



# Texas Municipal Retirement System

## Asset Allocation Study

GYdhYa VYf 2019



**Texas Municipal Retirement System  
Asset Allocation Study  
GYdHya VYf 2019**

## **Introduction**

The selection of the asset allocation is one of the most important decisions that Texas Municipal Retirement System can make. It is the major determinant of both the long-term rates of return and the volatility of asset values. Two facets comprise the asset allocation decision: identification of the alternative asset allocations to be considered and selection of the alternative allocation that best meets the investment objectives. The identification of alternative asset allocations begins with estimating the probable future performance of the various asset classes. Using these projections, we can identify the most desirable alternative allocations (potential portfolios) and evaluate them in light of the investment objectives to select that which is most appropriate.

The structure of this report follows the process described above. First, we present our return and risk expectations for each asset class, along with a brief explanation of their relevance to asset allocation. Next, the report will address the creation of the asset allocation alternatives. A description of how the alternatives were identified accompanies a table detailing their composition.

## **Asset Class Expectations**

To create asset allocation alternatives, it is necessary to estimate, for each asset class to be employed, its probable return, risk, and behavior relative to other asset classes. The expected returns are our best estimates of the average annual percentage increases in the values of each asset class over a prospective long period of time. The expected returns and risks (as measured by standard deviation of returns) are listed on the left side of Figure 1 (page 4), and the historical risks and returns of each asset class, as measured by comparable indexes, are listed on the right side of Figure 1 (page 4).

# Asset Allocation Inputs

## RVK Assumptions: Summary of Year-over-Year Changes

Asset Class	Benchmark	2018			2019			Change (2019 - 2018)		
		Nominal Return (Arith.)	Risk (St. Dev.)	Nominal Return (Geo.)	Nominal Return (Arith.)	Risk (St. Dev.)	Nominal Return (Geo.)	Nominal Return (Arith.)	Risk (St. Dev.)	Nominal Return (Geo.)
Large/Mid Cap US Equity	S&P 500 (Cap Weighted)	6.75%	17.75%	5.30%	6.75%	17.75%	5.30%	0.00%	0.00%	0.00%
Small Cap US Equity	Russell 2000	7.25%	21.25%	5.20%	7.25%	21.25%	5.20%	0.00%	0.00%	0.00%
Broad US Equity	Russell 3000	6.80%	17.80%	5.35%	6.80%	17.80%	5.35%	0.00%	0.00%	0.00%
Dev'd Large/Mid Cap Int'l Equity	MSCI EAFE (Gross)	8.00%	19.00%	6.37%	8.25%	19.00%	6.62%	0.25%	0.00%	0.25%
Dev'd Small Cap Int'l Equity	MSCI EAFE Small Cap (Gross)	8.25%	23.00%	5.89%	8.50%	23.00%	6.14%	0.25%	0.00%	0.26%
Emerging Markets Equity	MSCI Emerging Markets (Gross)	10.25%	29.00%	6.62%	10.75%	29.00%	7.14%	0.50%	0.00%	0.51%
Broad International Equity	MSCI ACW Ex US IMI (Gross)	8.60%	20.80%	6.66%	8.90%	20.95%	6.94%	0.30%	0.15%	0.28%
Global Equity	MSCI ACW IMI (Gross)	7.65%	18.35%	6.12%	7.80%	18.40%	6.26%	0.15%	0.05%	0.14%
US Aggregate Fixed Income	Bloomberg US Aggregate Bond	3.50%	6.00%	3.33%	3.75%	6.00%	3.58%	0.25%	0.00%	0.25%
Non-US Dev'd Sovereign Fixed Income UH	Citi Non-US World Gov't Bond	2.25%	10.50%	1.72%	2.25%	10.50%	1.72%	0.00%	0.00%	0.00%
Emerging Markets Debt Hard Currency	JPM EMBI Global Diversified	5.25%	12.50%	4.52%	5.75%	10.50%	5.23%	0.50%	-2.00%	0.72%
Emerging Markets Debt Local Currency	JPM GBI EM Global Diversified	5.75%	12.50%	5.02%	5.75%	12.50%	5.02%	0.00%	0.00%	0.00%
TIPS	Bloomberg US Treasury: US TIPS	3.75%	6.25%	3.56%	4.00%	6.25%	3.81%	0.25%	0.00%	0.25%
Low Duration Fixed Income	Bloomberg US Gov't/Cred: 1-3 Year	3.00%	3.50%	2.94%	3.50%	3.50%	3.44%	0.50%	0.00%	0.50%
Long Duration Fixed Income	Bloomberg US Gov't/Cred: LT Bond	3.50%	11.50%	2.87%	3.75%	11.50%	3.12%	0.25%	0.00%	0.25%
High Yield	Bloomberg US Corp: High Yield	5.50%	15.00%	4.45%	6.00%	15.00%	4.95%	0.50%	0.00%	0.50%
Core Real Estate	NCREIF ODCE (Gross) (AWA)	6.25%	12.50%	5.52%	6.00%	12.50%	5.27%	-0.25%	0.00%	-0.25%
Global REITs	MSCI World Real Estate Index (Gross)	6.25%	19.00%	4.59%	6.50%	19.00%	4.84%	0.25%	0.00%	0.25%
Funds of Hedge Funds	HFRI Fund of Funds Composite Index	5.75%	9.50%	5.33%	5.50%	9.50%	5.07%	-0.25%	0.00%	-0.25%
GTAA	Custom GTAA Index	6.00%	10.50%	5.48%	6.25%	10.50%	5.73%	0.25%	0.00%	0.25%
Private Equity	Cambridge US Private Equity Index	9.75%	25.50%	6.90%	9.50%	25.50%	6.65%	-0.25%	0.00%	-0.26%
Commodities	Bloomberg Commodity Index	5.75%	19.75%	3.95%	5.50%	19.75%	3.70%	-0.25%	0.00%	-0.25%
Diversified Inflation Strategies	Custom DIS Index	5.25%	11.50%	4.63%	5.35%	11.50%	4.73%	0.10%	0.00%	0.10%
US Inflation	Consumer Price Index	2.50%	3.00%	2.46%	2.50%	3.00%	2.46%	0.00%	0.00%	0.00%
Cash Equivalents	BofA ML 3 Mo US T-Bill	2.50%	3.00%	2.46%	3.00%	3.00%	2.96%	0.50%	0.00%	0.50%

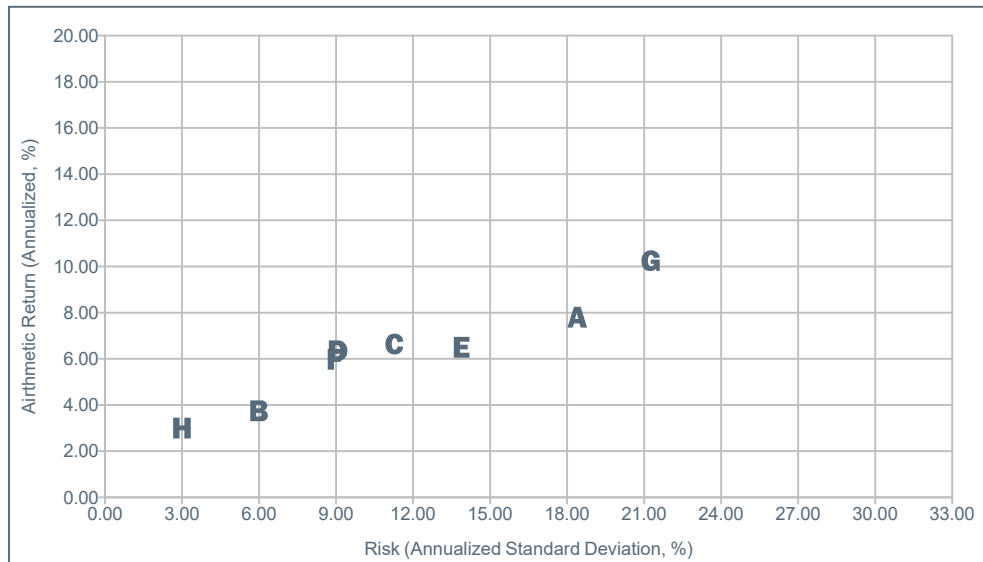
Yellow highlighted cells indicate values are being calculated based on a roll up of underlying asset classes. Global Equity is a combination of 54.0% Broad US Equity and 46.0% Broad International Equity. Broad US Equity is a combination of 92.9% Large/Mid Cap US Equity and 7.1% Small Cap US Equity. Broad International Equity is a combination of 64.0% Dev'd Large/Mid Cap Int'l Equity, 10.7% Dev'd Small Cap Int'l Equity, and 25.3% Emerging Markets Equity. Diversified Inflation Strategies is a combination of 1/3 TIPS, 1/3 Global REITs, and 1/3 Commodities. The Custom GTAA Index is comprised of 30% MSCI ACWI, 25% BB US Agg, 5% Citi Non-US WGBI UH, 10% JPM GBI EM Gbl, 10% BB US TIPS, 10% BB US HY, and 10% DJ-UBS Commodities. The Custom DIS Index is comprised of 1/3 BB US Trsry: US TIPS Index, 1/3 MSCI World Real Estate Index, and 1/3 DJ-UBS Commodity Index.

**Figure 1 - RVK Assumptions vs. Longest Historical Time Frame**

Statistics are calculated based on annual periodicity.

Asset Class	Arithmetic Return Assumption	Standard Deviation Assumption
Global Equity	7.80	18.40
US Agg Fixed Income	3.75	6.00
TMRS Non-Core Fixed Income	6.64	11.27
TMRS Real Return	6.35	9.08
TMRS Real Estate	6.50	13.89
TMRS Absolute Return Strategies	5.98	8.97
TMRS Private Equity	10.25	21.25
Cash Equivalents	3.00	3.00

Index	Longest Historical Time Frame	Annualized Arithmetic Return	Annual Standard Deviation
MSCI ACW IMI (Gross)	Jun 1994 - Dec 2018	6.94	18.88
Bloomberg US Agg Bond	Jan 1976 - Dec 2018	7.27	6.82
Custom Blend	Jan 2005 - Dec 2018	4.93	6.07
Custom Blend	Jan 1997 - Dec 2018	8.59	5.63
Custom Blend	June 1989 - Dec 2018	7.96	6.46
Custom Blend	Jan 1990 - Dec 2018	9.39	5.49
Cambridge US Private Equity Index	Jun 1986 - Jun 2018	13.72	12.96
BofA ML 3 Mo US T-Bill	Jan 1978 - Dec 2018	4.90	4.08



**A** Global Equity  
**H** Cash

**B** Agg FI

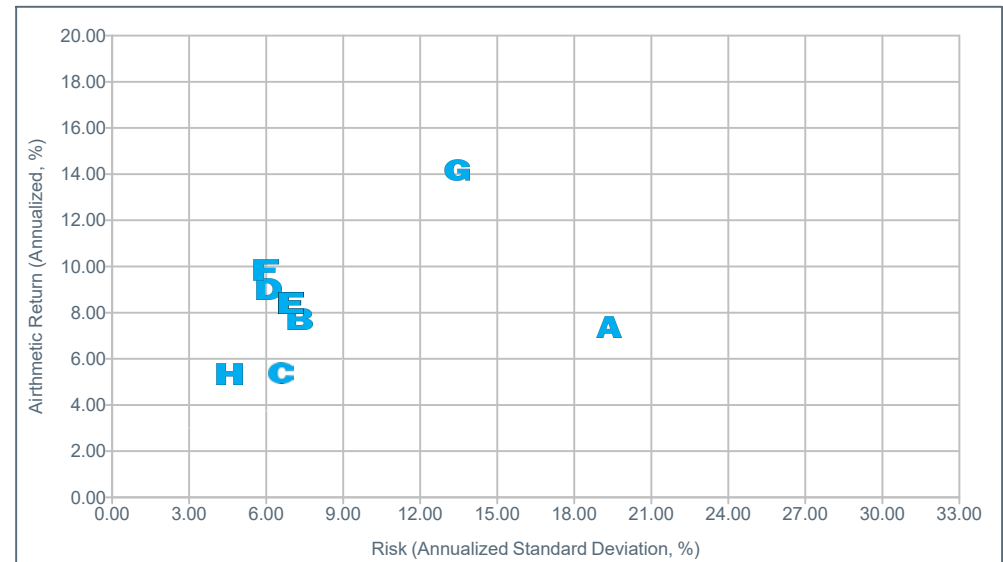
**C** Non-Core Fixed Income

**D** Real Return

**E** Real Estate

**F** Hedge Funds

**G** Priv. Eq.



\*See appendix for custom index definitions.

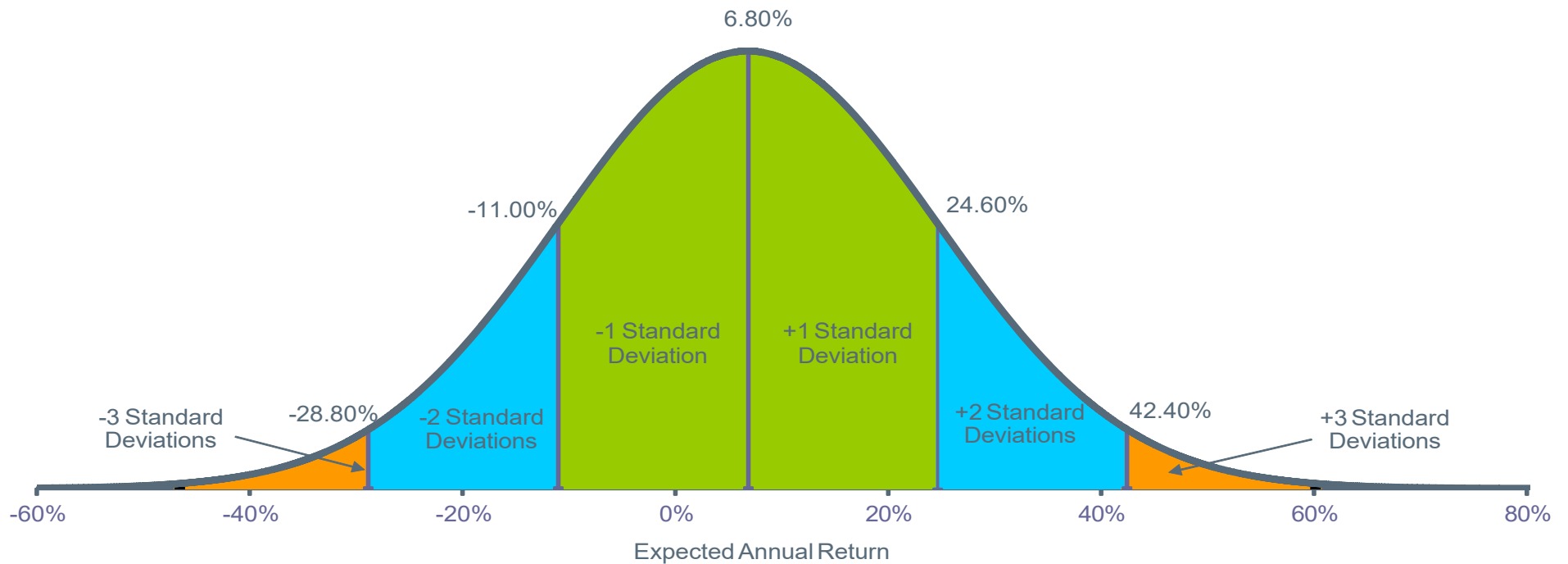
Please reference the RVK Capital Market Assumptions white paper for details of the analysis undergone in developing the assumptions for each asset class. Also, note that the relationship between the asset classes (their positioning in the graph relative to one another) is much more important for investment decision-making than the absolute expected return level of each asset class.

It is important to understand that these expectations are assumptions of long-term future performance and are, therefore, subject to uncertainty. The risk, or volatility, of each asset class reflects this uncertainty, which is quantified by the statistic known as standard deviation of returns. The standard deviation for each asset class is listed in Figure 1.

The standard deviation of returns measures the volatility ("risk") of an asset class by assigning probabilities to a range of different possible returns. If asset returns are normally distributed (bell-shaped curve) then two-thirds (67%) of all returns are expected to lie within one standard deviation on either side of the mean. For example, if we assume Broad US Equity will return, annually on average, 6.80% with a standard deviation of 17.80%, we would expect that two-thirds of the time the returns would lie between -11.00% ( $= 6.80\% - 17.80\%$ ) and 24.60% ( $= 6.80\% + 17.80\%$ ). Moreover, we would expect 95% of all return outcomes to lie within two standard deviations of the mean return, implying only a one-in-twenty chance that the return on Broad US Equity will either fall below -28.80% or rise above 42.40%. Figure 2 (next page) provides the expected range of single year returns in each asset class using the above methodology, and also uses a bell-shaped (normal distribution) diagram to illustrate the above example.

**Figure 2 - Annual Volatility of Return Assumptions**

	-3 St Dev	-2 St Dev	-1 St Dev	Expected Return	+1 St Dev	+2 St Dev	+3 St Dev
Global Equity	-47.40	-29.00	-10.60	7.80	26.20	44.60	63.00
US Agg Fixed Income	-14.25	-8.25	-2.25	3.75	9.75	15.75	21.75
TMRS Non-Core Fixed Income	-27.17	-15.90	-4.63	6.64	17.91	29.18	40.45
TMRS Real Return	-20.89	-11.81	-2.73	6.35	15.43	24.51	33.59
TMRS Real Estate	-35.17	-21.28	-7.39	6.50	20.39	34.28	48.17
TMRS Absolute Return Strategies	-20.93	-11.96	-2.99	5.98	14.95	23.92	32.89
TMRS Private Equity	-53.50	-32.25	-11.00	10.25	31.50	52.75	74.00
Cash Equivalents	-6.00	-3.00	0.00	3.00	6.00	9.00	12.00



## Correlation

Creating a diversified portfolio of asset classes enables the investor to achieve a high rate of return while minimizing volatility of the portfolio. Diversification exists because the returns of different asset classes do not always move in the same direction, at the same time, or with the same magnitude. Varied investment environments cause some asset classes to rise in value while others fall, and correlation is the measure that quantifies the degree to which asset classes do not move in tandem.

Correlation can take on values between 1.00 and -1.00. If returns of two asset classes rise or fall at the same time they are said to be perfectly correlated and have a correlation value of 1.00. Conversely, two asset classes that simultaneously move in opposite directions are said to be perfectly negatively correlated and have a correlation value of -1.00. A correlation of 0 indicates no relationship between the returns. It is imperfect correlations between asset classes that enable an investor to create efficient portfolios; that is, those with the highest amount of return at a given level of risk. The correlations for the asset classes used in this study are shown in Table 1 (next page).

The fact that the correlations shown in the table are nearly all positive does not imply that these asset classes do not diversify one another. Their correlations are significantly less than 1.00, meaning we expect a measurable number of instances when the underperformance of one or more of the asset classes will be offset by the outperformance of others.

**Table 1 - Correlation Matrix**

	Global Equity	US Agg Fixed Income	TMRS Non-Core Fixed Income	TMRS Real Return	TMRS Real Estate	TMRS Absolute Return Strategies	TMRS Private Equity	Cash Equivalents
Global Equity	1.00	-0.02	0.76	0.52	0.10	0.81	0.75	-0.05
US Agg Fixed Income	-0.02	1.00	0.17	0.22	-0.15	0.11	-0.26	0.26
TMRS Non-Core Fixed Income	0.76	0.17	1.00	0.70	-0.09	0.78	0.50	-0.11
TMRS Real Return	0.52	0.22	0.70	1.00	0.11	0.63	0.53	0.09
TMRS Real Estate	0.10	-0.15	-0.09	0.11	1.00	-0.05	0.27	0.01
TMRS Absolute Return Strategies	0.81	0.11	0.78	0.63	-0.05	1.00	0.72	0.14
TMRS Private Equity	0.75	-0.26	0.50	0.53	0.27	0.72	1.00	0.06
Cash Equivalents	-0.05	0.26	-0.11	0.09	0.01	0.14	0.06	1.00

**Table 2 - Historical Performance**

Asset Class	Global Equity	US Agg Fixed Income	TMRS Non-Core Fixed Income	TMRS Real Return	TMRS Real Estate	TMRS Absolute Return Strategies	TMRS Private Equity	Cash Equivalents
Index	MSCI ACW IMI (Gross)	Bloomberg US Agg Bond	Custom Blend	Custom Blend	Custom Blend	Custom Blend	Cambridge US Private Equity Index	BofA ML 3 Mo US T-Bill
1986		15.26						6.75
1987		2.76					4.09	6.73
1988		7.89					12.41	6.93
1989		14.53					9.71	8.99
1990		8.96			1.12	10.27	5.31	8.42
1991		16.00			-6.59	30.57	9.82	6.38
1992		7.40			-6.99	21.62	15.08	3.93
1993		9.75			-0.65	32.58	24.25	3.19
1994		-2.92			7.73	1.38	12.75	4.19
1995	17.41	18.47			8.92	22.78	24.24	6.03
1996	11.51	3.63			13.29	18.00	28.17	5.30
1997	11.17	9.65		12.75	17.79	18.56	30.53	5.33
1998	17.90	8.69		4.87	16.05	3.37	15.43	5.23
1999	31.05	-0.82		2.56	12.85	24.07	41.40	4.85
2000	-15.19	11.63		13.28	14.82	6.64	5.77	6.18
2001	-15.38	8.44		7.76	6.09	7.61	-11.65	4.42
2002	-17.24	10.25		10.62	5.5	2.03	-7.68	1.78
2003	36.08	4.10		18.75	10.45	19.74	22.66	1.15
2004	16.91	4.34		19.71	15.68	9.73	25.34	1.33
2005	12.08	2.43	4.51	15.6	24.93	8.08	28.69	3.07
2006	21.45	4.33	8.85	16.83	19.88	12.64	28.38	4.85
2007	11.66	6.97	3.52	15.44	17.34	8.19	18.85	5.00
2008	-42.01	5.24	-21.94	-7.03	-14.78	-17.89	-22.61	2.06
2009	37.18	5.93	40.06	17.69	-31.19	20.68	13.41	0.21
2010	14.87	6.54	10.73	10.84	16.89	10.31	21.74	0.13
2011	-7.43	7.84	2.72	11.49	15.61	-3.34	11.11	0.10
2012	17.04	4.21	10.30	8.66	11.48	7.34	13.36	0.11
2013	24.17	-2.02	3.91	6.84	13.74	9.40	21.08	0.07
2014	4.36	5.97	1.83	5.22	14	2.56	11.22	0.03
2015	-1.68	0.55	-2.60	-8.38	17.19	-2.8	5.65	0.05
2016	8.96	2.65	10.31	10.74	10.41	7.32	13.11	0.33
2017	24.58	3.54	5.84	7.38	8.84	6.89	17.52	0.86
2018	-9.61	0.01	-0.21	-4.05	11.94	-3.25		1.87

\*See appendix for custom index definitions.

Table 2 (previous page) lists historical annual returns for most major asset classes reflected in this study. The highest-performing asset class in each year is highlighted in blue, while the lowest-performing asset class is highlighted in green. The chart illustrates how investments among several asset classes can diversify the portfolio, helping to lower the risk level and potentially increase returns over full market cycles.

## **Asset Allocation Alternatives**

The expected returns, risks and correlations described in the previous section are the primary inputs for the model that constructs the asset allocation alternatives. The model uses this information to build many portfolios with different proportions of each, subject to whatever constraints are placed upon it. The model then determines which of these hypothetical portfolios are most "efficient" – that is, those that achieve the best combination of return and risk. Allocations achieving a given rate of return at the least amount of risk, or the highest amount of return at a specific level of risk, are known as "efficient" or "optimal" portfolios. We constrain the model to take into account reasonable minimum or maximum allocations to each asset class or groups of asset classes.

It is worth noting that the model determines optimal portfolios by considering not only the return and volatility of all asset classes individually, but also the correlations between the asset classes. Because correlation amongst asset classes is what determines the efficiency of a portfolio, another way of describing the process of minimizing volatility is maximizing diversification.

## Efficient Allocations

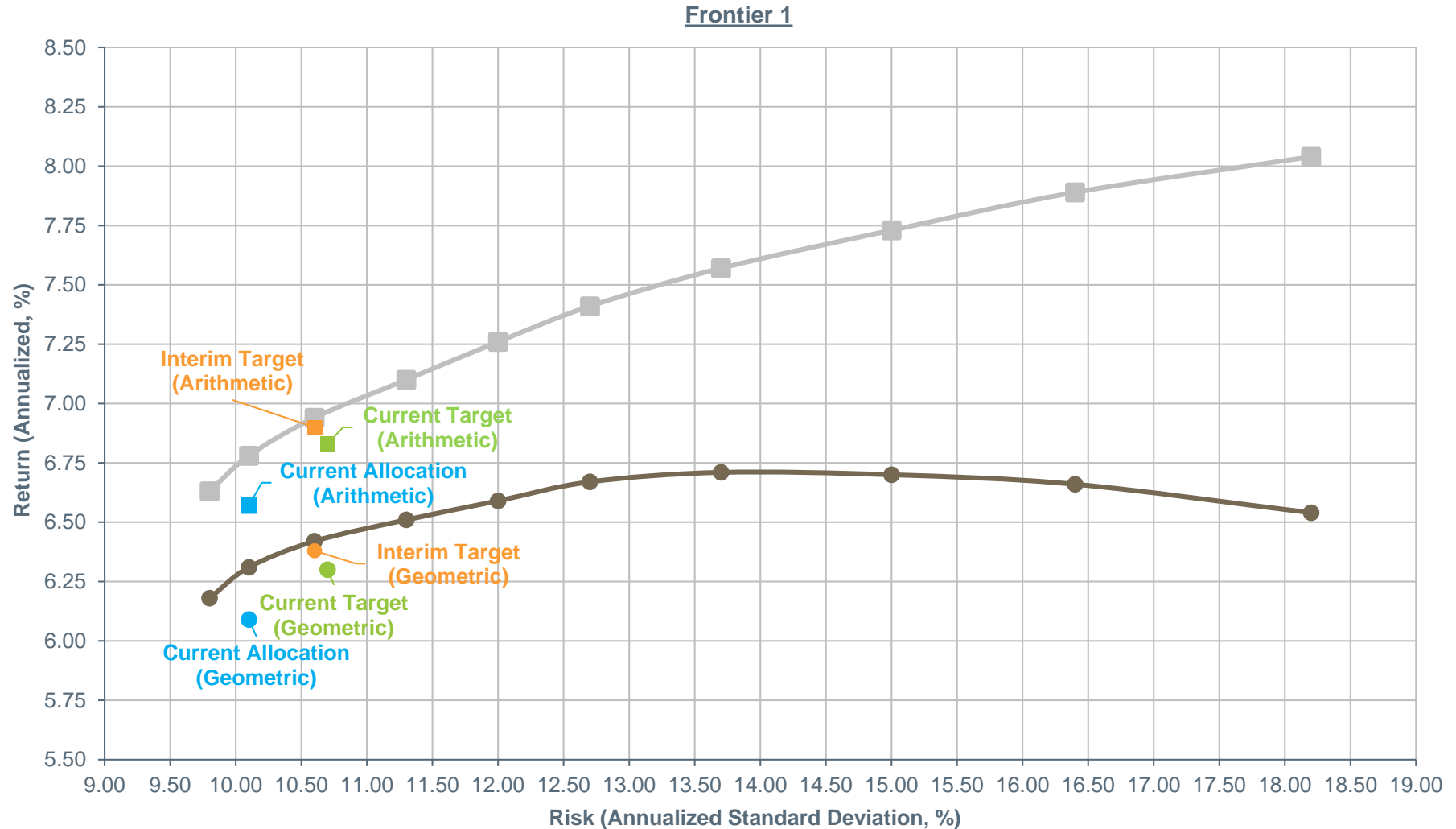
The table below shows the range of possible optimal allocations given the selected asset classes and constraints listed under "Min" and "Max." This range illustrates the tradeoff between return and risk; additional return can only be achieved by undertaking additional risk.

### Frontier 1

	Min	Max	1	2	3	4	5	6	7	8	9	10	Current Target	Current 6/30/2019	Interim Target
Global Equity	30	100	30	30	30	34	38	43	53	67	78	90	35	36	32
US Agg Fixed Income	0	15	15	15	10	6	2	0	0	0	0	0	10	14	10
TMRS Non-Core Fixed Income	0	20	20	16	20	20	20	20	17	3	0	0	20	18	20
TMRS Real Return	0	10	10	10	10	10	10	10	10	10	2	0	10	11	10
TMRS Real Estate	0	10	10	10	10	10	10	10	10	10	10	0	10	9	10
TMRS Absolute Return Strategies	0	10	10	10	10	10	10	7	0	0	0	0	10	8	10
TMRS Private Equity	0	10	5	9	10	10	10	10	10	10	10	10	5	2	8
Cash Equivalents	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Total			100	100	100	100	100	100	100	100	100	100	100	100	100
Capital Appreciation			46	49	51	55	59	64	73	82	91	100	51	48	51
Capital Preservation			15	15	10	6	2	0	0	0	0	0	10	16	10
Alpha			19	17	19	19	19	16	8	2	0	0	19	16	19
Inflation			20	19	20	20	20	20	19	17	9	0	20	20	20
Expected Arithmetic Return			6.63	6.78	6.94	7.10	7.26	7.41	7.57	7.73	7.89	8.04	6.83	6.57	6.90
Expected Risk (Standard Deviation)			9.8	10.1	10.6	11.3	12.0	12.7	13.7	15.0	16.4	18.2	10.7	10.1	10.6
Expected Compound Return			6.18	6.31	6.42	6.51	6.59	6.67	6.71	6.70	6.66	6.54	6.30	6.09	6.38
Expected Return (Arithmetic)/Risk Ratio			0.68	0.67	0.65	0.63	0.61	0.58	0.55	0.52	0.48	0.44	0.64	0.65	0.65
RVK Expected Eq Beta (LCUS Eq = 1)			0.49	0.52	0.54	0.57	0.60	0.65	0.71	0.79	0.87	0.97	0.53	0.50	0.54
RVK Liquidity Metric (T-Bills = 100)			55	54	51	51	51	53	59	67	73	82	55	60	53

## Efficient Frontier

The figure below illustrates the relationship between risk and return. The risk of each alternative allocation is plotted against the horizontal axis, while the return is measured on the vertical axis. The line connecting the points represents all the optimal portfolios subject to the given constraints and is known as the "efficient frontier." The upward slope of the efficient frontier indicates the direct relationship between return and risk.



## Appendix

### Definition of terms used in this analysis:

**Asset Allocation** is a systematic analysis of the properties of specified asset classes to determine the allocation of those assets that meet the return targets of a portfolio.

**Correlation** is a statistical measure of the relationship between asset class returns. A value of 1.00 is a perfect correlation; that is, the asset classes always move in the same direction. A value of  $-1.00$  indicates a perfect negative correlation, in which the asset classes always move in opposite directions of each other. A value of 0 indicates there is no relationship between the direction of returns of the two asset classes. Correlation calculations only consider the direction of changes relative to two variables and not the magnitude of those changes.

The **Efficient Frontier** is the set of portfolios that minimizes risk at given target levels of return. This process takes into account the risk, return and correlation of the asset classes to arrive at the most efficient set of portfolios.

**Expected Equity Beta** is a measure of the sensitivity of a portfolio to movements in the Large/Mid Cap US Equity market. It is a measure of a portfolio's non-diversifiable or systematic risk.

**Performance Expectation** is the best estimate of the average annual percentage increase in the value of an asset class over the next ten years.

**Risk** is quantified by the *standard deviation* of returns. Also known as the volatility of returns, it provides a statistical range of performance relative to the average expectations. With this measure, we can establish a level of "confidence" about the expected range of returns for the portfolios.

**RVK Liquidity Metric** is a qualitative method for determining the relative amount of liquidity in a portfolio. The characteristics considered when determining relative liquidity include trading volume, gates for redemption, leverage, nature of transactions, and pricing mechanisms. The RVK Liquidity Metric is calculated using investment weights applied to each corresponding asset class liquidity rating. See next page for more details.

**Thematic Classification** - Represents dedicated manager allocations; as such, thematic allocations are approximations. RVK categorizes asset classes as Alpha, Capital Appreciation, Capital Preservation, and Inflation as displayed in the table on the next page.

Asset Class	Thematic Bucket	Liquidity Bucket	RVK Liquidity Metric
Broad US Equity	Capital Appreciation	Liquid	95
Large/Mid Cap US Equity	Capital Appreciation	Liquid	95
Broad International Equity	Capital Appreciation	Liquid	90
Dev'd Large/Mid Cap Int'l Equity	Capital Appreciation	Liquid	90
Global Equity	Capital Appreciation	Liquid	90
Dev'd Small Cap Int'l Equity	Capital Appreciation	Liquid	85
Emerging Markets Equity	Capital Appreciation	Liquid	85
Small Cap US Equity	Capital Appreciation	Liquid	85
Convertibles	Capital Appreciation	Liquid	80
Distressed Debt	Capital Appreciation	Less Liquid	50
Emerging Markets Debt (Local and Hard)	Capital Appreciation	Less Liquid	50
High Yield Fixed Income	Capital Appreciation	Less Liquid	50
Non-Core Real Estate	Capital Appreciation	Not Liquid	5
Private Equity	Capital Appreciation	Not Liquid	5
T-Bills and Treasuries	Capital Preservation	Liquid	100
Cash Equivalents	Capital Preservation	Liquid	98
Int. Duration Fixed Income	Capital Preservation	Liquid	85
Long Duration Fixed Income	Capital Preservation	Liquid	85
Low Duration Fixed Income	Capital Preservation	Liquid	85
Stable Value	Capital Preservation	Less Liquid	50
Non-US Dev'd Sovereign Fixed Income UH	Capital Preservation	Less Liquid	50
GTAA	Alpha	Liquid	88
Diversified Hedge Funds	Alpha	Less Liquid	35
Equity Market Neutral	Alpha	Less Liquid	35
Long-Biased Long/Short Equity	Alpha	Less Liquid	35
Managed Futures FoF	Alpha	Less Liquid	35
Commodities	Inflation	Liquid	98
TIPS	Inflation	Liquid	95
Diversified Inflation Strategies	Inflation	Liquid	93
Global REITs/MLPs	Inflation	Liquid	85
Bank Loans	Inflation	Less Liquid	50
Core Real Estate	Inflation	Not Liquid	25
Infrastructure	Inflation	Not Liquid	5
Timber	Inflation	Not Liquid	5