

# FEDERAL THRIFT SAVINGS PLAN

## L Funds: Analysis of Additional Asset Classes

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## Background

- In order to analyze the impact of certain additional asset classes on the Thrift Savings Plan Lifecycle Funds, we have assessed the impact of these asset classes using mean-variance optimization
- We are reflecting the new allocations approved in 2013 (Increase G Allocation over 5-year period)
- We have incorporated constraints as detailed in the appendix (in addition to the standard constraints detailed in our main presentation)
- We have outlined proposed allocations for each scenario
  - Add Emerging Markets Equity (EME)
  - Add International Small Cap (ISC)
  - Add Global REITs
  - Add Commodities
  - Add All of the above

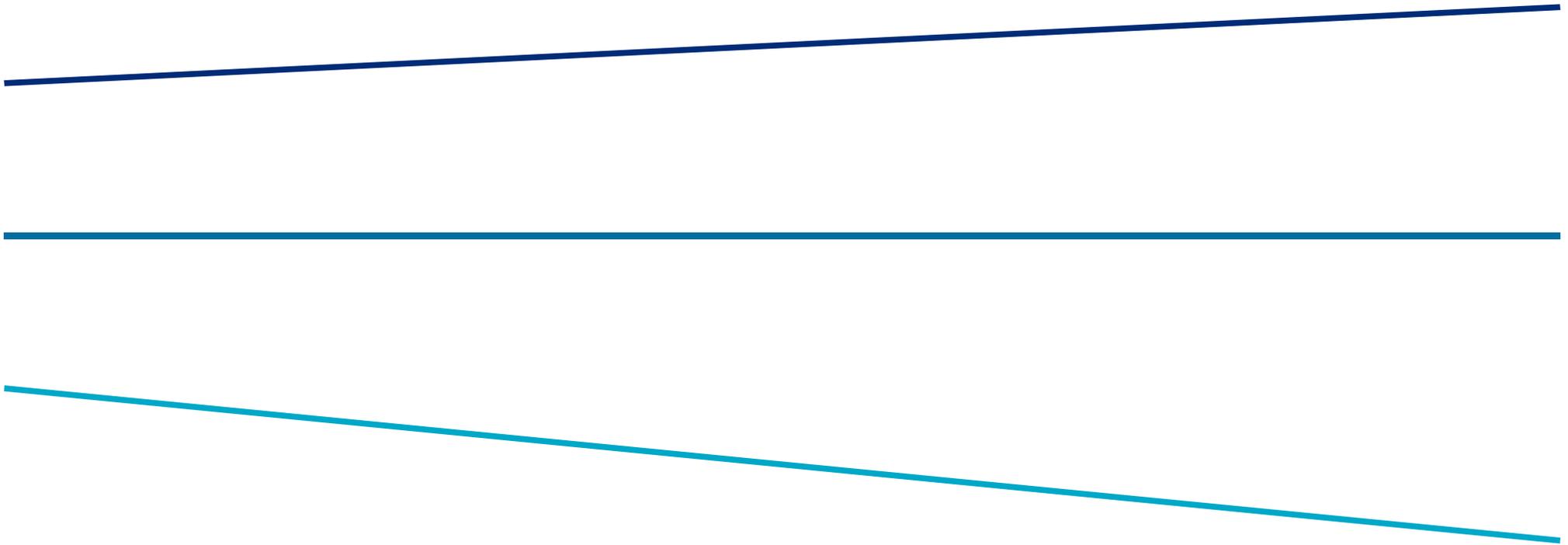
## Executive Summary

*A review of the analysis and metrics highlights the following:*

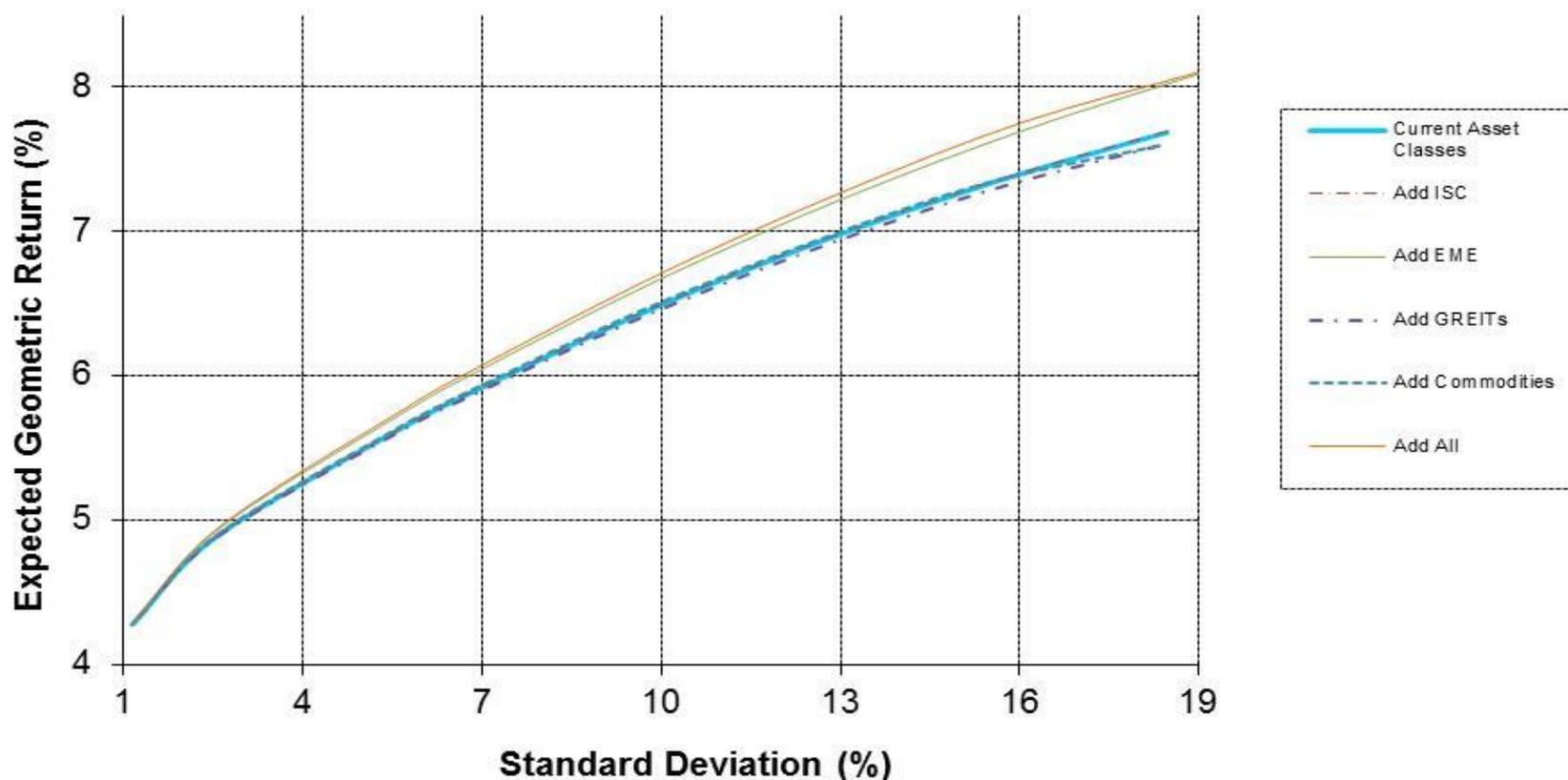
- Incorporating additional asset classes generally creates opportunity for higher returns for a given level of risk due to diversification benefits
- Of the additional asset classes considered, emerging markets equities have the highest long term return potential based on Mercer's capital market outlook
- Commodities are least correlated with the existing L Fund lineup, so provide the most potential diversification benefit, although expected returns for commodities are lower than the other classes considered
- In terms of participant outcomes, adding emerging markets equities alone or adding all four classes combined provide the best improvement in results
  - Overall, outcomes are very similar to the current L Funds



# Efficient Frontiers with Additional Asset Classes

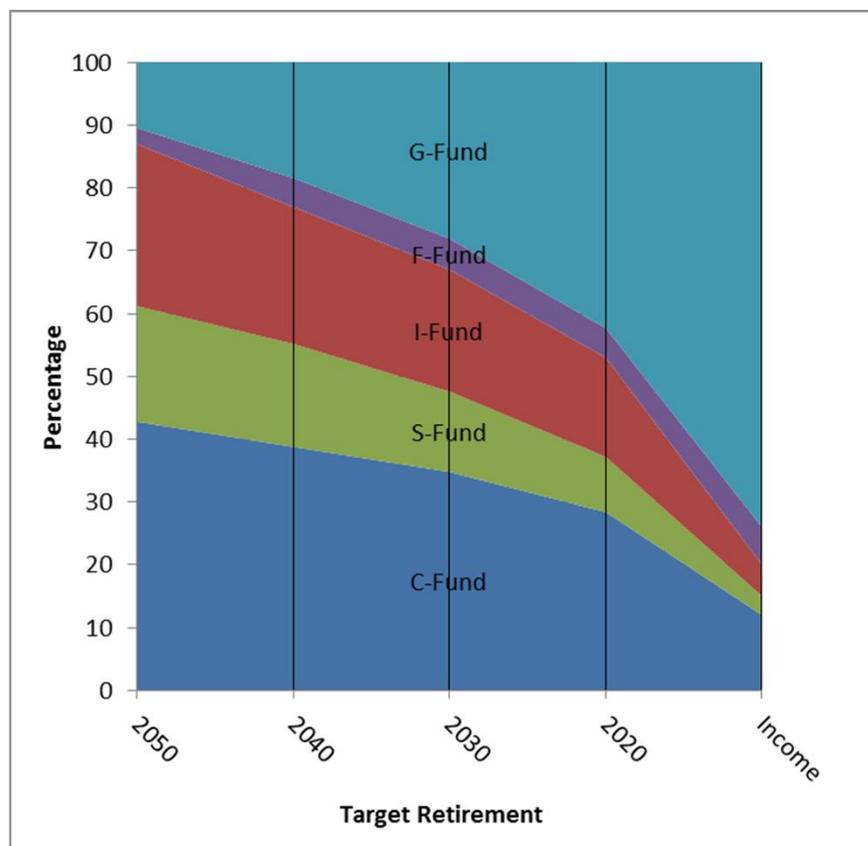


## Efficient Frontiers with Additional Classes



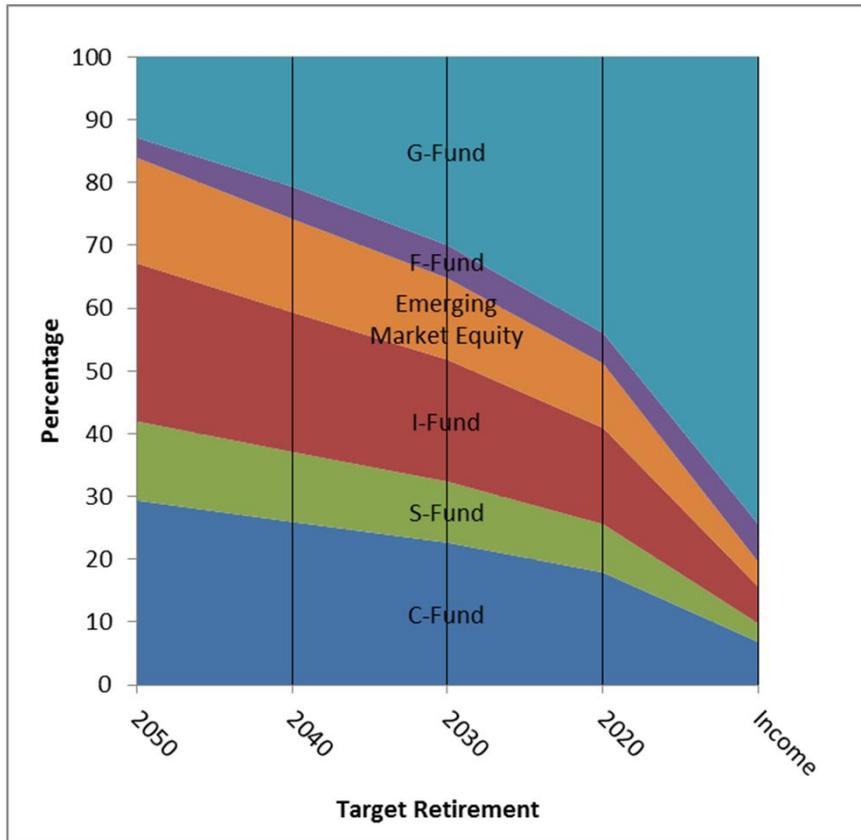
- EME has largest impact on efficient frontier
- International small cap least beneficial due to constraints on total small cap exposure
- Other classes add some diversification, slight improvement in return expectations for given risk level

## Increase G Fund Allocations (Approved November 2013)



Allocations	2050 Portfolio	2040 Portfolio	2030 Portfolio	2020 Portfolio	Income Portfolio
C-Fund	42.8	38.8	34.8	28.4	12.0
S-Fund	18.4	16.4	12.8	8.8	3.0
I-Fund	25.8	21.8	19.4	15.8	5.0
F-Fund	2.6	4.6	5.0	4.7	6.0
G-Fund	10.4	18.4	28.1	42.3	74.0
Emerging Market Equity					
International Small Cap					
Global REITs					
Commodities					
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>Asset Class Ratios</b>					
Pct Eq (ex-REITs/Comm)	87.0	77.0	67.0	53.0	20.0
S-Fund/Domestic Eq	30.1	29.7	26.9	23.7	20.0
Int Eq/Tot Eq	29.7	28.3	29.0	29.8	25.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5
<b>Mean/Variance Statistics</b>					
Geometric Return	7.31%	7.06%	6.79%	6.37%	5.15%
Arithmetic Return	8.47%	7.97%	7.48%	6.80%	5.22%
Std Dev	15.96%	14.14%	12.27%	9.68%	3.77%
Reward/Risk Ratio	0.46	0.50	0.55	0.66	1.37
Sharpe Ratio (@2%)	0.33	0.36	0.39	0.45	0.84

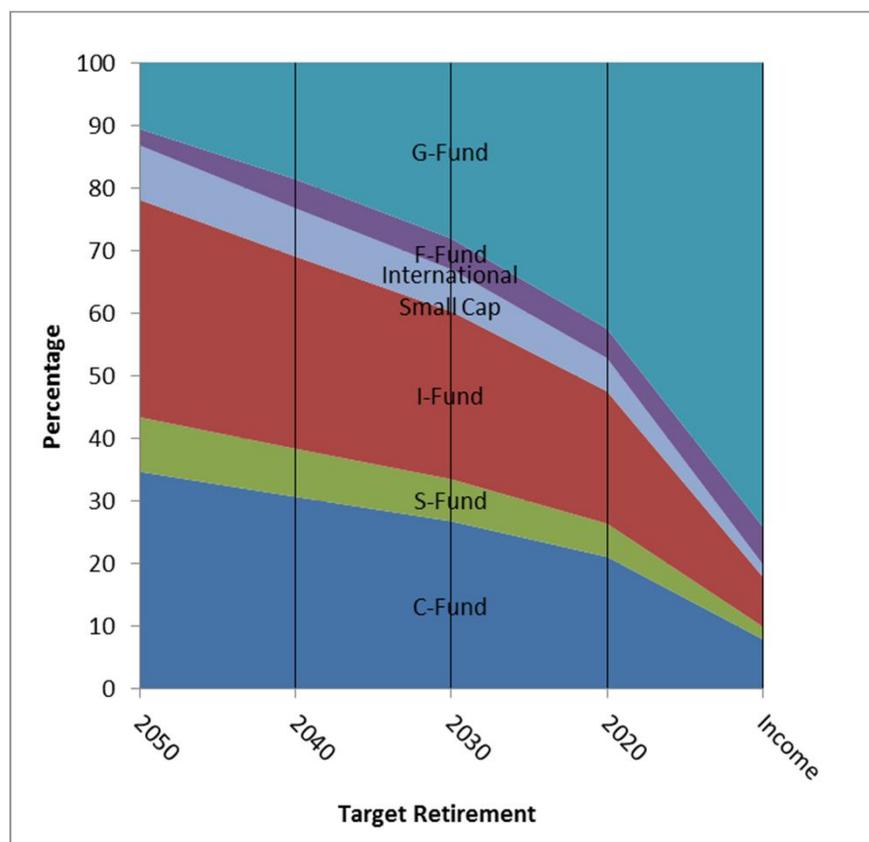
# Proposed Allocations: Add Emerging Markets



Allocations	2050 Portfolio	2040 Portfolio	2030 Portfolio	2020 Portfolio	Income Portfolio
C-Fund	29.4	26.0	22.5	17.8	6.7
S-Fund	12.6	11.1	9.7	7.6	2.9
I-Fund	25.2	22.3	19.3	15.3	5.7
F-Fund	3.2	5.2	5.3	4.9	6.1
G-Fund	12.8	20.6	30.2	44.2	74.8
Emerging Market Equity	16.8	14.8	12.9	10.2	3.8
International Small Cap	0.0	0.0	0.0	0.0	0.0
Global REITs	0.0	0.0	0.0	0.0	0.0
Commodities	0.0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>Asset Class Ratios</b>					
Pct Eq (ex-REITs/Comm)	84.0	74.2	64.4	50.8	19.1
S-Fund/Domestic Eq	30.0	30.0	30.0	30.0	30.0
Int Eq/Tot Eq	50.0	50.0	50.0	50.0	50.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5
<b>Mean/Variance Statistics</b>					
Geometric Return	7.68%	7.39%	7.08%	6.60%	5.25%
Arithmetic Return	8.85%	8.31%	7.78%	7.04%	5.32%
Std Dev	16.03%	14.18%	12.32%	9.74%	3.79%
Reward/Risk Ratio	0.48	0.52	0.57	0.68	1.39
Sharpe Ratio (@2%)	0.35	0.38	0.41	0.47	0.86

- Weight to EME up to 40% of total Non-US equity (overweight relative to ACWI ex-US)
- EME has highest expected return of additional asset classes
- Due to higher risk, total equity allocation reduced for same risk portfolios

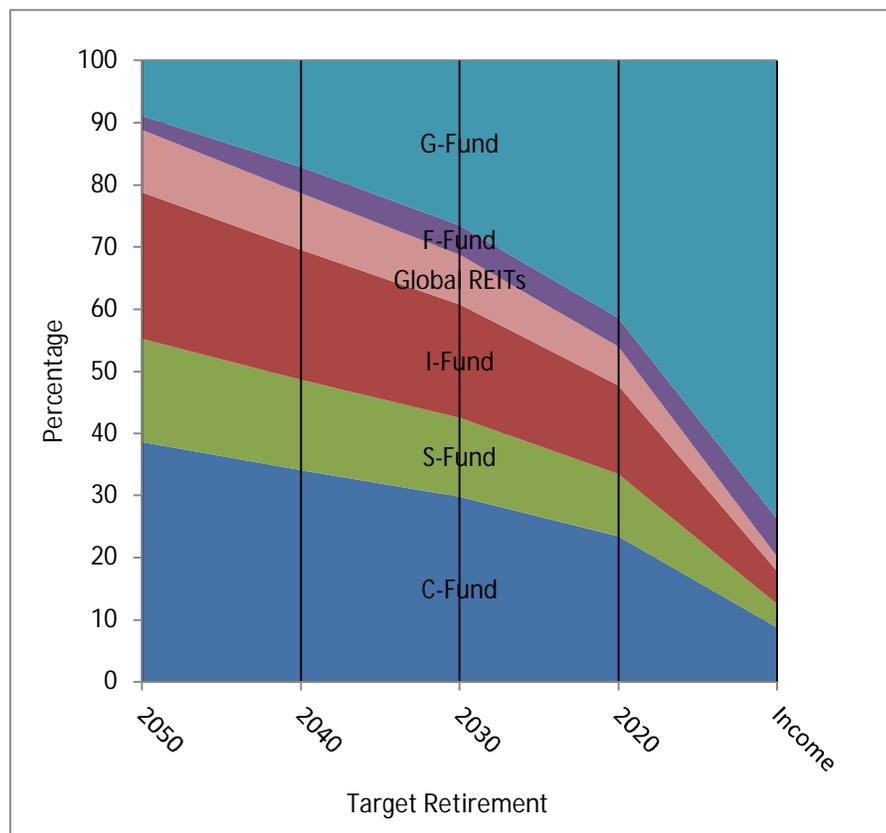
## Proposed Allocations: Add International Small Cap



Allocations	2050 Portfolio	2040 Portfolio	2030 Portfolio	2020 Portfolio	Income Portfolio
C-Fund	34.7	30.7	26.7	21.0	7.8
S-Fund	8.7	7.7	6.7	5.3	2.0
I-Fund	34.7	30.7	26.7	21.0	7.8
F-Fund	2.6	4.6	5.0	4.7	6.0
G-Fund	10.5	18.6	28.3	42.7	74.4
Emerging Market Equity	0.0	0.0	0.0	0.0	0.0
International Small Cap	8.7	7.7	6.7	5.3	2.0
Global REITs	0.0	0.0	0.0	0.0	0.0
Commodities	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0
<b>Asset Class Ratios</b>					
Pct Eq (ex-REITs/Comm)	86.8	76.8	66.7	52.5	19.6
S-Fund/Domestic Eq	20.0	20.0	20.0	20.0	20.0
Int Eq/Tot Eq	50.0	50.0	50.0	50.0	50.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5
<b>Mean/Variance Statistics</b>					
Geometric Return	7.40%	7.14%	6.86%	6.43%	5.17%
Arithmetic Return	8.56%	8.06%	7.56%	6.87%	5.24%
Std Dev	16.04%	14.20%	12.34%	9.73%	3.76%
Reward/Risk Ratio	0.46	0.50	0.56	0.66	1.38
Sharpe Ratio (@2%)	0.34	0.36	0.39	0.45	0.84

- ISC limited to 20% of Total Non-US equity
- S Fund also limited further to keep total small cap allocation at 20% of total equity
- Expected returns very similar to current allocations

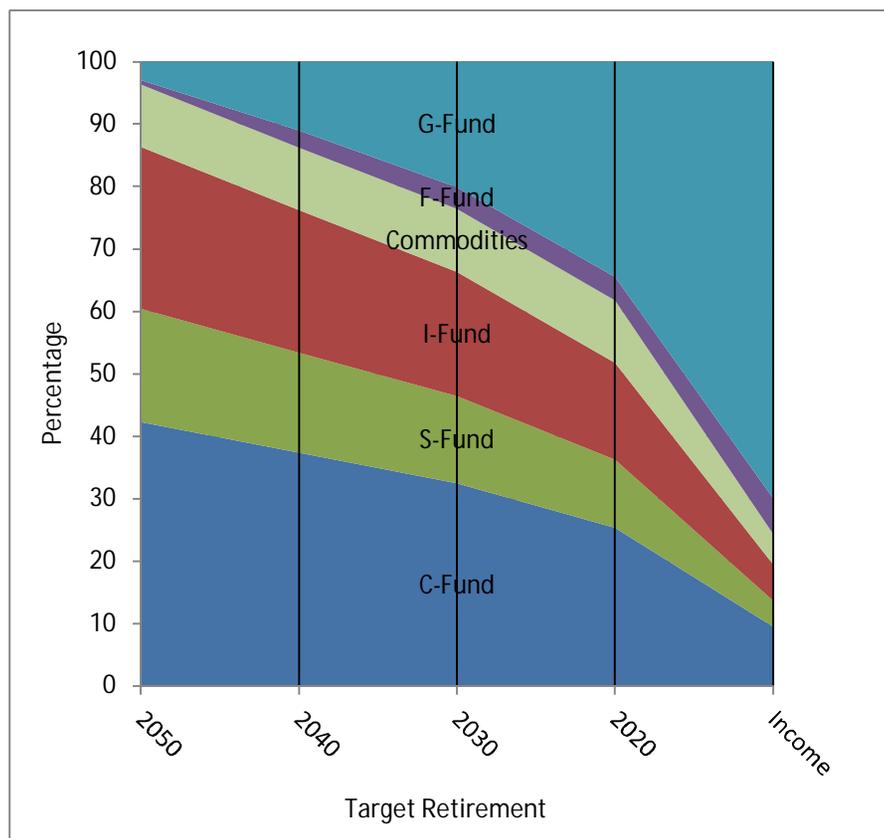
## Proposed Allocations: Add Global REITs



	2050	2040	2030	2020	Income
<b>Allocations</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>
C-Fund	38.6	34.1	29.5	23.3	8.8
S-Fund	16.6	14.6	12.6	10.0	3.8
I-Fund	23.6	20.9	18.1	14.2	5.4
F-Fund	2.2	4.3	4.8	4.6	6.0
G-Fund	8.9	17.1	27.1	41.7	73.7
Emerging Market Equity	0.0	0.0	0.0	0.0	0.0
International Small Cap	0.0	0.0	0.0	0.0	0.0
Global REITs	10.0	9.1	7.9	6.2	2.4
Commodities	0.0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>Asset Class Ratios</b>					
Pct Eq (ex-REITs/Comm)	78.8	69.5	60.2	47.5	17.9
S-Fund/Domestic Eq	30.0	30.0	30.0	30.0	30.0
Int Eq/Tot Eq	30.0	30.0	30.0	30.0	30.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5
<b>Mean/Variance Statistics</b>					
Geometric Return	7.34%	7.09%	6.82%	6.39%	5.17%
Arithmetic Return	8.51%	8.02%	7.52%	6.83%	5.24%
Std Dev	16.04%	14.21%	12.32%	9.73%	3.81%
Reward/Risk Ratio	0.46	0.50	0.55	0.66	1.36
Sharpe Ratio (@2%)	0.33	0.36	0.39	0.45	0.83

- Global REITs capped at 10% of total portfolio
- I Fund capped at 30% of total equity
- Expected returns very similar to current allocations

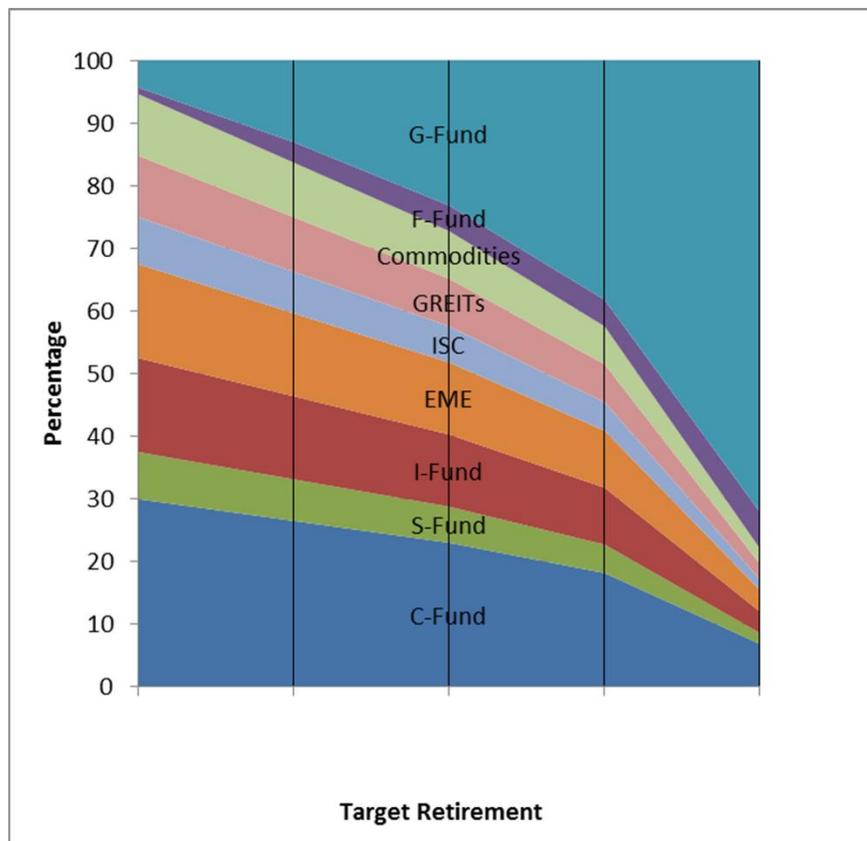
## Proposed Allocations: Add Commodities



	2050	2040	2030	2020	Income
<b>Allocations</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>	<b>Portfolio</b>
C-Fund	42.3	37.3	32.2	25.2	9.4
S-Fund	18.1	16.0	13.8	10.8	4.0
I-Fund	25.9	22.9	19.7	15.4	5.8
F-Fund	0.7	2.8	3.6	3.9	5.7
G-Fund	2.9	11.0	20.6	34.7	70.3
Emerging Market Equity	0.0	0.0	0.0	0.0	0.0
International Small Cap	0.0	0.0	0.0	0.0	0.0
Global REITs	0.0	0.0	0.0	0.0	0.0
Commodities	10.0	10.0	10.0	10.0	4.8
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>Asset Class Ratios</b>					
Pct Eq (ex-REITs/Comm)	86.3	76.2	65.8	51.4	19.2
S-Fund/Domestic Eq	30.0	30.0	30.0	30.0	30.0
Int Eq/Tot Eq	30.0	30.0	30.0	30.0	30.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5
<b>Mean/Variance Statistics</b>					
Geometric Return	7.41%	7.16%	6.88%	6.44%	5.19%
Arithmetic Return	8.57%	8.08%	7.57%	6.88%	5.26%
Std Dev	16.03%	14.20%	12.31%	9.73%	3.81%
Reward/Risk Ratio	0.46	0.50	0.56	0.66	1.36
Sharpe Ratio (@2%)	0.34	0.36	0.40	0.46	0.84

- Commodities capped at 10% of total portfolio
- I Fund capped at 30% of total equity
- Expected returns slightly higher than current allocations

## Proposed Allocations: Add All



Allocations	2050 Portfolio	2040 Portfolio	2030 Portfolio	2020 Portfolio	Income Portfolio
C-Fund	29.9	26.4	22.9	18.1	6.8
S-Fund	7.5	6.6	5.7	4.5	1.7
I-Fund	14.9	13.2	11.5	9.0	3.4
F-Fund	1.1	3.3	4.1	4.3	5.9
G-Fund	4.6	13.3	23.5	38.5	72.4
Emerging Market Equity	14.9	13.2	11.5	9.0	3.4
International Small Cap	7.5	6.6	5.7	4.5	1.7
Global REITs	9.8	8.7	7.6	6.0	2.4
Commodities	9.8	8.7	7.6	6.0	2.4
Total	100.0	100.0	100.0	100.0	100.0

Asset Class Ratios	2050	2040	2030	2020	Income
Pct Eq (ex-REITs/Comm)	74.7	66.0	57.3	45.2	16.9
S-Fund/Domestic Eq	20.0	20.0	20.0	20.0	20.0
Int Eq/Tot Eq	50.0	50.0	50.0	50.0	50.0
F-Fund/Total FI	20.0	20.0	15.0	10.0	7.5

Mean/Variance Statistics	2050	2040	2030	2020	Income
Geometric Return	7.75%	7.45%	7.13%	6.64%	5.26%
Arithmetic Return	8.91%	8.36%	7.83%	7.08%	5.33%
Std Dev	16.03%	14.18%	12.32%	9.74%	3.80%
Reward/Risk Ratio	0.48	0.53	0.58	0.68	1.38
Sharpe Ratio (@2%)	0.36	0.38	0.42	0.48	0.86



# Stochastic Modeling

## Stochastic Modeling

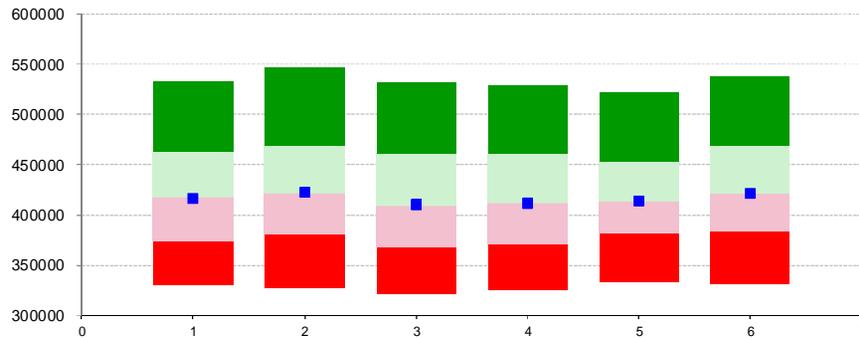
- We projected inflation, economic growth, salary growth, corporate profits, P/E ratios, interest rates and exchange rates and used these results to compute capital market returns.
- We also had special states of the world to accommodate these regimes:
  - Normal Growth: Above average growth with modest inflation
  - Recession: Negative economic growth, low inflation
  - Stagflation: Low economic growth, high inflation (6%)
  - Inflationary Growth: Above average growth with high inflation
  - Ideal Growth: Very high growth with very low inflation
  - Credit crunch: Severely negative growth, deflation
  - High Inflation: Inflation moves to 10%, growth slumps

## Model Outcomes

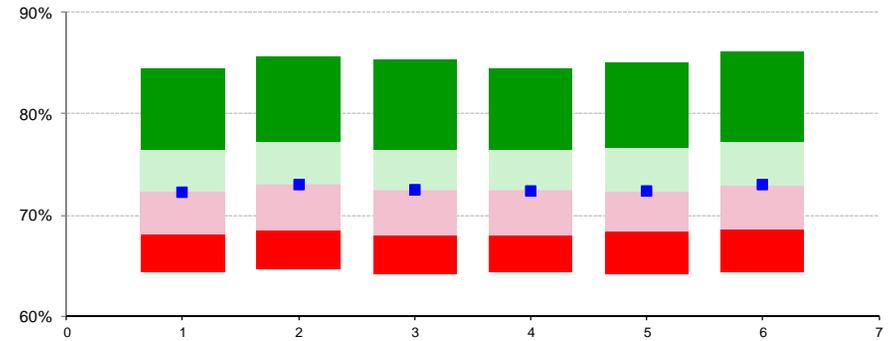
- Incorporate demographic assumptions
- Project investment outcomes by using stochastic analysis (1,000 simulations) of:
  - Economic factors
    - Inflation, growth, interest rates, salary growth, capital market returns
  - Typical behavior of participants by age group
    - Participants increase contributions over time
    - Participants retire at approximately age 61
  - Change in asset allocation over time as the Lifecycle fund becomes more conservative

# Summary of Real Account Balances and Replacement Ratios: 2030 Fund

Range of Real Account Balances



Range of Replacement Ratios



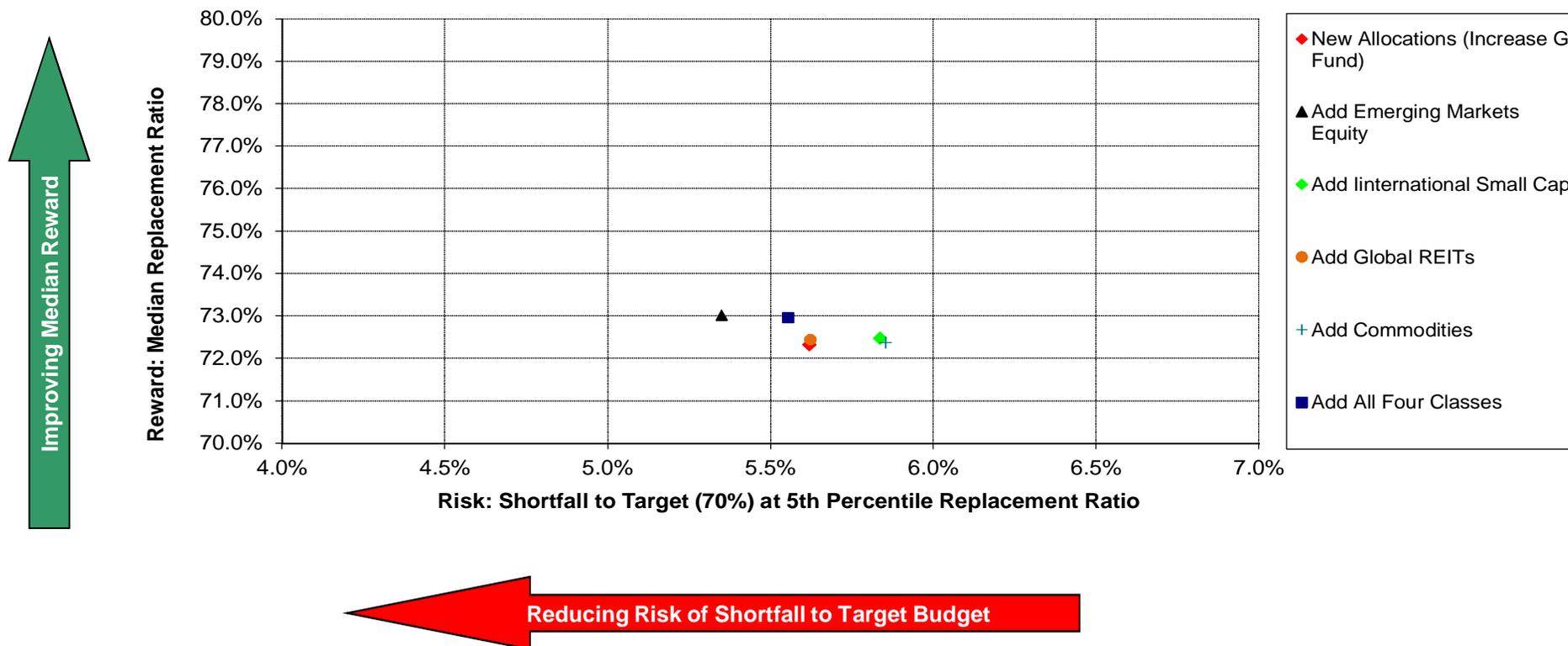
(\$ thousands)

		New Allocations (Increase G Fund)	Add Emerging Markets Equity	Add International Small Cap	Add Global REITs	Add Commodities	Add All Four Classes
95th		533	548	532	529	523	539
75th		464	469	460	461	453	469
50th		417	423	410	412	414	422
25th		374	380	369	371	381	384
5th		330	327	321	325	333	332

		New Allocations (Increase G Fund)	Add Emerging Markets Equity	Add International Small Cap	Add Global REITs	Add Commodities	Add All Four Classes
95th		84%	86%	85%	85%	85%	86%
75th		76%	77%	77%	77%	77%	77%
50th		72%	73%	72%	72%	72%	73%
25th		68%	69%	68%	68%	68%	69%
5th		64%	65%	64%	64%	64%	64%

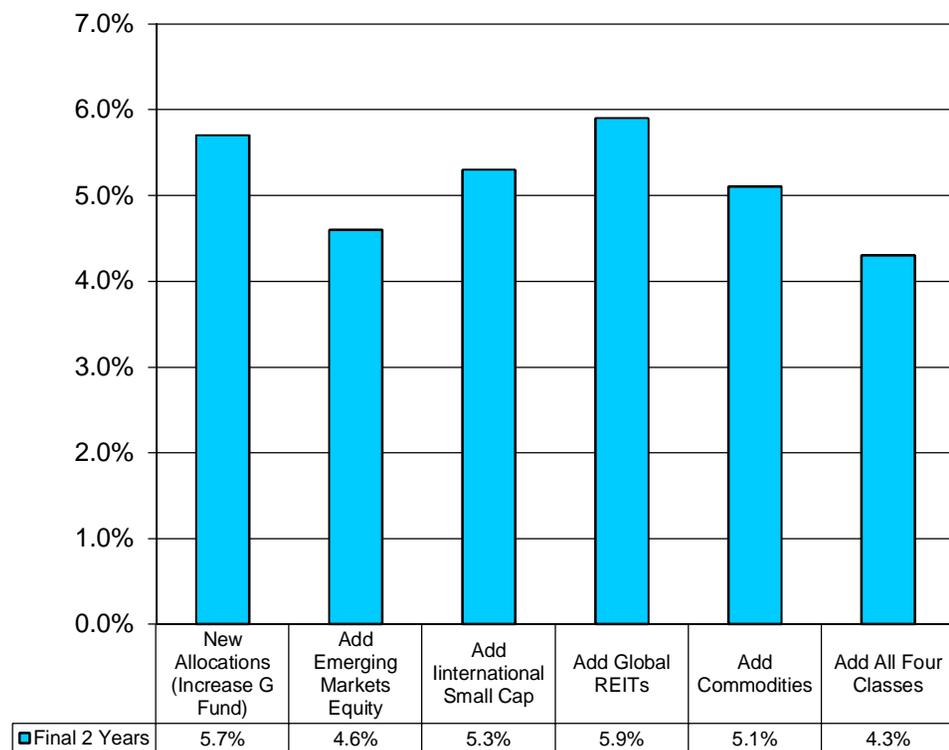
- Emerging markets equity provide improvement at median and upside outcomes without increasing downside risk at 5<sup>th</sup> percentile
- Diversification benefit of commodities in particular seen through tightening of range of outcomes

## Replacement Ratio Efficient Frontier: 2030 Fund

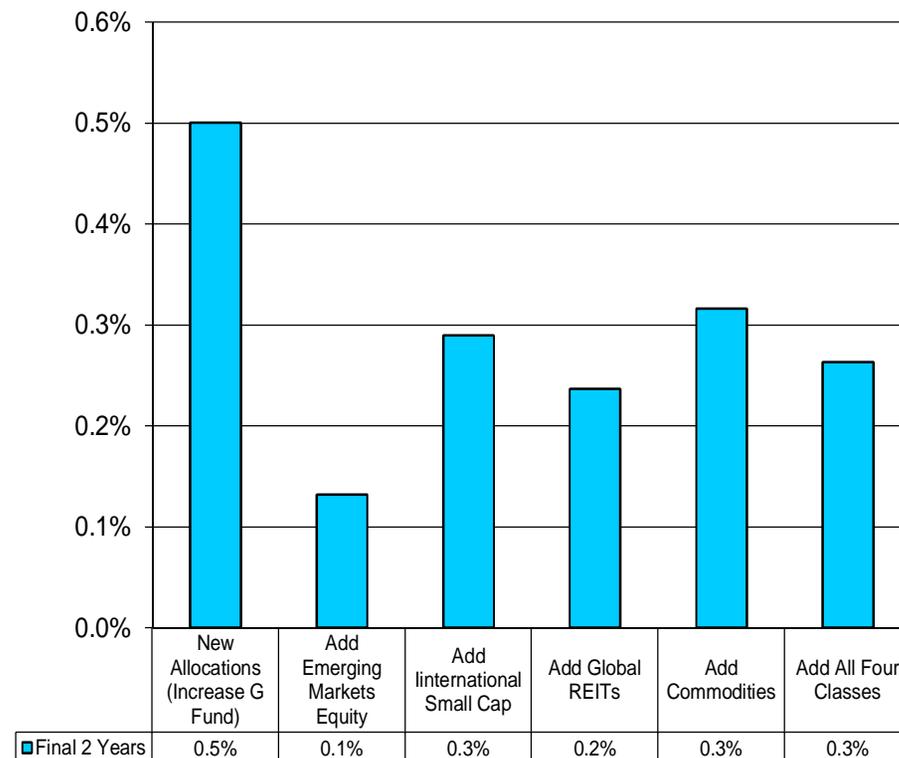


- We can look at replacement ratios in an efficient frontier context
- 70% target is at low end of typical range studies show retirees need to maintain living standard post-retirement (70% to 80%)

## Probability of Decline in Account Balance In Final Two Years Before Maturity, In Nominal and Real (Inflation-Adjusted) Terms: 2030 Fund



Probability of Loss in Final Two Years (Real)



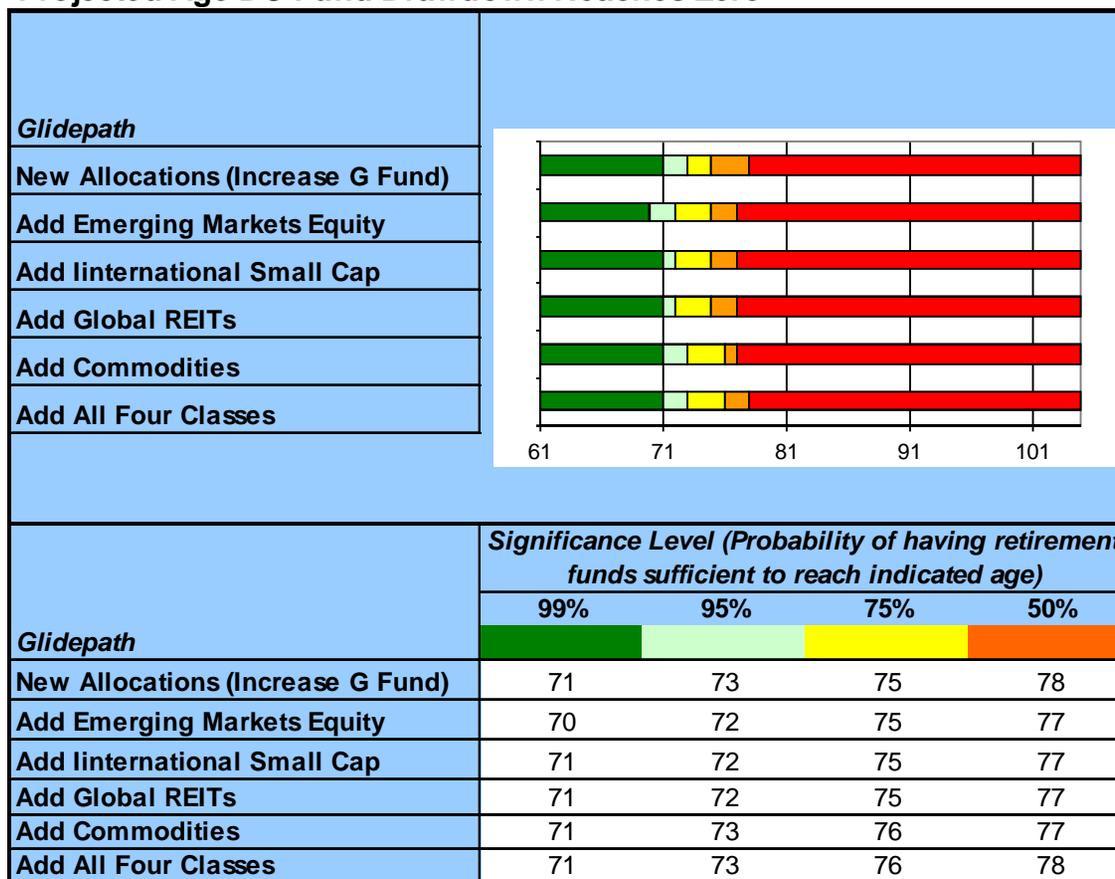
Probability of Loss in Final Two Years (Nominal)

- Emerging markets equity or adding all four classes improve capital preservation outcomes
- Inflation hedging benefit of commodities seen through different impact on real vs. nominal results

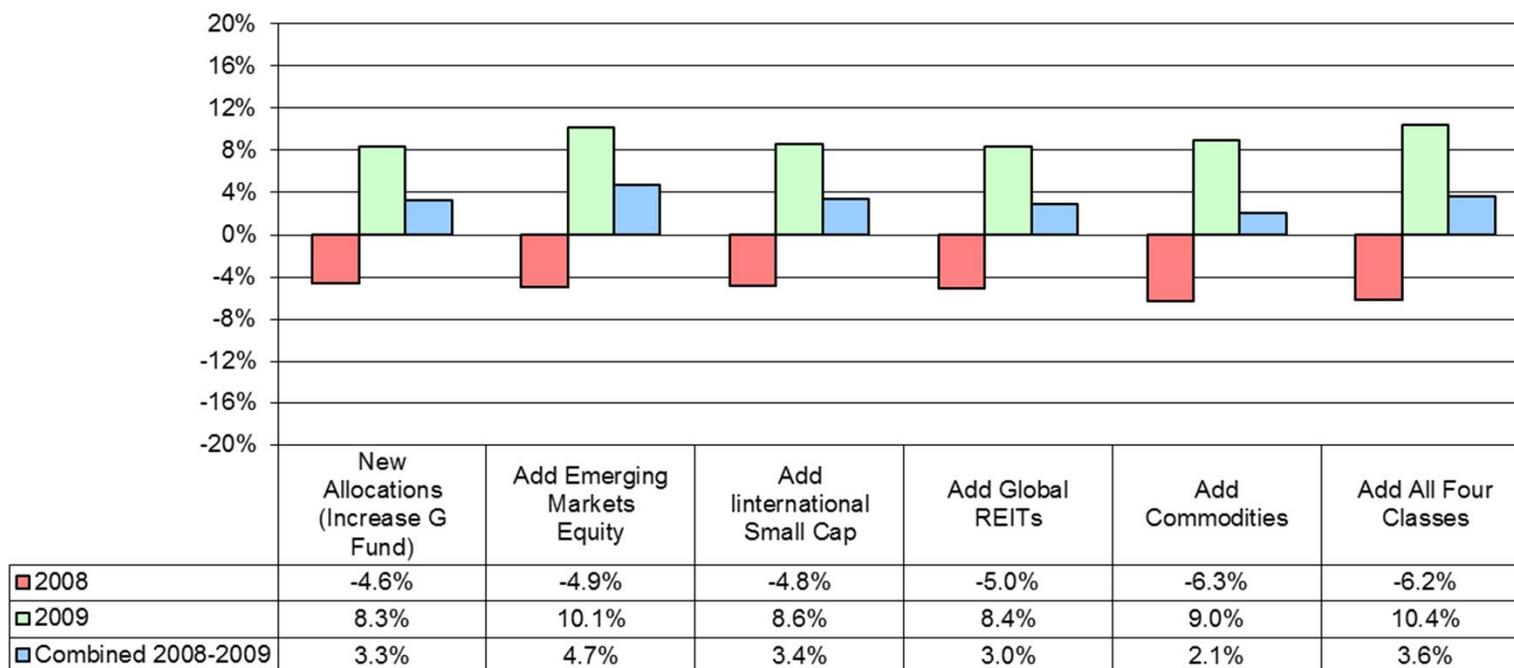
## Expected Account Depletion Ages: 2030 Fund

- Graphs look at range of account depletion ages for assumed 80% of final salary budget
- Improvement seen with commodities only or all four classes – highlights post-retirement inflation hedging benefit of commodities allocation

Projected Age DC Fund Drawdown Reaches Zero



## Stress Test: Income Fund Allocations



Stress Test: Hypothetical 2008 and 2009 Returns

- Global REITs and commodities experienced significant downturns in 2008 along with broad equity markets, so potential long term diversification benefits not seen in that period



# Appendix

## Constraints

- With EME only:
  - EME + Non-US Developed  $\leq$  50% of total equity
  - EME  $\leq$  40% of total non-US equity
- With ISC only:
  - ISC + Non-US Developed  $\leq$  50% of total equity
  - ISC  $\leq$  20% of total non-US equity
  - S Fund  $\leq$  20% of domestic equity (prior constraint was 30%)
- With Global REITs only: Global REITs capped at 10% of total portfolio
- With Commodities only: Commodities capped at 10% of total portfolio
- With Global REITs and Commodities only the I Fund is capped at 30% of total equity
- With all classes:
  - ISC  $\leq$  20% of non-US equity
  - EME  $\leq$  40% of total non-US equity
  - EME + ISC + Non-US developed  $\leq$  50% of total equity
  - S Fund  $\leq$  20% of domestic equity
  - Global REITs = Commodities (similar to diversified inflation approach)
  - Global REITs and Commodities each capped at 10% of total portfolio

## Mean Variance Assumptions

Asset Class	Geometric Return	Standard Deviation	Correlation Matrix											
			1	2	3	4	5	6	7	8	9			
C Fund	7.2%	18.0%	1.00											
S Fund	7.4%	22.1%	0.91	1.00										
I Fund	7.6%	20.3%	0.77	0.72	1.00									
F Fund	3.8%	5.3%	0.12	0.10	0.03	1.00								
G Fund	4.3%	1.2%	0.00	0.00	0.00	(0.10)	1.00							
Emerging Markets Equity Unhedged	9.1%	26.3%	0.73	0.67	0.76	(0.02)	0.00	1.00						
Non-US Developed Small Cap Equity Unhedged	7.8%	22.4%	0.73	0.80	0.94	0.04	0.00	0.72	1.00					
Global Real Estate - REITS	6.6%	21.2%	0.66	0.66	0.67	0.25	0.00	0.57	0.69	1.00				
Commodities - Long Only	4.2%	17.3%	0.04	0.04	0.11	0.18	0.00	0.06	0.10	0.11	1.00			

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Returns for periods greater than one year are annualized. Returns are calculated gross of investment management fees, unless noted as net of fees.

Style analysis graph time periods may differ reflecting the length of performance history available.

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**Mercer believes that as opportunities in the capital markets change, so do the expected returns for asset classes. A key factor in our process is the level of interest rates, as they combine the market's expectations of inflation and economic growth. In general, as interest rates rise, our expected returns will rise; as interest rates decline, our expected returns will decline. This runs counter to the realized returns as interest rates change and is part of the difference between ex ante and ex post results.**

**When interest rates change, we may change our assumptions. However, we are cautious about making changes. We have designed our assumptions to be strategic in nature, so they will typically not be adjusted to short-term market spikes. We use our judgment to determine whether interest rate moves are sustainable. In practice, we continuously review our assumptions and work to refine our methodology as we gain additional information relating to the capital markets, but we do not anticipate changes every time interest rates rise in 25 or 50 basis point increments.**

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