

## MacroRisk Analytics Capital Market Assumptions 2024 Technical Description

1. Calculating correlation matrices: For computing the correlation matrix, we used standard methods for updating historical correlation matrices with newer data. In this instance, we began with a long-range, historically-based correlation matrix and combined it with a more recent correlation matrix to reflect current information. This method provides a stable, yet evolving, approach to correlation estimation that is consistent with long-term market stability and with changing correlations between asset classes.
  - a. The MRA Correlation Matrices use a blend estimate in which “historical” correlations between 12 asset classes are calculated as well as “current” correlations between those same asset classes. For this purpose, we begin with estimated correlations of monthly returns, using Pearson correlation, using data over the past three years. We also use historical sources to obtain a correlation matrix representing long-term historical correlations between the asset classes. Historical data was primarily used for the post-1980 period to acknowledge significant institutional differences prior to then.
  - b. We next compute a new combination correlation matrix which is obtained as a linear combination with 25 percent weight on the current matrix and 75 percent weight on the historical matrix. This is a standard adaptive forecasting (filtering) method, widely used in industry for incorporating current information while building on historical relations between the asset classes (Granger, Forecasting in Business and Economics 2e, 1989)
  - c. The resulting correlation matrix reflects current values with some adjustments to reflect historical realities.
2. Calculating combination forecasts of annualized returns and volatilities: The actual numerical forecasts of annualized returns and volatilities are based on consensus predictions from government, professional forecasters and institutional sources. We regularly use consensus information sources in its research and c4cast® has several patents regarding the collection and use of data for creating optimal consensus forecasts. We reviewed data and projections from standard institutional sources. The projections presented here are the medians of the forecasts we collected.
  - a. MacroRisk Analytics is a recognized expert at producing combination forecasting with decades of experience. MacroRisk scientists have received U.S. patents regarding combination forecasting and forecasting with interpolation modeling and additional patents for asset price forecasting, tracking and evaluation (U.S. Patents 6,792,399; 7,072,863; 7,337,135; 7,383,219; 8,494,940; and others).
  - b. MacroRisk obtained long-term forecasts for returns and volatilities for the 12 asset classes from
    - i. U.S. Federal Reserve System
    - ii. Large institutional money management firms
    - iii. Boutique research firms
    - iv. MacroRisk Analytics internal models
  - c. This year’s forecast is comprised of the median value of projected returns and projected volatilities for each asset class. Using medians rather than means

eliminates “outlier problems” and generates a more representative consensus estimate, which was our current goal.

- d. In future years, forecasts will continue with the above methodology but may also consider optimal combination forecasting methods following Granger and Ramanathan (Journal of Forecasting, 1984) and MacroRisk’s patented techniques, which may result in more accurate projections.
3. The MacroRisk forecasts are intended to reflect a five-year investment horizon, though some of the contributing forecasts were for as long as a 10-year period. We believe the attached projections (see Table 1) are appropriate for asset allocation with annual or biannual portfolio reviews though some will undoubtedly choose to go longer between assessments or portfolio modifications.

**Table 1 - Capital Market Assumption Return and Standard Deviation**

	Long-range Expected Return	Long-range Expected Volatility
Large Cap Equity	6.85%	16.80%
Mid Cap Equity	7.80%	19.70%
Small Cap Equity	7.20%	22.00%
International Equity	7.90%	17.60%
Emerging Market Equity	8.80%	23.82%
REITs	6.43%	17.67%
High Yield Bond	6.60%	10.01%
Long term Bond	4.70%	12.39%
Intermediate term Bond	4.27%	5.30%
International Bond	4.50%	8.00%
Money Market	3.90%	1.58%
Commodities	5.15%	18.00%

Source: MacroRisk Analytics

**Table 2 - Correlation Matrix**

<b>Large Cap Equities</b>	1.000	0.889	0.814	0.843	0.695	0.732	0.779	-0.060	-0.018	0.286	0.015	0.296
<b>Mid Cap Equities</b>	0.889	1.000	0.960	0.823	0.676	0.778	0.727	-0.080	-0.053	0.268	-0.019	0.321
<b>Small Cap Equities</b>	0.814	0.960	1.000	0.763	0.622	0.734	0.678	-0.090	-0.058	0.253	-0.016	0.336
<b>International Equity</b>	0.843	0.823	0.763	1.000	0.893	0.649	0.728	-0.054	-0.008	0.418	0.033	0.361
<b>Emerging Market Equity</b>	0.695	0.676	0.622	0.893	1.000	0.497	0.608	-0.052	-0.027	0.342	0.009	0.319
<b>REITs</b>	0.732	0.778	0.734	0.649	0.497	1.000	0.661	0.071	0.111	0.317	0.119	0.236
<b>High Yield Bond</b>	0.779	0.727	0.678	0.728	0.608	0.661	1.000	0.217	0.285	0.495	0.270	0.270
<b>Long Term Bond</b>	-0.060	-0.080	-0.090	-0.054	-0.052	0.071	0.217	1.000	0.911	0.564	0.591	-0.137
<b>Intermediate Term Bond</b>	-0.018	-0.053	-0.058	-0.008	-0.027	0.111	0.285	0.911	1.000	0.668	0.799	-0.096
<b>International Government Bond</b>	0.286	0.268	0.253	0.418	0.342	0.317	0.495	0.564	0.668	1.000	0.597	0.143
<b>Money Market</b>	0.015	-0.019	-0.016	0.033	0.009	0.119	0.270	0.591	0.799	0.597	1.000	-0.040
<b>Commodities</b>	0.296	0.321	0.336	0.361	0.319	0.236	0.270	-0.137	-0.096	0.143	-0.040	1.000

Source: MacroRisk Analytics