

2015 ASSET-LIABILITY STUDY – PRESENTATION 5



Employees' Retirement System
of the State of Hawaii

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Recap of July & August Asset/Liability Presentations

Discussion of Survey Findings - Summary

- **Key Priorities:**
 - Maintain consistent progress along funding path
 - Avoid deterioration in ERS funding ratio
 - Avoid seeking higher %-of-pay contribution levels

Integrating Survey Conclusions with A/L Modeling

- **PCA engineered the A/L model to identify policy portfolios that attempt to:**
 - Stay as close to the projected funding ratio path as possible
 - i.e., at or above 90% of projected funding path
 - Limit rapid deterioration in funding status
 - i.e., avoid significant drawdowns/dropping below 55%
 - Maintain a growth rate close to compound 7.5%

Preliminary Takeaways from A/L Modeling

- PCA provided ERS Board with potential output/takeaways
 - Preliminary modeling indicates meaningful portfolio change

- Per modeling, potential implications of optimal policies:
 - *Public Growth* assets would decrease

 - Significant allocation to *Crisis Risk Offset* class materially improves outcomes

 - *Principal Protection* assets would decrease

 - *Private Equity & Real Estate* assets would increase

 - *Real Return* assets would increase

Overview of Modeling Process

Overview of Conducted A/L Models

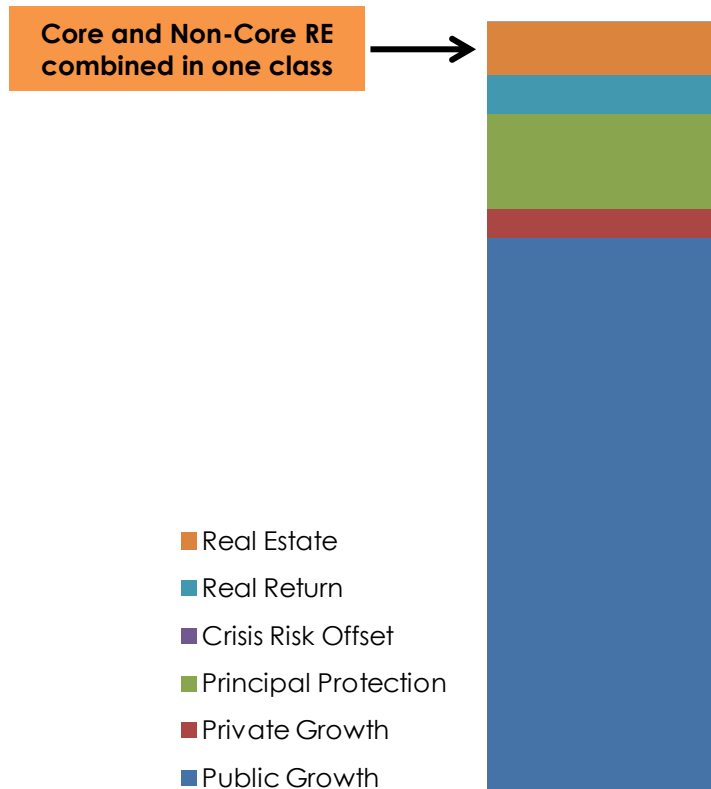
- PCA has completed three separate A/L models
 - 1) Mean-Variance Optimization
 - Numerous drawbacks (e.g., single period, poorly aligned with Board's views, etc.)
 - Completed for comparison purposes
 - 2) Simulation Optimization #1 (*Real Estate as a separate class*)
 - Optimized on factors that better incorporate Board's viewpoints and concerns
 - Indicated long-term return targets could be met in a more stable path
 - Meaningful change would be required
 - 3) Simulation Optimization #2 (*Real Estate embedded in other classes*)
 - In-line with Simulation Optimization #1
 - More aligned with risk/functional allocation framework

Similar Results

Model Constructs – Real Estate Component

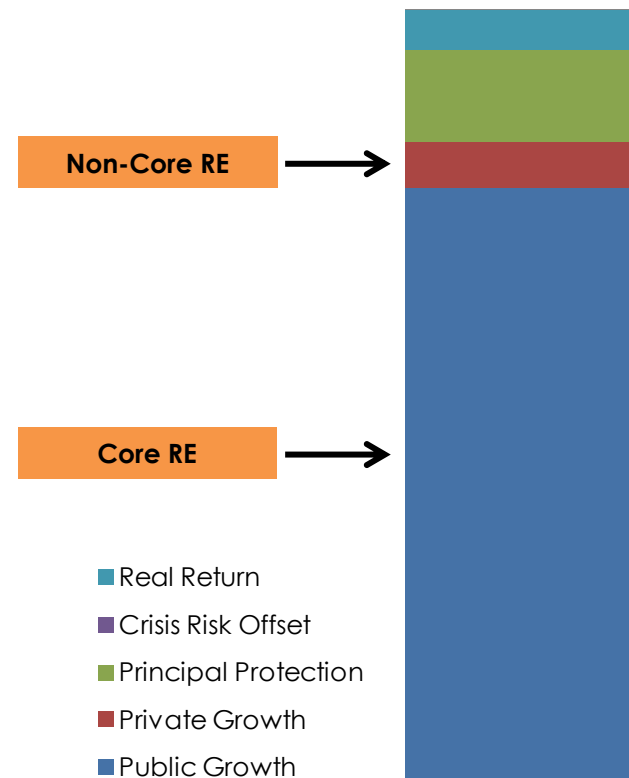
Simulation Version #1

- Real Estate Separate -



Simulation Version #2

- Real Estate Embedded -



Simulation Version #1 – Real Estate Component

Simulation Version #1

- Real Estate Separate -

- As presented in July, PCA initially modeled Real Estate as separate class
- Core and Non-Core Real Estate remained combined
 - Strategy-type allocations determined by Courtland/long-term plan
 - Class risk/return characteristics represent actual leverage and allocations
- Modeling indicated a likely increase in total Real Estate allocation
- If approved, ERS Policy would be mix of risk/functional and asset classes

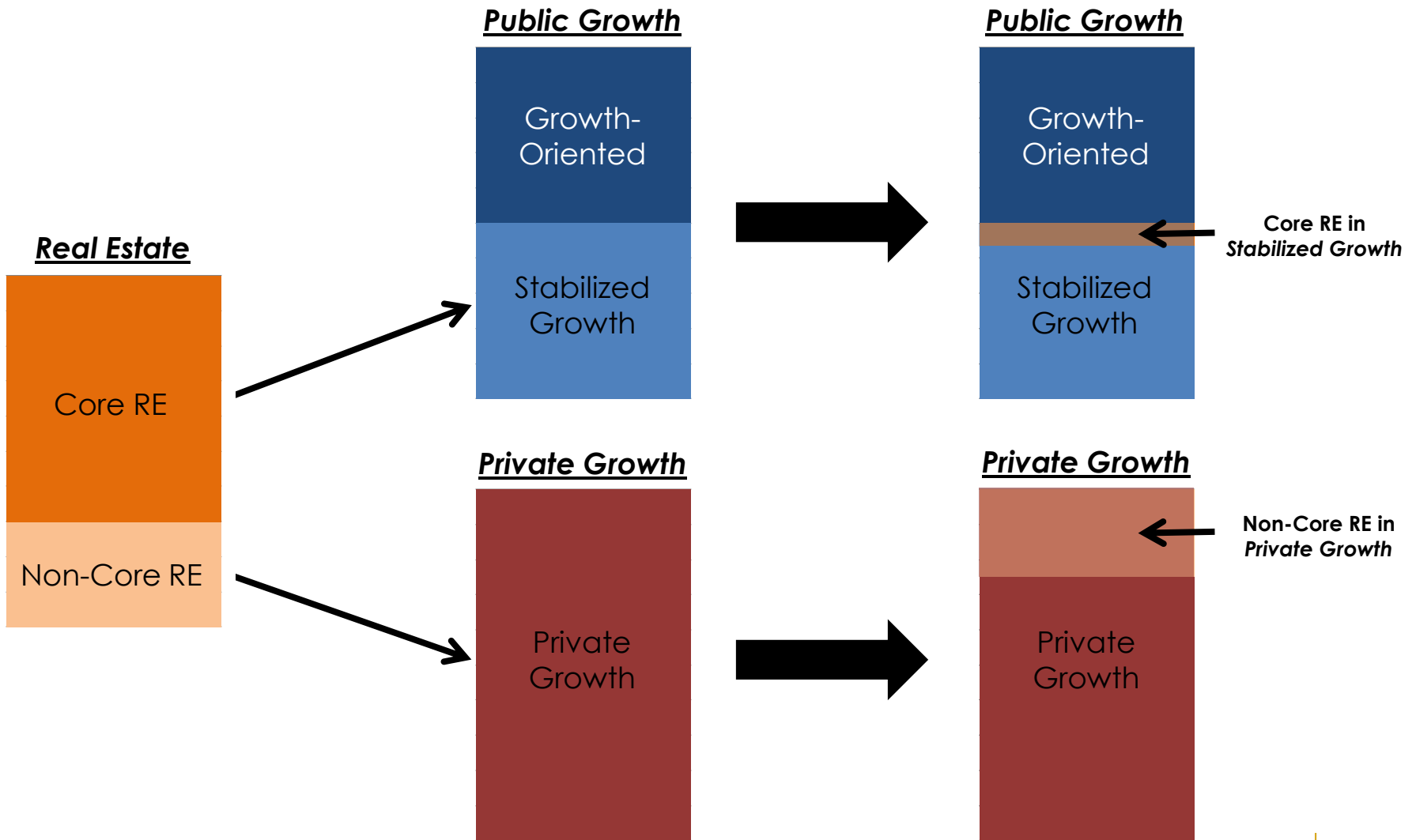
Simulation Version #2 – Real Estate Component

Simulation Version #2

- Real Estate Embedded -

- PCA separated the two components of Real Estate (core | non-core)
- Core RE was embedded in *Public Growth* at current policy weight
 - 70% of Total Real Estate \approx 6.5% of *Public Growth*
 - Within *Public Growth*, Core Real Estate would lie within *Stabilized Growth*
- Non-Core RE was embedded in *Private Growth* at current policy weight
 - 30% of Total Real Estate \approx 25% of *Private Growth*
- Core and Non-Core maintain respective risk/return characteristics
- Model Construct #2 better reflects risk/functional allocation framework

Simulation Version #2 – Real Estate Component



Model Inputs – Simulation Version #1

		Public Growth	Private Growth	Principal Protection	Real Return	Real Estate	Crisis Risk Offset	
Expected Avg. 1-Year Return		8.3	12.4	3.0	6.7	9.2	5.8	
Expected Std. Dev. of 1-Year Returns		14.6	26.0	3.8	9.2	14.5	12.3	
Expected Compound Returns - various horizons								
	5-Years	5	7.6	10.0	2.9	6.3	8.4	5.3
	10-Years	10	7.5	9.7	2.9	6.3	8.3	5.2
	20-Years	20	7.4	9.6	2.9	6.3	8.3	5.2
Modeled Annual Return Behavior								
1970		(3.2)	(32.5)	6.5	6.7	5.6	12.3	
1971		11.3	(2.5)	2.9	6.0	9.1	7.1	
1972		14.8	3.9	1.2	12.0	4.8	6.2	
1973		(19.4)	(33.2)	(0.6)	26.9	4.8	12.6	
1974		(30.0)	(29.5)	1.9	11.2	4.1	2.9	
1975		30.2	24.7	2.4	(4.2)	0.3	(7.1)	
1976		12.6	45.7	5.2	2.1	9.4	22.1	
1977		(5.7)	40.0	(1.2)	9.6	12.4	10.8	
1978		8.8	46.5	(1.8)	7.9	26.6	(9.4)	
1979		7.7	23.9	0.5	15.0	37.5	3.4	
1980		21.2	72.5	0.7	2.6	31.6	(11.6)	
1981		(8.4)	(11.3)	3.1	(7.4)	27.8	2.9	
1982		10.0	17.7	16.0	11.9	9.7	28.3	
1983		17.4	30.6	2.7	5.1	19.0	(1.9)	
1984		1.3	(9.2)	6.8	5.3	20.8	11.6	
1985		32.7	3.2	7.3	12.0	14.2	26.5	
1986		29.7	(3.2)	5.4	6.1	6.8	17.7	
1987		5.1	(1.7)	1.0	5.5	6.1	(8.9)	
1988		17.4	3.4	2.2	13.2	10.2	8.8	
1989		15.1	(0.4)	2.7	26.7	5.5	5.3	
1990		(16.3)	(7.3)	1.0	4.8	(8.3)	(2.2)	
1991		17.4	13.7	5.6	0.5	(28.2)	5.9	
1992		(4.2)	7.1	1.9	4.2	(24.9)	2.9	
1993		17.4	18.5	4.5	0.6	(10.6)	20.8	
1994		(2.4)	1.9	(5.5)	(5.7)	2.0	(16.0)	
1995		15.2	9.8	8.5	18.9	4.9	18.1	
1996		8.4	26.2	2.4	6.5	11.9	10.2	
1997		13.8	20.8	3.6	1.1	21.0	8.2	
1998		14.7	15.8	3.7	(9.1)	26.9	9.8	
1999		17.2	75.4	(2.2)	3.7	14.6	(22.3)	
2000		0.3	(14.3)	10.7	26.6	13.7	11.9	
2001		(8.0)	(11.5)	5.9	(10.4)	6.0	3.6	
2002		(8.5)	(18.8)	7.5	7.6	5.2	21.3	
2003		28.4	54.4	(0.5)	14.3	8.7	9.1	
2004		15.2	22.1	2.5	15.1	17.2	7.0	
2005		10.2	12.1	2.4	16.4	25.9	4.2	
2006		19.0	15.5	1.2	8.6	20.5	2.7	
2007		11.1	16.9	4.5	18.9	19.3	3.1	
2008		(27.9)	(28.0)	7.5	(15.2)	(15.4)	25.5	
2009		30.7	69.0	(0.2)	7.3	(31.6)	(26.0)	
2010		12.8	22.6	1.5	3.1	15.2	2.2	
2011		1.7	3.6	3.4	2.9	16.9	20.8	
2012		14.2	12.3	2.1	4.1	11.1	(3.1)	
2013		18.3	30.7	(3.5)	2.8	11.8	(9.8)	
2014		7.5	(1.4)	(0.8)	(2.5)	13.1	15.0	

- PCA utilizes strategic class-level time series in the stochastic A/L model
- Private Growth is separated in process to improve flexibility/align with funding schedule
- Time series maintain historical/dynamic behavior, but are modified to expected risk/return specifications
- Opportunistic Class does not have a time series; the design/purpose of this class does not lend itself to modeling

Model Inputs – Simulation Version #2

		Public Growth	Private Growth	Principal Protection	Real Return	Crisis Risk Offset
Expected Avg. 1-Year Return		8.3	12.4	3.0	6.7	5.8
Expected Std. Dev. of 1-Year Returns		14.0	20.4	3.8	9.2	12.3
Expected Compound Returns - various horizons						
	5-Years	5	7.6	10.9	2.9	6.3
	10-Years	10	7.5	10.7	2.9	6.3
	20-Years	20	7.5	10.6	2.9	6.3
Modeled Annual Return Behavior						
1970		(2.9)	(20.0)	6.5	6.7	12.3
1971		11.3	1.5	2.9	6.0	7.1
1972		14.5	3.4	1.2	12.0	6.2
1973		(18.2)	(20.7)	(0.6)	26.9	12.6
1974		(28.4)	(18.8)	1.9	11.2	2.9
1975		28.6	16.0	2.4	(4.2)	(7.1)
1976		12.1	33.7	5.2	2.1	22.1
1977		(4.6)	31.7	(1.2)	9.6	10.8
1978		10.1	42.9	(1.8)	7.9	(9.4)
1979		9.2	34.1	0.5	15.0	3.4
1980		21.8	63.3	0.7	2.6	(11.6)
1981		(6.5)	5.8	3.1	(7.4)	2.9
1982		9.6	15.7	16.0	11.9	28.3
1983		17.5	29.0	2.7	5.1	(1.9)
1984		2.2	3.1	6.8	5.3	11.6
1985		32.0	8.4	7.3	12.0	26.5
1986		29.1	(0.0)	5.4	6.1	17.7
1987		5.7	0.5	1.0	5.5	(8.9)
1988		17.1	6.0	2.2	13.2	8.8
1989		14.3	1.6	2.7	26.7	5.3
1990		(16.4)	(9.5)	1.0	4.8	(2.2)
1991		14.7	(2.4)	5.6	0.5	5.9
1992		(5.8)	(7.6)	1.9	4.2	2.9
1993		16.0	6.6	4.5	0.6	20.8
1994		(2.1)	4.0	(5.5)	(5.7)	(16.0)
1995		14.5	10.7	8.5	18.9	18.1
1996		8.5	25.5	2.4	6.5	10.2
1997		13.8	26.7	3.6	1.1	8.2
1998		15.5	20.7	3.7	(9.1)	9.8
1999		17.4	58.6	(2.2)	3.7	(22.3)
2000		0.4	(5.8)	10.7	26.6	11.9
2001		(7.2)	(7.2)	5.9	(10.4)	3.6
2002		(8.0)	(13.1)	7.5	7.6	21.3
2003		27.5	44.1	(0.5)	14.3	9.1
2004		15.3	22.9	2.5	15.1	7.0
2005		11.2	18.4	2.4	16.4	4.2
2006		19.1	21.9	1.2	8.6	2.7
2007		11.7	19.6	4.5	18.9	3.1
2008		(27.2)	(29.3)	7.5	(15.2)	25.5
2009		27.3	36.9	(0.2)	7.3	(26.0)
2010		13.0	21.2	1.5	3.1	2.2
2011		2.2	7.6	3.4	2.9	20.8
2012		14.2	13.0	2.1	4.1	(3.1)
2013		18.1	29.2	(3.5)	2.8	(9.8)
2014		7.7	6.0	(0.8)	(2.5)	15.0

- Version #2 utilizes similar strategic class-level time series
- Private Growth remains separated in process for flexibility/alignment with funding schedule
- Core and Non-Core RE are now subsets of higher-level strategic classes
- All strategic classes are aligned with risk/functional framework

Model Constraints

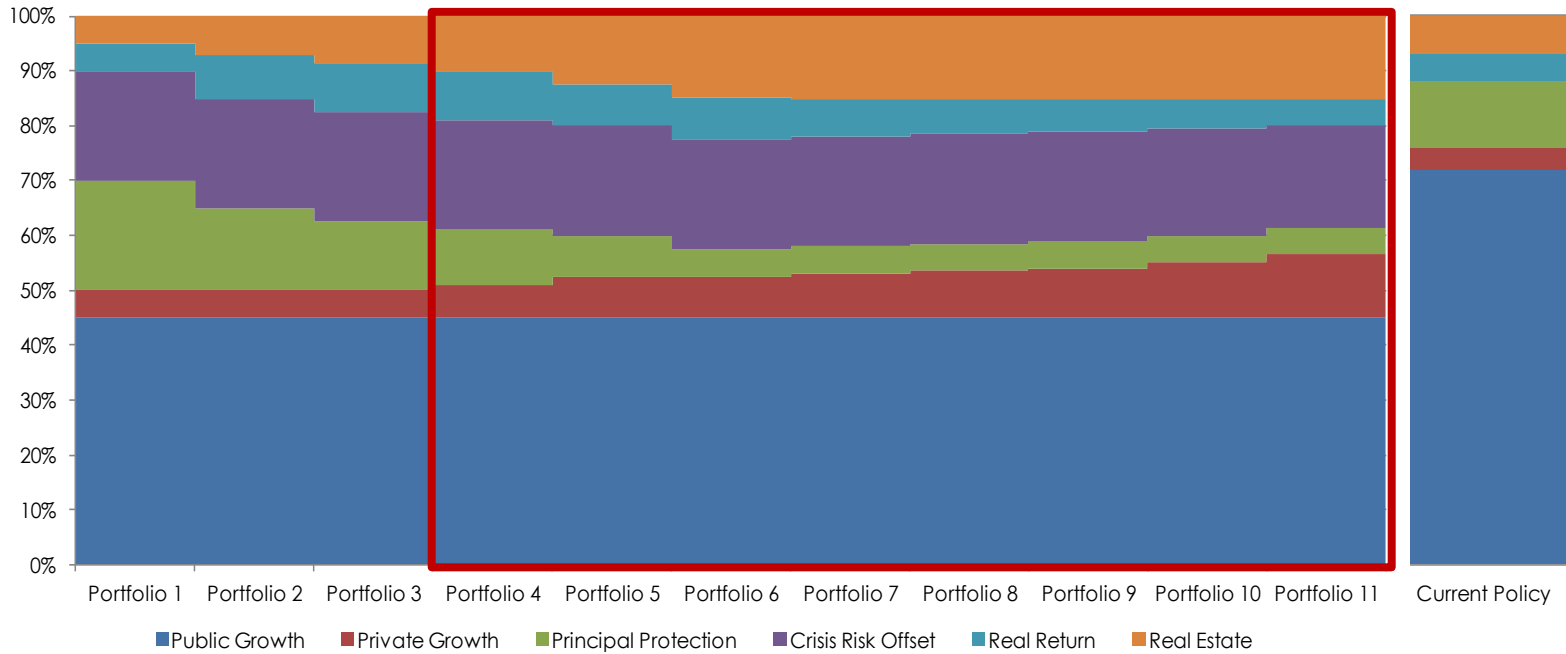
PCA's Revised Constraints

Strategic Class	Current Policy	Optimizing Version #1		Optimizing Version #2	
		Min (%)	Max (%)	Min (%)	Max (%)
Public Growth	72%	45%	70%	45%	80%
Private Growth	4%	5%	12%	7%	20%
Principal Protection	12%	5%	20%	5%	20%
Real Return	5%	5%	20%	5%	20%
Real Estate	7%	5%	15%		
Crisis Risk Offset		0%	20%	0%	20%
Total	100%				

- Private Growth remains a sub-component of Broad Growth, but modeling no longer restricts it to 10% of Broad Growth
- Version #2 incorporates Real Estate into Public Growth and Private Growth

Output from PCA's Simulation Modeling

Simulation Modeling Outcomes – V1 (RE Separate)



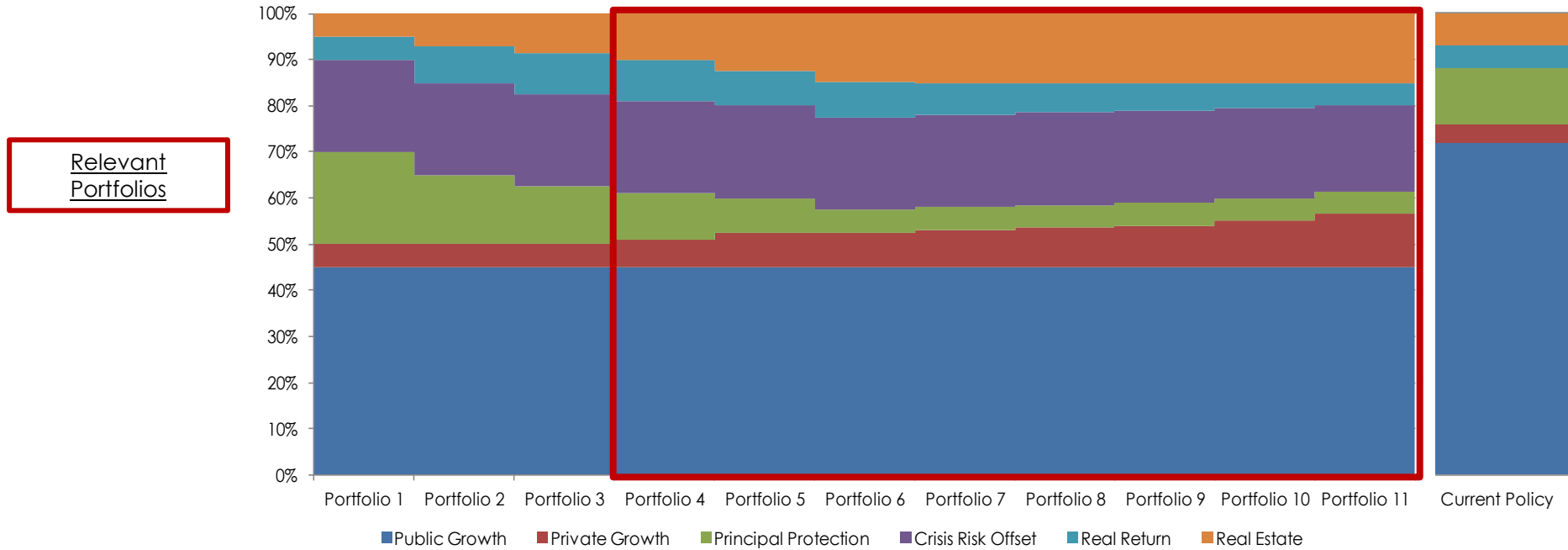
27-Year Statistics

Expected Compound Return	6.8%	7.0%	7.1%	7.3%	7.5%	7.7%	7.7%	7.7%	7.7%	7.8%	7.9%	7.3%
Standard Deviation	6.8%	7.0%	7.1%	7.4%	7.7%	7.9%	8.0%	8.0%	8.1%	8.3%	8.6%	11.3%
Median Funded Ratio	80.1%	86.5%	90.1%	95.4%	102.2%	106.3%	106.9%	107.7%	108.8%	111.2%	113.6%	97.7%
% of Scenarios <100%	66.3%	61.3%	57.8%	54.3%	48.4%	44.9%	44.4%	44.0%	43.6%	42.8%	41.7%	51.2%
% that Breached 30yr Amortization	28.4%	27.8%	26.9%	25.3%	24.2%	23.8%	23.8%	23.9%	23.9%	23.7%	24.4%	38.7%
% Scenarios >= Current Funding Path	32.6%	37.9%	41.1%	44.7%	50.4%	54.1%	54.4%	54.9%	55.4%	56.4%	57.2%	47.9%
% Scenarios >= 90% of Funding Path	41.0%	46.0%	50.1%	55.0%	58.6%	60.7%	61.3%	61.5%	61.7%	62.5%	63.4%	53.8%
Best Calendar Year	23.0%	23.3%	23.4%	23.5%	23.5%	23.7%	23.6%	23.6%	23.5%	23.4%	23.1%	26.2%
Worst Calendar Year	-13.3%	-13.0%	-12.8%	-13.1%	-13.7%	-13.6%	-13.8%	-14.0%	-14.2%	-14.6%	-15.1%	-22.1%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-7.3%	-7.8%	-8.0%	-8.5%	-9.3%	-9.7%	-9.8%	-9.9%	-10.0%	-10.3%	-11.0%	-21.0%
% Scenarios <55% During 5-year	6.6%	6.6%	6.6%	6.6%	7.0%	7.2%	7.3%	7.5%	7.6%	7.7%	8.7%	14.7%

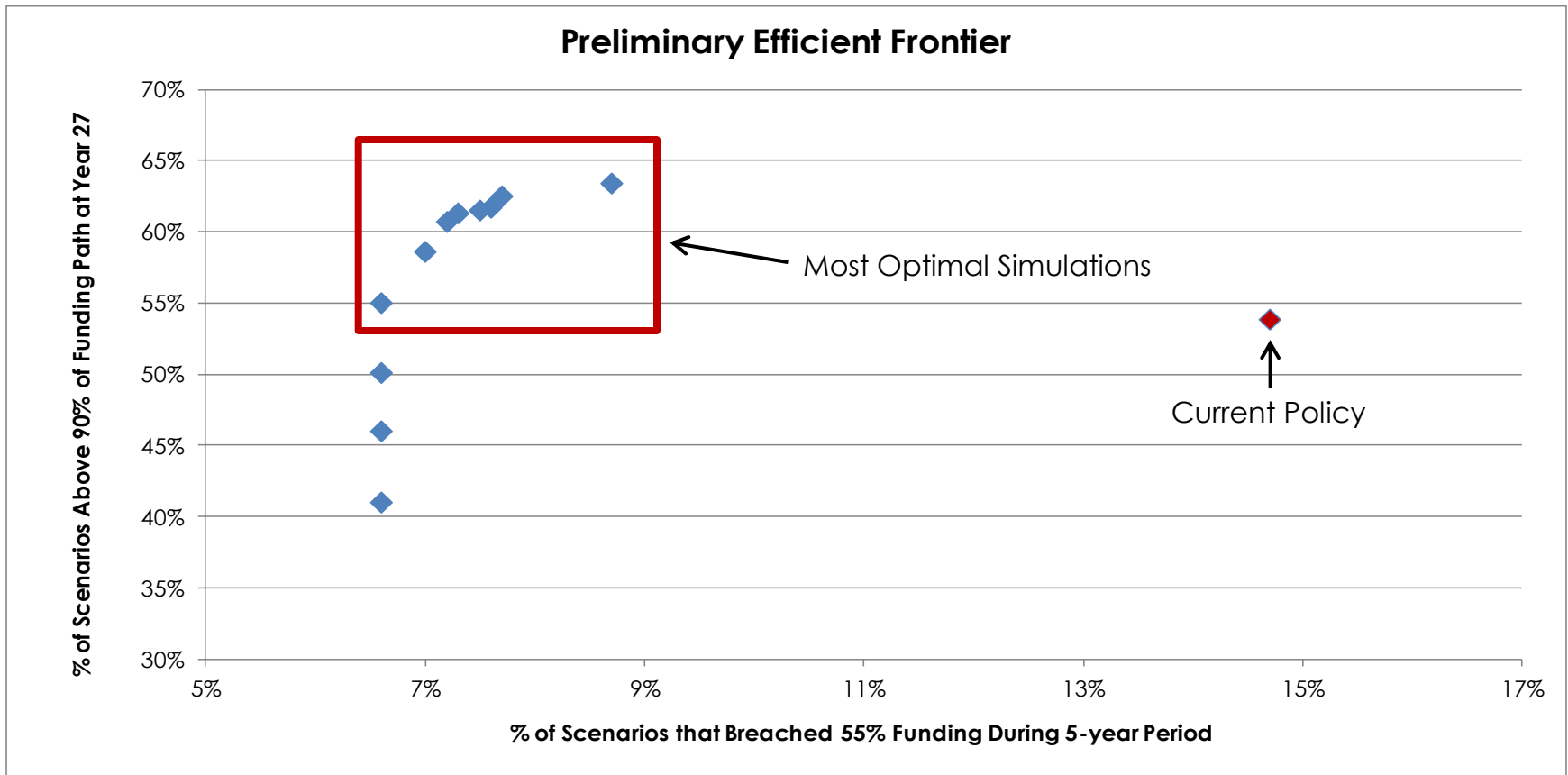
Simulation Modeling Outcomes – V1 (RE Separate)



Portfolio Allocations

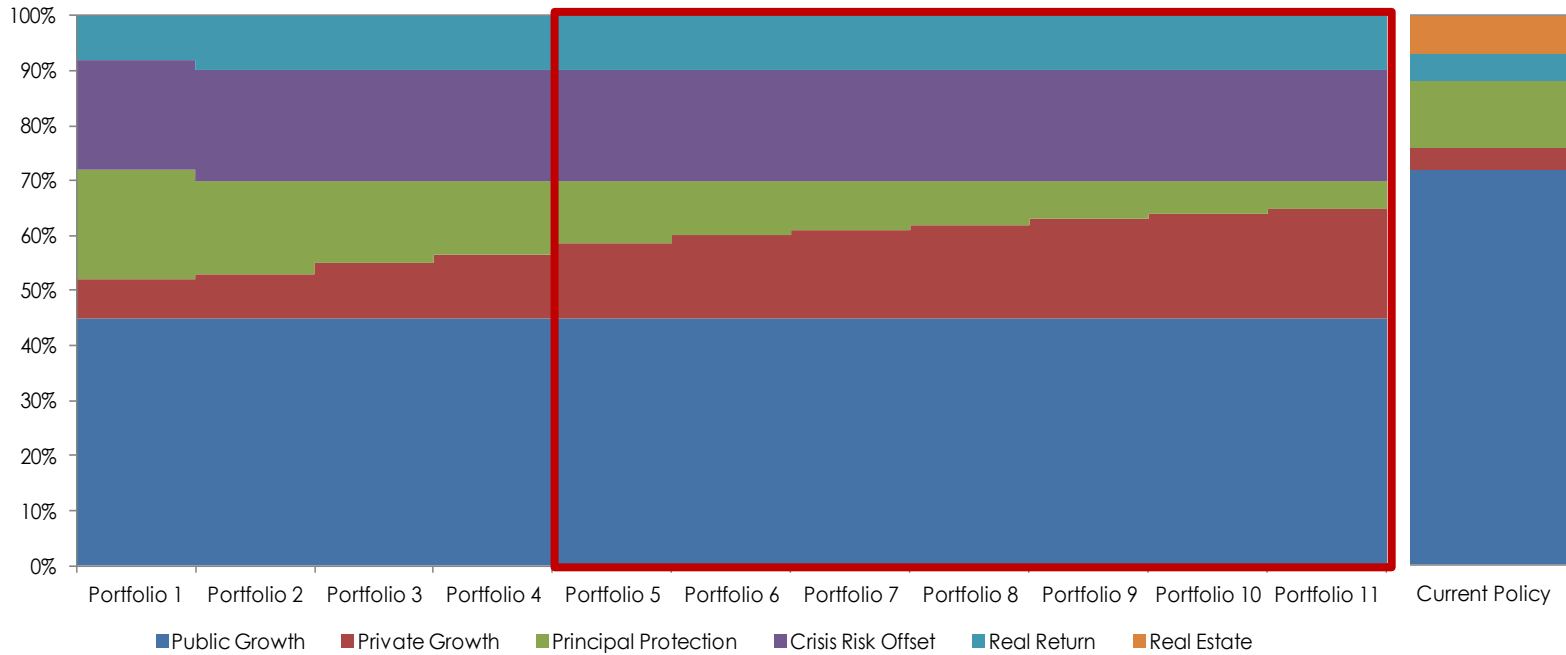
Public Growth	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	72.0%
Private Growth	5.0%	5.0%	5.0%	6.0%	7.5%	7.5%	8.0%	8.5%	9.0%	10.0%	11.5%	4.0%
Principal Protection	20.0%	15.0%	12.5%	10.0%	7.5%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	12.0%
Crisis Risk Offset	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	19.5%	18.5%	0.0%
Real Return	5.0%	8.0%	9.0%	9.0%	7.5%	7.5%	7.0%	6.5%	6.0%	5.5%	5.0%	5.0%
Real Estate	5.0%	7.0%	8.5%	10.0%	12.5%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	7.0%

Simulation Modeling Outcomes – V1 (RE Separate)



- Optimized solutions exhibit better chances of funding success with materially lower short-term drawdowns/funding risks
- Simulations indicate material improvements can be made

Simulation Modeling Outcomes – V2 (RE Embedded)



27-Year Statistics

Expected Compound Return	6.8%	6.9%	7.1%	7.2%	7.4%	7.5%	7.6%	7.7%	7.8%	7.8%	7.9%	7.3%
Standard Deviation	6.7%	6.9%	7.2%	7.5%	7.8%	8.0%	8.2%	8.4%	8.6%	8.7%	8.9%	11.3%
Median Funded Ratio	80.0%	84.2%	89.9%	93.9%	99.0%	103.4%	105.9%	108.8%	111.9%	114.5%	116.8%	97.7%
% of Scenarios <100%	65.9%	62.6%	58.3%	54.8%	50.8%	47.4%	45.9%	44.4%	42.5%	41.3%	39.9%	51.2%
% that Breached 30yr Amortization	28.2%	27.3%	26.8%	26.4%	26.1%	25.3%	25.2%	25.0%	24.9%	24.8%	24.7%	38.7%
% Scenarios >= Current Funding Path	32.8%	36.7%	40.0%	43.7%	48.2%	51.6%	53.2%	54.4%	56.3%	58.2%	59.3%	47.9%
% Scenarios >= 90% of Funding Path	40.6%	44.5%	49.7%	53.0%	56.9%	59.5%	60.5%	61.7%	62.4%	63.3%	64.6%	53.8%
Best Calendar Year	22.8%	22.9%	22.9%	23.0%	23.0%	23.0%	23.0%	23.1%	23.6%	24.0%	24.4%	26.2%
Worst Calendar Year	-12.2%	-12.3%	-12.7%	-13.0%	-13.4%	-13.7%	-13.9%	-14.1%	-14.3%	-14.5%	-14.7%	-22.1%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-7.0%	-7.5%	-8.1%	-8.6%	-9.3%	-9.8%	-10.1%	-10.5%	-10.9%	-11.2%	-11.6%	-21.0%
% Scenarios <55% During 5-year	6.3%	6.6%	6.6%	6.6%	6.8%	7.3%	7.5%	7.7%	8.3%	8.5%	8.5%	14.7%

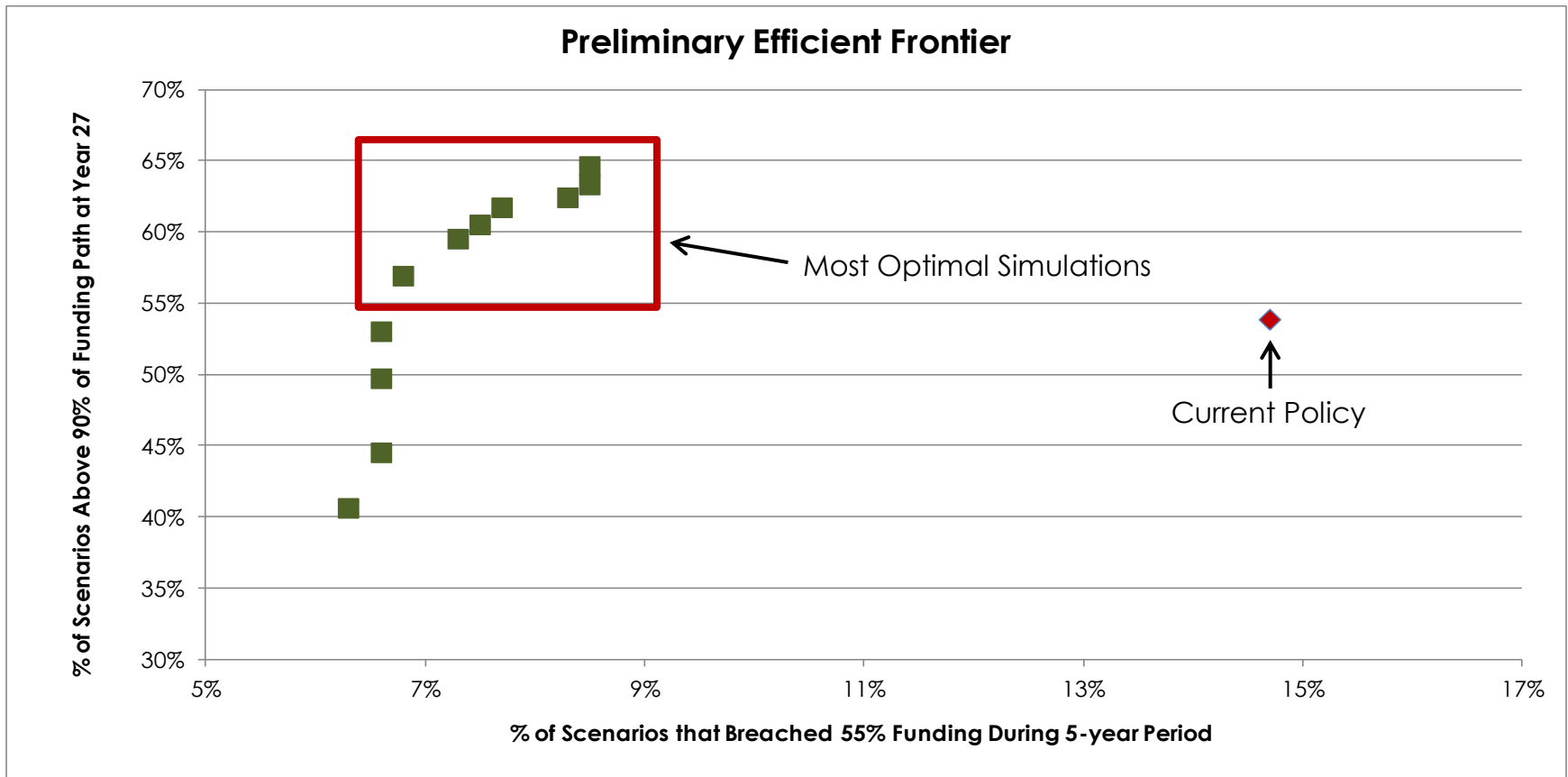
Simulation Modeling Outcomes – V2 (RE Embedded)



Portfolio Allocations

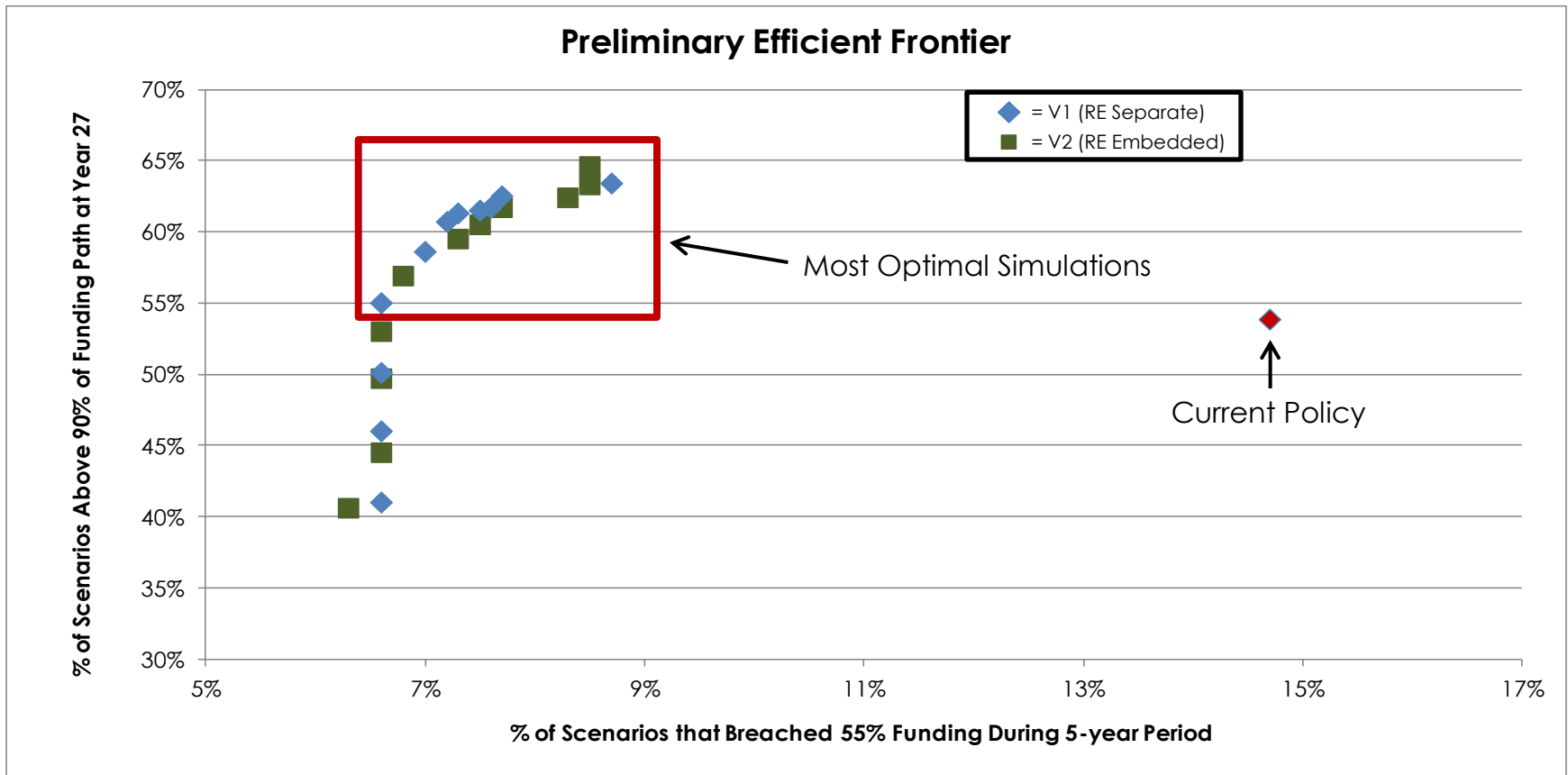
Public Growth	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	72.0%
Private Growth	7.0%	8.0%	10.0%	11.5%	13.5%	15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	4.0%
Principal Protection	20.0%	17.0%	15.0%	13.5%	11.5%	10.0%	9.0%	8.0%	7.0%	6.0%	5.0%	12.0%
Crisis Risk Offset	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	0.0%
Real Return	8.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	5.0%
Real Estate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.0%

Simulation Modeling Outcomes – V2 (RE Embedded)



- Optimized solutions exhibit better chances of funding success with materially lower short-term drawdowns/funding risks
- Simulations indicate material improvements can be made

Simulation Modeling Outcomes – V1 & V2 Compared



- Version #1 and Version #2 produce very similar results

High-level Conclusions

- Both versions of simulations provide similar results:
 - Version #1 (RE separate) = marginally better short-term characteristics
 - Version #2 (RE embedded) = marginally better long-term characteristics
 - Improvement in long-term characteristics evident at higher risk/success spectrum
- Policy portfolio can be improved to better reflect Board's risk preferences
- Focusing on Board's risk preferences results in materially different portfolios
- **Potential Implications of Optimal Policies:**
 - *Public Growth* assets would decrease
 - *New Crisis Risk Offset* class materially improves outcomes
 - *Principal Protection* assets would decrease
 - *Private Equity & Real Estate* assets would increase
 - *Real Return* assets would increase

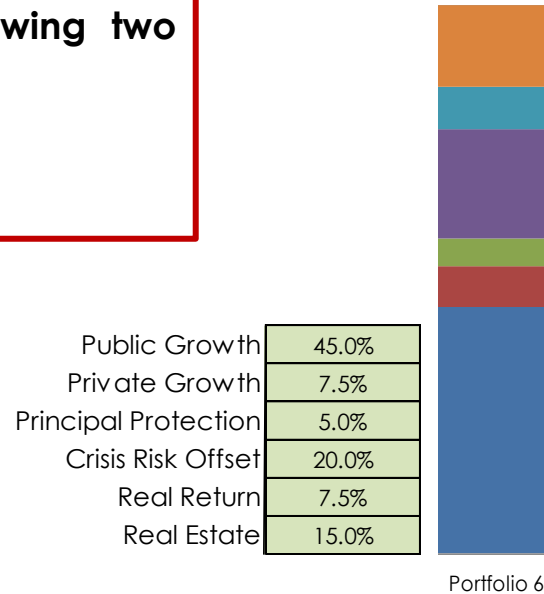
Portfolio Recommendations and Takeaways

PCA Recommendations

PCA recommends the ERS Board select one of the following two policy portfolios:

Version #1 = Portfolio 6
Version #2 = Portfolio 9

Simulation Version #1 - Real Estate Separate -



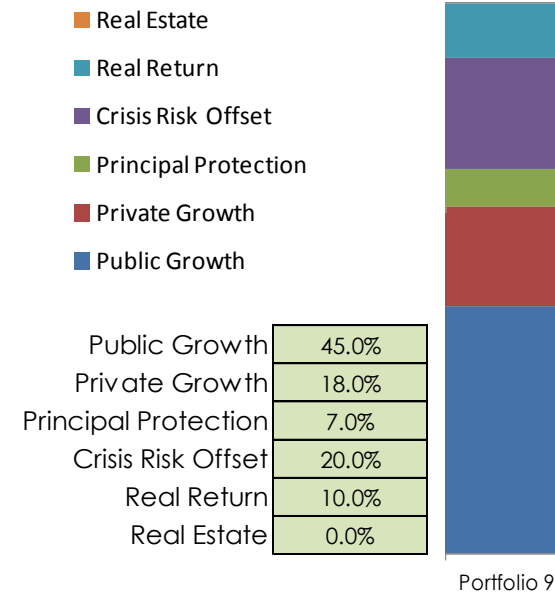
27-Year Statistics

Expected Compound Return	7.7%
Standard Deviation	7.9%
Median Funded Ratio	106.3%
% of Scenarios <100%	44.9%
% that Breached 30yr Amortization	23.8%
% Scenarios >= Current Funding Path	54.1%
% Scenarios >= 90% of Funding Path	60.7%
Best Calendar Year	23.7%
Worst Calendar Year	-13.6%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-9.7%
% Scenarios <55% During 5-year	7.2%

Simulation Version #2 - Real Estate Embedded -



27-Year Statistics

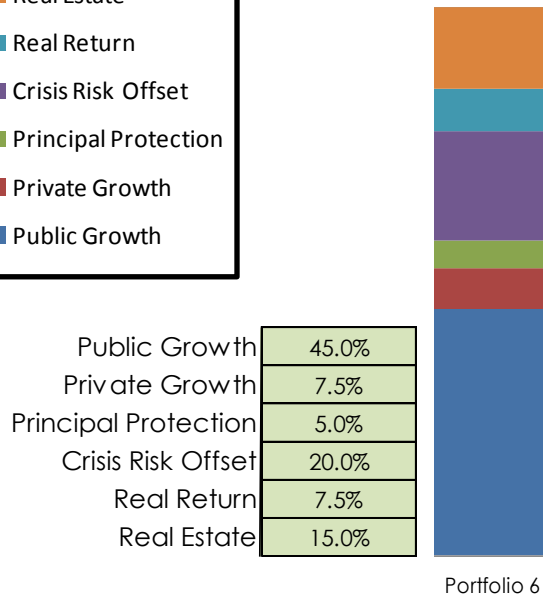
Expected Compound Return	7.8%
Standard Deviation	8.6%
Median Funded Ratio	111.9%
% of Scenarios <100%	42.5%
% that Breached 30yr Amortization	24.9%
% Scenarios >= Current Funding Path	56.3%
% Scenarios >= 90% of Funding Path	62.4%
Best Calendar Year	23.6%
Worst Calendar Year	-14.3%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-10.9%
% Scenarios <55% During 5-year	8.3%

PCA Recommendations – Comparison to Current Policy

Simulation Version #1
- Real Estate Separate -



Portfolio 6

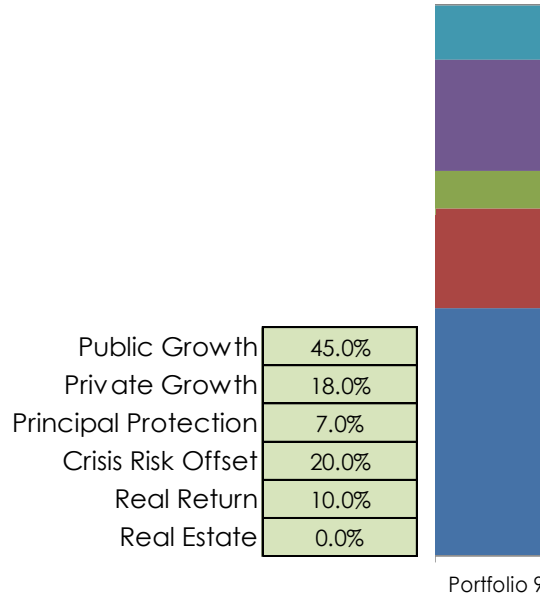
27-Year Statistics

Expected Compound Return	7.7%
Standard Deviation	7.9%
Median Funded Ratio	106.3%
% of Scenarios <100%	44.9%
% that Breached 30yr Amortization	23.8%
% Scenarios >= Current Funding Path	54.1%
% Scenarios >= 90% of Funding Path	60.7%
Best Calendar Year	23.7%
Worst Calendar Year	-13.6%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-9.7%
% Scenarios <55% During 5-year	7.2%

Simulation Version #2
- Real Estate Embedded -



Portfolio 9

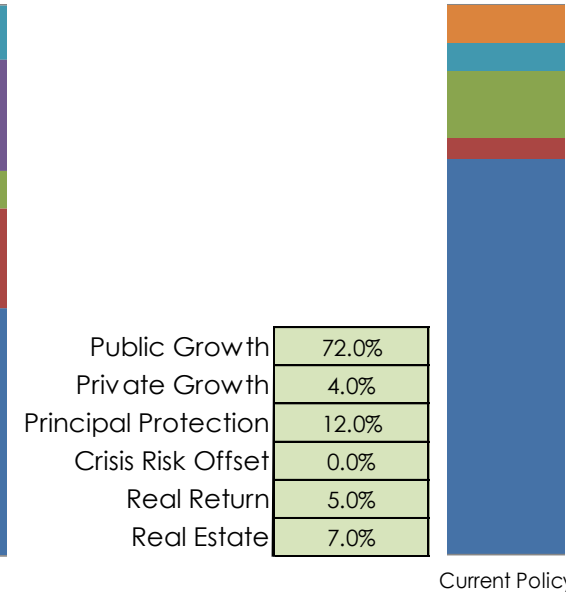
27-Year Statistics

Expected Compound Return	7.8%
Standard Deviation	8.6%
Median Funded Ratio	111.9%
% of Scenarios <100%	42.5%
% that Breached 30yr Amortization	24.9%
% Scenarios >= Current Funding Path	56.3%
% Scenarios >= 90% of Funding Path	62.4%
Best Calendar Year	23.6%
Worst Calendar Year	-14.3%

Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-10.9%
% Scenarios <55% During 5-year	8.3%

Current Policy



Current Policy

27-Year Statistics

Expected Compound Return	7.3%
Standard Deviation	11.3%
Median Funded Ratio	97.7%
% of Scenarios <100%	51.2%
% that Breached 30yr Amortization	38.7%
% Scenarios >= Current Funding Path	47.9%
% Scenarios >= 90% of Funding Path	53.8%
Best Calendar Year	26.2%
Worst Calendar Year	-22.1%

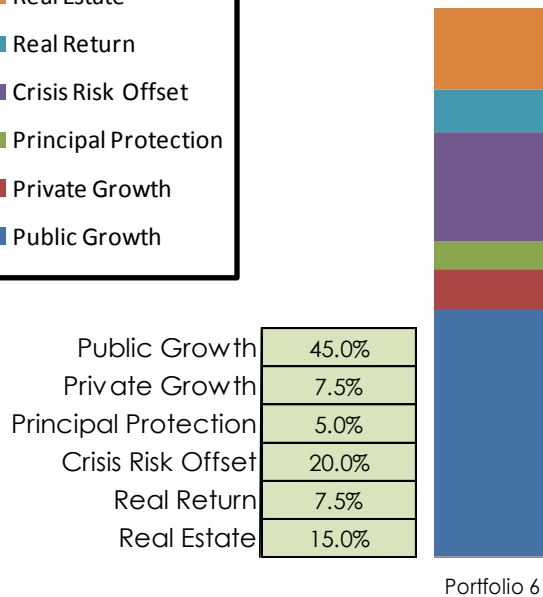
Short-term Statistics

Avg 2-year Drawdown of Bottom 10%	-21.0%
% Scenarios <55% During 5-year	14.7%

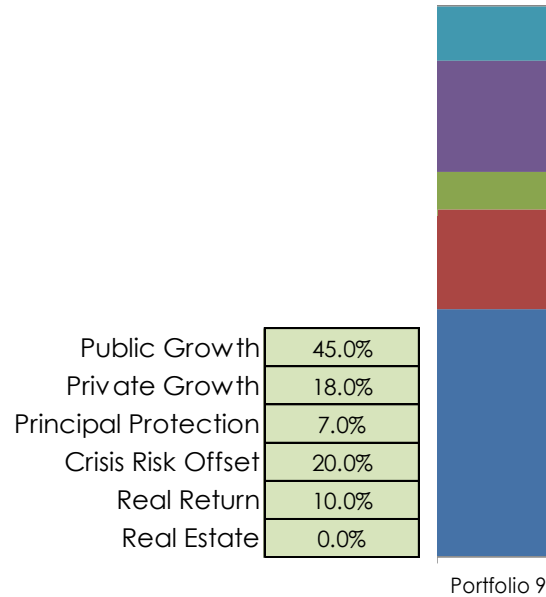
PCA Recommendations – Impact on Real Estate



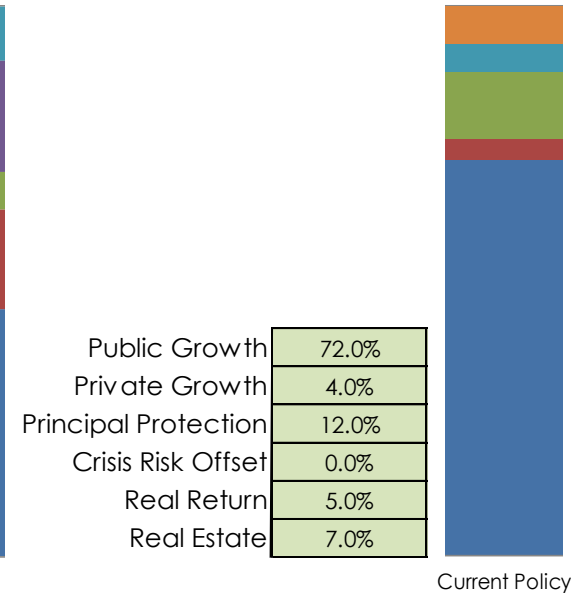
Simulation Version #1
- Real Estate Separate -



Simulation Version #2
- Real Estate Embedded -



Current Policy



	% of Total Portfolio
Core RE	10.5%
Non-Core RE	4.5%

	% of Total Portfolio
Core RE	5%
Non-Core RE	4.5%*

	% of Total Portfolio
Core RE	5%
Non-Core RE	2%

* Depending on deal flow, this % could vary as PE and Non-Core RE compete for allocations; improved flexibility for ERS

PCA Recommendations – Impact on Real Estate

- **Version #1 (RE Separate):**

- Overall Real Estate allocation increases materially (i.e., double)
- ERS maintains 70% Core / 30% Non-Core (subject to Courtland considerations)

- **Version #2 (RE Embedded):**

- Overall Real Estate allocation increases to near 10%
 - Increase partially depends on Non-Core vs. Private Equity deal flow
- Core RE maintains near current level ($\approx 5\%$)
- Non-Core RE receives larger consideration as part of Private Growth
- Real Return increases; begins to play Core RE role
 - Future unlevered Core RE could be allocated to Real Return

PCA Recommendations

- Both potential portfolios better reflect the Board's risk preferences
- Both potential portfolios offer meaningful risk/success improvements
- Overall risk/success attributes are very similar
- Primary consideration = alignment with risk/functional framework
 - Allocation differences = fine tuning rather than material differences

Next Steps

Next Steps

- **September/October:**
 - Develop timeline/evolving policy portfolio plan

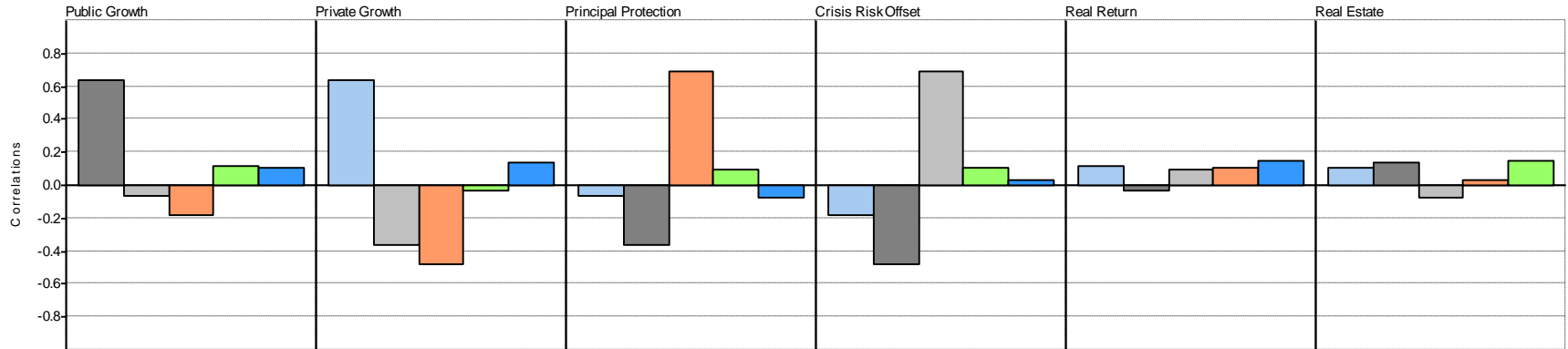
- **Recurring:**
 - Manager searches for Public Growth restructuring
 - Update IPS

Appendix

Mean-Variance Optimization (MVO) Input for ERS

Mean-Variance Assumptions

Correlation Inputs



■ Corr with Public Growth
■ Corr with Crisis Risk Offset

■ Corr with Private Growth
■ Corr with Real Return

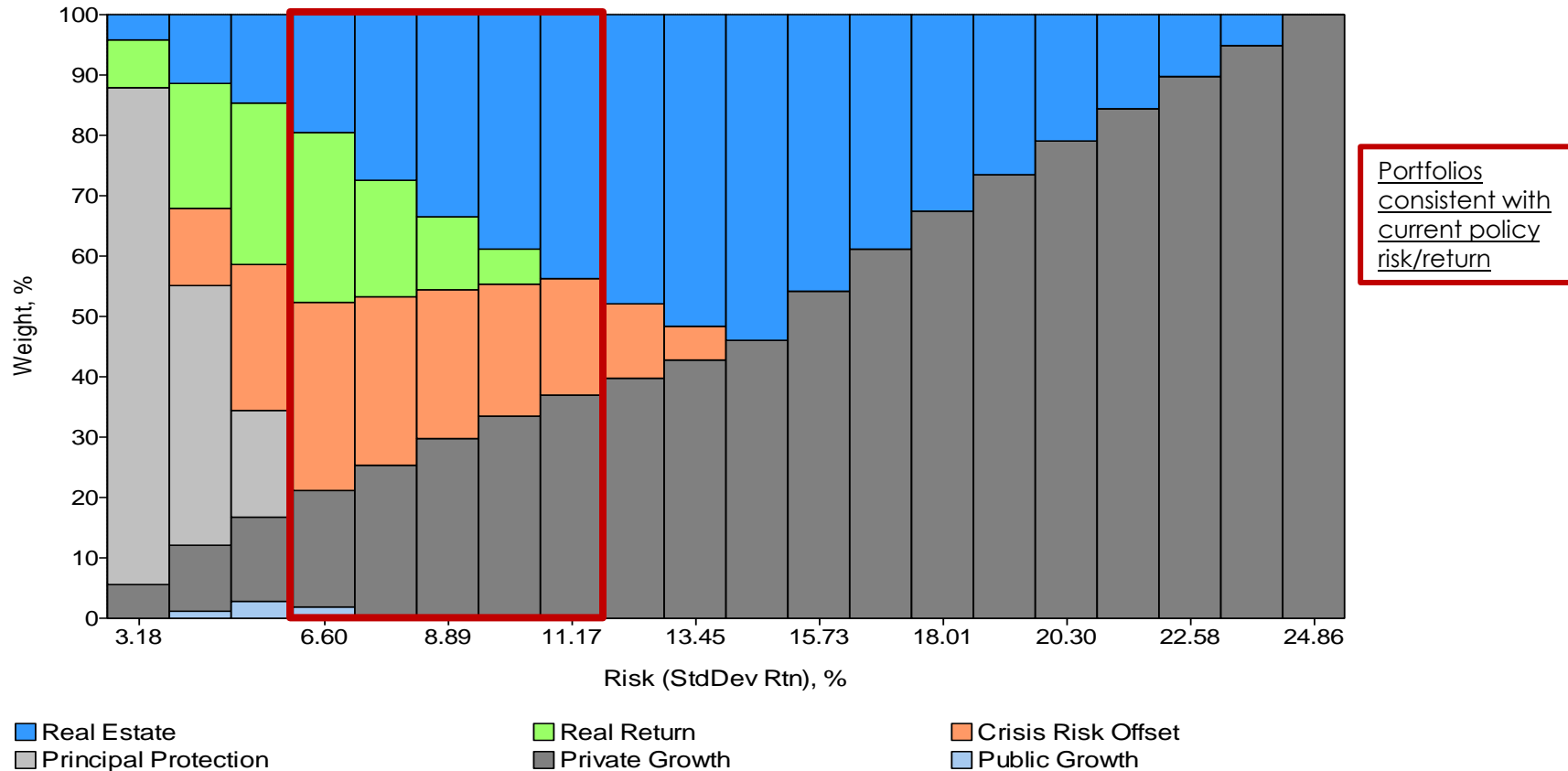
■ Corr with Principal Protection
■ Corr with Real Estate

Correlation Matrix (Model Inputs)

	Return, %	StdDev Rtn, %	Corr with Public Growth	Corr with Private Growth	Corr with Principal Protection	Corr with Crisis Risk Offset	Corr with Real Return	Corr with Real Estate
Public Growth	8.33	14.56	1.00	0.64	-0.06	-0.18	0.12	0.11
Private Growth	12.35	26.00	0.64	1.00	-0.36	-0.48	-0.03	0.14
Principal Protection	2.95	3.82	-0.06	-0.36	1.00	0.69	0.10	-0.07
Crisis Risk Offset	5.84	12.26	-0.18	-0.48	0.69	1.00	0.11	0.03
Real Return	6.65	9.23	0.12	-0.03	0.10	0.11	1.00	0.15
Real Estate	9.18	14.49	0.11	0.14	-0.07	0.03	0.15	1.00

Mean-Variance Optimization (MVO) Output for ERS

Unconstrained Results

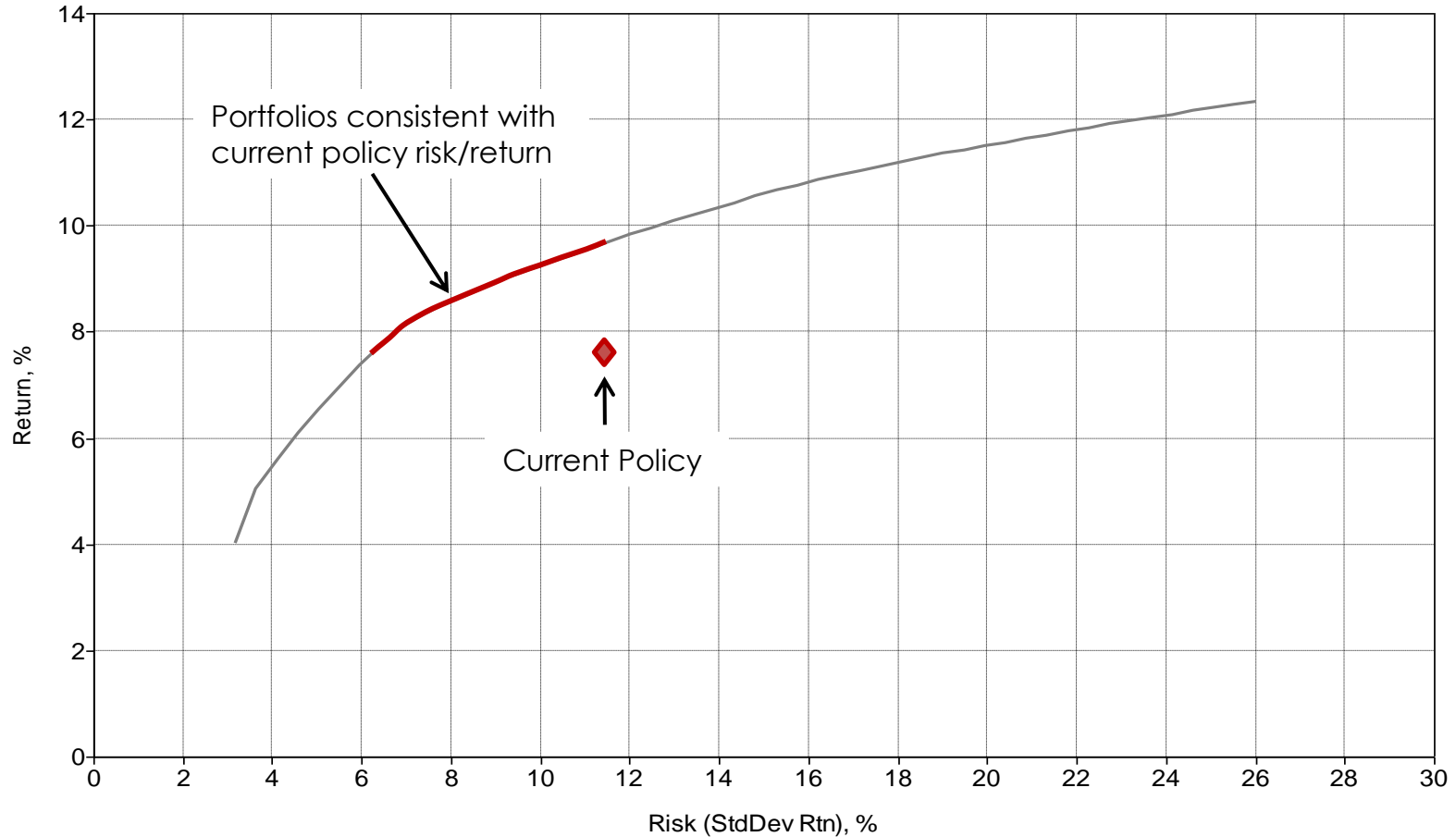


Low Risk Portfolio: largely Principal Protection

Max Risk Portfolio: 100% Private Growth

Mean-Variance Optimization (MVO) Output for ERS

Unconstrained Results

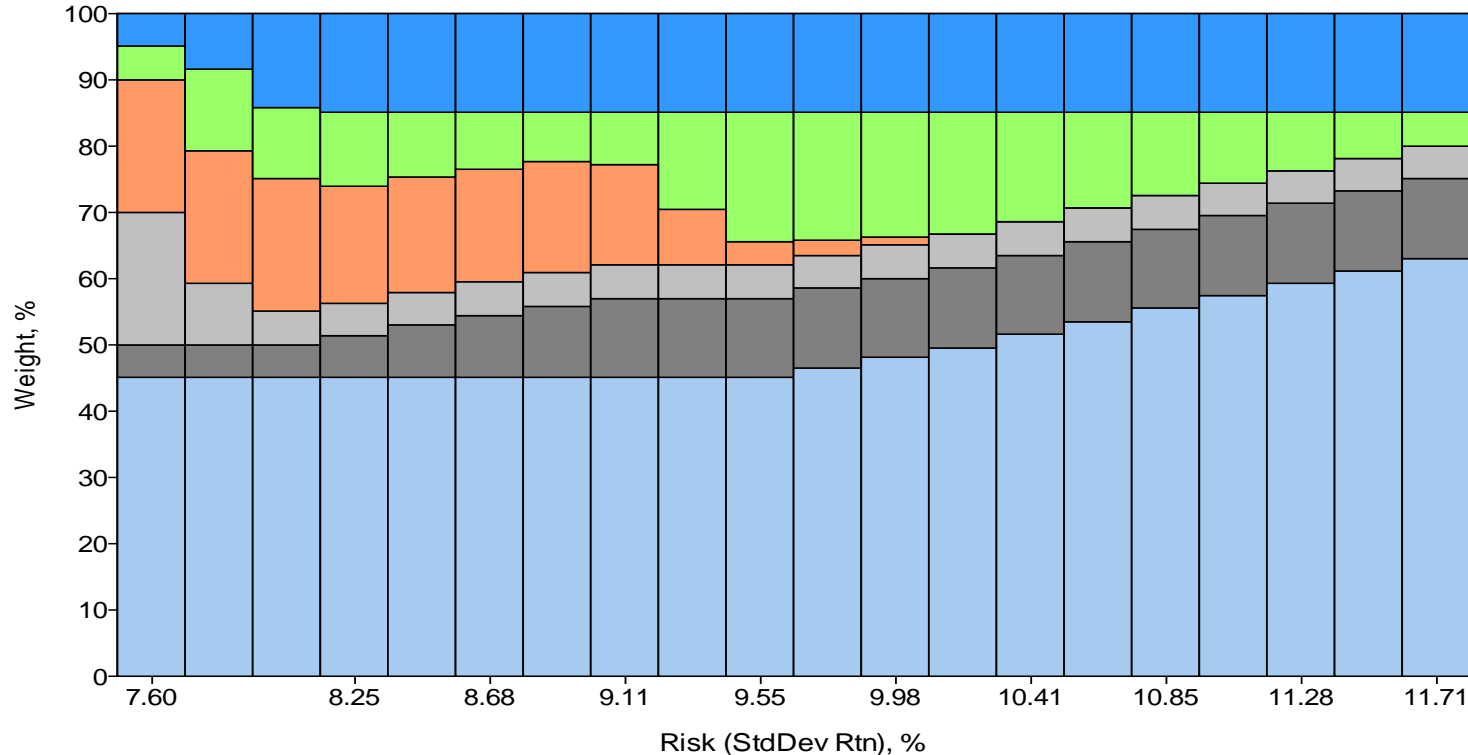


Return Estimates: 4.0% to 12.4%

Risk Estimates: 3.2% to 26.0%

Mean-Variance Optimization (MVO) Output for ERS

Constrained Results



■ Real Estate
■ Principal Protection

■ Real Return
■ Private Growth

■ Crisis Risk Offset
■ Public Growth

Low Risk Portfolio:

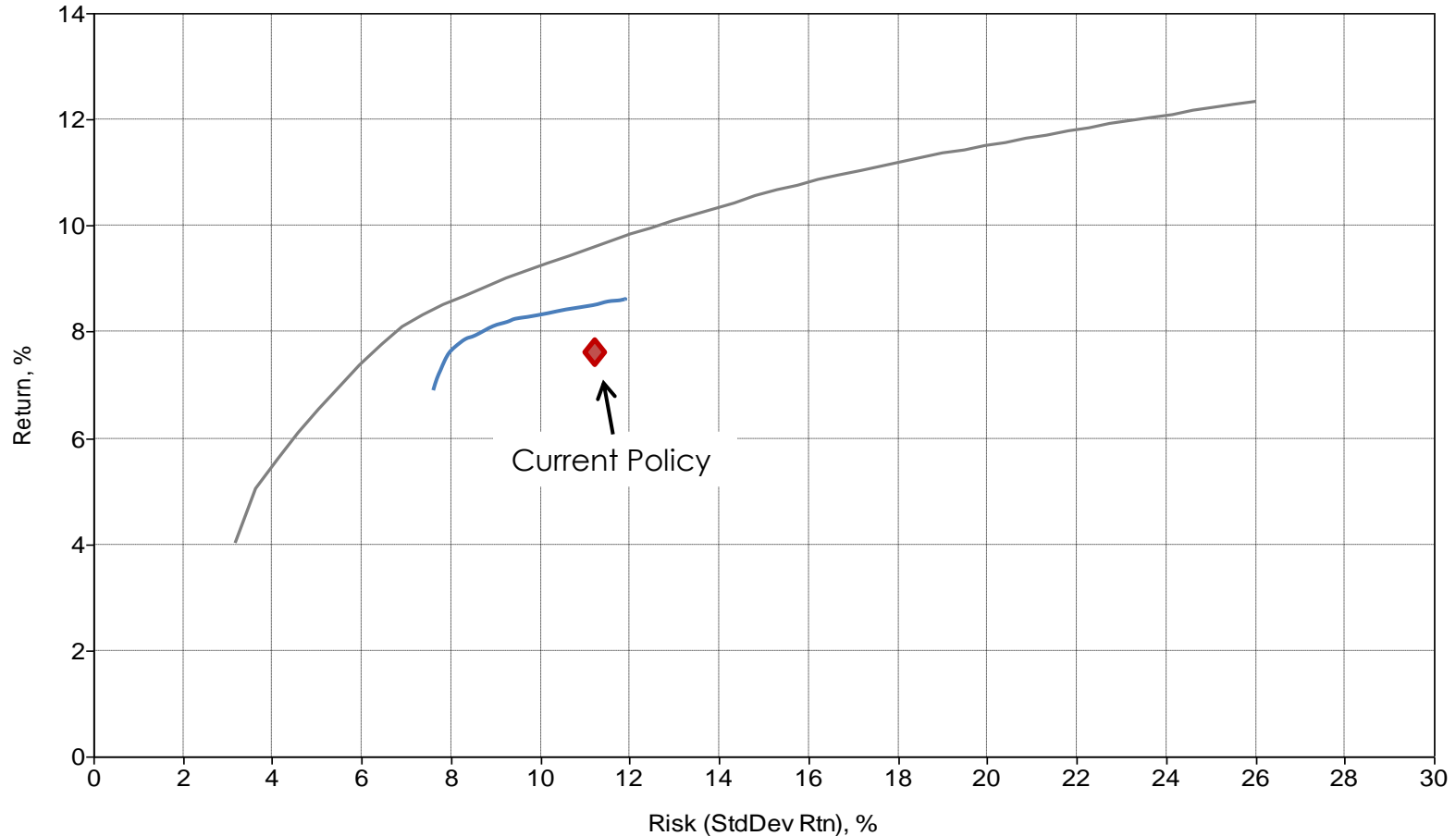
maximums in Principal Protection & CRO
 minimums in Public Growth, Real Return, Real Estate & Private Growth

Max Risk Portfolio:

maximums in Private Growth & Real Estate
 minimums in Principal Protection, Real Return & CRO

Mean-Variance Optimization (MVO) Output for ERS

Unconstrained vs. Constrained Results



- Constraints shift the efficient frontier down and to the right

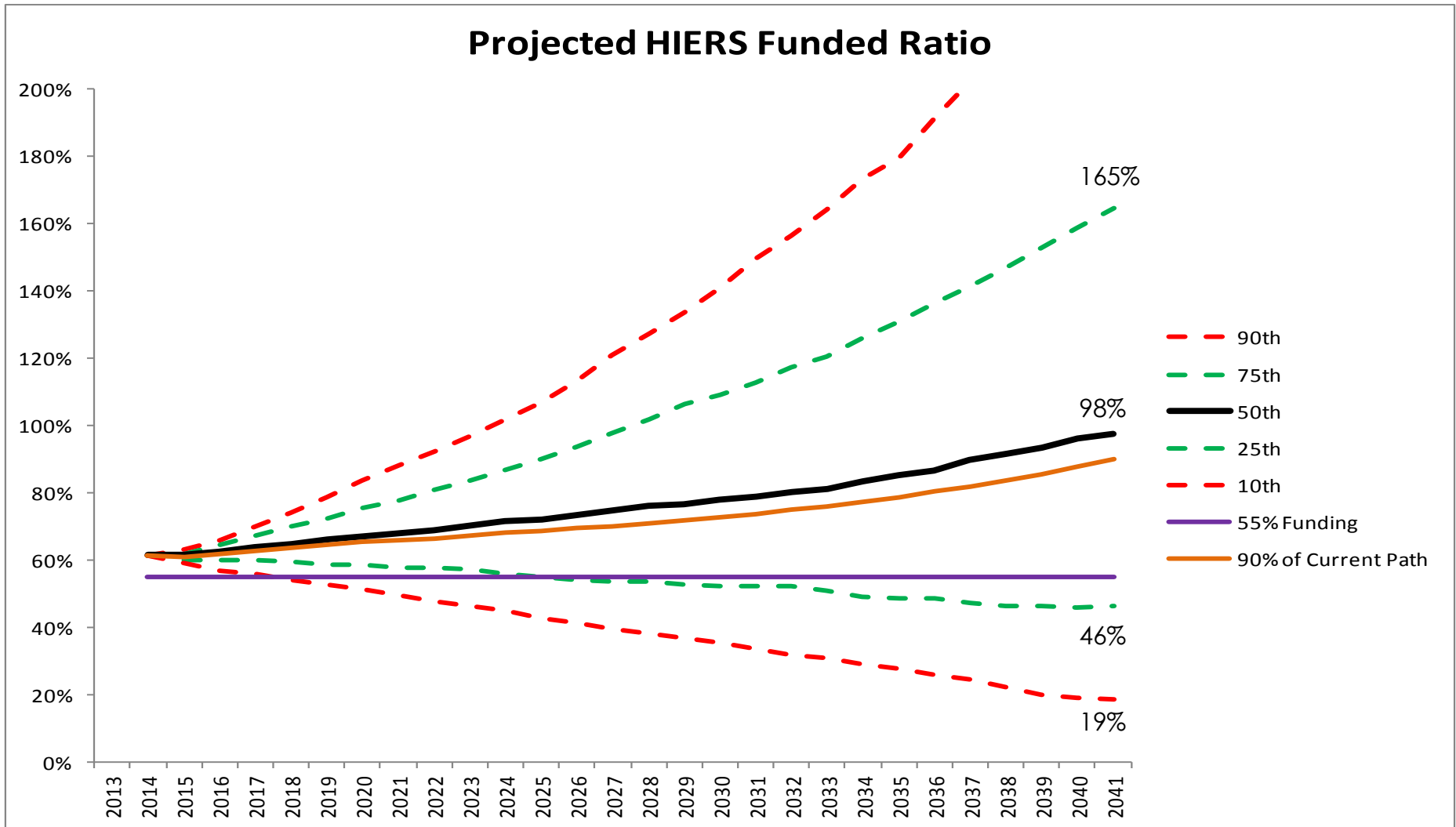
Mean-Variance Optimization (MVO) Output for ERS

Constrained MVO Portfolio Options

		Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	Portfolio 6	Portfolio 7	Portfolio 8	Portfolio 9	Portfolio 10
Risk / Return	Expected 27-year Compound Return	6.7	7.1	7.4	7.5	7.6	7.7	7.7	7.8	7.8	7.8
	Annual Standard Deviation	7.6	7.8	8.1	8.3	8.5	8.7	9.0	9.2	9.4	9.7
Portfolio Weights	Public Growth	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Private Growth	5.0	5.0	5.0	6.3	7.9	9.4	10.9	12.0	12.0	12.0
	Principal Protection	20.0	9.4	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Crisis Risk Offset	20.0	20.0	20.0	17.6	17.3	17.1	16.8	15.2	8.5	3.6
	Real Return	5.0	12.3	10.9	11.1	9.7	8.5	7.4	7.8	14.5	19.4
	Real Estate	5.0	8.3	14.1	15.0	15.0	15.0	15.0	15.0	15.0	15.0

		Portfolio 11	Portfolio 12	Portfolio 13	Portfolio 14	Portfolio 15	Portfolio 16	Portfolio 17	Portfolio 18	Portfolio 19	Portfolio 20
Risk / Return	Expected 27-year Compound Return	7.9	7.9	7.9	7.9	7.9	7.9	7.9	8.0	8.0	8.0
	Annual Standard Deviation	9.9	10.1	10.3	10.6	10.8	11.0	11.3	11.5	11.7	11.9
Portfolio Weights	Public Growth	46.5	48.1	49.6	51.6	53.6	55.5	57.4	59.3	61.2	63.0
	Private Growth	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
	Principal Protection	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Crisis Risk Offset	2.3	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Real Return	19.2	18.7	18.2	16.4	14.4	12.5	10.6	8.7	6.8	5.0
	Real Estate	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

Appendix



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