



# 10-Year Capital Market Forecasts. (2022-2031)

January 2022

## Synopsis

Fi3 Advisors updates asset class assumptions at least annually to reflect 10-year estimates for asset class returns, standard deviations, skewness, kurtosis and correlations. This paper details our input assumptions for the investment period from January 2022 to December 2031.

### Executive Summary of Year-Over-Year Return Assumption Changes

Asset Class	2022 Outlook E(R) - 10 Year	2021 Outlook E(R) - 10 Year	Year Over Year Change
Inflation	2.5%	1.8%	0.7%
Cash*	0.1%	0.1%	0.0%
TIPS	1.3%	0.7%	0.5%
ST Bonds	0.6%	0.5%	0.1%
Muni Bond**	1.2%	1.0%	0.2%
Muni High Yield**	4.9%	6.7%	-1.8%
US Bond	1.7%	1.2%	0.5%
Dynamic Bonds***	2.0%	1.7%	0.3%
Global Bonds	1.4%	0.8%	0.6%
For. Dev. Bond	1.2%	0.4%	0.7%
LT Bonds	2.5%	2.3%	0.2%
Corp HY Bond	3.7%	3.4%	0.4%
EM Bond	2.6%	1.7%	0.8%
Global Equity	7.2%	6.8%	0.4%
US Equity (AC)	5.9%	5.5%	0.3%
US Equity (LC)	5.7%	5.4%	0.3%
US Equity (MC)	6.1%	5.7%	0.3%
US Equity (SC)	6.1%	5.8%	0.2%
Int'l Dev. Equity	7.7%	7.0%	0.7%
EM Equity	9.6%	8.5%	1.1%
Real Estate	5.4%	5.3%	0.1%
Private Real Estate	6.4%		
Broad Real Assets****	4.7%	3.9%	0.8%
Global Infrastructure	7.1%	5.4%	1.7%
Commod. Fut.	3.3%	2.3%	1.0%
Marketable Alternatives	5.9%	5.4%	0.5%
Liquid Alternatives	4.4%	3.9%	0.5%
Private Equity	8.9%	8.5%	0.3%

### Our Investment Themes for 2022-2031

- Nominal return forecasts rose for most asset classes but rising inflation expectations means most asset classes have declining year-over-year real return expectations.
- Meaningfully negative real returns continue to make cash an expensive opportunity cost for investors.
- Global bond yields generally rose. Despite the increase, most fixed income asset class forward-looking return expectations remain below expected inflation levels.
- Earnings accelerated in 2021 and expanded faster than stock prices. Non-U.S. equities remain more attractive on a valuation basis as U.S. equities have grown to represent 61 percent of the global equity market capitalization compared to 58 percent a year ago.
- With higher inflation expectations, real assets remain an important diversifier. Within real assets, broad real assets return expectations rose meaningfully faster than real estate.
- Alternative asset class return expectations rose modestly.

\*3-month forecast

\*\*Tax-equivalent yield based on highest marginal tax rate (37%)

\*\*\*33% Cash, 33% Corp HY and 34% Global Bonds

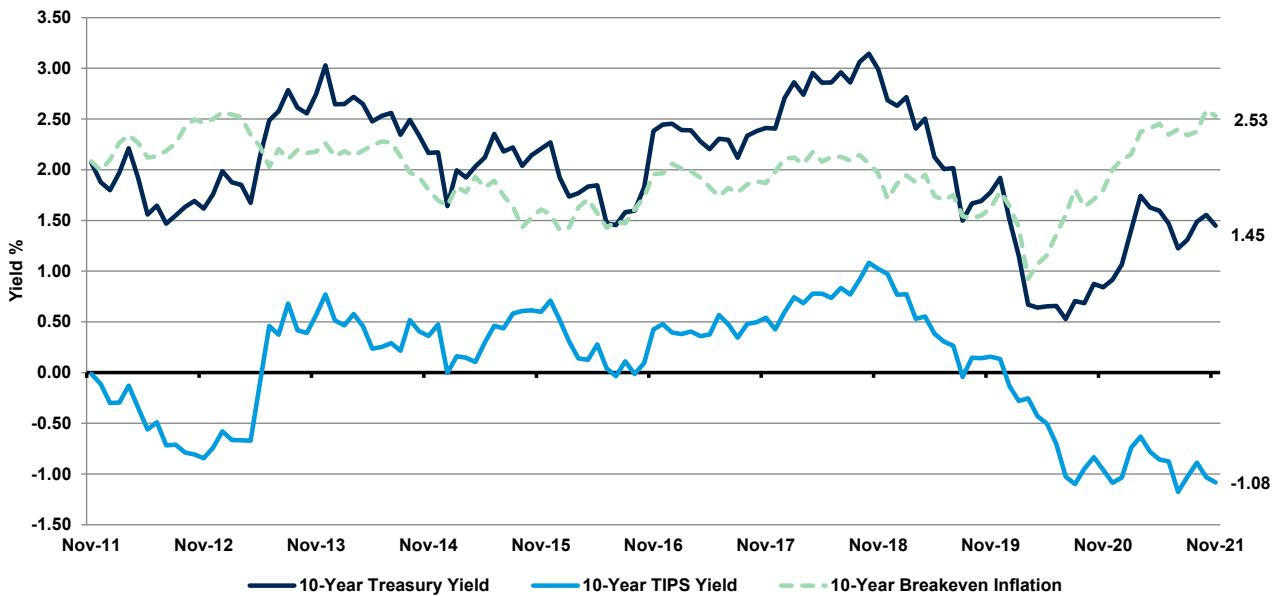
\*\*\*\*20% REITs, 20% Global Infrastructure, 20% Commodities, 20% US Bonds, 15% Corp High Yield, 5% TIPS

This report is intended for the exclusive use of clients or prospective clients of Fi3 Advisors. The information contained herein is intended for the recipient, is confidential and may not be disseminated or distributed to any other person without the prior approval of Fiduciant Advisors. Any dissemination or distribution is strictly prohibited. Information has been obtained from a variety of sources believed to be reliable though not independently verified. Any forecasts represent future expectations and actual returns, volatilities and correlations will differ from forecasts and it should not be assumed that any of these expectations will become actual results. Outputs and opinions are as of the date referenced and are subject to change based on market or economic conditions. This report does not represent a specific investment recommendation. Please consult with your advisor, attorney and accountant, as appropriate, regarding specific advice. Past performance does not indicate future performance and there is a possibility of a loss.



## 10-Year Return Forecasts by Asset Class

**INFLATION (CPI):** Inflation is used as a building block of total return for several asset classes. Our forecast of inflation is the difference between the 10-year nominal U.S. Treasury yield and the 10-year TIPS real yield. As of November 30, 2021, this difference was 2.53 percent (i.e., 1.45% - -1.08%). We believe this implied breakeven inflation rate (2.53 percent) is a rational median case assumption regarding CPI inflation for all items in the Consumer Price Index over the next 10 years. The following are the implied breakeven and our forward CPI expectations based on current breakeven inflation relationships.



Source: Bloomberg

### Historical 10-Year U.S. Nominal and Real Rates (as of November 30, 2021)

While the 10-year CPI forecast is 2.53 percent, we expect higher inflation (2.81 percent) in the first five years and lower inflation (2.25 percent) in the following five years.

#### 10-Year Forecast of Annual CPI: 2.5%

Implied Breakeven CPI (11/30/21)			
Maturity	Nominal	TIPS	Implied CPI
5 Years	1.16%	-1.65%	2.81%
7 Years	1.37%	-1.48%	2.85%
10 Years	1.45%	-1.08%	2.53%
20 Years	1.86%	-0.65%	2.51%
30 Years	1.79%	-0.51%	2.31%

Implied Forward CPI (11/30/21)	
Forward CPI	Implied CPI
1-5 Years	2.81%
5-10 Years	2.25%
10-20 Years	2.50%
20-30 Years	1.89%

Source: Bloomberg



**TIPS:** As of November 30, 2021, the Bloomberg U.S. TIPS Index had 45 issues (all U.S. Sovereign) with an average real yield of -1.27 percent and an average maturity of 8.13 years.

**Bloomberg U.S. TIPS (11/30/21)**

Summary Statistics	Value
Average Maturity (Yrs)	8.13
Average Real Duration (Yrs)	5.01
Average Coupon (%)	0.65
Yield to Worst (%)	1.26
Number of Issues	45

*Source: Bloomberg*

Combining the real yield of the Bloomberg Barclays Capital U.S. TIPS Index (-1.27 percent) with our forecasted inflation (2.53 percent) leads to an expected return of 1.26 percent.

**10-Year Forecast of Annualized Geometric Return: 1.3%**

**SHORT TERM BONDS:** The historical duration of the asset class has been steady at approximately two years, which is calculated using blended return assumptions for cash and U.S. investment-grade fixed income. The blended return comes two-thirds from cash and one third from U.S. Investment Grade Fixed Income. Our expected geometric return forecast is 0.65 percent.

**10-Year Forecast of Annualized Geometric Return: 0.7%**

**U.S. TAX-EXEMPT (MUNICIPAL) FIXED INCOME:** As of November 30, 2021, the Bloomberg Capital U.S. Municipal Bond: 5 Year (4-6) Index had 6,083 issues with an average maturity of 4.98 years and an average duration of 3.82 years. The index is investment-grade rated.

**Bloomberg 5-Year U.S. Municipal Bond (11/30/21)**

Summary Statistics	Value
Average Maturity (Yrs)	4.98
Average Duration (Yrs)	3.82
Average Coupon (%)	4.65
Yield to Worst (%)	0.73
Number of Issues	6,083

*Source: Bloomberg*

Our tax-adjusted return forecast for the Bloomberg Capital Municipal Bond: 5 Year (4-6) Index is found by dividing the current yield to worst by one minus the highest marginal federal tax rate  $[(0.73\% / (1 - 0.37))] = 1.16\%$ .



**10-Year Forecast of Annualized Geometric Return: 1.2%<sup>1</sup>**

**U.S. TAX-EXEMPT (MUNICIPAL) HIGH YIELD FIXED INCOME:** As of November 30, 2021, the Bloomberg U.S. Municipal High Yield Index had 5,261 issues with an average maturity of 21.27 years and an average duration of 6.06 years. The index is below investment-grade rated.

**Bloomberg U.S. Municipal High Yield Bond (11/30/21)**

Summary Statistics	Value
Average Maturity (Yrs)	21.27
Average Duration (Yrs)	6.06
Average Coupon (%)	4.54
Yield to Worst (%)	3.07
Number of Issues	5,261

Source: Bloomberg

Our tax-adjusted return forecast for the Bloomberg Barclays Capital U.S. Municipal High Yield Index is found by dividing the current yield to worst by one minus the highest marginal federal tax rate  $[(3.07\% / (1 - 0.37))] = 4.87\%$ .

**10-Year Forecast of Annualized Geometric Return: 4.9%<sup>2</sup>**

**U.S. INVESTMENT GRADE FIXED INCOME:** As of November 30, 2021, the Bloomberg Capital U.S. Aggregate Bond Index had 12,297 issues with an average maturity of 8.72 years and an average duration of 6.78 years. The index is investment-grade rated. The return forecast for the Bloomberg Barclays Capital U.S. Aggregate Bond Index is its current yield to worst of 1.69 percent.

**Bloomberg U.S. Aggregate (11/30/21)**

Sector Breakdown	%	Credit Breakdown	%	Maturity Breakdown	%	Summary Statistics	Value
Govt / Agency	40.3	AAA	71.5	1-3 Years	19.6	Average Maturity (Yrs)	8.72
Credit	30.1	AA	3.3	3-5 Years	20.5	Average Duration (Yrs)	6.78
MBS	27.3	A	11.2	5-7 Years	22.5	Average Coupon (%)	2.45
ABS	0.3	BBB	14.0	7-10 Years	17.4	Yield to Worst (%)	1.69
CMBS	2.0	BB or lower	0.0	> 10 Years	20.0	Number of Issues	12,297

Source: Bloomberg

**10-Year Forecast of Annualized Geometric Return: 1.7%**

<sup>1</sup> The 1.2 percent annualized return assumption is used for optimization purposes to advantage municipal bonds over taxable bonds in taxable accounts as appropriate. However, 0.7 percent in annualized return is used when looking at portfolio level forward looking returns that are a weighted average of the underlying asset class return expectations.

<sup>2</sup> The 4.9 percent annualized return assumption is used for optimization purposes to advantage municipal bonds over taxable bonds in taxable accounts as appropriate. However, 3.1 percent in annualized return is used when looking at portfolio level forward looking returns that are a weighted average of the underlying asset class return expectations.



**DYNAMIC BONDS:** The asset class is calculated using blended return assumptions for cash (1/3), corporate high yield (1/3) and global bonds (1/3). The (unbiased) expected geometric return forecast is 1.99 percent.

**10-Year Forecast of Annualized Geometric Return: 2.0%**

**LONG-TERM BONDS:** As of November 30, 2021, the Bloomberg Capital U.S. Long Gov/Credit Index had 3,063 issues with an average maturity of 23.73 years and an average duration of 16.50 years. The index is investment-grade rated. The return forecast for the Bloomberg Capital U.S. Long Gov/Credit Index is its current yield to worst of 2.53 percent.

**10-Year Forecast of Annualized Geometric Return: 2.5%**

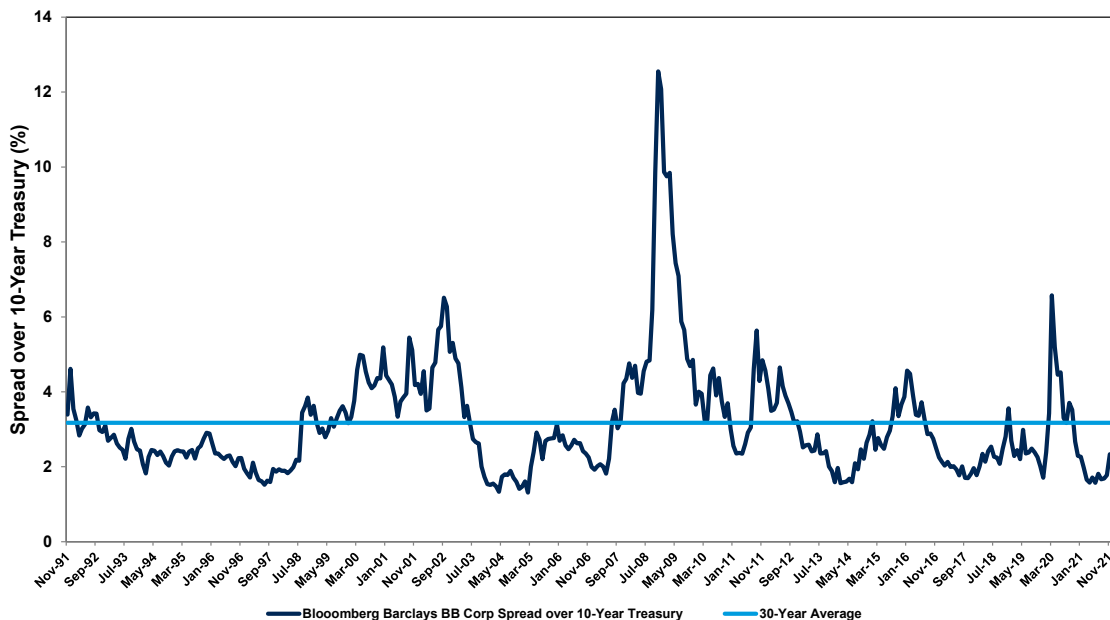
**HIGH YIELD BONDS:** As of November 30, 2021, the FTSE U.S. High Yield Market Index had 2,005 issues (all BB rated or lower) representing \$1.47 trillion in market value. The yield to worst was 4.95 percent with an average maturity of 6.3 years and a 4.36-year average duration. The following charts reflect current high yield bond market metrics and historical spread data.

**FTSE U.S. High Yield Market Index**

Market Value (\$B)	Par Value (\$B)	MV / PV Premium (Discount)	Average Coupon (per \$100 Par)	Coupon/ MV Yield	Current YTW
\$1,469	\$1,428	103%	5.71%	5.55%	4.95%

Source: Bloomberg, FTSE

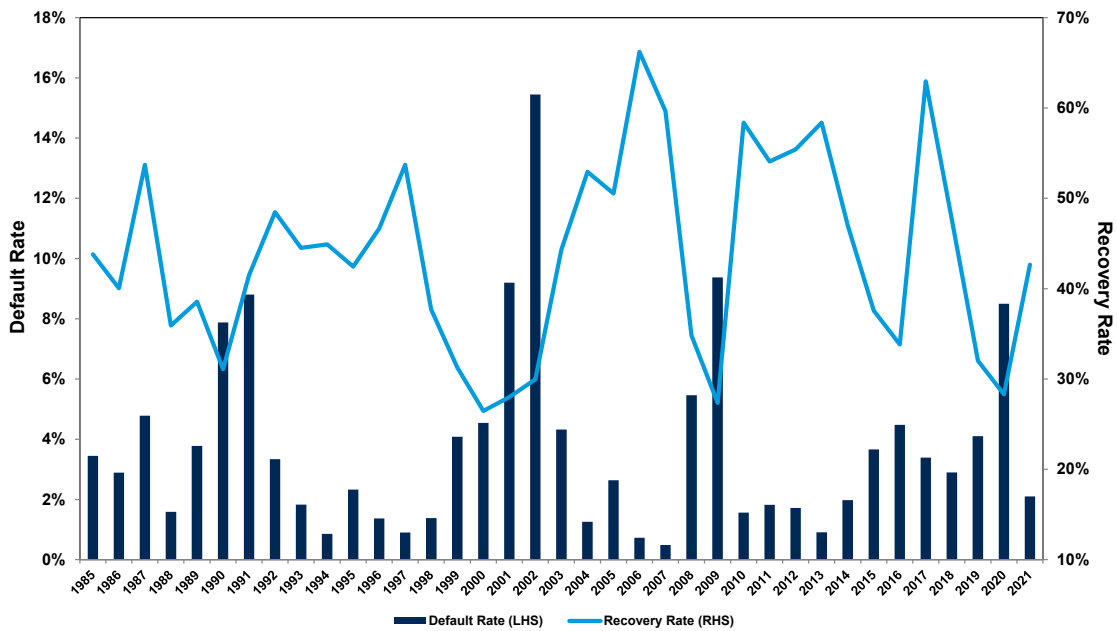
**BB-Rated Corporate Spread vs. 10-Year U.S. Treasury (1991-2021)**



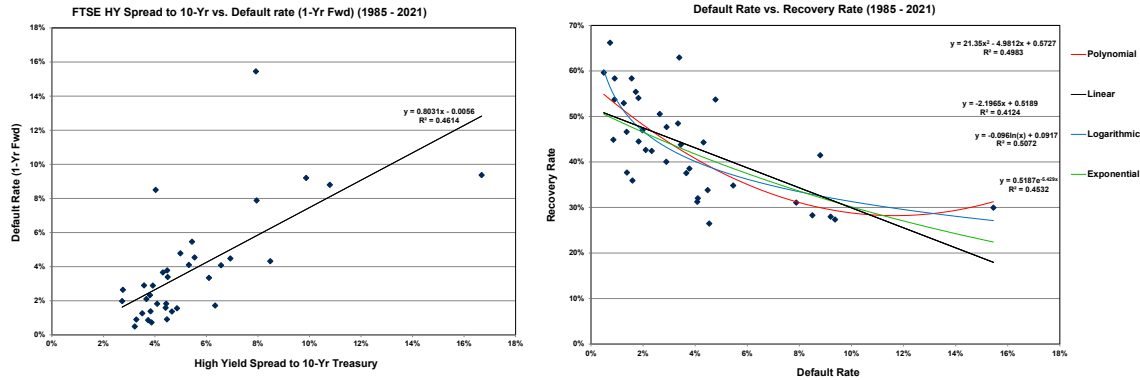


- As of November 30, 2021, the Bloomberg Barclays BB-rated Corporate Bond spread over the 10-year U.S. Treasury was 2.34 percent, which is 0.83 percent below the long-term historical average of 3.17 percent since November 1991.
- This represents a spread compression of 34 basis points on a year-over-year basis, which comes from both a higher yield on the index (+27 bps), but also a rise in the 10 Year-Treasury yield (+61 bps).
- From August 1983 to November 2021, the Bloomberg Barclays U.S. Corporate High Yield Index returned an annualized 8.71 percent versus 6.90 percent for the Bloomberg Barclays Capital U.S. Aggregate Bond Index. This represents a historical risk premium of 1.81 percent for high yield bonds (over investment-grade intermediate bonds).
- Moody’s current forecast for U.S. high yield default rate is 2.1 percent through October 2021, which is a significant decrease from last year’s spike to 8.50 percent.

**Historical High Yield Bond Default and Recovery Rates**



Source: Credit Suisse through 2013 and Moody’s since 2014



Source: Credit Suisse, Moody's, Fiducient Advisors Analysis

- The geometric return forecast is derived from the *High Yield Default-Loss Method*, where expected return is a function of current credit spreads, our internal expected default rates and expected recovery rates.
- Each year end's high yield credit spread is used to estimate the following year's default rate (left pane above) from 1985 to 2021 and each year's actual default rate is used to predict an implied recovery rate using four different mathematical relationships (right pane above).

### High Yield Default-Loss Method applied as of November 30, 2021<sup>3</sup>

Polynomial Default-Recovery Regression							Linear Default-Recovery Regression						
10-Year Treasury	Current Yield-to-Worst	Current Spread	Assumed Annual Default Rate	Assumed Annual Recovery Rate	Assumed Annual Loss Rate	Expected Return	10-Year Treasury	Current Yield-to-Worst	Current Spread	Assumed Annual Default Rate	Assumed Annual Recovery Rate	Assumed Annual Loss Rate	Expected Return
1.45%	4.95%	3.50%	2.26%	47.28%	-1.19%	3.76%	1.45%	4.95%	3.50%	2.26%	47.08%	-1.20%	3.75%

Logarithmic Default-Recovery Regression							Exponential Default-Recovery Regression						
10-Year Treasury	Current Yield-to-Worst	Current Spread	Assumed Annual Default Rate	Assumed Annual Recovery Rate	Assumed Annual Loss Rate	Expected Return	10-Year Treasury	Current Yield-to-Worst	Current Spread	Assumed Annual Default Rate	Assumed Annual Recovery Rate	Assumed Annual Loss Rate	Expected Return
1.45%	4.95%	3.50%	2.26%	45.71%	-1.23%	3.72%	1.45%	4.95%	3.50%	2.26%	46.01%	-1.22%	3.73%

Source: Credit Suisse, Moody's, FTSE, Bloomberg, Fiducient Advisors Analysis

- Based on the High Yield Default-Loss Method, the market is pricing in a 12-month forward looking 2.26 percent annual expected default rate as of November 30, 2021. This implies an expected recovery rate of around 46 percent, and subsequent annual loss rate of approximately 1.20 percent. This represents an estimate based on recent default and recovery rates. We believe the midpoint of the range of all methods reflects a sensible view of default losses over a full market cycle.

### 10-Year Forecast of Annualized Geometric Return: 3.7%

<sup>3</sup> Default Rate =  $-0.0056\% + 0.8031 * [\text{HY Yield-to-Worst Spread vs. 10-Year Treasury}]$ .  $R^2 = 0.4614$ . Recovery Rate algorithm combines linear, polynomial, logarithmic and exponential factors; additional details available upon request.



**FOREIGN DEVELOPED FIXED INCOME:** As of November 30, 2021, the FTSE World Government Bond ex-U.S. Index had an average yield to maturity of 0.46 percent with an average maturity of 11.0 years and a 9.82-year average duration.

**Foreign Developed Bond Market Data as of November 30, 2021<sup>4</sup>**

Country	Global Allocation Ex-US (%)	Local Bond Market Maturity (Years)	Local Bond Market YTM (%)	U.S. Treasury Equivalent YTM (%)	Interest Parity (Currency) Spread (%)	Gross Debt to GDP Ratio (%)	Sovereign Credit and/or Currency Premium / (Discount) (%)
Japan	27.1%	13.3	0.21	1.35	1.14	254	(0.81)
France	13.7%	10.0	0.07	1.27	1.20	115	0.02
Italy	12.6%	8.8	0.77	1.24	0.46	156	(0.03)
Germany	10.0%	8.7	(0.28)	1.25	1.54	69	0.23
United Kingdom	8.5%	16.3	0.99	1.43	0.44	104	0.05
Spain	8.2%	9.2	0.30	1.31	1.01	120	0.01
Belgium	3.1%	11.7	0.14	1.33	1.19	114	0.02
Canada	2.8%	8.6	1.42	1.32	(0.11)	117	0.02
Netherlands	2.6%	9.8	(0.13)	1.34	1.47	52	0.37
Australia	2.4%	8.7	1.72	1.29	(0.43)	57	0.33
Austria	2.0%	12.9	(0.01)	1.44	1.45	83	0.14
Ireland	1.1%	9.9	0.15	1.33	1.18	59	0.32
Mexico	1.0%	8.6	7.34	1.23	(6.11)	61	0.30
Finland	0.8%	9.0	(0.09)	1.30	1.39	70	0.23
Poland	0.7%	4.6	2.29	1.14	(1.15)	57	0.33
Denmark	0.7%	9.5	(0.06)	1.27	1.33	42	0.47
Malaysia	0.7%	9.6	3.50	1.31	(2.19)	67	0.25
Israel	0.6%	7.6	0.99	1.21	0.21	72	0.21
Singapore	0.6%	9.7	1.57	1.28	(0.29)	155	(0.02)
Sweden	0.4%	6.7	0.22	1.21	0.99	37	0.52
Norway	0.3%	5.0	1.50	1.14	(0.36)	41	0.48
<b>Total / WTD Average</b>	<b>100.00%</b>	<b>11.0</b>	<b>0.46</b>	<b>1.31</b>	<b>0.85</b>	<b>146</b>	<b>(0.15)</b>
United States	N/A*	8.1	1.13			134	

\*The United States is 39.0% of the Total World Government Bond Index.

Source: Factset, FTSE

<sup>4</sup> Source: FTSE (FTSE World Government Bond ex-U.S. Index data); Fiducient Advisors Calculation. Formerly the Citi World Government Bond ex-U.S. Index.





Expected return is calculated by isolating the sovereign index yield and currency and/or credit components of the foreign developed bond market. The sovereign index yield component is calculated by taking the weighted average local bond market yield. Interest rate parity is then used to calculate the expected currency impact embedded in the foreign developed bond markets (in U.S. dollar terms). The difference in like-maturity rates across borders explains the currency Spot-Futures exchange rate relationship. If not, one could borrow in one currency, lend in the other and lock in an arbitrage profit.

**Fixed Income Returns Decomposition Method: (YLD) +/- (IRP) +/- (CRE/CUR)**

10-Year Forecast (2022 - 2031): (0.46%) + (0.85%) + (-0.15%) = 1.16%

- *YLD* = Index Yield
- *IRP* = Interest Rate Parity Currency Adjustment
- *CRE/CUR* = Sovereign Credit/Currency Adjustment

The sovereign credit and/or currency premium / (discount) adjustment is applied to individual countries based on their debt-to-GDP ratios and reflects our opinion of how interest parity relationships do not fully reflect the potential for currency debasement (a form of implicit default) or actual potential principal losses due to explicit default.

**10-Year Forecast of Annualized Geometric Return: 1.2%**

**EMERGING MARKETS (LOCAL CURRENCY) FIXED INCOME:** As of November 30, 2021, the JPMorgan GBI-EM Global Diversified Index had an average yield to maturity of 6.1 percent with an average maturity of 7.3 years and a 5.19-year average duration. Expected return is calculated by isolating the *sovereign index yield, currency and/or credit* components of the emerging markets bond market. The *sovereign index yield* component is calculated by taking the weighted average local bond market yield. Interest rate parity is then used to calculate the expected currency impact embedded in the emerging markets bond markets (in U.S. dollar terms). The difference in like-maturity rates across borders explains the currency Spot-Futures exchange rate relationship. If not, one could borrow in one currency, lend in the other and lock in an arbitrage profit. In order to isolate each country's implied credit spread, credit default swaps for each country are used to quantify credit risk above and beyond that of U.S. denominated bonds. This amount is then backed out of each country's yield in order to be removed from the interest rate parity calculation since implied credit risk is captured in the local bond yield and therefore should not be accounted for in the interest rate parity calculation as well.



**JPMorgan GBI-EM Emerging Markets Bond Data as of November 30, 2021<sup>5</sup>**

Country	Allocation (%)	Local Bond Maturity (Years)	Local Bond Market YTM (%)	U.S. Treasury Equivalent YTM (%)	Market Implied Credit Spread	Interest Parity (Currency) Spread (%)	Gross Debt to GDP Ratio (%)	Sovereign Credit and/or Currency Premium / (Discount) (%)
Indonesia	10.0%	8.4	6.2	1.2	0.4	(4.6)	37	0.5
China	10.0%	6.9	3.0	1.2	1.0	(0.7)	66	0.3
Mexico	9.6%	8.5	7.5	1.3	0.7	(5.6)	61	0.3
Thailand	9.0%	8.1	2.0	1.2	0.2	(0.6)	50	0.4
Brazil	8.6%	2.7	11.7	1.1	2.4	(8.2)	99	0.1
Malaysia	8.5%	7.5	3.6	1.2	0.4	(2.0)	67	0.2
South Africa	8.3%	13.1	10.3	1.5	1.0	(7.8)	69	0.2
Russia	7.5%	6.3	8.3	1.2	2.3	(4.9)	19	0.7
Poland	7.2%	4.4	3.0	1.1	0.5	(1.5)	57	0.3
Czech Republic	4.7%	6.7	2.6	1.2	0.4	(1.0)	38	0.5
Colombia	4.1%	8.5	8.1	1.3	0.2	(6.6)	65	0.3
Hungary	3.5%	6.1	4.3	1.2	2.1	(1.0)	80	0.2
Romania	3.0%	4.2	5.1	1.1	0.7	(3.2)	50	0.4
Peru	2.1%	9.6	6.0	1.3	0.9	(3.9)	35	0.5
Chile	2.0%	8.6	5.7	1.2	0.8	(3.7)	33	0.6
Turkey	1.2%	3.5	20.6	1.1	4.9	(14.6)	40	0.5
Serbia	0.3%	7.0	3.9	1.2	2.4	(0.3)	58	0.3
Dominican Republic	0.2%	3.4	5.6	1.1	2.9	(1.6)	71	0.2
Philippines	0.1%	9.8	4.8	1.3	0.8	(2.6)	52	0.4
Uruguay	0.1%	8.2	8.9	1.2	0.5	(7.2)	68	0.2
<b>Total / WTD Average</b>	<b>100%</b>	<b>7.3</b>	<b>6.1</b>	<b>1.2</b>	<b>1.0</b>	<b>(3.9)</b>	<b>57</b>	<b>0.3</b>
United States		8.1	1.1				134	

Source: Factset, JPMorgan

**Fixed Income Returns Decomposition Method: (YLD) +/- (IRP) +/- (CRE/CUR)**

10-Year Forecast (2022 - 2031): (6.11%) + (-3.90%) + (0.35%) = 2.56%

- YLD = Index Yield
- IRP = Interest Rate Parity Currency Adjustment
- CRE/CUR = Sovereign Credit/Currency Adjustment

The sovereign credit and/or currency premium / (discount) adjustment is applied to individual countries based on their debt-to-GDP ratios and reflects our bias for how interest parity relationships do not fully reflect the potential for currency debasement (a form of implicit default) or actual potential principal losses due to explicit default.

**10-Year Forecast of Annualized Geometric Return: 2.6%**

**GLOBAL FIXED INCOME:** The asset class is calculated using blended return assumptions for U.S. investment-grade fixed income (40 percent) and foreign investment grade developed sovereign bonds (60 percent). Our expected geometric return forecast is 1.4 percent.

**10-Year Forecast of Annualized Geometric Return: 1.4%**

<sup>5</sup> Source: JPMorgan (JPMorgan GBI-EM Global Diversified Index data); Factset (CDS Spreads); Fiducient Advisors Calculation.



**U.S. LARGE CAP EQUITIES:** The expected geometric return forecast for U.S. Large Cap Equities (S&P 500) is derived by applying the *Cyclically-Adjusted Earnings Yield Method* where return is a function of the historical 10-year average real earnings, current price and our 10-year inflation assumption (CPI).

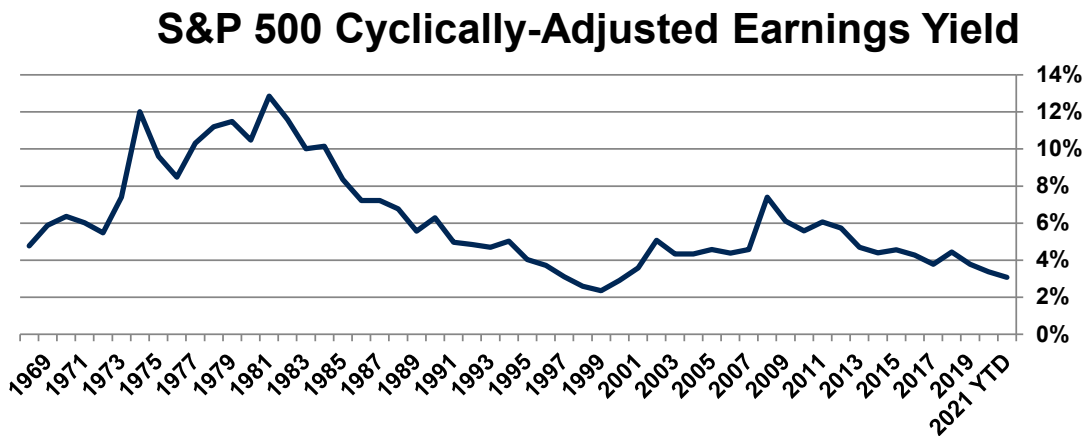
**Cyclically-Adjusted Earnings Yield Method:**  $\{[1 + (\text{EARNINGS}/\text{PRICE})] * (1 + \text{CPI})\} - 1$

10-Year Forecast (2022 - 2031):  $\{[1 + (140.69 / 4,567)] * (1 + 2.53\%)\} - 1$

10-Year Forecast (2022 - 2031):  $\{(1 + 3.08\%) * (1 + 2.53\%)\} - 1 = 5.69\%$

- *EARNINGS* = Historical 10-year average real earnings of the S&P 500 Index as of November 30, 2021
- *PRICE* = Current S&P 500 Index real price as of November 30, 2021
- *CPI* = Our Inflation Forecast

**10-Year Forecast of Annualized Geometric Return: 5.7%**



*Source: Bloomberg, as of November 30, 2021*

**U.S. MID CAP EQUITIES:** Using historical correlations and volatility for Large, Mid and Small Cap U.S. Equities (from 1979-2021) and U.S. market cap weights, the Black-Litterman arithmetic return forecast for Mid Cap is 7.7 percent (vs. 7.1 percent for Large Cap). Adjusting for forecasted volatility (18.3 percent Annual Standard Deviation), our expected geometric return is 6.1 percent.

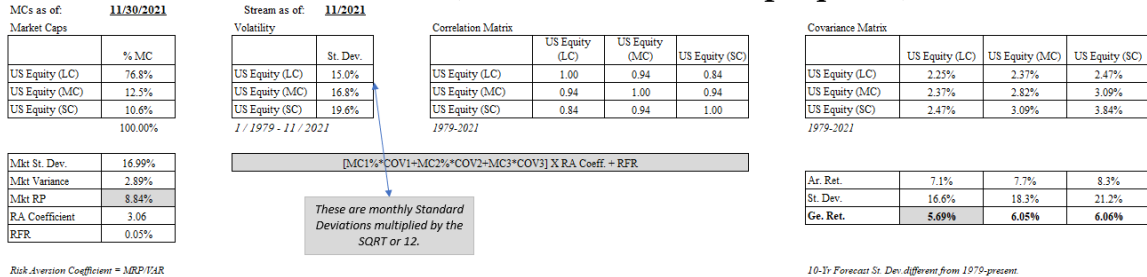
**10-Year Forecast of Annualized Geometric Return: 6.1%**

**U.S. SMALL CAP EQUITIES:** Using historical correlations and volatility for Large, Mid and Small Cap U.S. Equities (from 1979-2021) and U.S. market cap weights, the (unbiased) Black-Litterman arithmetic return forecast for Small Cap is 8.3 percent (vs. 7.1 percent for Large Cap). Adjusting for forecasted volatility (21.2 percent Annual Standard Deviation), our expected geometric return is 6.1 percent.

**10-Year Forecast of Annualized Geometric Return: 6.1%**



## Black-Litterman (U.S. Mid and Small Cap Equities)<sup>6,7</sup>



Source: Morningstar, Bloomberg, MSCI

Use of Indices and Benchmark Return: Indices cannot be invested in directly. Index performance is reported gross of fees and expenses and assumes the reinvest dividends and capital gains. Past performance does not indicate future performance and there is a possibility of a loss. See disclosure page for indices representing each asset class. See the appendix for additional information about the Black-Litterman method.

**U.S. ALL CAP EQUITIES:** Using relative market capitalization weights<sup>8</sup>, historical correlation, volatility and our forecasted expected returns for Large, Mid and Small Cap U.S. Equities, the expected geometric return forecast for All Cap is 5.9 percent.

**10-Year Forecast of Annualized Geometric Return: 5.9%**

**FOREIGN DEVELOPED EQUITIES:** The expected geometric return forecast for Foreign Developed Equities (MSCI EAFE) is derived by applying the *Cyclically-Adjusted Earnings Yield Method* where return is a function of the 10-year average real earnings, current price and our 10-year inflation assumption (CPI).

**Cyclically-Adjusted Earnings Yield Method:  $\{[1 + (\text{EARNINGS}/\text{PRICE})] * (1 + \text{CPI})\} - 1$**

10-Year Forecast (2022 - 2031):  $\{[1 + (112.21 / 2,223.70)] * (1 + 2.53\%)\} - 1$

10-Year Forecast (2022 - 2031):  $\{(1 + 5.05\%) * (1 + 2.53\%)\} - 1 = 7.70\%$

- EARNINGS = 10-Year average real earnings of the MSCI EAFE Index as of November 30, 2021
- PRICE = Current MSCI EAFE Index real price as of November 30, 2021
- CPI = Inflation Forecast

**10-Year Forecast of Annualized Geometric Return: 7.7%**

See disclosures for list of indices representing each asset class. Indices cannot be invested in directly. Performance is reported gross of fees and expenses and assumes the reinvest dividends and capital gains. Past performance does not indicate future performance and there is a possibility of a loss

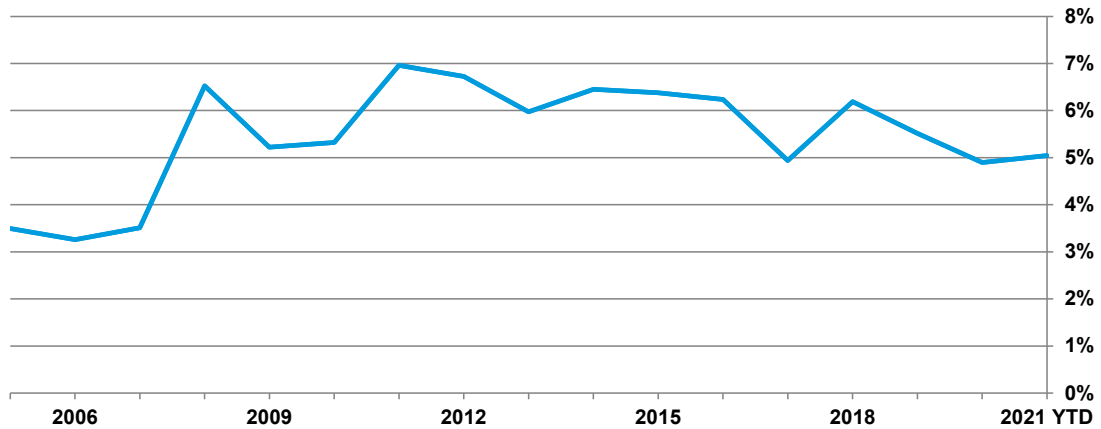
<sup>6</sup> RA Coefficient (i.e., Risk Aversion Coefficient) = Market Risk Premium/Market Variance.

<sup>7</sup> 10-Year forecast standard deviation different from 1979-2021 historical standard deviation.

<sup>8</sup> As of November 30, 2021, the U.S. equity market capitalization was comprised as follows: 76.8% Large Cap, 12.5% Mid Cap and 10.6% Small Cap. Source: Bloomberg, MSCI.



## MSCI EAFE Cyclically-Adjusted Earnings Yield



Source: Morningstar, MSCI, as of November 30, 2021

**EMERGING MARKETS EQUITIES:** The expected geometric return forecast for Emerging Markets Equities (unhedged MSCI Emerging Markets) is derived by applying the *Cyclically-Adjusted Earnings Yield Method* where return is a function of the 10-year average real earnings, current price and our 10-year inflation assumption (CPI).

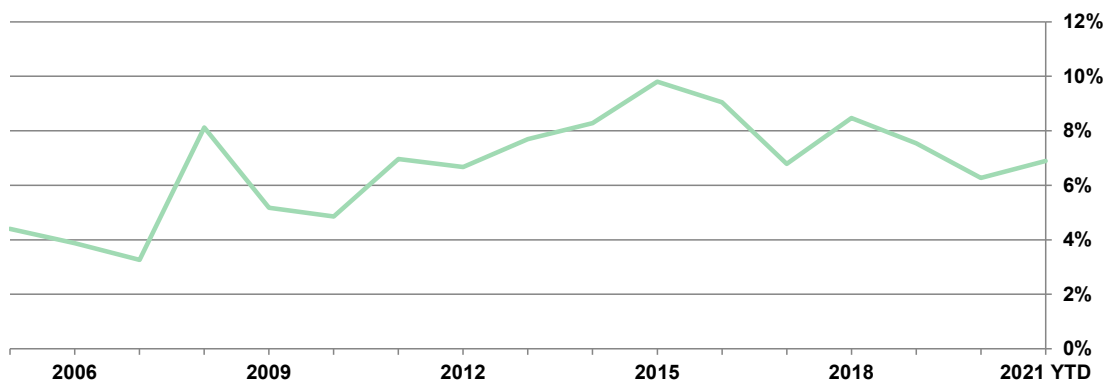
**Cyclically-Adjusted Earnings Yield Method:**  $\{[1 + (\text{EARNINGS}/\text{PRICE})] * (1 + \text{CPI})\} - 1$

10-Year Forecast (2022 - 2031):  $\{[1 + (83.56 / 1,212.42)] * (1 + 2.53\%)\} - 1$

10-Year Forecast (2022 - 2031):  $\{(1 + 6.89\%) * (1 + 2.53\%)\} - 1 = 9.60\%$

- *EARNINGS* = 10-year average real earnings of the MSCI Emerging Markets Index as of November 30, 2021
- *PRICE* = Current MSCI Emerging Markets Index real price as of November 30, 2021
- *CPI* = Inflation Forecast

## MSCI EM Cyclically-Adjusted Earnings Yield



Source: Morningstar, MSCI, as of November 30, 2021



**10-Year Forecast of Annualized Geometric Return: 9.6%**

**GLOBAL EX-U.S. EQUITIES:** Using relative market capitalization weights<sup>9</sup> (excluding the U.S.), historical correlation, volatility and forecasted expected returns for Foreign Developed and Emerging Markets Equity, our expected geometric return forecast for Global ex-U.S. is 8.6 percent.

**10-Year Forecast of Annualized Geometric Return: 8.6%**

**GLOBAL EQUITIES:** Using relative market capitalization weights<sup>10</sup>, correlation, volatility and forecasted expected returns for U.S. All Cap, Foreign Developed and Emerging Markets Equity, our expected geometric return forecast for Global is 7.2 percent.

**10-Year Forecast of Annualized Geometric Return: 7.2%**

**PUBLIC REAL ESTATE (REITs):** From 1972-2021, the FTSE NAREIT All Equity REITs Total Return Index had a total annualized return of 11.77 percent. The price component of return was 3.77 percent with 1.60 percent (annualized) coming from yield compression (*as the dividend yield fell from 6.13 percent in 1972 to 2.84 percent in 2021*). CPI averaged 3.88 percent annually, so real price return (excluding yield compression) was -0.99 percent annually. At 7.28 percent annually, the dividend was the largest component of return. The following returns decomposition method is used to forecast returns where total return is a function of dividend yields, real price return, yield compression and inflation (CPI).

**Modified Returns Decomposition Method: [(DY) + (RPR<sup>11</sup>) + (YLD C) + (CPI)]**

*Historical FTSE NAREIT All Equity REITs Total Return Index (1972-2021): [(7.28%) + (-0.99%) + (1.60%) + (3.88%)] = 11.77%*

*10-Year Forecast (2022-2031): [(2.84%) + (0.00%) + (0.00%) + (2.53%)] = 5.37%*

- *DY* = Dividend Yield
- *RPR* = Real price return excluding yield compression
- *YLD C* = Return resulting from yield compression
- *CPI* = Inflation Forecast

**10-Year Forecast of Annualized Geometric Return: 5.4%**

<sup>9</sup> As of November 30, 2021, the Global ex-U.S. equity market capitalization was comprised as follows: 70.6% Foreign Developed and 29.4% Emerging Markets. Source: Bloomberg, MSCI.

<sup>10</sup> As of November 30, 2021, the Global equity market capitalization was comprised as follows: 61.4% U.S., 27.2% Foreign Developed and 11.3% Emerging Markets. Source: Bloomberg, MSCI.

<sup>11</sup> Unlike traditional stocks, REITs pay out virtually all their earnings (or FFO) in dividends and rely on the issuance of new equity (and debt) to grow earnings (or FFO). Therefore, the expected long-term RPR is capped at zero.



*Use of Indices and Benchmark Return Indices cannot be invested in directly. Index performance is reported gross of fees and expenses and assumes the reinvest dividends and capital gains. Past performance does not indicate future performance and there is a possibility of a loss. See disclosure page for indices representing each asset class.*

**PRIVATE REAL ESTATE:** The asset class return assumption is calculated using the public real estate return assumption plus an alpha assumption of +100 bps as compensation for less liquidity compared to public real estate.

**10-Year Forecast of Annualized Geometric Return: 6.4%<sup>12</sup>**

**BROAD REAL ASSETS:** The asset class is calculated using blended return assumptions for REITs (20 percent), Global Infrastructure (20 percent), Commodities (20 percent), Investment-Grade Fixed Income (20 percent), Corporate High Yield (15 percent) and TIPS (5 percent). Our expected geometric return forecast is 4.7 percent.

**10-Year Forecast of Annualized Geometric Return: 4.7%**

**GLOBAL INFRASTRUCTURE:** The current weighted yield on the Dow Jones Brookfield Global Infrastructure Index is 4.52 percent as of November 30, 2021. Adding the yield to our inflation assumption results in a 7.05 percent return expectation.

**10-Year Forecast of Annualized Geometric Return: 7.1%**

**COMMODITIES:** The expected return for a Commodity Futures index aggregates the expected spot price appreciation of the underlying commodities (expected to match inflation/CPI over a full market cycle), the expected excess return generated from the roll return in a forward contract, and the return from holding T-Bills (or TIPS) as collateral for the futures contracts. As of November 30, 2021, the historical components of return for the S&P GSCI and Bloomberg Commodity Indices were as follows:

**Commodity Futures Returns Decomposition Method: [(SPOT) +/- (ROLL) +/- (COLLATERAL)]**

Historical S&P GSCI Total Return Index (1971-2021): [(2.31%) + (-2.58%) + (4.19%)] = 3.94%

Historical Bloomberg Commodity Total Return Index (1991-2021): [(5.46%) + (-5.04%) + (2.09%)] = 2.34%

10-Year Forecast (2022-2031): [(2.53%) + (0.00%) + (0.75%)] = 3.28%

- SPOT = Spot price return, assumed to keep pace with inflation as measured by CPI forecast
- ROLL = Roll return, assumed to be earned from holding a futures contract to (near) maturity

---

Use of Indices and Benchmark Return Indices cannot be invested in directly. Index performance is reported gross of fees and expenses and assumes the reinvest dividends and capital gains. Past performance does not indicate future performance and there is a possibility of a loss. See disclosure page for indices representing each asset class



- COLLATERAL = Collateral return, earned by the return of the asset used to collateralize futures/swaps (i.e., T-Bills, TIPS, etc.). Collateral return is assumed to keep pace with a 10-year incremental rise in risk free rates (currently 0.05 percent) to the expected 10-year Treasury (1.45 percent).

### **10-Year Forecast of Annualized Geometric Return: 3.3%**

**MARKETABLE ALTERNATIVES:** The return forecast for Marketable Alternatives is unique in that it, along with private equity, are the only investment categories with net positive manager alpha assumptions. That is, the return forecast is not meant to represent a return expectation for the aggregate market, but rather a skillful portfolio of Marketable Alternatives strategies. For purposes of measuring historical risk exposures and correlations to other asset classes, the HFRI Fund of Funds Index, an equal-weighted composite, is used as the proxy. The return, risk, correlation, skewness and kurtosis assumptions are expected to differ on a strategy-by-strategy basis.

Our current 10-year standard deviation (or volatility) forecast for a diversified multi-strategy portfolio of Marketable Alternatives is 8.7 percent, the same volatility expected of hypothetical portfolio consisting of 58 percent investment grade U.S. fixed income and 42 percent global equity mix based on our 10-year forecasts. This fixed/equity mix has a 4.40 percent 10-year geometric expected return forecast. Our expectation is for a skillful and diversified portfolio of hedge fund managers to add 1.5 percent of excess return (i.e., 4.4% + 1.5% = 5.9%) net of manager fees at approximately the same volatility level. For Liquid Alternatives, the same process is employed but a zero percent excess return is used to arrive at a 4.4 percent return assumption.

### **10-Year Forecast of Annualized Geometric Return: 5.9% for Marketable Alternatives<sup>12</sup> & 4.4% for Liquid Alternatives**

**PRIVATE EQUITY:** We assume investors demand a 3 percent risk premium over U.S. All Cap Equity net of manager fees to justify the risk and illiquidity of investing in private equity. The private equity return forecast is not meant to represent a return expectation for the aggregate private equity market, but rather a portfolio of skillful private equity funds. This return forecast is expected to differ depending upon the unique properties of the private equity investment product (i.e., buyout, venture, etc.).

### **10-Year Forecast of Annualized Geometric Return: 8.9%**

---

<sup>12</sup> While our 10-year return forecast is expressed as if Marketable Alternatives returns were normally distributed, the Frontier Engineer® model treats the return forecast as a median (rather than mean), and fattens the left tail, increasing the magnitude of lower probability events. Additional detail surrounding forecast assumptions at the individual sub-strategy level is available upon request.





## APPENDIX 1: RETURN, RISK AND CORRELATION ASSUMPTIONS (ANNUALIZED)

Return & Risk Assumptions (Forecasts)	Arithmetic Return	Geometric Return	Standard Deviation	Skewness	Kurtosis
Cash	0.1%	0.1%	0.0%	0	0
ST Bonds	0.6%	0.6%	2.3%	0.57	1.06
TIPS	1.8%	1.3%	9.8%	-0.78	5.30
Muni Bond	0.8%	0.7%	4.6%	-0.35	1.80
Muni High Yield	4.1%	3.1%	14.4%	-1.57	10.97
US Bond	1.9%	1.7%	6.8%	-0.21	0.94
US Bonds - Dynamic	2.2%	2.0%	5.6%	-1.09	8.41
For. Dev. Bond	1.6%	1.2%	8.8%	0.00	0.63
HY Bond	4.7%	3.7%	13.9%	-1.19	9.30
EM Bond	4.0%	2.6%	16.7%	-1.66	9.56
Global Bonds	1.7%	1.4%	7.2%	-0.15	0.06
Long Term Bonds	3.1%	2.5%	11.0%	0.04	1.64
Global Equity	8.8%	7.2%	17.7%	-0.70	1.67
US Equity (AC)	7.3%	5.9%	16.9%	-0.65	1.31
US Equity (LC)	7.1%	5.7%	16.6%	-0.60	1.08
US Equity (MC)	7.8%	6.1%	18.3%	-0.76	2.55
US Equity (SC)	8.3%	6.1%	21.2%	-0.51	1.42
Non-US Equity (ACWI)	11.0%	8.6%	22.0%	-0.66	1.81
Int'l Dev. Equity	10.1%	7.7%	21.8%	-0.58	1.50
EM Equity	13.7%	9.6%	28.5%	-0.69	2.06
Real Estate	7.6%	5.4%	21.2%	-0.74	7.73
Private Real Estate	6.8%	6.4%	9.0%	-0.74	7.73
Broad Real Assets	5.5%	4.7%	12.5%	-1.70	10.31
Commod. Fut.	5.4%	3.3%	20.3%	-0.79	3.82
Global Infrastructure	8.7%	7.1%	17.9%	-0.88	2.26
Marketable Alternatives	6.3%	5.9%	8.7%	-0.87	5.07
Hedge Funds (Liquid)	4.8%	4.4%	8.7%	-0.87	5.07
Private Equity	11.5%	8.9%	23.0%	0.00	0.00

Correlation Assumptions (Forecasts)	Cash	ST Bonds	TIPS	Muni Bond	Muni High Yield	US Bond	US Bonds - Dynamic	For. Dev. Bond	HY Bond	EM Bond	Global Bonds	Long Term Bonds	Global Equity	US Equity (AC)	US Equity (LC)	US Equity (MC)	US Equity (SC)	Non-US Equity (ACWI)	Int'l Dev. Equity	EM Equity	Real Estate	Private Real Estate	Broad Real Assets	Commod. Fut.	Global Infrastructure	Marketable Alternatives	Hedge Funds (Liquid)	Private Equity
Cash	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ST Bonds	0	1.00	0.59	0.66	0.11	0.89	0.21	0.51	0.17	0.23	0.78	0.71	0.01	0.11	0.11	0.11	0.05	0.01	0.11	-0.01	0.14	0.14	0.07	0.29	0.12	0.06	0.06	-0.16
TIPS	0	0.59	1.00	0.57	0.36	0.76	0.47	0.58	0.29	0.34	0.68	0.70	0.10	0.06	0.05	0.10	0.02	0.14	0.12	0.16	0.25	0.25	0.56	0.54	0.39	0.14	0.14	-0.04
Muni Bond	0	0.66	0.57	1.00	0.47	0.75	0.44	0.46	0.25	0.27	0.72	0.65	0.08	0.10	0.10	0.11	0.03	0.08	0.08	0.05	0.16	0.16	0.23	0.14	0.27	0.12	0.12	-0.09
Muni High Yield	0	0.11	0.36	0.47	1.00	0.32	0.53	0.20	0.47	0.24	0.32	0.31	0.26	0.23	0.22	0.28	0.19	0.28	0.26	0.25	0.33	0.33	0.47	0.28	0.43	0.36	0.36	0.14
US Bond	0	0.89	0.76	0.75	0.32	1.00	0.35	0.55	0.29	0.30	0.94	0.93	0.09	0.18	0.19	0.19	0.10	0.08	0.15	0.03	0.21	0.21	0.20	0.31	0.29	0.08	0.08	-0.11
US Bonds - Dynamic	0	0.21	0.47	0.44	0.53	0.35	1.00	0.26	0.95	0.60	0.49	0.40	0.59	0.54	0.53	0.57	0.51	0.55	0.47	0.53	0.54	0.54	0.65	0.30	0.76	0.50	0.50	0.17
For. Dev. Bond	0	0.51	0.58	0.46	0.20	0.55	0.26	1.00	0.12	0.33	0.66	0.52	0.26	0.04	0.05	0.03	-0.03	0.33	0.37	0.12	0.11	0.11	0.25	0.28	0.41	0.04	0.04	-0.08
HY Bond	0	0.17	0.29	0.25	0.47	0.29	0.95	0.12	1.00	0.57	0.20	0.27	0.63	0.63	0.61	0.67	0.63	0.60	0.54	0.59	0.61	0.61	0.66	0.32	0.74	0.52	0.52	0.22
EM Bond	0	0.23	0.34	0.27	0.24	0.30	0.60	0.33	0.57	1.00	0.29	0.26	0.64	0.57	0.57	0.58	0.52	0.66	0.61	0.74	0.47	0.47	0.59	0.46	0.74	0.57	0.57	0.21
Global Bonds	0	0.78	0.68	0.72	0.32	0.94	0.49	0.66	0.20	0.29	1.00	0.89	0.08	0.07	0.09	0.08	-0.01	0.07	0.07	0.02	0.18	0.18	0.24	0.15	0.28	0.09	0.09	-0.10
Long Term Bonds	0	0.71	0.70	0.65	0.31	0.93	0.40	0.52	0.27	0.26	0.89	1.00	0.08	0.17	0.17	0.18	0.08	0.07	0.13	0.03	0.23	0.23	0.26	0.27	0.28	0.07	0.07	-0.08
Global Equity	0	0.01	0.10	0.08	0.26	0.09	0.59	0.26	0.63	0.64	0.08	0.08	1.00	0.90	0.90	0.87	0.78	0.97	0.95	0.77	0.57	0.57	0.63	0.34	0.83	0.64	0.64	0.40
US Equity (AC)	0	0.11	0.06	0.10	0.23	0.18	0.54	0.04	0.63	0.57	0.07	0.17	0.90	1.00	0.99	0.97	0.89	0.77	0.69	0.69	0.65	0.65	0.57	0.30	0.77	0.62	0.62	0.40
US Equity (LC)	0	0.11	0.05	0.10	0.22	0.19	0.53	0.05	0.61	0.57	0.09	0.17	0.90	0.99	1.00	0.94	0.84	0.77	0.69	0.67	0.62	0.62	0.55	0.29	0.78	0.59	0.59	0.38
US Equity (MC)	0	0.11	0.10	0.11	0.28	0.19	0.57	0.03	0.67	0.58	0.08	0.18	0.87	0.97	0.94	1.00	0.94	0.76	0.67	0.70	0.71	0.71	0.62	0.32	0.78	0.65	0.65	0.39
US Equity (SC)	0	0.05	0.02	0.03	0.19	0.10	0.51	-0.03	0.63	0.52	-0.01	0.08	0.78	0.89	0.84	0.94	1.00	0.69	0.62	0.66	0.70	0.70	0.57	0.27	0.69	0.62	0.62	0.38
Non-US Equity (ACWI)	0	0.01	0.14	0.08	0.28	0.08	0.55	0.33	0.60	0.66	0.07	0.07	0.97	0.77	0.77	0.76	0.69	1.00	0.99	0.77	0.52	0.52	0.63	0.37	0.83	0.62	0.62	0.37
Int'l Dev. Equity	0	0.11	0.12	0.08	0.26	0.15	0.47	0.37	0.54	0.61	0.07	0.13	0.95	0.69	0.69	0.67	0.62	0.99	1.00	0.71	0.50	0.50	0.55	0.35	0.82	0.58	0.58	0.35
EM Equity	0	-0.01	0.16	0.05	0.25	0.03	0.53	0.12	0.59	0.74	0.02	0.03	0.77	0.69	0.67	0.70	0.66	0.77	0.71	1.00	0.47	0.47	0.56	0.38	0.77	0.67	0.67	0.30
Real Estate	0	0.14	0.25	0.16	0.33	0.21	0.54	0.11	0.61	0.47	0.18	0.23	0.57	0.65	0.62	0.71	0.70	0.52	0.50	0.47	1.00	1.00	0.75	0.28	0.68	0.35	0.35	0.21
Private Real Estate	0	0.14	0.25	0.16	0.33	0.21	0.54	0.11	0.61	0.47	0.18	0.23	0.57	0.65	0.62	0.71	0.70	0.52	0.50	0.47	1.00	1.00	0.75	0.28	0.68	0.35	0.35	0.21
Broad Real Assets	0	0.07	0.56	0.23	0.47	0.20	0.65	0.25	0.66	0.59	0.24	0.26	0.63	0.57	0.55	0.62	0.57	0.63	0.55	0.56	0.75	0.75	1.00	0.60	0.91	0.50	0.50	0.25
Commod. Fut.	0	0.29	0.54	0.14	0.28	0.31	0.30	0.28	0.32	0.46	0.15	0.27	0.34	0.30	0.29	0.32	0.27	0.37	0.35	0.38	0.28	0.28	0.60	1.00	0.58	0.44	0.44	0.12
Global Infrastructure	0	0.12	0.39	0.27	0.43	0.29	0.76	0.41	0.74	0.74	0.28	0.28	0.83	0.77	0.78	0.78	0.69	0.83	0.82	0.77	0.68	0.68	0.91	0.58	1.00	0.72	0.72	0.45
Marketable Alternatives	0	0.06	0.14	0.12	0.36	0.08	0.50	0.04	0.52	0.57	0.09	0.07	0.64	0.62	0.59	0.65	0.62	0.62	0.58	0.67	0.35	0.35	0.50	0.44	0.72	1.00	1.00	0.50
Hedge Funds (Liquid)	0	0.06	0.14	0.12	0.36	0.08	0.50	0.04	0.52	0.57	0.09	0.07	0.64	0.62	0.59	0.65	0.62	0.62	0.58	0.67	0.35	0.35	0.50	0.44	0.72	1.00	1.00	0.50
Private Equity	0	-0.16	-0.04	-0.09	0.14	-0.11	0.17	-0.08	0.22	0.21	-0.10	-0.08	0.40	0.40	0.38	0.39	0.38	0.37	0.35	0.30	0.21	0.21	0.25	0.12	0.45	0.50	0.50	1.00

### Disclosures

This report does not represent a specific investment recommendation. Comparisons to any indices referenced herein are for illustrative purposes only and are not meant to imply that actual returns or volatility will be similar to the indices. Indices cannot be invested in directly. Unmanaged index returns assume reinvestment of any and all distributions and are reported gross of any fees and expenses. Any forecasts represent future expectations and actual returns; volatilities and correlations will differ from forecasts.

When referencing asset class returns or statistics, the following indices are used to represent those asset classes, unless otherwise notes. Each index is unmanaged and investors can not actually invest directly into an index:



## APPENDIX 2: INDEX DISCLOSURES

Indices used to generate historical risk and return metrics	Most Recent Index	Index Dates		Linked Index 1	Index Dates		Linked Index 2	Index Dates		Linked Index 2	Index Dates	
Cash	FTSE Treasury Bill 3 Mon USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
ST Bonds	Bloomberg US Govt/Credit 1-3 Yr TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
TIPS	Bloomberg US Treasury US TIPS TR USD	12/21	- 3/97	Bloomberg US Agg Bond TR USD	2/97	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Muni Bond	Bloomberg Municipal 5 Yr 4-6 TR USD	12/21	- 1/88	Bloomberg US Agg Bond TR USD	12/87	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Muni High Yield	Bloomberg HY Muni TR USD	12/21	- 11/95	Bloomberg Municipal 5 Yr 4-6 TR USD	10/95	- 1/88	Bloomberg US Agg Bond TR USD	12/87	- 1/79	N.A.	N.A.	- N.A.
US Bond	Bloomberg US Agg Bond TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
US Bonds - Dynamic	*Custom Blend of Indices	12/21	- 2/90	Bloomberg US Agg Bond TR USD	1/90	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
For. Dev. Bond	50% CFI/WGBI NonUSD Hdg 50% CFI/WGBI NonUSD	12/21	- 1/85	Bloomberg US Agg Bond TR USD	12/84	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
HY Bond	Bloomberg US Corporate High Yield TR USD	12/21	- 7/83	Bloomberg US Agg Bond TR USD	6/83	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
EM Bond	JPM GBI-EM Global Diversified TR USD	12/21	- 1/03	JPM EMBI Global Diversified TR USD	12/02	- 1/94	Bloomberg US Corporate High Yield TR USD	12/93	- 7/83	Bloomberg US Agg Bond TR USD	6/83	- 1/79
Global Bonds	Bloomberg Global Aggregate TR Hdg USD	12/21	- 2/90	Bloomberg US Agg Bond TR USD	1/90	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Long Term Bonds	Bloomberg US Govt/Credit Long TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Global Equity	MSCI ACWI GR USD	12/21	- 1/88	S&P 500 TR USD	12/87	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
US Equity (AC)	Russell 3000 TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
US Equity (LC)	S&P 500 TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
US Equity (MC)	Russell Mid Cap TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
US Equity (SC)	Russell 2000 TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Non-US Equity (ACWI)	MSCI ACWI Ex USA GR USD	12/21	- 1/88	MSCI EAFE GR USD	12/87	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Int'l Dev. Equity	MSCI EAFE GR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
EM Equity	MSCI EM GR USD	12/21	- 1/88	MSCI EAFE GR USD	12/87	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Real Estate	FTSE Nareit All Equity REITs TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Private Real Estate	FTSE Nareit All Equity REITs TR USD	12/21	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Broad Real Assets	S&P Real Asset TR USD	12/21	- 5/05	*Custom Real Assets Index	4/05	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Commod. Fut.	BCI+TIPS-CASH	12/21	- 3/97	BCI+AGG-CASH	2/97	- 1/91	GSCH+AGG-CASH	12/90	- 1/79	N.A.	N.A.	- N.A.
Global Infrastructure	DJ Brookfld Global Infra TR USD	12/21	- 2/03	Alerian MLP TR USD	1/03	- 1/96	Wilshire US RESI TR USD	12/95	- 1/79	N.A.	N.A.	- N.A.
Marketable Alternatives	HFRI Fund of Funds Composite USD	12/21	- 1/90	HFNI Hedge Fund Aggregate Average	12/89	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Hedge Funds (Liquid)	HFRI Fund of Funds Composite USD	12/21	- 1/90	HFNI Hedge Fund Aggregate Average	12/89	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.
Private Equity	Cambridge PE 67% Buyout vs. 33% Venture	12/21	- 4/86	Russell 2000 TR USD	3/86	- 1/79	N.A.	N.A.	- N.A.	N.A.	N.A.	- N.A.

\*US Bonds - Dynamic Index - 1/3 Bloomberg Gbl Agg Ex USD TR Hdg USD, 1/3 FTSE Treasury Bill 3 Mon USD & 1/3 Bloomberg US Corporate High Yield TR USD

## APPENDIX 3: STANDARD DEVIATION FORECASTS

Annualizing a historical monthly standard deviation by multiplying by  $\sqrt{12}$  understates true annual volatility (because of monthly serial correlation). Therefore, standard deviation is derived (for all asset classes) by calculating the annual standard deviation of all historical 12-month periods.



An adjustment will be made to asset classes with shorter return streams that will attempt to normalize volatility between asset classes. The methodology is used for the following asset classes:

**Asset Classes**

- TIPS (March 1997)
- Emerging Markets Bonds (January 1994)
- Hedge Funds Portfolio (January 1990)
- Midstream Energy (January 1990)
- Emerging Market Equities (January 1988)
- Foreign Bonds (January 1985)
- High Yield Bonds (November 1984)

**Methodology**

Standard Deviation ( $\sigma$ ) of Asset =  $\frac{[\text{short-term } \sigma \text{ of asset}] * [\text{long-term } \sigma \text{ of comparable asset}]}{[\text{short-term } \sigma \text{ of comparable asset}]}$

**APPENDIX 4: DIFFERENTIATING ARITHMETIC AND GEOMETRIC ASSUMPTIONS**

**1. ARITHMETIC RETURNS VS. GEOMETRIC RETURNS**

The arithmetic average annual return is always equal to or greater than a geometric (or compounded) annualized return. Since the CAPM and the Black-Litterman are single time period models, they forecast an arithmetic return (i.e., one-year). On the other hand, geometric returns are more appropriate for quantifying expected holding period returns (i.e., 10-years).

**Geometric Return = [Arithmetic Return] – [(Standard Deviation)<sup>2</sup>] / 2**

The Frontier Engineer® asset allocation modeling seeks to optimize (the median expected) aggregate portfolio geometric returns (per unit risk) rather than arithmetic returns (per unit risk).

**2. OPTIMIZING FOR GEOMETRIC RETURN**

If two assets have the same expected return (and low correlation), they can be combined in a portfolio to generate a higher holding period return (geometric) than either two investments on a segregated basis. The following example shows how two investments with 10 percent expected arithmetic returns and 20 percent expected annual standard deviations can be combined in a portfolio to generate a higher time horizon return (geometric) than either on a segregated basis (*correlation = 0*).

Expected Arithmetic Return (2 asset portfolio) =  $w_1 * (AR_1) + w_2 * (AR_2)$   
 Expected Arithmetic Return (2 asset portfolio) =  $0.50 * 10\% + 0.50 * 10\% = 10.0\%$   
 $AR_1 = \text{Arithmetic Return of asset 1}$   
 $AR_2 = \text{Arithmetic Return of asset 2}$   
 $w_1 = \text{weight of asset 1}$   
 $w_2 = \text{weight of asset 2}$

Expected Standard Deviation (2 asset portfolio) =  $\sqrt{[(w_1^2 * \sigma_1^2 + w_2^2 * \sigma_2^2) + (2 * w_1 * w_2 * \sigma_1 * \sigma_2 * r_{(1,2)})]}$



Expected Standard Deviation (2 asset portfolio) =  $\sqrt{[(0.502*0.202+0.502*0.202) + (2*0.50*0.50*0.20*0.20*0.00)]}$  = **14.1%**

$w_1$  = weight of asset 1

$w_2$  = weight of asset 2

$\sigma_1$  = standard deviation of asset 1

$\sigma_2$  = standard deviation of asset 2

$r_{(1,2)}$  = Correlation between asset 1 and 2

As previously stated, geometric return = arithmetic return –  $\sigma_2/2$

- Expected Geometric Return (Asset 1 in vacuum) = 10% - 20%<sup>2</sup>/2 = **8.0%**
- Expected Geometric Return (Asset 2 in vacuum) = 10% - 20%<sup>2</sup>/2 = **8.0%**
- Expected Geometric Return (50/50 Portfolio) = 10% - 14.1%<sup>2</sup>/2 = **9.0%**

### 3. Conclusion

Two low correlating assets with the same arithmetic return have a higher geometric return when combined within a portfolio (and rebalanced) than either has on a stand-alone basis.

## APPENDIX 5: DEFINITIONS

Fiducient Advisors' Frontier Engineer® portfolio optimization requires 10-year forecasts of the following metrics:

1. **Expected Median Annual Return**<sup>13</sup> of each asset class
2. **Expected Annual Geometric Return**<sup>14</sup> of each asset class
3. **Expected Annual Standard Deviation** of each asset class
4. **Expected Correlation** among all asset classes
5. **Expected Skewness** of each asset class (corrected for asymmetry)
6. **Expected Excess Kurtosis** of each asset class (corrected for tails)

### Expected 10-Year Median Annual Return Forecast

Our annual median return forecast represents the expected midpoint of all possible future 10-year returns for an asset class. These return forecasts (or expected returns) are highly unlikely to be precisely correct over the 10-year time horizon. We expect the actual 10-year return to have a 50 percent probability of being higher or lower than the forecast.

### Expected 10-Year Geometric Annual Return<sup>15</sup> Forecast

<sup>13</sup> Median return is used because it does not require a normal return distribution assumption.

<sup>14</sup> The expression of the expected geometric return forecast (from median returns) requires a normal return distribution assumption (i.e., that mean = median). This is for illustrative purposes only. The geometric return forecasts are expressed as if returns were normal (i.e., median = mean). For Frontier Engineer® optimization, asset class return distributions do not have to be normally (Gaussian) distributed.

<sup>15</sup> Geometric Return = Arithmetic Mean or Median Return –  $\sigma^2/2$ .



Our geometric return forecast represents the expected midpoint of all possible future 10-year outcomes for an asset class. These geometric return forecast estimates (or expected returns) are highly unlikely to be precisely correct over the 10-year time horizon. We expect the actual 10-year return to have a 50 percent probability of being higher or lower than the forecast.

### **Expected 10-Year Annual Standard Deviation Forecast**

Our 10-year standard deviation forecast represents the median expected (normally distributed) variability of annual returns about the mean. The higher the standard deviation, the more uncertain the outcome.

### **Expected Correlation**

Our 10-year forecast of asset class correlation coefficients quantifies the degree to which two assets are expected to move together. The correlation coefficient can range from -1 (perfect negative correlation) to +1 (perfect positive correlation).

### **Expected Skewness**

Our 10-year skewness forecast quantifies the degree of expected asymmetry of the return distribution. If the left tail is more pronounced than the right tail, the asset has negative skewness. If the reverse is true, it has positive skewness. If the two are equal, it has zero skewness (normally distributed).

### **Expected Excess Kurtosis**

Our 10-year excess kurtosis forecast of each asset class quantifies the degree of expected peakedness (or flatness) of the return distribution. If excess kurtosis is positive, the distribution is more peaked (with extreme events). If excess kurtosis is negative, the distribution is flatter (with fewer extreme events).

## **APPENDIX 6: FORECASTING METHODS**

### RETURNS:

10-year asset class return forecasts are developed using various methodologies including:

1. Risk Premium Method
2. Equity Returns Decomposition Method
3. Cyclically-Adjusted Earnings Yield (Modified CAPE) Method
4. Black-Litterman Method
5. Fixed Income Returns Decomposition Method



6. High Yield Default-Loss Method
7. Commodity Futures Returns Decomposition Method
8. Corrections for extreme asset class over/under valuation (or other disequilibrium in capital market assumptions)
1. The Risk Premium Method adds a risk premium to a referenced asset's return forecast.

$$\text{Return} = (\text{RA}) +/- (\text{RP})$$

- *RA = Forecasted Return of "Reference Asset"*
- *RP = Appropriate "Risk Premium" added to the Referenced Asset's forecast*

2. The Equity Returns Decomposition Method breaks out the components of equity returns.

$$\text{Return} = [(1 + \text{DIV}) * (1 + \text{P/E}) * (1 + \text{REG}) * (1 + \text{CPI})] - 1$$

- *DIV = Dividend Yield*
- *P/E = P/E Expansion/Contraction*
- *REG = Real Earnings Growth = [Return on Equity] \* [Earnings Retention Ratio]*
- *CPI = Inflation (Consumer Price Index)*

The following is the Modified Equity Returns Decomposition Method for REITs and MLPs:

$$\text{Return} = [(\text{DY}) +/- (\text{RPR}) +/- (\text{YLD C}) +/- (\text{CPI})]$$

- *DY = Dividend/Distribution Yield*
- *RPR = Real price return excluding yield compression*
- *YLD C = Price return resulting from yield compression*
- *CPI = Inflation (Consumer Price Index)*

3. The Cyclically-Adjusted Earnings Yield Method incorporates a smoothing technique to earnings by dividing the average real earnings by the current (real) Index price. The result is a cyclically-adjusted real earnings yield of an individual equity asset class, to which forward-looking inflation expectations are applied to garner an unbiased nominal expected return.

$$\text{Return} = \{[1 + (\text{EARNINGS/PRICE})] * (1 + \text{CPI})\} - 1$$

- *EARNINGS = 10-year average real earnings of Index*
- *PRICE = Current real price of Index*
- *CPI = Inflation (Consumer Price Index)*



4. The Black-Litterman Method uses reverse mean-variance optimization to arrive at unbiased asset class return forecasts by inputting correlation, volatility and market capitalization weights, then solving for (equilibrium) expected returns (or risk premiums).
  - *Market capitalization weights for each asset*
  - *Correlation between the assets*
  - *Volatility (or standard deviation) of assets*
  - *Risk free rate*
  - *The risk aversion coefficient of the reference market portfolio*
5. The Fixed Income Returns Decomposition Method forecasts the components of fixed income Index returns (Yield  $\Delta$  and Price  $\Delta$ ) and combines them for a total return forecast.

$$\text{Returns} = (\text{YLD}) +/- (\text{CUR}) +/- (\text{PE}) +/- (\text{CRED})$$

- *YLD = Bond Index YTM*
  - *CUR = Expected currency effect derived from interest rate parity*
  - *PE = Bond Index "Price Effect"*
  - *CRED = Credit spread premium*
6. The High Yield Default-Loss Method forecasts fixed income returns by regressing default rates, recovery rates and credit spreads to generate an expected loss rate, then combines the Index yield to solve for a total return forecast.
    - *Bond Index Yield*
    - *U.S. Treasury Yield*
    - *Historical Default Rates*
    - *Historical Recovery Rates*
  7. The Commodity Futures Index Returns Decomposition Method forecasts and aggregates the components of a commodity futures Index's total return.

$$\text{Returns} = (\text{SPOT}) +/- (\text{ROLL}) +/- (\text{COLLATERAL})$$

- *SPOT = Spot price return, which is assumed to keep pace with inflation as measured by CPI forecast*
- *ROLL = Roll return expected to be earned from holding a futures contract to (near) maturity*



- *COLLATERAL = Collateral return, which is earned by the return of the asset used to collateralize futures/swaps (i.e., T-Bills)*

#### STANDARD DEVIATION:

Standard deviation is derived by calculating the rolling annual standard deviation of all historical 12-month periods. For asset classes with short track records, adjustments to historical standard deviations may be made where appropriate. Such adjustments may be made using the following methodology:

$$\text{Standard Deviation } (\sigma) \text{ of Asset} = \frac{[\text{short-term } \sigma \text{ of asset}] * [\text{long-term } \sigma \text{ of comparable asset}]}{[\text{short-term } \sigma \text{ of comparable asset}]}$$

#### CORRELATION:

For all but two asset classes, correlation is calculated using long-term historical monthly data over common time periods. Cash is assumed to have a zero correlation to all asset classes. Private Equity's correlation is calculated using long-term historical (calendar year) annual data over common time periods.

#### SKEWNESS AND KURTOSIS:

We observe (monthly) skewness and excess kurtosis for each asset class over a uniform period of time (1997 to present). Failing to observe skewness and excess kurtosis over a uniform period of time for each asset class, especially during periods of stress (i.e., no emerging markets equity data for October 1987), will likely understate the impact of extreme events for asset classes with shorter return streams relative to those with longer return streams. Adjustments may be made to skewness and excess kurtosis from historical measures if warranted.

Fiducient Advisors reserves the right to make corrections for over or undervaluation of asset classes (or what we believe is capital markets disequilibrium) when developing forecasts. An expectation of mean-reversion in relative valuations (convergence of relationships) may be used when developing 10-year capital market assumptions.