition to the non-U.S. equity securities that we added to the Restricted Policies. The policy could be adopted with a change to existing statutes.
- In the case of Policies U-2 and U-3, we also added target allocations to below investment grade fixed income and to private market alternatives (i.e., private equity, real estate, and infrastructure) that would require a constitutional change.

Restricted Asset Allocation Policy Options<sup>1</sup>

	Current Policy (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)
<b>Equity</b>	<b>60</b>	<b>49</b>	<b>48</b>	<b>50</b>
U.S. Equity	60	37	27	24
Developed Foreign Equity	0	6	8	8
Emerging Market Equity	0	6	12	15
Frontier Market Equity	0	0	1	3
<b>Investment Grade Fixed Income</b>	<b>40</b>	<b>42</b>	<b>40</b>	<b>40</b>
Investment Grade Bonds	40	30	20	20
TIPS	0	12	20	20
<b>Real Assets (Public Equity)</b>	<b>0</b>	<b>9</b>	<b>12</b>	<b>10</b>
REITs	0	3	4	2
Natural Resources (public)	0	3	4	5
Infrastructure (public)	0	3	4	3
<i>Expected Return (%)</i>	<i>6.4</i>	<i>6.4</i>	<i>6.7</i>	<i>6.9</i>
<i>Standard Deviation (%)</i>	<i>11.0</i>	<i>10.2</i>	<i>10.8</i>	<i>11.2</i>
<i>Sharpe Ratio</i>	<i>0.58</i>	<i>0.63</i>	<i>0.62</i>	<i>0.61</i>
<i>Target Illiquid Assets (%)</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>Target Non-U.S. Assets (%)</i>	<i>0</i>	<i>12</i>	<i>21</i>	<i>26</i>

- Alternative policies R-1, R-2, and R-3 produce more efficient mean-variance outcomes than the current policy, largely due to the diversification benefits of investing outside the U.S.

<sup>1</sup> Expected return and standard deviation are based upon Meketa Investment Group's 2011 Annual Asset Study. Throughout this document, returns for periods longer than one year are annualized.

## Unrestricted Asset Allocation Policy Options

	Complies With Constitution		Requires Change to Constitution	
	Current Policy (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
<b>Equity</b>	<b>60</b>	<b>48</b>	<b>36</b>	<b>47</b>
U.S. Equity	60	21	12	16
Developed Foreign Equity	0	14	6	5
Emerging Market Equity	0	12	7	12
Frontier Market Equity	0	1	1	1
Private Equity	0	0	10	13
<b>Investment Grade Fixed Income</b>	<b>40</b>	<b>30</b>	<b>20</b>	<b>15</b>
Investment Grade Bonds	40	13	10	7
TIPS	0	17	10	8
<b>Credit</b>	<b>0</b>	<b>10</b>	<b>19</b>	<b>15</b>
High Yield	0	0	7	6
Bank Loans	0	0	3	2
Foreign Debt (Investment Grade)	0	10	1	0
Foreign/Emerging Market Debt (Below IG)	0	0	8	7
<b>Real Assets</b>	<b>0</b>	<b>12</b>	<b>25</b>	<b>23</b>
Core Real Estate	0	0	6	4
REITs	0	2	0.5	0.5
Value-Added Real Estate	0	0	2	2.5
Opportunistic Real Estate	0	0	2	2.5
Infrastructure (private)	0	0	4	3
Infrastructure (public)	0	5	0.5	0.5
Natural Resources (private)	0	0	4	5
Natural Resources (public)	0	5	2	1
Commodities	0	0	4	4
<i>Expected Return (%)</i>	<i>6.4</i>	<i>6.8</i>	<i>7.5</i>	<i>8.0</i>
<i>Standard Deviation (%)</i>	<i>11.0</i>	<i>11.0</i>	<i>11.0</i>	<i>12.7</i>
<i>Sharpe Ratio</i>	<i>0.58</i>	<i>0.62</i>	<i>0.68</i>	<i>0.63</i>
<i>Target Illiquid Assets (%)</i>	<i>0</i>	<i>0</i>	<i>28</i>	<i>30</i>
<i>Target Non-U.S. Assets (%)</i>	<i>0</i>	<i>37</i>	<i>23</i>	<i>25</i>

- The unrestricted policies meaningfully improve the mean-variance outcome for the Fund, as they take advantage of a variety of different (and illiquid, in the case of Policies U-2 and U-3) asset classes.

Peer Asset Allocation Target Comparison<sup>1</sup>

	Arizona (%)	New Mexico (%)	Texas (%)
U.S. Equity	60	31	28
Developed Foreign Equity	0	10	18
Emerging Market Equity	0	5	4
Hedge Funds	0	8	17
Private Equity	0	10	6
Fixed Income <sup>2</sup>	40	16	15
Real Estate	0	10	6
Commodities/Natural Resources	0	10	6
<i>Expected Return (%)</i>	6.4	7.6	7.3
<i>Standard Deviation (%)</i>	11.0	12.6	12.2
<i>Sharpe Ratio</i>	0.58	0.60	0.60
<i>Target Illiquid Assets (%)</i>	0	38	18
<i>Target Non-U.S. Assets (%)</i>	0	15	22

- Relative to similar vehicles in the states of New Mexico and Texas, the Arizona State Land Fund is invested more cautiously and across fewer asset classes.

<sup>1</sup> Peer targets are approximations based on available public data.

<sup>2</sup> Both New Mexico and Texas are allowed to invest in non-U.S. fixed income. New Mexico’s non-U.S. investments are limited to 15% of the portfolio, though there is a bill before the legislature to remove that requirement.

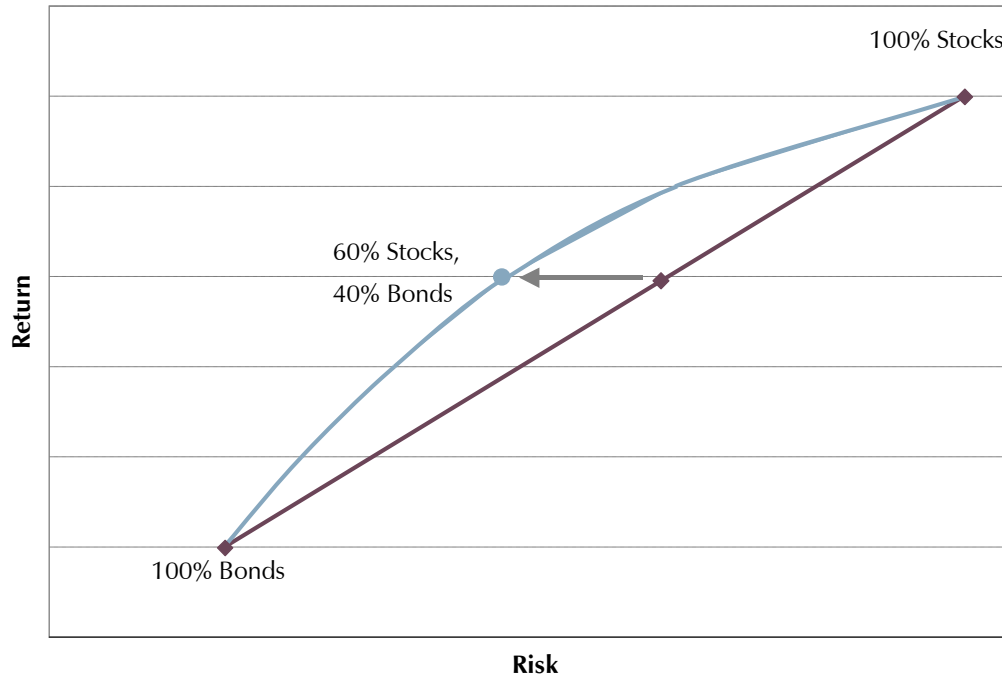
## **Risk/Return Analysis**

## Mean Variance Optimization

### Mean Variance Optimization

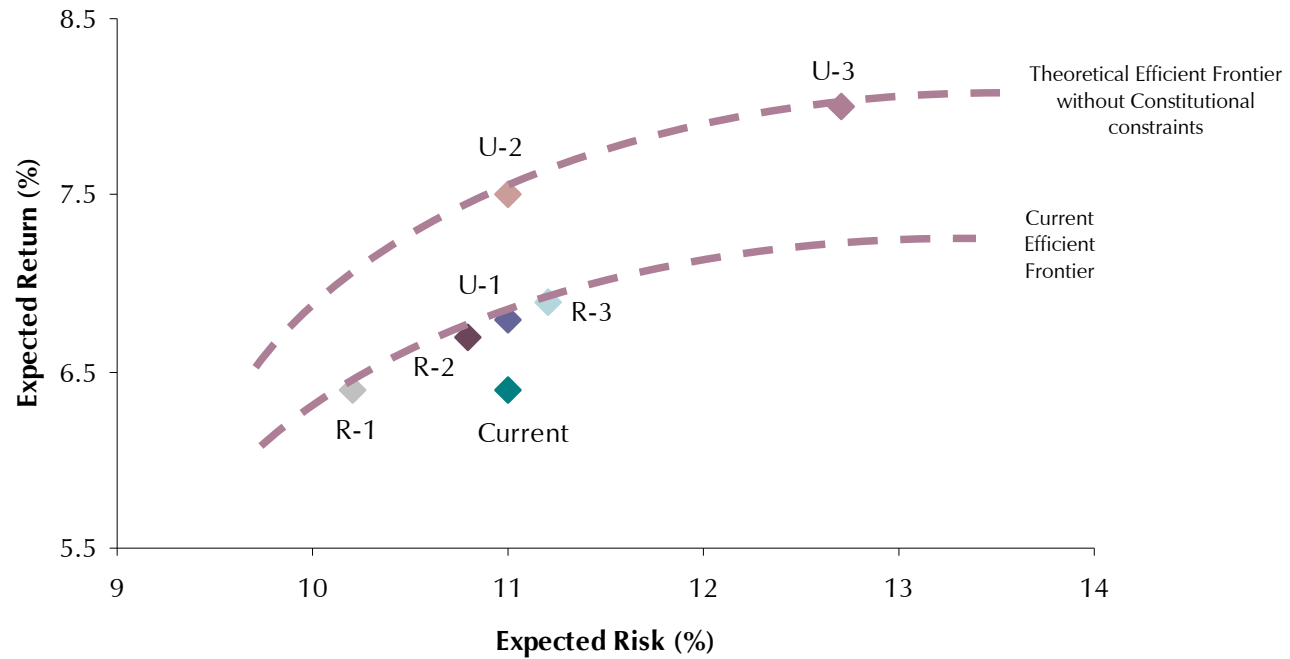
- Mathematically determines an “efficient frontier” of policy portfolios with the highest risk-adjusted returns.
- All asset classes exhibit only three characteristics, which serve as inputs to the model:
  - Expected return
  - Expected volatility
  - Expected co-variance with all other assets
- The model assumes:
  - Normal return distribution
  - Stable volatility and co-variances over time
  - Returns are not serially correlated
- The MVO Model tends to underestimate the risks of large negative events.

The Efficient Frontier



- Combining uncorrelated assets produces an “efficient frontier.” Different combinations of assets (e.g., 60% stocks & 40% bonds) will lie along this efficient frontier.
- By combining assets that are not highly correlated with each other, the Fund can produce a higher expected return for a given level of risk than it could by investing in perfectly correlated assets. Alternatively, it can experience lower risk for a given level of expected return.

Asset Allocation Policy Options



- Based on the MVO model inputs, each Restricted Policy (and Unrestricted Policy U-1) falls on an efficient frontier that expresses greater investment efficiency than current policy. The efficient frontier shifts upward (more efficient) for Policies U-2 and U-3, which include illiquid asset classes.<sup>1</sup>

<sup>1</sup> See the appendix for Meketa Investment Group’s MVO assumptions.

Asset Allocation Policy Options

	Current Policy (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
Expected Return (%)	6.4	6.4	6.7	6.9	6.8	7.5	8.0
Expected Standard Deviation (%)	11.0	10.2	10.8	11.2	11.0	11.0	12.7
Sharpe Ratio	0.58	0.63	0.62	0.61	0.62	0.68	0.63
<b>20-Year Projected Return (Percentiles)</b>							
95th	9.9	9.7	10.1	10.4	10.4	11.0	11.9
75th	7.5	7.5	7.8	8.0	7.9	8.6	9.1
50th	5.8	6.0	6.2	6.3	6.3	6.9	7.2
25th	4.2	4.4	4.6	4.6	4.6	5.3	5.4
5th	1.9	2.3	2.4	2.3	2.3	3.0	2.7

- Each asset allocation policy option expresses a distinct expected return and expected volatility, as shown in the efficient frontier on the previous page.
- While the "expected return" represents the "median" of all possible outcomes, we also show the 20-year projected return across the 95th, 75th, 50th, 25th, and 5th percentiles to emphasize that the range of potential returns varies widely.

**20-Year Opportunity Cost of the Current Allocation as Compared to Alternate Policies  
Based on \$3 Billion Beginning Value at Selected Percentile Returns<sup>1</sup>**

Ending Wealth Percentiles	Policy R-1 (\$ millions)	Policy R-2 (\$ millions)	Policy R-3 (\$ millions)	Policy U-1 (\$ millions)	Policy U-2 (\$ millions)	Policy U-3 (\$ millions)
95th Percentile (highest value)	-520	1,040	2,140	1,870	4,480	9,190
75th Percentile	60	810	1,250	1,180	2,910	4,710
50th Percentile	250	660	850	850	2,150	2,890
25th Percentile	330	530	570	610	1,580	1,720
5th Percentile (lowest value)	350	390	330	390	1,030	760

- The power of compounding makes small differences in average annual returns into large differences in end-of-period value.
- In the "median" expectation (50th percentile), each of the alternative policies would add between \$250 million and \$2.9 billion to the value of the Fund over 20 years (assuming no cash inflows or outflows).

<sup>1</sup> See the appendix for Meketa Investment Group's MVO assumptions. Ending market values assume no inflows to, or outflows from, the Fund.

## Deterministic Economic Scenario Analysis

- Where mean-variance optimization captures a probabilistic forecast of portfolio returns, deterministic economic scenario analysis allows one to look at “path dependent” scenarios. These scenarios can incorporate many of the real world risks that are often overlooked when using only traditional mean-variance optimization.
- With history as a guide, we have developed five realistic economic scenarios, ranging from very pessimistic to very optimistic.
  - Our methodology is strict but also allows some creativity in how we construct our twenty-year forecasts: essentially, we use history to model five-year sub-periods with different economic characteristics, then we string these periods together in a way that captures possible future scenarios.
  - At the same time, we ensure that the entire twenty-year history passes reasonability checks. We believe that this methodology allows us to be cognizant of historical relationships between assets and economic factors, while at the same time ensuring that we are not presenting a set of scenarios dominated by (possibly unrepeatable) periods in history.

**Deterministic Economic Scenario Analysis Summary**

- Over the next twenty years, the investment outcome of the State Land Fund will be more determined by the economic conditions that unfold than the asset allocation policy selected.

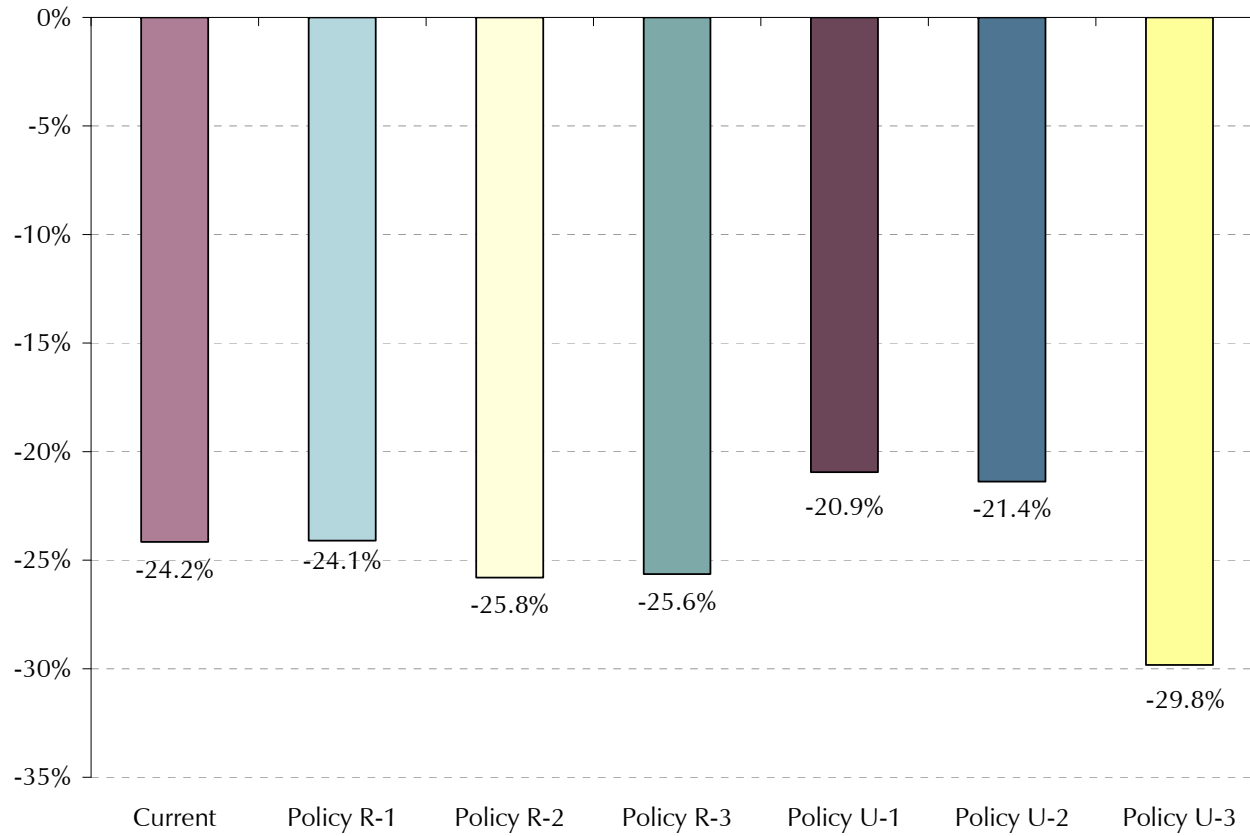
**Average Annual Return**

	Very Pessimistic (%)	Pessimistic (%)	Moderate (%)	Optimistic (%)	Very Optimistic (%)	Range (%)
Current Policy	3.2	4.7	6.8	8.8	10.9	7.7
R-1	3.6	5.3	7.2	8.7	10.5	6.9
R-2	3.9	5.7	7.6	8.9	10.4	6.6
R-3	3.9	5.5	7.4	8.5	10.0	6.1
U-1	4.1	5.9	7.7	8.7	10.1	6.0
U-2	2.4	6.0	7.6	9.2	11.6	9.2
U-3	2.2	5.9	7.9	9.5	12.1	9.9

- Policy U-1 has the narrowest range of outcomes across economic scenarios.

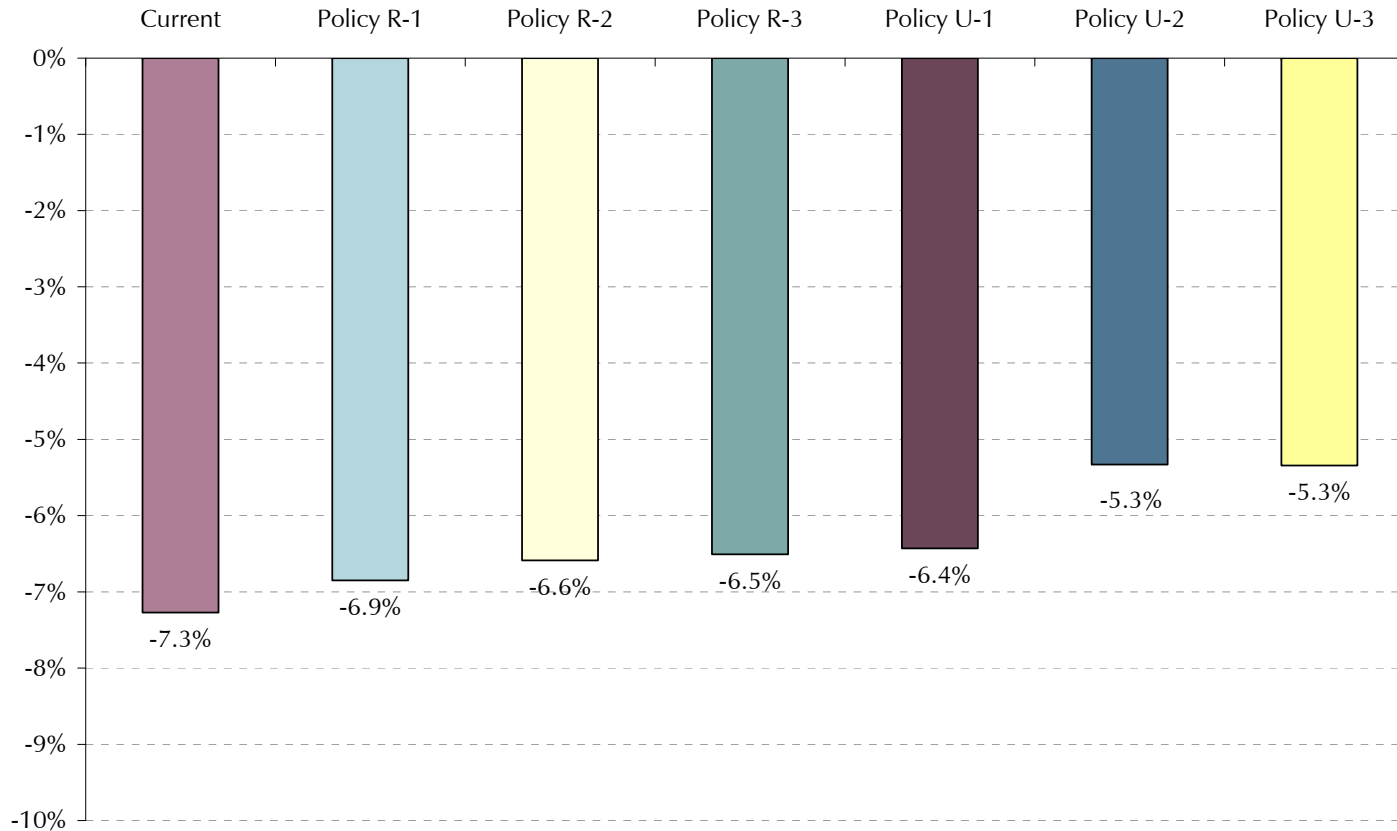
## Risk Analytics

**Historical Stress Test: Global Financial Crisis (4Q07 thru 1Q09)  
(Cumulative Return)**



- In an *extended down market* environment (e.g., the GFC), only Policy R-1 would produce a higher relative return than the current allocation.

**Historical Stress Test: Stagflation (January thru March 1980)**  
**(Cumulative Return)**



- In an environment of high inflation but low growth (e.g., early 1980), the alternative policies protect better than the current allocation, due to higher allocations to real assets and foreign assets.

**Stress Testing: Impact of Market Movements**  
Expected Returns<sup>1</sup>

What happens if (over a 12-month period):	Current Allocation (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
10-Year T-Bond rates rise 100 bp	5.9	7.3	8.6	8.1	9.0	8.6	9.8
10-Year T-Bond rates rise 200 bp	6.6	7.3	8.5	7.2	8.8	8.5	10.6
10-Year T-Bond rates rise 300 bp	-0.8	-0.6	-0.1	-3.3	-0.7	1.9	3.0
BBB Spreads widen by 100 bp, HY by 200 bp	3.6	4.2	4.9	5.1	4.7	4.2	4.5
BBB Spreads widen by 300 bp, HY by 1000 bp	-26.6	-23.0	-22.0	-21.6	-21.9	-23.4	-26.9
Trade-weighted US\$ gains 10%	5.3	3.8	2.7	2.3	0.6	1.4	0.9
Trade-weighted US\$ gains 20%	10.6	7.7	5.4	4.5	1.3	2.9	1.9
Equities decline 10%	-5.2	-5.1	-5.5	-5.0	-5.9	-5.6	-6.5
Equities decline 25%	-13.0	-12.8	-13.8	-12.5	-14.7	-14.0	-16.2
Equities decline 40%	-20.8	-20.4	-22.0	-19.9	-23.6	-22.0	-25.9

- Each policy portfolio has a different sensitivity to four major risk factors: interest rates, credit spreads, currency values, and equity values.
- The Fund’s primary risk factor would continue to be a decline in the equity markets, regardless of the policy.

<sup>1</sup> Assumes that assets not directly exposed to the factor are effected nonetheless. See the Appendix for further details.



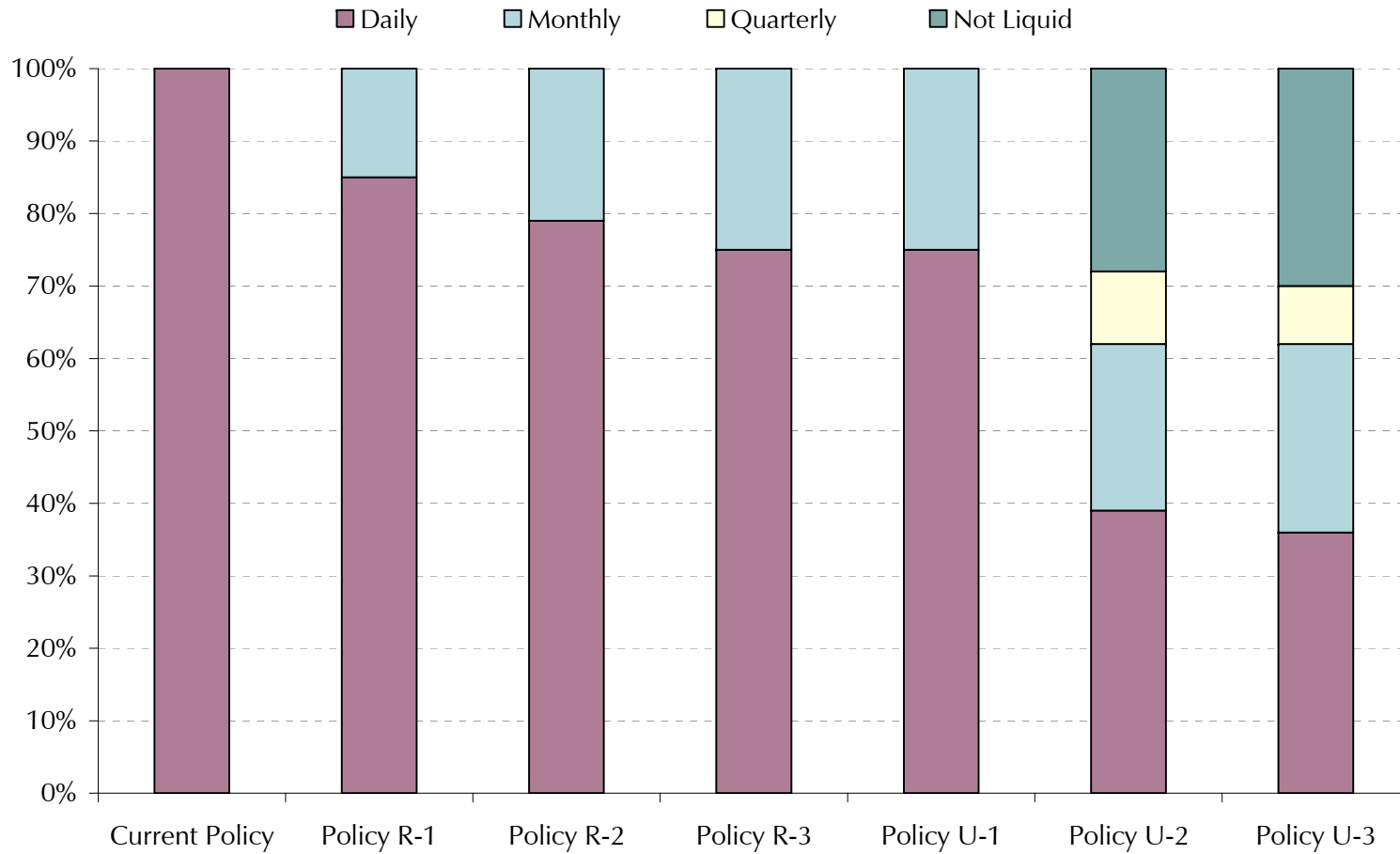
### Risk Analytics Summary

- Using mean-variance optimization, only the current allocation has a more than a 10% chance of producing a negative return over a five-year period. Over the 20-year period, the current allocation has the lowest probability of earning a 5% return.
- In most historical market scenarios, the alternative policies would outperform the current allocation. The exceptions are a stronger U.S. Dollar or a repeat of the 2008 Global Financial Crisis, when all assets suffered except for high quality bonds and cash.
- In each portfolio, equity risk dominates the risk profile of the portfolio, and the Fund's primary risk factor would continue to be a decline in the equity markets, though the alternative policies reduce equity risk somewhat.

## Liquidity Analysis

- Liquidity risk is a meaningful risk that is generally not captured in traditional asset allocation processes.
- The Fund should maintain adequate liquidity to avoid having to sell illiquid assets at distressed prices to satisfy any distribution needs.

Liquidity Profile



- Using strict liquidity assumptions, each policy portfolio except for Unrestricted Policies U-2 and U-3 has at least 75% daily liquid assets.

# **Analysis of Distribution Policy**

**Historical Distributions**  
**Arizona Permanent State Land Fund**



- Over the last 13 years, the State Land Fund’s distributions have averaged approximately \$40 million per year, with a high in 2012 near \$80 million and a low in 2010 of zero.

## Distribution Policy

### Current Policy

- The current annual distribution is the average total rate of return for the previous five fiscal years less the average of the annual percentage change in the GDP price deflator for the previous five fiscal years, multiplied by the average market value over the previous five years.

### Possible Alternative Policies

#### Alternative Distribution Policy A

- The Fund could modify the current return-oriented distribution policy to one that is based on a static proportion of the value of the corpus. A static proportion distribution would further smooth the annual distribution rate.
  - For example, 2.5% of the average five-year market value. This policy would result in a distribution of approximately \$67 million in 2012.

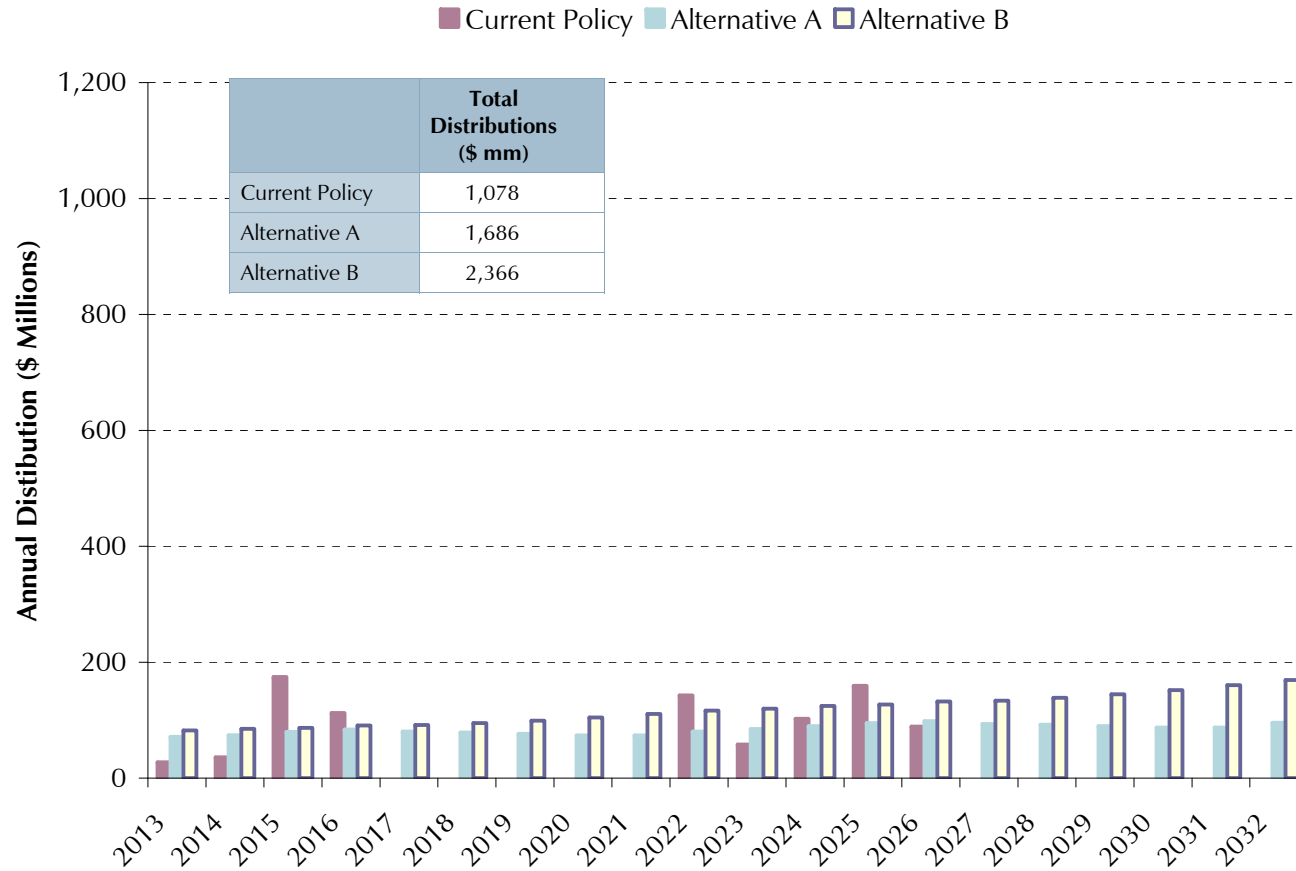
#### Alternative Distribution Policy B

- The Fund could set an absolute value as its distribution policy; i.e., a flat dollar amount. This policy would allow beneficiaries to plan on a more consistent distribution amount for budgeting purposes.
  - For example, \$80 million in 2012, increased by the GDP inflator each year.

## Peer Distribution Policies

- New Mexico State Investment Council Land Grant Permanent Fund: Annual Distributions are equal to 5% of the five-year average market value. As this rule is being phased in, the distribution will be 5.8% for fiscal years 2005 to 2012, 5.5% for fiscal years 2013 to 2016, and 5% thereafter.
- Texas Permanent School Fund: Distributions are determined by the State Board of Education based on the projected return of the current fiscal year, as well as the realized returns during the nine previous fiscal years. Any one-year distribution shall not exceed 6% of the average market value of the total fund.
- Utah School and Institutional Trust Lands: Interest and dividend income are distributed, while market gains remain in the fund. Each of twelve beneficiaries receives a specific percentage of total interest and dividend income.
- Wyoming Permanent Land Funds: A specific acreage of trust lands is assigned to each beneficiary, and the revenue generated from those lands is deposited into the corresponding fund. The state legislature can vote to distribute a portion of the Public School Permanent Land Fund each year.

Projected Future Distributions Under Very Pessimistic Case<sup>1</sup>

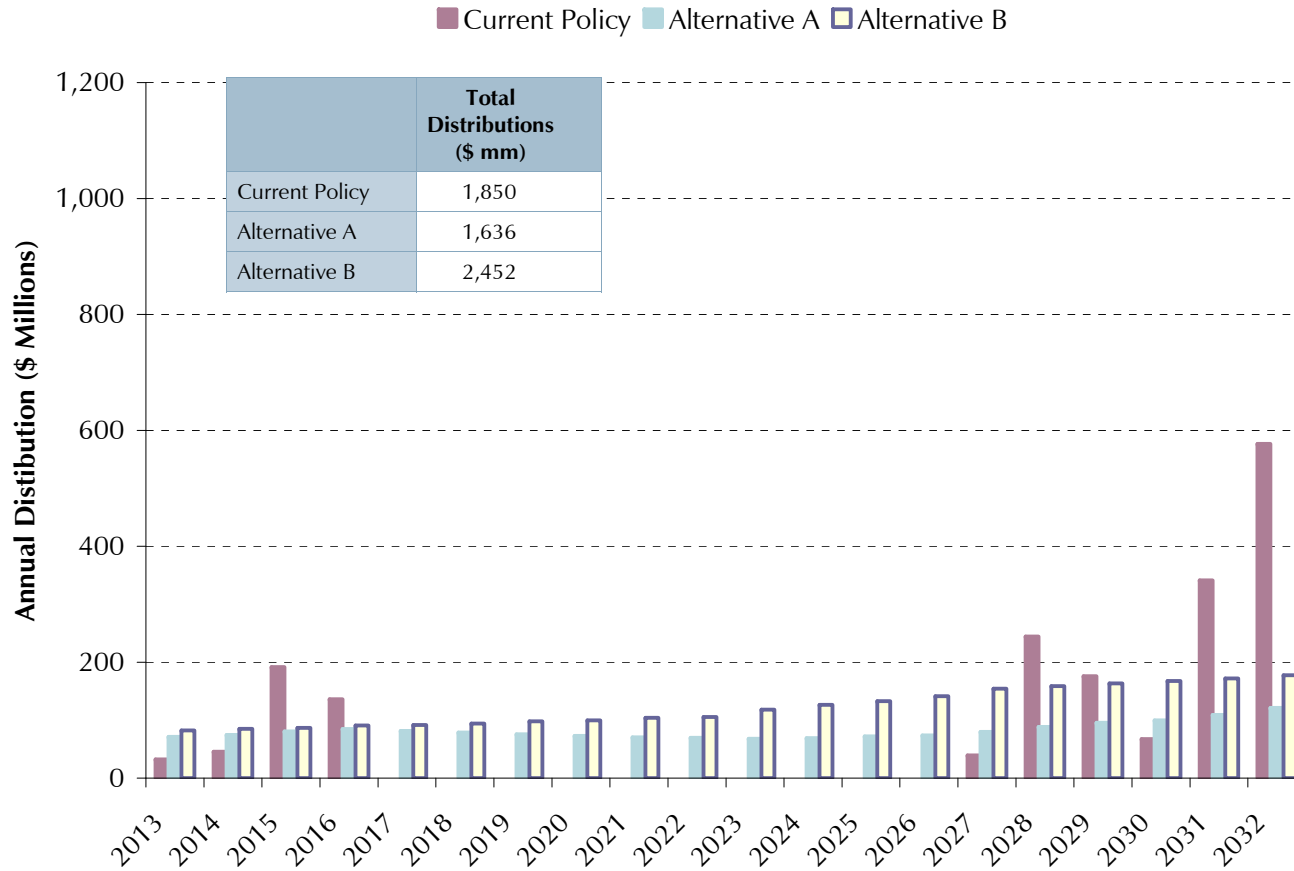


- Using the very pessimistic scenario, distributions under the Current Policy would vary from zero to nearly \$200 million during the twenty-year period.

<sup>1</sup> Actual data used for 2007-2011, and projected data used thereafter.



Projected Future Distributions Under Pessimistic Case<sup>1</sup>

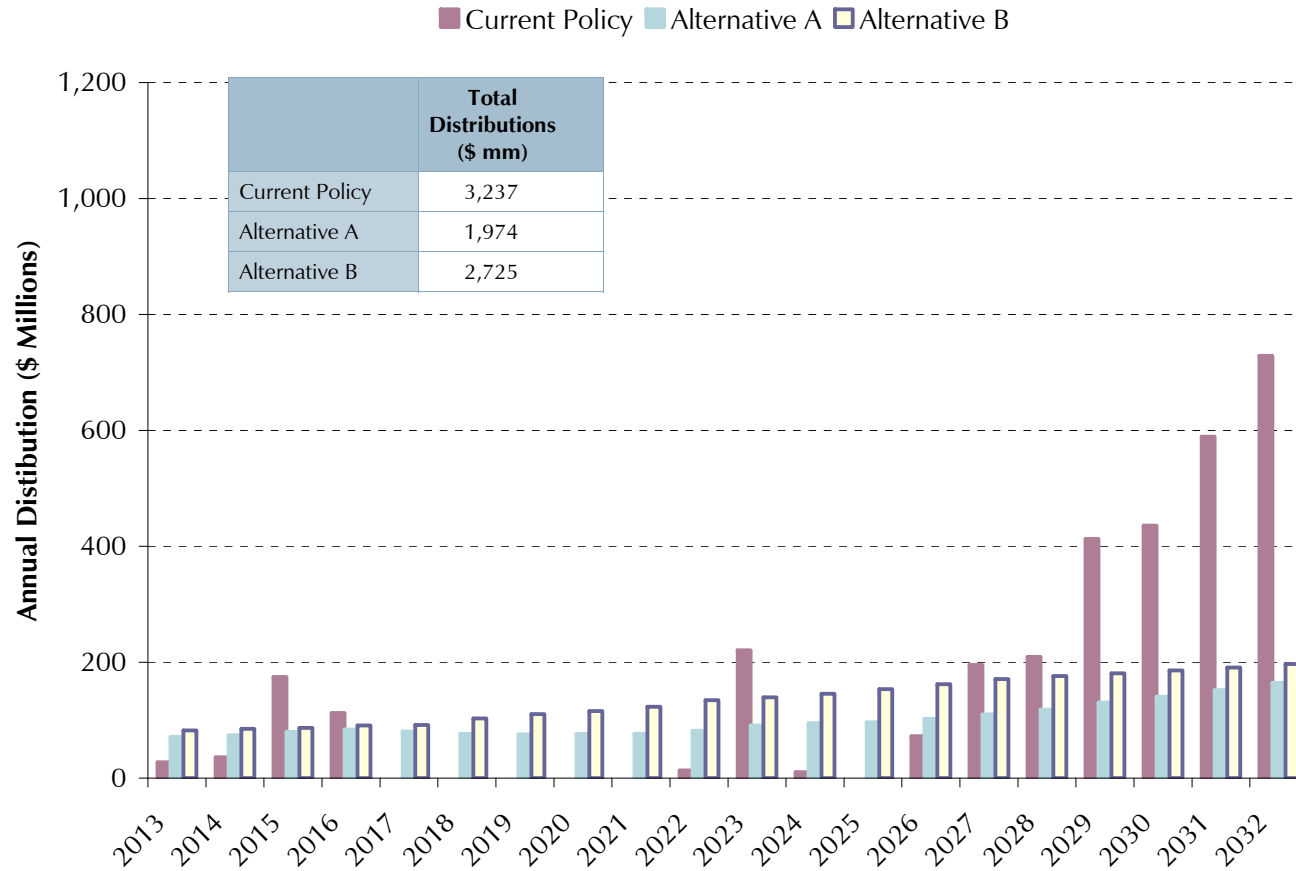


- Using the pessimistic scenario, distributions under the Current Policy would vary from zero to nearly \$600 million during the twenty-year period.

<sup>1</sup> Actual data used for 2007-2011, and projected data used thereafter.



Projected Future Distributions Under Moderate Case<sup>1</sup>

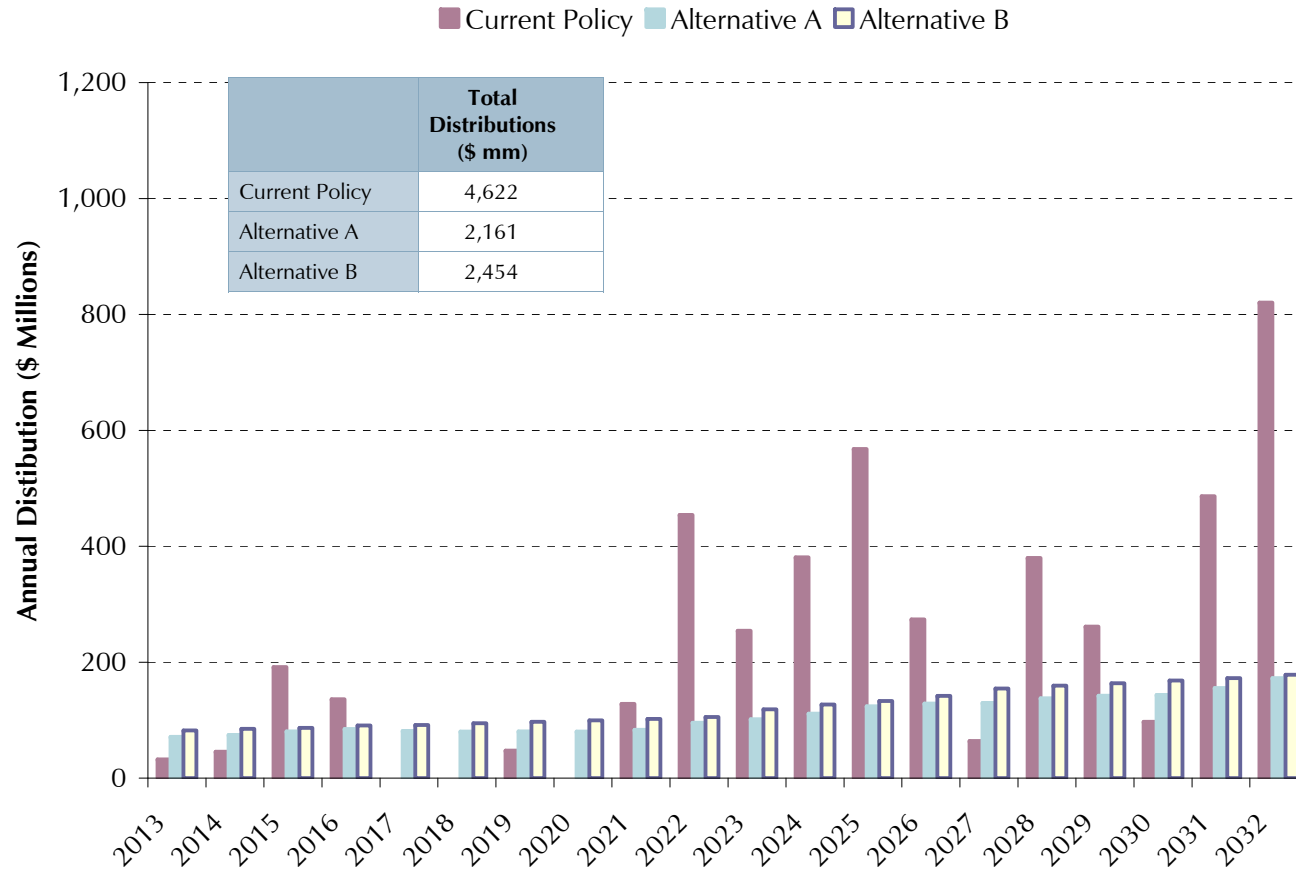


- Using the moderate scenario, distributions under the Current Policy would vary from zero to nearly \$800 million during the twenty-year period, and would total over \$1 billion more than the alternative policies.

<sup>1</sup> Actual data used for 2007-2011, and projected data used thereafter.



Projected Future Distributions Under Optimistic Case<sup>1</sup>

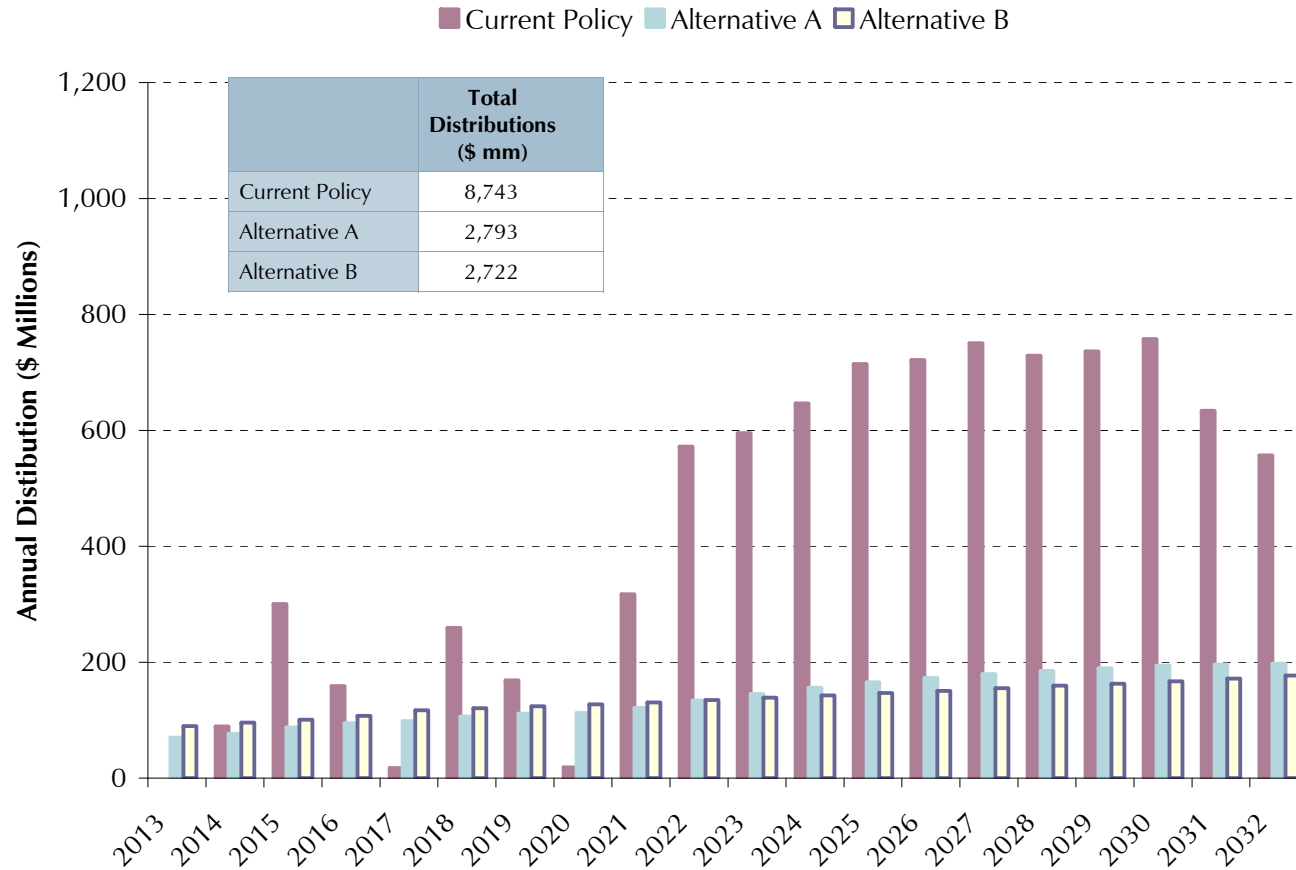


- Using the optimistic scenario, distributions under the Current Policy would vary from zero to over \$800 million during the twenty-year period, and would be nearly double those of the alternatives over the entire period.

<sup>1</sup> Actual data used for 2007-2011, and projected data used thereafter.



Projected Future Distributions Under Very Optimistic Case<sup>1</sup>



- Using the very optimistic scenario, distributions under the Current Policy would vary from zero to nearly \$800 million during the twenty-year period.

<sup>1</sup> Actual data used for 2007-2011, and projected data used thereafter.



**Projected Future Distribution Characteristics Under Each Economic Scenario, Using Current Distribution Policy**

<b>Very Pessimistic Scenario 20-Year Period</b>	<b>Current Policy</b>	<b>Policy R-1</b>	<b>Policy R-2</b>	<b>Policy R-3</b>	<b>Policy U-1</b>	<b>Policy U-2</b>	<b>Policy U-3</b>
Average Annual Distribution (\$ millions)	54	53	60	57	60	39	43
Standard Deviation of Distribution (\$ millions)	67.1	67.8	76.0	72.7	76.8	57.5	59.8
Range of Distribution (\$ millions)	175	184	212	206	217	208	211
Number of Years With No Distribution	10	10	10	10	7	10	10

<b>Pessimistic Scenario 20-Year Period</b>	<b>Current Policy</b>	<b>Policy R-1</b>	<b>Policy R-2</b>	<b>Policy R-3</b>	<b>Policy U-1</b>	<b>Policy U-2</b>	<b>Policy U-3</b>
Average Annual Distribution (\$ millions)	93	110	122	117	131	151	157
Standard Deviation of Distribution (\$ millions)	151.0	163.3	177.4	167.6	181.7	202.9	211.3
Range of Distribution (\$ millions)	577	581	609	565	577	595	622
Number of Years With No Distribution	10	10	10	10	9	10	10

<b>Moderate Scenario 20-Year Period</b>	<b>Current Policy</b>	<b>Policy R-1</b>	<b>Policy R-2</b>	<b>Policy R-3</b>	<b>Policy U-1</b>	<b>Policy U-2</b>	<b>Policy U-3</b>
Average Annual Distribution (\$ millions)	162	177	206	196	209	191	213
Standard Deviation of Distribution (\$ millions)	217.0	202.4	217.3	200.3	196.3	183.9	199.3
Range of Distribution (\$ millions)	728	667	667	611	600	649	692
Number of Years With No Distribution	6	5	5	5	5	5	5

## Projected Future Distribution Characteristics Under Each Economic Scenario (continued)

Optimistic Scenario 20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Distribution (\$ millions)	231	229	240	222	233	270	287
Standard Deviation of Distribution (\$ millions)	224.6	196.8	195.8	181.6	186.1	225.5	240.9
Range of Distribution (\$ millions)	820	753	758	698	689	767	824
Number of Years With No Distribution	3	2	1	1	1	2	2

Very Optimistic Scenario 20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Distribution (\$ millions)	437	401	399	367	371	469	509
Standard Deviation of Distribution (\$ millions)	285.7	239.8	228.9	208.8	198.7	241.5	263.9
Range of Distribution (\$ millions)	757	670	649	594	589	763	828
Number of Years With No Distribution	1	1	1	1	1	1	1

- Under the current distribution policy, there is little difference in the size or variability of distributions as a result of the asset allocation policy selected.

## **Analysis of Fiscal Year Change**

**Fiscal Year Analysis<sup>1</sup>**  
**50% Equity/50% Bond Allocation since 1926**

<b>Fiscal Year Ending</b>	<b>Average Annual Return (%)</b>	<b>Standard Deviation of Annual Return (%)</b>	<b>Maximum Annual Return (%)</b>	<b>Minimum Annual Return (%)</b>
March 31	8.6	12.8	45.3	-30.0
June 30	8.5	13.7	77.2	-40.9
September 30	8.3	10.7	30.9	-23.2
December 31	8.3	10.7	28.7	-23.7

- Historically, a fiscal year of June 30 has proved to be the most volatile end point of the four calendar quarters.

<sup>1</sup> Equity returns reflect the S&P 500 Index, while bond returns reflect the intermediate government bond yield from 1926 to 1976, and the Barclays Aggregate Index return thereafter, rebalanced monthly.



## Conclusions

- The Trustees should assess the current risk profile of the Fund and reconfirm, or modify, the asset allocation policy based on their determination of the appropriate level of risk.
- The Trustees should consider diversifying the Fund into additional asset classes to benefit from modest improvement to the Fund's long term risk/return profile.
  - Shifting a modest amount of the Fund's U.S. equity exposure to non-U.S. equities moderately improved the Fund's investment efficiency.
- The Trustees should evaluate the pros/cons of lifting some of the current restrictions on the investment of the Fund. The unconstrained policies tend to exhibit stronger risk/return attributes.
  - A change in statutory restrictions would allow the Fund to diversify into non-U.S. debt investments, slightly improving the Fund's investment efficiency.
  - A change in the state Constitution would be required to allow private market strategies, below investment grade debt investments, and commodities.
- The Trustees should consider modifying the distribution policy, if more stable and predictable distributions over time are an objective of the Fund.

## Appendices

## Detail of Deterministic Scenario Analysis

### Scenario A – Very Pessimistic Case

#### Economic Conditions

- The economy suffers from a major recessions intermittently throughout the twenty-year period. Unemployment becomes a major economic concern, reaching double-digit levels for multiple years. Unemployment averages 7.4% during the period.
- Inflation is at its peak in the period's early years, and remains relatively low. The U.S. dollar declines in value by 3.1%.

#### Asset Class Returns

- Bonds produce a relatively attractive return during the period, with Treasuries and corporates outperforming the U.S. equity market over the entire period.
- Equity markets are volatile throughout the period, and produce an average annual return of only 2.6%, less than the rate of inflation. Twice during the period, in 2016 and 2026, domestic equities fall by nearly 40%. Developed and emerging market foreign stocks perform poorly as well.

**Scenario A – Very Pessimistic Case**

20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Return (%)	3.2	3.6	3.9	3.9	4.1	2.4	2.2
Standard Deviation (%)	11.8	10.7	11.2	10.7	10.9	11.2	12.5
Maximum Drawdown (%)	-24.5	-22.6	-24.0	-23.3	-23.6	-26.2	-30.3
Ending Period Value (\$ millions) <sup>1</sup>	5,607	6,089	6,480	6,450	6,721	4,866	4,648

- In a very pessimistic scenario, the more conservative policies outperform the riskier policies.

<sup>1</sup> Assumes no cash inflows into, or out of, the Fund.



## Scenario B – Pessimistic Case

### Economic Conditions

- Weak and inconsistent economic growth characterizes the period. A prolonged recession occurs in 2021-2023, followed by a recovery. Domestic unemployment remains an economic problem throughout the period, averaging 6.4%.
- Inflation peaks around 12% in 2022, during the recession. Long-term Treasury yields are low at the beginning of the time period, then increase after the recession and remain high until the end of the period.

### Asset Class Returns

- Bond returns vary considerably during the period. As yields rise in the second half of the period, bonds produce a healthy return.
- Equities produce a negative return in 2016, and again in 2021-2022 during the recession. They experience a “bull run” from 2027-2031.

**Scenario B – Pessimistic Case**

20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Return (%)	4.7	5.3	5.7	5.5	5.9	6.0	5.9
Standard Deviation (%)	13.3	11.9	11.9	11.3	11.6	13.5	14.8
Maximum Drawdown (%)	-23.7	-20.7	-20.9	-20.2	-20.5	-24.0	-27.2
Ending Period Value (\$ millions) <sup>1</sup>	7,557	8,497	9,006	8,803	9,391	9,544	9,474

- In a pessimistic scenario, the current policy underperforms the alternative policies.

<sup>1</sup> Assumes no cash inflows to, or outflows from, the Fund.



### Scenario C – Moderate Case

#### Economic Conditions

- Overall, GDP grows at a normal rate, with frequent but shallow economic cycles. Unemployment is held largely in check, peaking around 8% during cyclical downturns.
- Inflation is high (10%) at the beginning of the time period, then moderates after that. Long-term Treasury yields move within a range of 3% to 9%.

#### Asset Class Returns

- Bond returns reflect the moderate interest rate environment. Negative returns occur only during a few periods of economic stress.
- Equities exhibit normal levels of volatility and produce an average annual return of about 8%. A “bear market” afflicts equity investors in 2016-2017.

Scenario C – Moderate Case

20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Return (%)	6.8	7.2	7.6	7.4	7.7	7.6	7.9
Standard Deviation (%)	11.9	10.5	10.6	10.0	10.2	11.5	12.6
Maximum Drawdown (%)	-24.5	-22.4	-23.6	-22.8	-23.2	-16.0	-29.8
Ending Period Value (\$ millions) <sup>1</sup>	11,286	12,058	12,927	12,498	13,190	13,002	13,716

- In a moderate case, Policy U-3 has the highest ending value, approximately \$2.5 billion more than the Current Policy.

<sup>1</sup> Assumes no cash inflows to, or outflows from, the Fund.



## Scenario D – Optimistic Case

### Economic Conditions

- Economic growth is strong and persistent, interrupted only by a short recession in 2016. Unemployment is regularly maintained at or below the 6% level.
- Inflation is generally low and controlled, except for one high inflation year in 2022. Strong economic growth prevents long-term interest rates from going too low.

### Asset Class Returns

- Bond returns reflect the low and controlled inflation environment, averaging over 6% for both Treasuries and corporates.
- The strong economy drives equity markets both in the U.S. and overseas. Over the entire period, U.S. stocks produce an average return of 9.8% per year, outpacing inflation, while private equity returns are very high. Foreign emerging equities outpace foreign developed equities.

**Scenario D – Optimistic Case**

20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Return (%)	8.8	8.7	8.9	8.5	8.7	9.2	9.5
Standard Deviation (%)	12.0	10.6	10.6	10.1	10.2	11.3	12.4
Maximum Drawdown (%)	-23.7	-21.6	-22.8	-22.0	-22.4	-25.2	-29.0
Ending Period Value (\$ millions) <sup>1</sup>	16,190	15,909	16,388	15,362	15,804	17,427	18,350

- In the optimistic scenario, all policies perform very well.

<sup>1</sup> Assumes no cash inflows to, or outflows from, the Fund.



## Scenario E – Very Optimistic Case

### Economic Conditions

- The global economy enters a period of enhanced productivity and economic growth, very much like that experienced by America in the 1950s and 1960s. U.S. real GDP grows at an average rate of 3.5%. After recovering from the current environment, the economy spends most of its time at or beyond what is now typically termed “full employment.” The unemployment rate averages 5.3%.
- After a couple of high years in 2012 and 2016, inflation is controlled throughout the period. Treasury yields are stable, reflecting low inflation and a stable economy.

### Asset Class Returns

- Bond returns are strong, with Treasuries averaging 6.8% and corporate bonds averaging 8.9%.
- Equities produce a superb “real” return, as the economy’s increased productivity results in high earnings growth for corporate America. For the entire period, U.S. stocks return 13.7% per year. Riskier market segments of the equity markets (private equity, high yield bonds, real estate, and emerging market equities) perform impressively as well.

Scenario E – Very Optimistic Case

20-Year Period	Current Policy	Policy R-1	Policy R-2	Policy R-3	Policy U-1	Policy U-2	Policy U-3
Average Annual Return (%)	10.9	10.5	10.4	10.0	10.1	11.6	12.1
Standard Deviation (%)	8.6	7.2	6.7	6.2	6.3	7.2	7.6
Maximum Drawdown (%)	-4.4	-5.6	-5.9	-5.2	-5.4	-6.7	-8.5
Ending Period Value (\$ millions) <sup>1</sup>	23,862	22,044	21,833	20,109	20,542	26,832	29,208

- In the very optimistic scenario, the least constrained asset allocation policy performs best.

<sup>1</sup> Assumes no cash inflows into, or out of, the Fund.



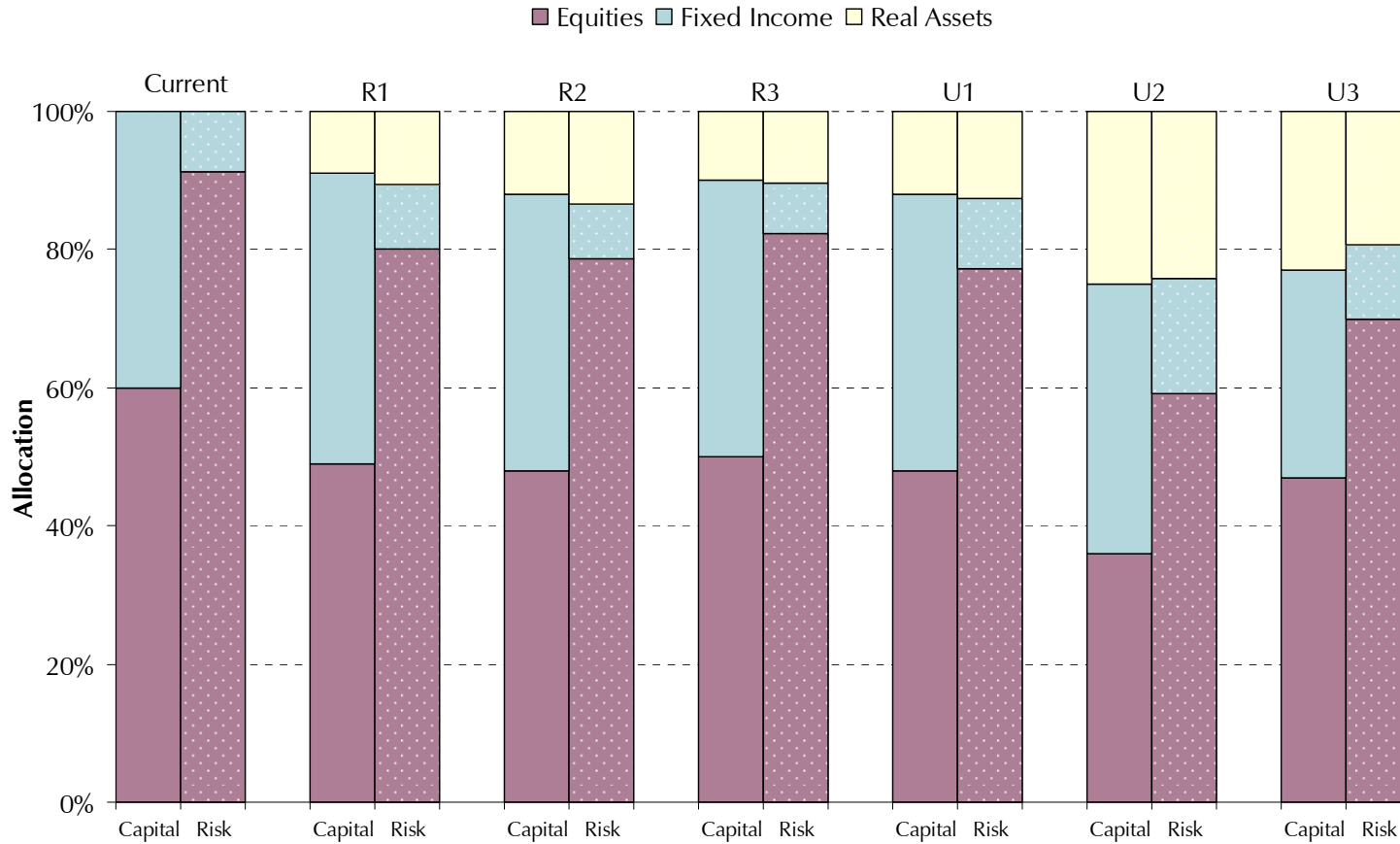
## Additional Risk Analytics

### Types of Risk Analysis Addressed

- Risk budgeting<sup>1</sup>
  - Attributes overall portfolio risks to specific asset classes
  - Highlights the source and scale of portfolio-level risk
- MVO-based risk analytics
  - Includes worst-case return expectations
  - Relies on assumptions underlying MVO
- Stress Testing
  - Stress tests policy portfolios using actual historical examples
  - Stress tests policy portfolios under specific hypothetical scenarios

<sup>1</sup> Risk budgeting seeks to decompose the aggregate risk of a portfolio into different sources (in this case, by asset class), with risk defined as standard deviation.

**Risk Budgeting Analysis<sup>1</sup>**  
Capital Allocation vs. Risk Allocation

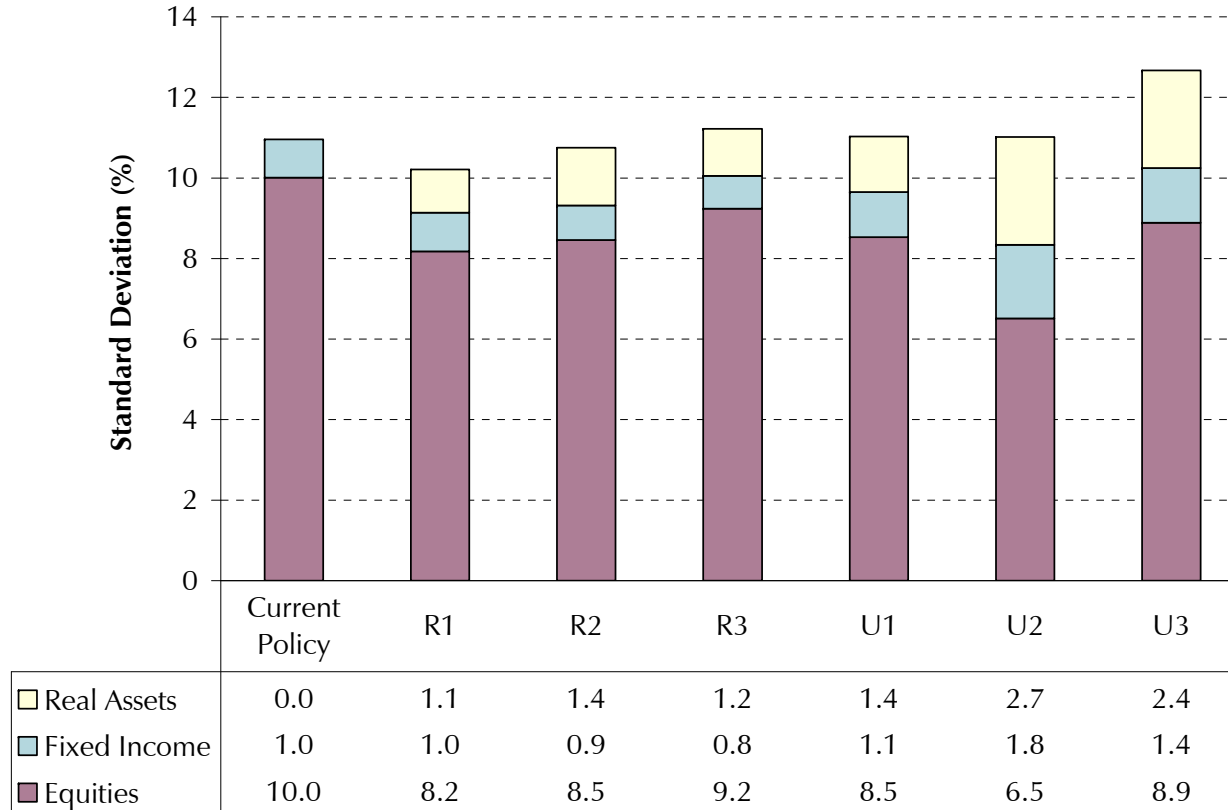


- Assets with low relative volatility, such as fixed income, contribute less to risk than their asset weights imply.

<sup>1</sup> Risk allocation is calculated by multiplying the weight of the asset class by its standard deviation and its correlation with the total portfolio and then dividing this by the standard deviation of the total portfolio.



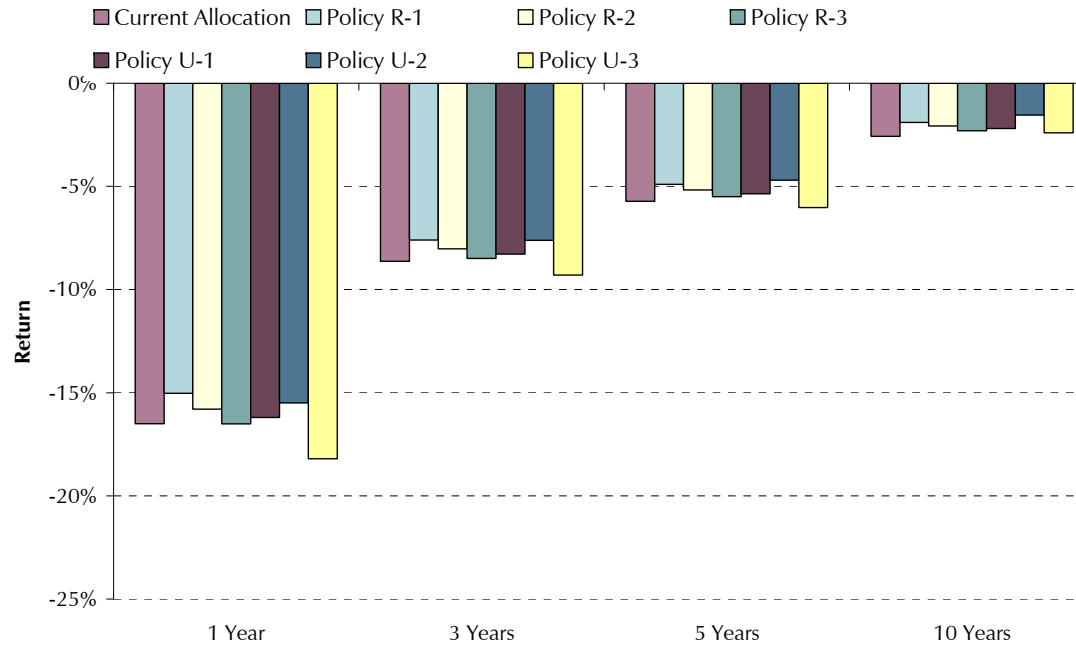
**Risk Budgeting Analysis<sup>1</sup>**  
Absolute Contribution to Risk



- In each policy option, equity risk dominates the risk profile of the portfolio, though the alternative policies reduce equity risk somewhat.

<sup>1</sup> Contribution to risk is calculated by multiplying the weight of the asset class by its standard deviation and its correlation with the total portfolio.

**“Worst Case” Return Projections<sup>1</sup>**



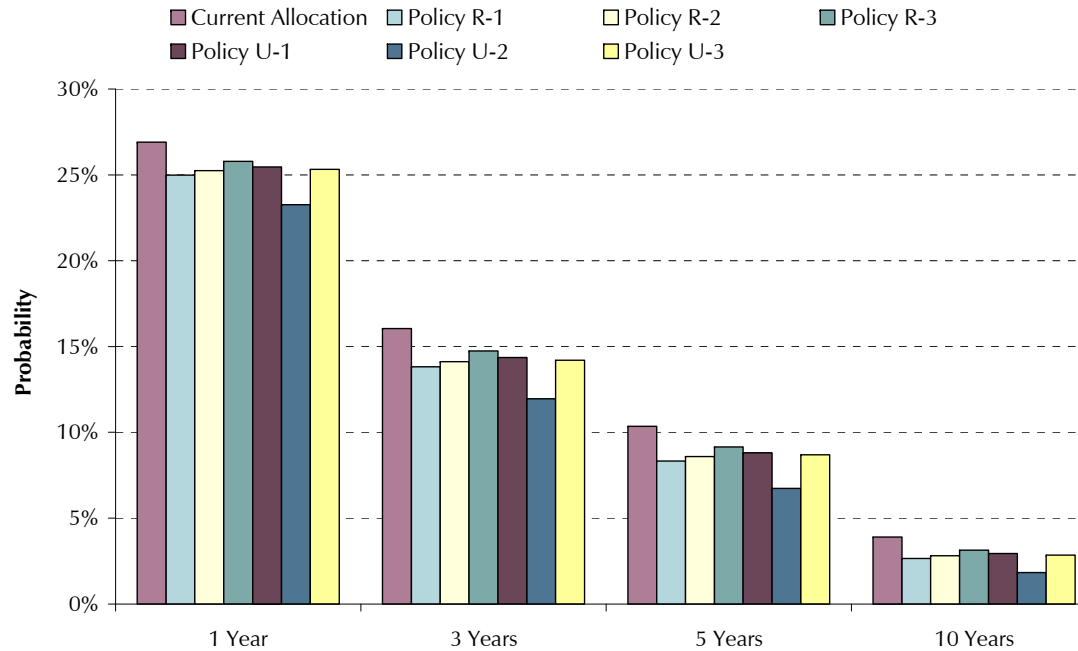
	Current Allocation (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
One Year	-16.5	-15.0	-15.8	-16.5	-16.2	-15.5	-18.2
Three Years	-8.6	-7.6	-8.0	-8.5	-8.3	-7.6	-9.3
Five Years	-5.7	-4.9	-5.2	-5.5	-5.4	-4.7	-6.0
Ten Years	-2.6	-1.9	-2.1	-2.3	-2.2	-1.5	-2.4

- Policies R-1 and U-2 best defend the portfolio in a “worst case” scenario, as defined by MVO model assumptions.

<sup>1</sup> “Worst Case” Return Projections encompass >99% of possible outcomes.



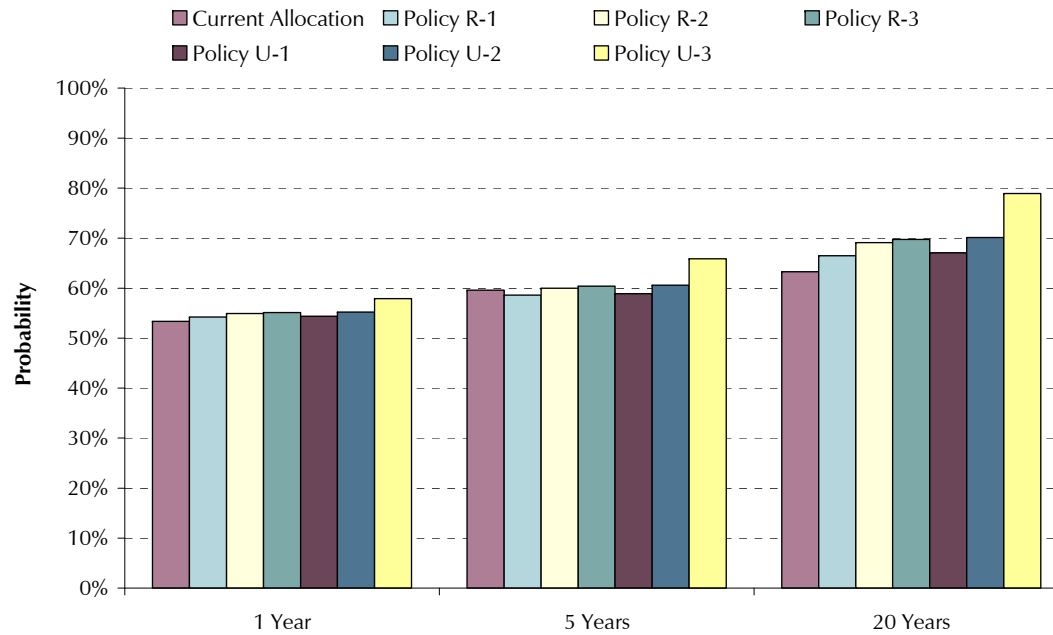
Probability of Experiencing Negative Returns



	Current Allocation (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
One Year	26.9	25.0	25.3	25.8	25.5	23.3	25.3
Three Years	16.1	13.8	14.1	14.7	14.4	12.0	14.2
Five Years	10.4	8.3	8.6	9.2	8.8	6.7	8.7
Ten Years	3.9	2.7	2.8	3.1	2.9	1.8	2.9

- Only the current allocation has a more than a 10% chance of producing a negative return over a five-year period.

**Probability of Achieving a 5% Annualized Return<sup>1</sup>**



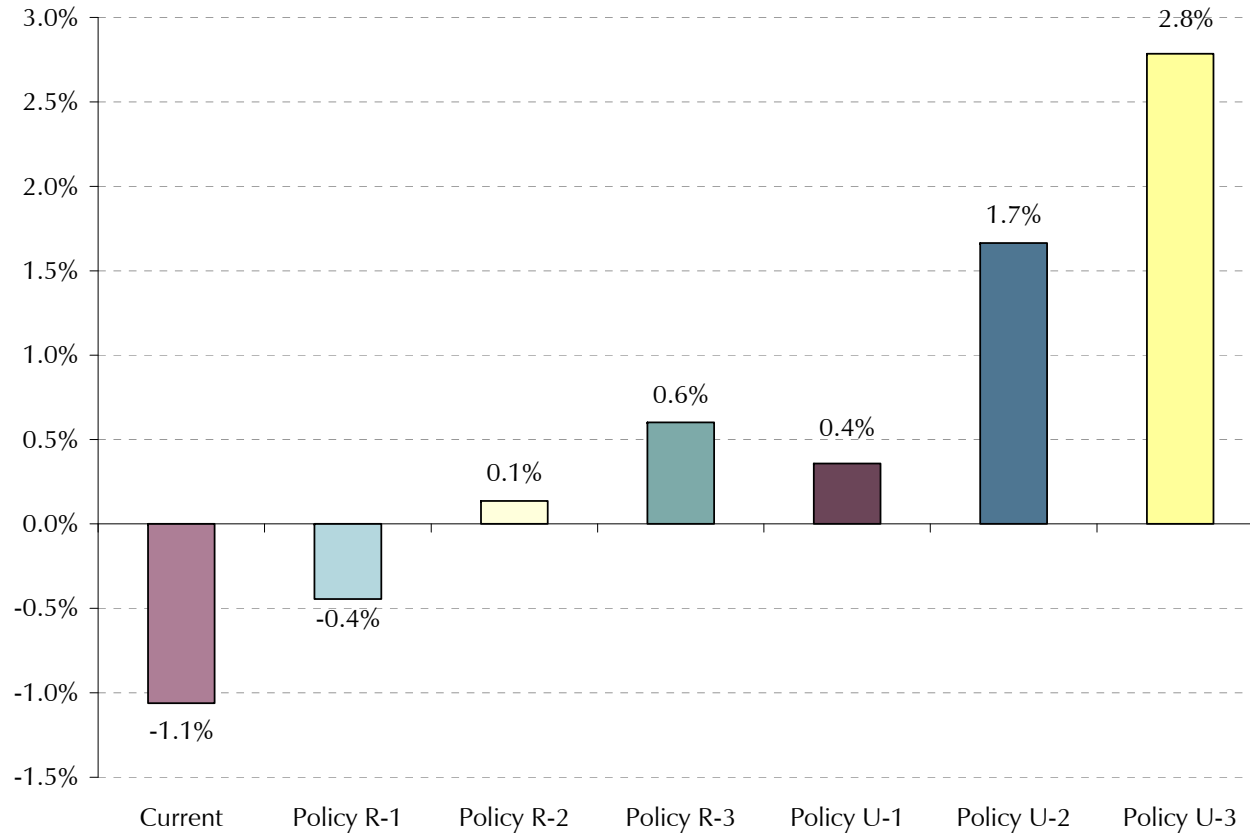
	Current Allocation (%)	Policy R-1 (%)	Policy R-2 (%)	Policy R-3 (%)	Policy U-1 (%)	Policy U-2 (%)	Policy U-3 (%)
One Year	53.4	54.2	54.9	55.1	55.2	57.8	57.9
Five Years	55.4	56.8	57.9	58.2	58.3	62.4	62.6
Ten Years	56.9	58.6	60.0	60.4	60.6	66.9	65.9
Twenty Years	63.3	66.5	69.1	69.8	70.1	78.5	78.9

- Policy U-3 has the highest likelihood of producing a 5% annualized return over all time periods.

<sup>1</sup> Represents the probability of achieving a 5% return over the specified time horizon.

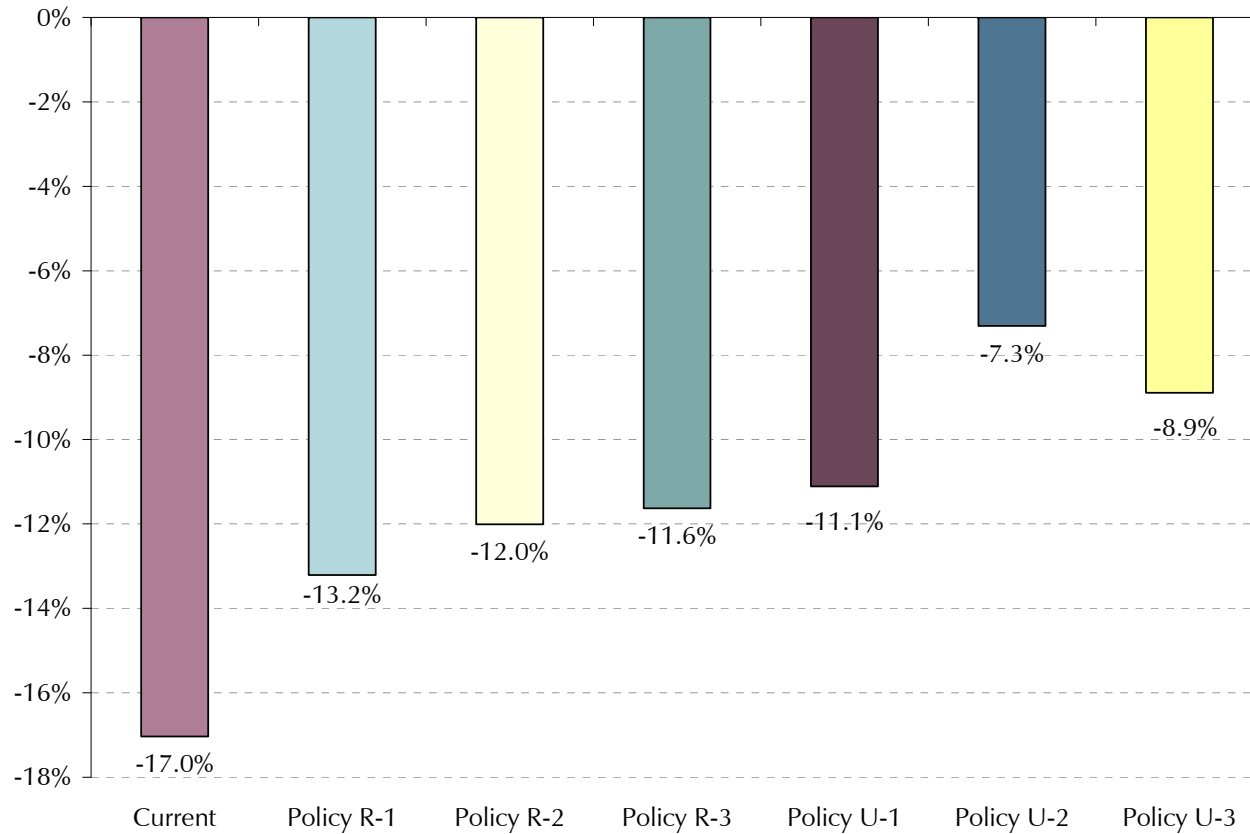


**Historical Stress Test: Interest Rate Spike (1994)  
(Cumulative Return)**



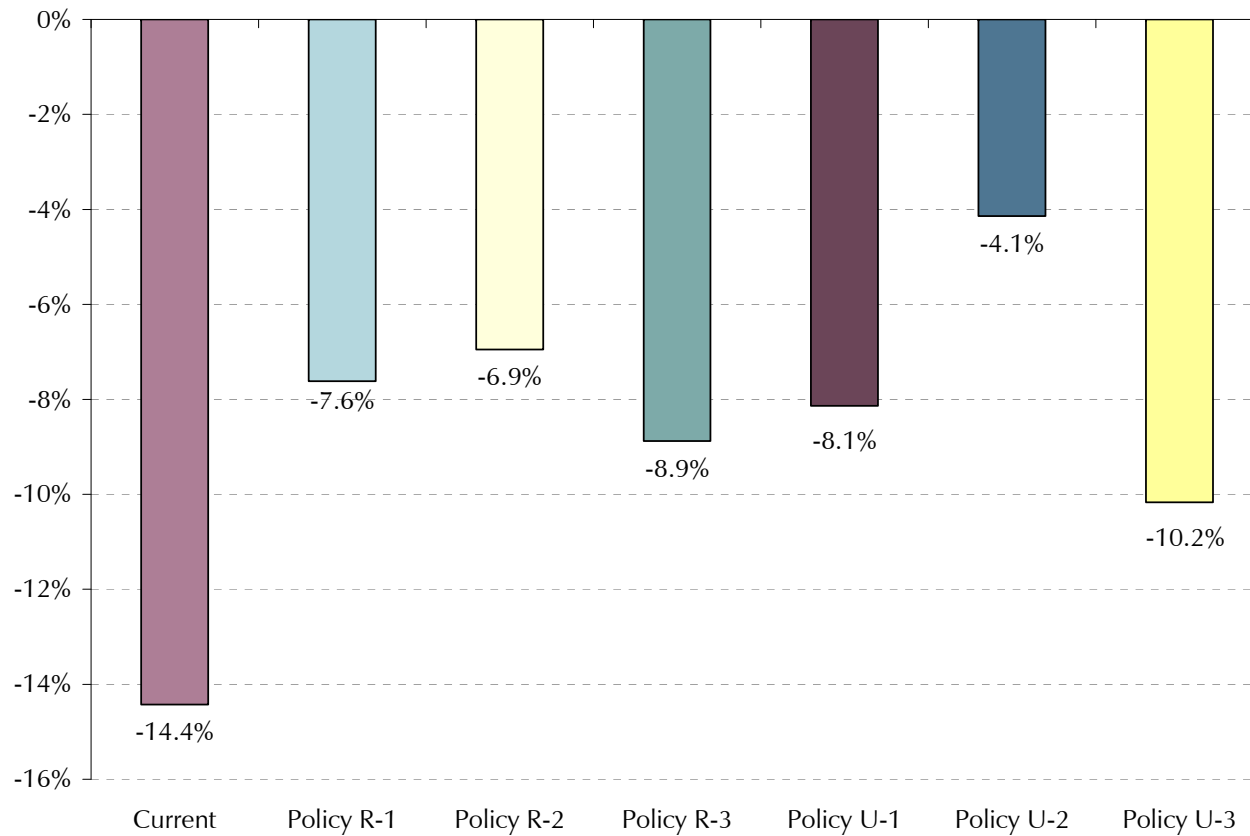
- In a period of rising interest rates (e.g., 1994), Policy U-3 produces the highest return, as it has the lowest allocation to investment grade bonds and the highest allocation to private equity.

**Historical Stress Test: Crash of 1987 (September thru November 1987)  
(Cumulative Return)**



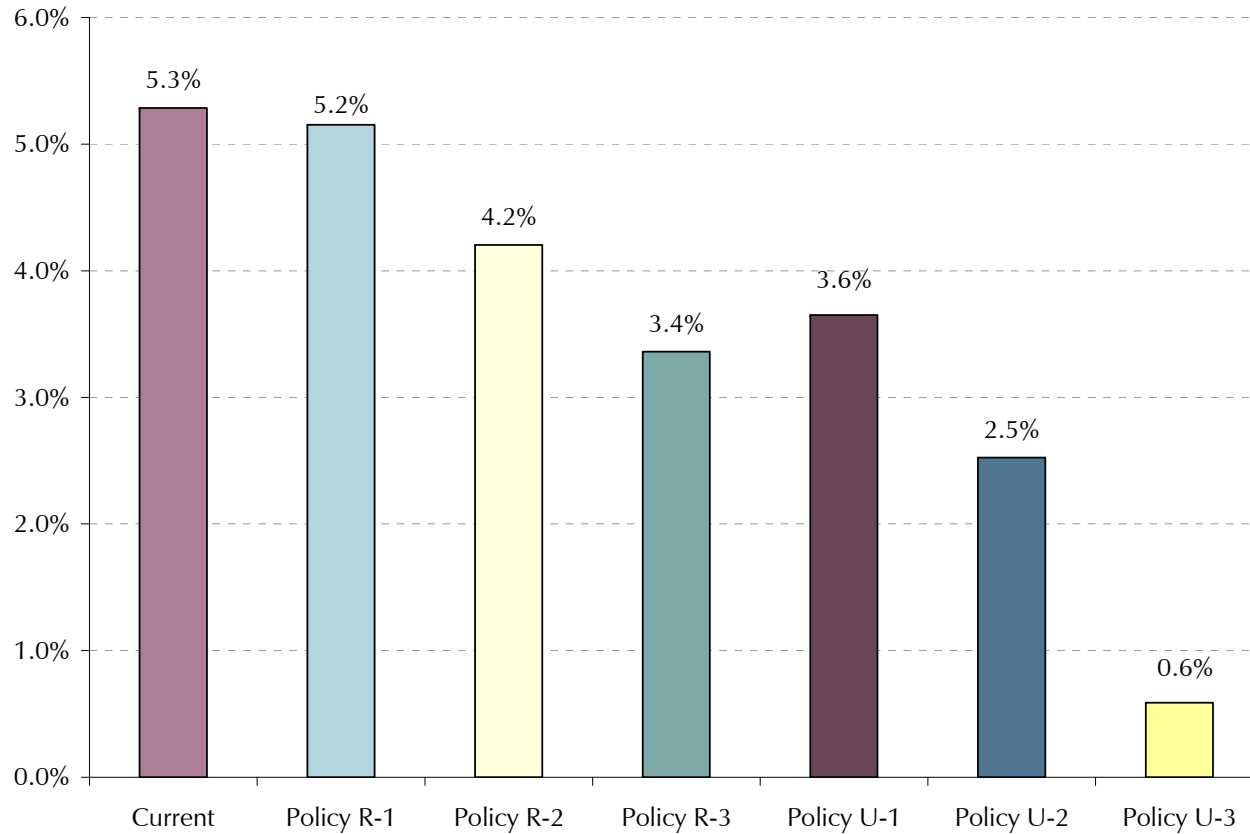
- In a *down market* environment that differs from 2008 (e.g., the Crash of '87), the alternative policies would produce higher returns relative to the current allocation.

**Historical Stress Test: Bursting of the dot.com Bubble (2Q00 thru 3Q02)**  
**(Cumulative Return)**



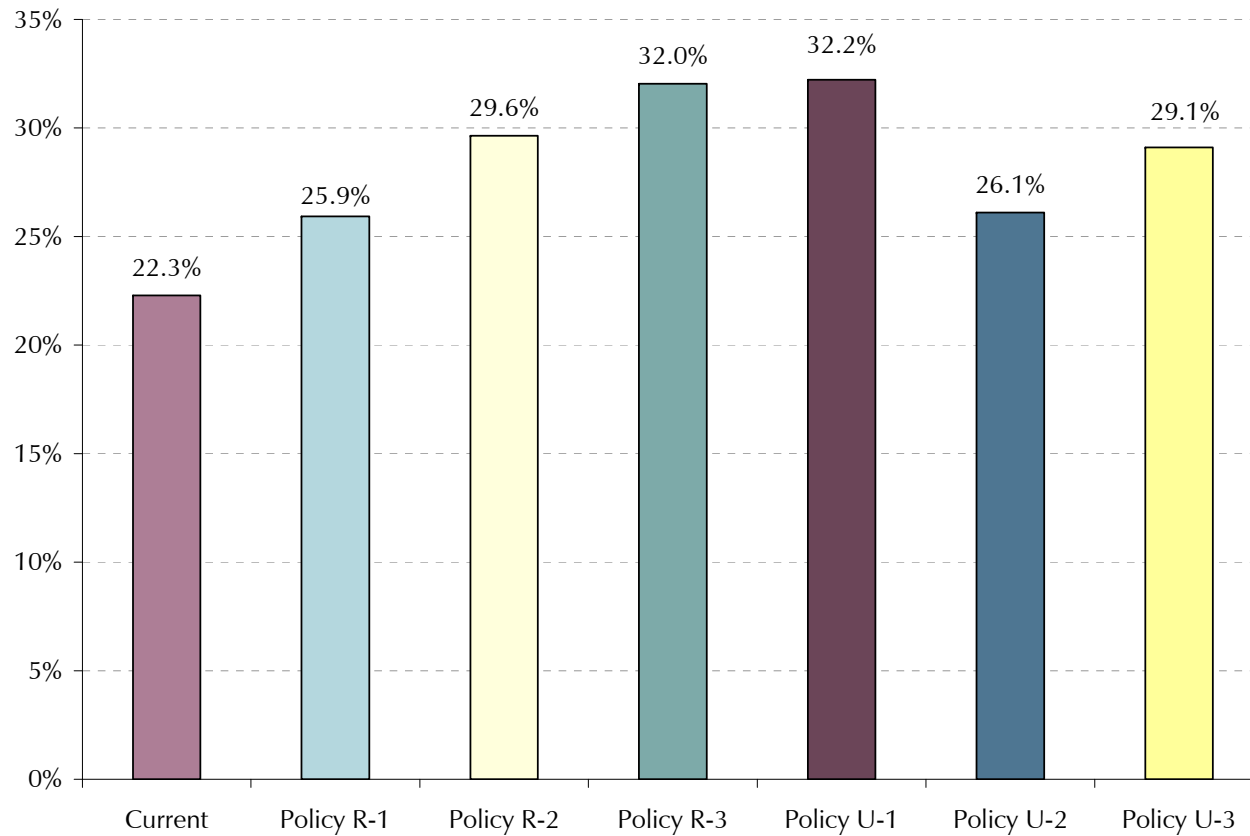
- In another *down market* environment that differs from 2008 (e.g., the bursting of the dot.com bubble), the alternative policies produce higher returns relative to the current allocation.

**Historical Stress Test: Strong US Dollar (1Q81 through 3Q82)  
(Cumulative Return)**



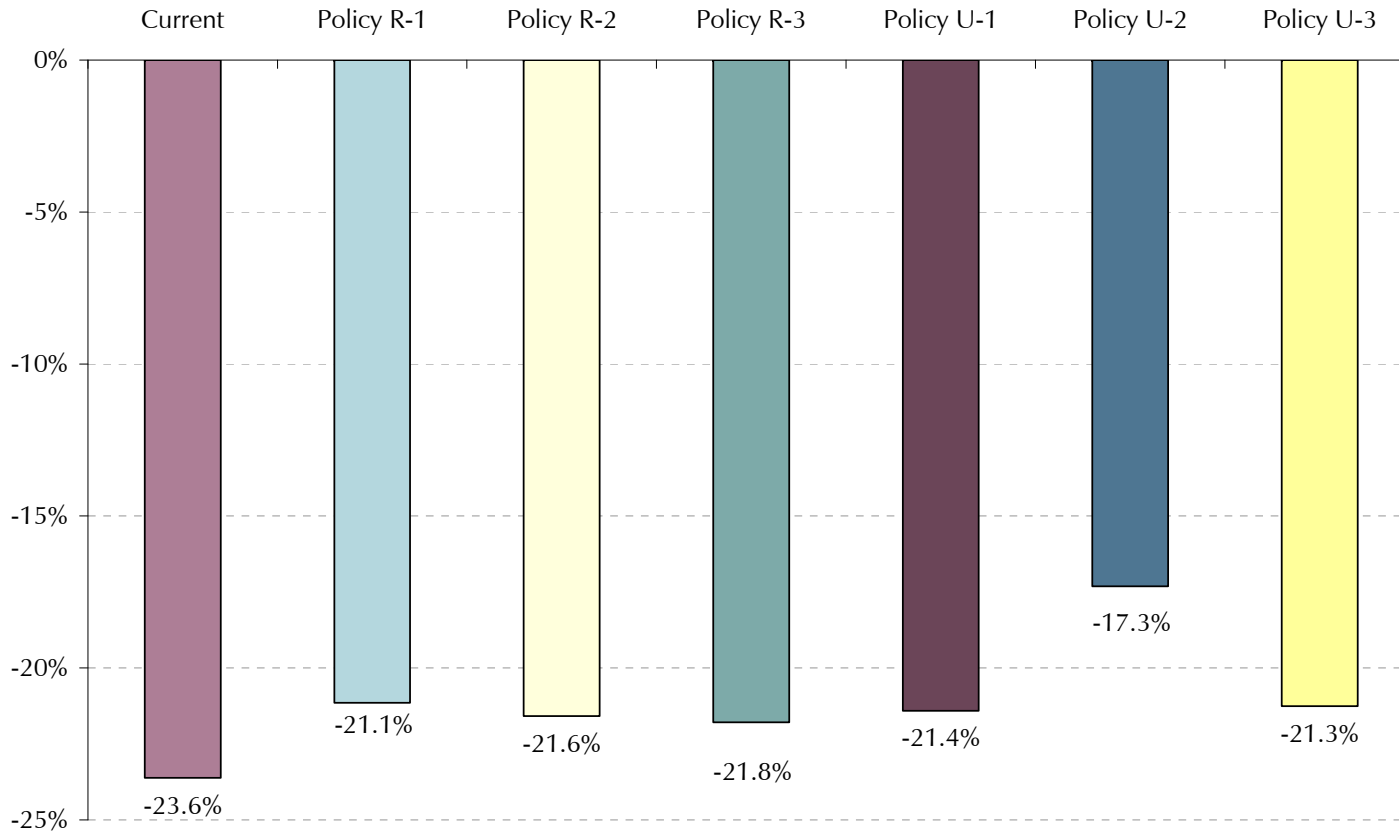
- In a period of an appreciating U.S. dollar (e.g., the early 1980's), the alternative policies generally produce lower returns relative to the current allocation due to their allocations to foreign assets.

**Historical Stress Test: Weak US Dollar (January 1986 thru August 1987)  
(Cumulative Return)**



- In a period of a declining US dollar (e.g., the middle 1980's), the alternative policies produce higher returns relative to the current allocation due to their allocations to foreign assets.

**Historical Stress Test: Stagflation (1Q73 thru 3Q74)  
(Cumulative Return)**



- In an extended environment of high inflation but low growth (e.g., the middle 1970's), the alternative policies protect better than the current allocation due to their allocations to real assets.

## Asset Class Definitions

## Asset Class Definitions

### Domestic Equity

- Investments in publicly traded U.S. companies. There are over 6,000 investable U.S. stocks.
- Historically, have provided the main engine of growth for investors.
- Includes huge multinational companies and very small operations. Some investors consider large cap and small cap stocks to be different asset classes, due to their varying performance cycles.

### International Developed Equity

- International equity investing refers to investing in companies domiciled outside of the U.S.
- Developed foreign markets predominantly include the countries of Western Europe and Japan.
- International equity markets provide opportunities to add value through active management, by allocating holdings across markets and within markets.

### Emerging Markets Equity

- Proponents of emerging markets support the thesis that the most rapid economic growth in the coming decades will occur in less developed nations (e.g., the BRIC countries).
- Emerging markets have produced higher returns than developed markets historically.
- However, emerging markets have been far more volatile, having experienced three calendar years with declines in excess of 25% since 1998.

### Frontier Markets Equity

- Frontier markets represent stock markets in underdeveloped countries. Frontier markets feature young and fast-growing populations, and these countries are generally net natural resource exporters.
- Frontier markets are characterized by illiquidity, low transparency, low levels of foreign investment, and immature regulation.
- Of more than 115 stock markets worldwide, over 60 may be characterized as frontier markets. As of 2009, these 60 carried a market capitalization of \$1.1 trillion, or 2% of world market capitalization.

### Private Equity

- Investments in privately held companies; generally structured in the form of partnerships, consisting of ten to twenty investments.
- Historically, private equity has returned 2% to 3% per year more than public equity.
- Although they are self-liquidating, usually over periods of eight to ten years, private equity partnership interests are not generally traded on a short-term basis.

### Investment Grade Bonds

- Reduce portfolio volatility, provide stability in crisis environments, provide diversification benefits, and serve as a source of liquidity.
- An investment grade bond portfolio can be structured to target a certain sector, duration, and quality rating.
- The intermediate-term duration associated with a broad bond market index is likely to provide an investor with the best risk/reward tradeoff.

### Treasury Inflation-Protected Securities (TIPS)

- Inflation-linked bonds offer investors a guaranteed return over inflation, if held to maturity.
- Investors receive an explicit annual coupon plus a variable adjustment based on the rate of inflation, providing inflation protection.
- TIPS should produce returns very close to nominal Treasuries.
- Since their inception in 1997, TIPS have exhibited a level of volatility similar to that of nominal Treasuries.
- TIPS should be uncorrelated with public equities and only modestly correlated with nominal bonds.

### High Yield Bonds

- High yield bonds, also known as “junk bonds,” are usually issued by corporations rated below investment grade.
- Three main types of risk affect the high yield bond market: liquidity risk, interest rate risk, and default risk.
- Even though they are often referred to as “junk” bonds, high yield bonds have historically been less risky than public equities.
- High yield bonds have been only modestly correlated with investment grade bonds and public equities.

## Bank Loans

- Investable bank loans are senior floating-rate loans made to speculative-grade issuers that theoretically constitute a safer alternative to high yield bonds. Bank loans are typically secured by company assets.
- Because bank loans pay a floating interest rate, they provide a hedge against rising short-term interest rates and potentially a hedge against inflation.
- The secondary bank loan market has grown rapidly in the last decade, due primarily to their popularity as a source of financing for mergers and acquisitions. Like high yield bonds, they experienced a sharp sell-off in 2008.

## Emerging Market Debt

- Emerging market debt can be divided into two broad categories: “External” debt is issued in currencies other than the country’s home currency (i.e., U.S. Dollars or Euros); “Local” debt is issued in the local currency of the issuing country or company.
- The addition of an emerging markets debt allocation provides diversification benefits to a portfolio, either on a stand-alone basis or as a complementary strategy to a high yield bond portfolio.
- The risks of investing in emerging market debt include political, event (i.e., crises) and currency volatility.

## Core Real Estate

- Real estate investing entails the direct or indirect ownership of physical property or land.
- This is a hybrid asset, exhibiting both equity and fixed income characteristics; it provides increased diversification and helps moderate aggregate returns over time. Relative to stocks and bonds, real estate offers moderate inflation protection.
- Core real estate is generally liquid and developed, and achieves a high percentage of its return from income.

### **Value-Added Real Estate**

- Value-added real estate includes real estate that achieves a significant portion of its return from an appreciation in value.
- Value-added real estate typically uses a higher degree of leverage and has higher volatility of returns than core real estate. Value-added real estate can also include core properties that are not highly leased.
- Major property types include specialty retail, hotels, assisted living, storage, and low-income housing.

### **Opportunistic Real Estate**

- Opportunistic real estate is expected to derive most of its return from property appreciation.
- Relative to core and value-added real estate, opportunistic real estate typically uses a higher degree of leverage and has higher volatility of returns.
- Opportunistic real estate includes nontraditional property types, including speculative development and land.

### **Infrastructure**

- Infrastructure is the underlying foundation of basic services, facilities, and institutions upon which a community depends.
- Infrastructure investments include utilities, transportation, communications, and social institutions like hospitals and prisons.
- These types of investments typically have large barriers to entry and long-duration contracts, which can be advantageous for matching the long-term liabilities or spending needs of institutional investors.

## Natural Resources

- Natural resources are essentially products of the Earth (e.g., oil, coal, wheat, timber, water, wind, etc.). Natural resources investments are holdings in companies which are involved with the following activities:
  - Extracted resources: oil, natural gas, coal, industrial and precious metals
  - Harvested resources: agricultural production, ownership of farm- or timberland
  - Renewable energy: solar, biofuels, wind, hydro, and geothermal
- Historical data suggest (1) that public market natural resources strategies should perform best during periods of high inflation, and (2) that natural resources should produce returns in excess of those of broader public equities.

## Commodities

- Commodities are generally physical goods or raw materials.
- Commodities may provide three benefits: increased portfolio diversification, a modest hedge against consumer price inflation, and a hedge against unique economic risks-including currency devaluation and armed conflict.
- Empirical work suggests that trend-following and momentum strategies can add value in commodities.

## Risk/Return Analysis Assumptions

## Scenario Return Inputs

Asset Class	Benchmark Used <sup>1</sup>
Investment Grade Bonds	Barclays Aggregate
TIPS	Barclays U.S. TIPS
EM Bonds	JPM GBI-EM Global Diversified
Bank Loans	CSFB Leveraged Loan
High Yield Bonds	Barclays High Yield
Core Real Estate	NCREIF Property
Value-Added RE	NCREIF Townsend Value Added
Opportunistic RE	NCREIF Townsend Opportunistic
REITs	NAREIT Equity
Infrastructure (private)	S&P Global Infrastructure
Natural Resources (private)	S&P Global Natural Resources
Commodities	Summer Haven Commodity
US Equity	Russell 3000
Public Foreign Equity (Developed)	MSCI EAFE
Public Foreign Equity (Emerging)	MSCI Emerging Markets
Long-short Equity	HFRI Equity Hedge
Private Equity	Venture Economics Private Equity Composite

<sup>1</sup> For U.S. Equity, we used the S&P 500 prior to 1979; for Investment Grade Bonds, we used Ibbotson's US Intermediate Government series prior to 1976; for EM Bonds, we used the JP Morgan EMBI+ prior to 2003; for Infrastructure, we used the S&P Utilities prior to 2002; for Natural Resources, we used a 75/25 mix of S&P Energy and S&P Diversified Metals and Mining prior to 2003.

### Notes and Disclaimers

- <sup>1</sup> The returns shown in the Policy Options and Risk Analysis sections rely on estimates of expected return, standard deviation, and correlation developed by Meketa Investment Group. To the extent that actual return patterns to the asset classes differ from our expectations, the results in the table will be incorrect. However, our inputs represent our best unbiased estimates of these simple parameters.
- <sup>2</sup> The returns shown in the Policy Options and Risk Analysis sections use a lognormal distribution, which may or may not be an accurate representation of each asset classes' future return distribution. To the extent that it is not accurate in whole or in part, the probabilities listed in the table will be incorrect. As an example, if some asset classes' actual distributions are even more right-skewed than the lognormal distribution (i.e., more frequent low returns and less frequent high returns), then the probability of the portfolio hitting a given annual return will be lower than that stated in the table.
- <sup>3</sup> The standard deviation bars in the chart in the Risk Analysis section do not indicate the likelihood of a 1, 2, or 3 standard deviation event—they simply indicate the return we expect if such an event occurs. Since the likelihood of such an event is the same across allocations regardless of the underlying distribution, a relative comparison across policy choices remains valid.

### Overview of Annual Asset Study Methodology

- In order to construct an optimal portfolio from a risk-return standpoint, conventional financial wisdom dictates that one develops return, volatility, and correlation expectations over the relevant investing horizon.
- Given the uncertainty surrounding financial and economic forecasts, expectations development is challenging, and any of several methodological approaches may meaningfully contribute to this complex task.
- Meketa Investment Group's process relies on both quantitative and qualitative methodologies.
- First, we employ a large set of quantitative models to arrive at a set of baseline expected ten-year annualized returns for major asset classes.
- These models attempt to forecast a gross "beta" return for each asset class.
- Our models may be econometrically derived (that is, based on a historical return relationship with current observable factors), factor-based (that is, based on a historical return relationship with predicted factors), or fundamentally based (that is, based on some theoretically defined return relationship with current observable factors).
- Some of these models are more predictive than others, for this reason, we next overlay a qualitative analysis, which takes the form of a data-driven deliberation among the asset allocation team (comprised of senior members of the firm).
- As a result of this process, we form our ten-year annualized return expectations, which serve as the primary foundation of our longer-term, twenty year expectations.
- We form our twenty-year annualized return expectations by systematically considering historical returns on an asset class by asset class level.

### Overview of Annual Asset Study Methodology (continued)

- Depending on our confidence in the historical average, we will modify the weightings of the ten-year forecast and historical average returns.
- Finally, we develop our twenty-year volatility and correlation expectations, relying primarily on various historical averages -- qualitative adjustments, when applied, usually serve to increase the correlations and volatility over and above the historical estimates (e.g., using the higher correlations usually observed during a volatile market).
- These volatility and correlation expectations are then combined with our twenty-year return expectations to assist us in subsequent asset allocation work, including mean-variance optimization and scenario analyses.
- We review and make modifications to the inputs, based on changing market dynamics, on a quarterly basis.
- Throughout the process, we remind ourselves of our overarching goals:
  - Consistency of results with historical experience and fundamentals
  - Consistency of results with macroeconomic reality
  - Consistency of results across asset classes
  - Recognition of forecasting error and its implications

## Meketa Investment Group 2011 Annual Asset Study

## Inputs Summary: 20-Year Assumptions

Asset Class	Annualized Return (%)	Annualized Standard Deviation (%)
<b>Fixed Income</b>		
Cash Equivalents	3.1	1.5
Short-Term Investment Grade Bonds	3.3	2.5
Investment Grade Bonds	3.8	5.5
Long-term Government Bonds	4.4	8.3
TIPS	4.2	7.0
High Yield Bonds	6.4	12.0
Bank Loans	5.9	11.0
Foreign Bonds (unhedged)	4.9	12.0
Emerging Market Bonds (local; unhedged)	7.3	15.0
<b>Equities</b>		
Public Domestic Equity	8.1	17.0
Public Foreign Equity (Developed)	8.1	19.0
Public Foreign Equity (Emerging)	10.5	26.0
Private Equity	10.5	25.0
Hedge Funds	6.4	10.5
<b>Real Assets</b>		
Real Estate	8.4	17.0
REITs	6.6	19.0
Core Private Real Estate	7.8	13.0
Value Added Real Estate	8.8	17.0
Opportunistic Real Estate	10.4	25.0
Natural Resources (Private)	9.6	22.0
Commodities	6.0	23.0
Infrastructure (Private)	8.5	18.0

**Meketa Investment Group 2011 Annual Asset Study**  
**Inputs Summary: Correlations for Major Asset Class**

	TIPS	Investment Grade Bonds	High Yield Bonds	Natural Resources (private)	Commodities	Public Domestic Equity	Public Foreign Equity (developed)	Public Foreign Equity (emerging)	Private Equity	Infrastructure (private)	Hedge Funds	Real Estate
TIPS	1.00											
Investment Grade Bonds	0.80	1.00										
High Yield Bonds	0.30	0.35	1.00									
Natural Resources (private)	0.20	0.20	0.45	1.00								
Commodities	0.30	0.15	0.05	0.7	1.00							
Public Domestic Equity	0.00	0.25	0.65	0.35	0.05	1.00						
Public Foreign Equity (developed)	0.10	0.20	0.55	0.30	0.10	0.80	1.00					
Public Foreign Equity (emerging)	0.10	0.00	0.50	0.50	0.50	0.75	0.80	1.00				
Private Equity	0.00	0.15	0.65	0.50	0.05	0.80	0.70	0.60	1.00			
Infrastructure (private)	0.30	0.35	0.45	0.50	0.20	0.40	0.35	0.35	0.50	1.00		
Hedge Funds	0.10	0.25	0.60	0.30	0.30	0.70	0.70	0.65	0.55	0.35	1.00	
Real Estate	0.10	0.25	0.50	0.50	0.10	0.40	0.35	0.30	0.45	0.45	0.35	1.00

Stress Test Return Assumptions<sup>1</sup>

	Rates rise 100 bp	Rates rise 200 bp	Rates rise 300 bp	BBB Spreads widen by 50 bp	BBB Spreads widen by 300 bp	USD Gains 10%	USD Gains 20%	Equities Decline 10%	Equities Decline 25%	Equities Decline 40%	Rates fall 100 bp	Rates fall 200 bp
Public Domestic Equity	11.3%	15.8%	6.9%	6.0%	-42.0%	3.5%	7.0%	-10.0%	-25.0%	-40.0%	10.5%	8.4%
Public Foreign Equity (Developed)	20.3	23.6	4.8	5.5	-33.0	-7.0	-14.0	-10.5	-26.3	-42.0	0.5	10.0
Public Foreign Equity (Emerging)	20.3	23.6	4.8	5.0	-39.0	-7.0	-14.0	-11.0	-27.5	-44.0	4.4	9.0
Long-Short Hedge Funds	11.5	12.8	4.2	6.5	-21.0	2.1	4.2	-6.0	-15.0	-24.0	13.6	6.8
Private Equity	11.3	15.8	6.9	6.0	-42.0	3.5	7.0	-8.0	-20.0	-32.0	10.5	8.4
Core Real Estate	11.4	12.2	17.4	9.5	-12.0	4.0	8.0	-5.0	-12.5	-20.0	5.5	5.2
REITs	19.3	12.8	16.8	0.5	-36.0	1.0	2.0	-9.5	-23.8	-38.0	14.9	7.4
Non-Core Real Estate	8.3	13.0	17.4	11.5	-24.0	4.0	8.0	-8.0	-20.0	-32.0	6.9	7.2
Infrastructure (private)	14.0	6.6	5.7	3.5	-24.0	3.0	6.0	-5.0	-12.5	-20.0	7.2	7.1
Natural Resources (private)	11.4	18.4	14.4	2.0	-16.5	-3.1	-6.2	-5.0	-12.5	-20.0	5.0	0.8
Natural Resources (public)	22.8	36.8	28.8	4.0	-33.0	-6.2	-12.3	-9.5	-23.8	-38.0	10.0	1.6
Commodities	12.6	9.6	-0.6	-0.5	-21.0	-15.0	-30.0	-7.0	-17.5	-28.0	1.8	-4.8
Long-Term Government Bonds	-12.7	-29.6	-46.5	12.0	15.0	10.0	20.0	5.0	12.5	20.0	21.1	38.0
TIPS	-2.3	-7.6	-12.9	8.5	12.0	8.0	16.0	1.0	2.5	4.0	8.3	13.6
Investment Grade Bonds	-2.3	-7.3	-12.3	-0.1	-3.6	8.0	16.0	2.0	5.0	8.0	7.7	12.7
Investment Grade Corporate Bonds	-2.9	-9.5	-16.1	-0.3	-14.9	8.0	16.0	-1.5	-3.8	-6.0	10.3	16.9
Foreign Developed Bonds	-4.1	-10.7	-17.3	0.4	-2.4	-6.3	-12.6	-2.0	-5.0	-8.0	9.0	15.5
Emerging Market Bonds (external)	0.0	-6.2	-12.4	-1.4	-25.7	5.0	10.0	-2.0	-5.0	-8.0	12.4	18.6
Emerging Market Bonds (local)	1.8	-2.8	-7.4	3.0	-10.5	-6.3	-12.6	-3.0	-7.5	-12.0	11.0	15.6
High Yield Bonds	2.5	-2.0	-6.4	-3.3	-33.5	4.5	9.0	-6.0	-15.0	-24.0	11.5	16.0
Bank Loans	12.0	12.0	15.0	2.5	-30.0	4.5	9.0	-6.0	-15.0	-24.0	4.3	-2.8
Hedge Funds	6.6	8.4	3.6	3.5	-18.0	5.0	10.0	-5.0	-12.5	-20.0	8.1	4.4
TAA	10.2	11.4	2.6	6.5	-22.2	3.2	6.4	-7.0	-17.5	-28.0	8.8	12.2
Risk Parity	7.3	5.0	-2.5	5.6	-12.0	1.6	3.3	-2.0	-5.0	-8.0	10.2	12.3

<sup>1</sup> Assumptions are based on performance for each asset class during historical periods that resembled these situations.

