Risk Models for Alternative Investments

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PIMCO
## Trends in asset and risk allocation

<table>
<thead>
<tr>
<th>Traditional Asset Allocation Approaches</th>
<th>New Normal Asset Allocation Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward looking and statistically driven</td>
<td>Forward looking and driven by macroeconomics</td>
</tr>
<tr>
<td>Focus on asset class diversification</td>
<td>Focuses on risk factor diversification</td>
</tr>
<tr>
<td>Underestimate the dynamic nature of the market</td>
<td>Focuses on the secular and the cyclical horizons</td>
</tr>
<tr>
<td>Use volatility as sole risk measure</td>
<td>Seeks to explicitly hedge “fat tail” risk</td>
</tr>
</tbody>
</table>
Viewing risk through a different lens

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| **STOCKS** |  |  |  |  |  |  |  |
| EQUITY | SIZE | VALUE / GROWTH | MOMENTUM | VOLATILITY | LIQUIDITY |  | EQUITY INDUSTRY |
| **BONDS** |  |  |  |  |  |  |  |
| DURATION | YIELD CURVE | SPREAD | CURRENCY | VOLATILITY | LIQUIDITY |  | EQUITY |
| **ALTERNATIVES** |  |  |  |  |  |  |  |
| EQUITY | DURATION | VALUE / GROWTH | MOMENTUM | VOLATILITY | LIQUIDITY |  | EQUITY INDUSTRY |
Asset class diversification does not equal risk diversification

As of 30 June 2014
SOURCE: NCSE, PIMCO

Hypothetical example for illustrative purposes only.

1 Average Endowment Portfolio information from the 2013 NACUBO-Commonfund Study of Endowments (NCSE). This study is based on information collected as of 30 June 2013. The asset allocation percentages shown are based on the Average Endowment Portfolio as of 30 June 2013 for endowments >$1 billion.

2 See Appendix for additional information regarding volatility estimates.

Refer to Appendix for additional endowment style portfolio index sources, hypothetical example and portfolio analysis information.
The intuition

Equity

Fixed Income
Hypothetical example

SOURCES: Bloomberg, PIMCO.

Hypothetical example for illustrative purposes only.
Refer to Appendix for additional investment strategy, hypothetical example and risk information.
Hypothetical example

\[ r_{obs,t} = \sum_{j=1}^{Q} w_j S&P\ 500_{t-j} \]

Illustration of the concept of smoothing

SOURCE: PIMCO. Hypothetical example for illustrative purposes only. Refer to Appendix for additional investment strategy, hypothetical example and risk information.
Illustration of the concept of smoothing

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Our model

\[ r_{obs,t} = \sum_j \omega_j r_{t-j} \]

Reported (or “observed”) returns are smoothed

\[ r_t = \alpha + \sum_i \beta_i f_{i,t} + \epsilon_t \]

Mark-to-market returns can be mapped to risk factors

\[ X_{i,t} = \sum_j \omega_j f_{i,t-j} \]

If we smooth risk factors the same way as the index...

\[ r_{obs,t} = \alpha + \sum_i \beta_i X_{i,t} + \eta_t \]

...we can recover the “true” betas.
Simplified example: private real estate, last 10 years

\[ \beta = 0.14 \]

SOURCES: NCREIF, PIMCO. As of March 31, 2014.
Refer to Appendix for additional investment strategy, hypothetical example and risk information.
Hypothetical example for illustrative purposes only.

SOURCES: NCREIF, PIMCO. As of March 31, 2014. The S&P 500. Total return index, has been smoothed with eight equally-weighted lags. Refer to Appendix for additional investment strategy, hypothetical example and risk information.
Risk factor models for alternative assets

<table>
<thead>
<tr>
<th>Asset class</th>
<th>Index</th>
<th>U.S. equity</th>
<th>Size</th>
<th>Value</th>
<th>Liquidity (P&amp;G)</th>
<th>Total industry</th>
<th>Nominal duration</th>
<th>Real duration</th>
<th>IG corp. spread</th>
<th>HY corp. spread</th>
<th>Equity beta (unity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private equity</td>
<td>Cambridge Assoc. PE</td>
<td>0.8</td>
<td>-0.9</td>
<td>-1.4</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td>1.2</td>
<td></td>
<td>0.9</td>
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<tr>
<td></td>
<td></td>
<td>6.5</td>
<td>-1.4</td>
<td>-3.3</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.1</td>
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<tr>
<td>Venture capital</td>
<td>Cambridge Assoc. VC</td>
<td>1.4</td>
<td>-3.9</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td>5.4</td>
<td></td>
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<td>5.4</td>
<td>-2.9</td>
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<td></td>
<td></td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Infrastructure</td>
<td>UBS Global Infr. &amp; Utilities</td>
<td>0.5</td>
<td>0.7</td>
<td>0.2</td>
<td>1.1</td>
<td>0.6</td>
<td>7.3</td>
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<td></td>
<td></td>
<td>3.8</td>
<td>1.1</td>
<td>1.4</td>
<td></td>
<td>0.4</td>
<td>2.6</td>
<td>5.8</td>
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<tr>
<td>REITs</td>
<td>FTSE NAREIT All Equity</td>
<td>0.7</td>
<td></td>
<td></td>
<td>1.4</td>
<td>2.5</td>
<td>10.9</td>
<td>5.8</td>
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<td></td>
<td>0.9</td>
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<tr>
<td></td>
<td></td>
<td>4.4</td>
<td></td>
<td></td>
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<td>1.1</td>
<td>3.5</td>
<td>6.6</td>
<td></td>
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<tr>
<td>Farmland</td>
<td>NCREIF Farmland</td>
<td>0.1</td>
<td></td>
<td></td>
<td>0.9</td>
<td>9.7</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td></td>
<td></td>
<td>1.0</td>
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<td></td>
<td></td>
<td>2.3</td>
<td></td>
<td>-0.2</td>
<td></td>
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<tr>
<td>Timberland</td>
<td>NCREIF Timberland</td>
<td>0.3</td>
<td></td>
<td></td>
<td>2.0</td>
<td>9.1</td>
<td>2.6</td>
<td>0.2</td>
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<td></td>
<td>1.1</td>
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<tr>
<td>Property (unlevered)</td>
<td>NCREIF Property</td>
<td>0.3</td>
<td></td>
<td></td>
<td>0.4</td>
<td>0.5</td>
<td>1.2</td>
<td>1.7</td>
<td>0.3</td>
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<td></td>
<td></td>
<td>5.2</td>
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<td>5.4</td>
<td>1.0</td>
<td>1.3</td>
<td>4.9</td>
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<tr>
<td>Real estate (core)</td>
<td>NCREIF Core</td>
<td>0.4</td>
<td></td>
<td></td>
<td>0.5</td>
<td>0.6</td>
<td>2.8</td>
<td>2.7</td>
<td>0.5</td>
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<tr>
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<td>5.2</td>
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<td></td>
<td>4.9</td>
<td>1.8</td>
<td>1.4</td>
<td>5.7</td>
<td></td>
<td></td>
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<tr>
<td>Real estate (value added)</td>
<td>NCREIF Value Added</td>
<td>0.5</td>
<td></td>
<td></td>
<td>0.6</td>
<td>1.2</td>
<td>2.4</td>
<td>3.0</td>
<td>5.1</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.4</td>
<td></td>
<td></td>
<td>4.3</td>
<td>1.1</td>
<td>1.1</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Real estate (opportunistic)</td>
<td>NCREIF Opportunistic</td>
<td>0.5</td>
<td></td>
<td></td>
<td>0.8</td>
<td>1.7</td>
<td>11.8</td>
<td>0.8</td>
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<tr>
<td></td>
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<td>3.6</td>
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<td>4.7</td>
<td>3.7</td>
<td></td>
<td>5.3</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

SOURCES: NCREIF, PIMCO, Cambridge Associates, Bloomberg. From December 1991 to December 2012. Analysis based on quarterly data, except for Timberland and Farmland which are annualized due to unreliable quarterly data. Numbers in bold are coefficients from regressions estimated on adjusted risk factor returns on based on the lag structure in the index data, while numbers in bold are the Newey-West T-Statistics.
Reported volatilities

- Venture Capital: 25%
- Equities: 18%
- Infrastructure (Listed): 15%
- Real Estate (Opportunistic): 12%
- Private Equity: 11%
- Timberland: 9%
- Real Estate (Value Added): 9%
- Farmland: 7%
- Hedge Fund Index: 7%
- Real Estate (Core): 6%
- Bonds: 5%
- Real Estate (Unlevered): 5%

Hypothetical example for illustrative purposes only.
Reported vs. adjusted volatilities

Hypothetical example for illustrative purposes only.
Portfolio diversification based on reported returns

Hypothetical example for illustrative purposes only.
SOURCES: NCREIF, PIMCO, Cambridge Associates, Bloomberg. From December 1991 to December 2012. See page 18 for asset class proxies. Blended portfolios are equal weighted among the asset classes listed. Analysis based on quarterly data, except for Timberland and Farmland which are annualized due to unreliable quarterly data.
Portfolio diversification: reported vs. adjusted

Hypothetical example for illustrative purposes only.
SOURCES: NCREIF, PIMCO, Cambridge Associates, Bloomberg. From December 1991 to December 2012. See page 18 for asset class proxies. Blended portfolios are equal weighted among the asset classes listed. Analysis based on quarterly data, except for Timberland and Farmland which are annualized due to unreliable quarterly data.
Summary

Trends in asset and risk allocation:

- Formulating forward-looking macro views
- Focusing on risk factors
- Adopting a dynamic approach
- Mitigating tail risks

Risk models for alternative investments:

- Focusing on mark-to-market volatility
- Re-assessing diversification benefits
Appendix

Past performance is not a guarantee or a reliable indicator of future results.

CORRELATION
The correlation of various indices or securities against one another or against inflation is based upon data over a certain time period. These correlations may vary substantially in the future or over different time periods that can result in greater volatility.

ENDOWMENT STYLE PORTFOLIO
Domestic Equities: S&P 500; Global Equities: MSCI EAFE Net Dividend Index in USD; EM Equities: MSCI Emerging Markets Index; Domestic (IG/HY) Bonds (IG bonds, HY bonds): 6.75% Investment Grade Bonds - Barclays Capital US Aggregate Index, 0.9% High Yield Bonds - Barclays Capital US High Yield Index; Global Bonds: Barclays Capital Global Aggregate Index; EM Bonds: JP Morgan EMBI Global Index; Real Estate: NCREIF Property Index; Hedge Funds: HFRI Fund Weighted Composite Index; Private Equity: Cambridge Associates LLC U.S. Private Equity Index®; Venture Capital: Cambridge Associates LLC U.S. Venture Capital Index®; Energy and Natural Resources (Energy, Timber, Commodities, Managed Futures): 3.6% Energy - Dow Jones UBS Commodity Energy Index, 1.8% Timber - NCREIF Timberland Index, 1.8% Commodities - Dow Jones UBS Commodity Index, 1.8% Managed Futures: DJCS Managed Futures Index; Distressed Debt: HFRI ED: Distressed/Restructuring Index; Cash: Citigroup 3 Month US T-Bill Index.

HYPOTHETICAL EXAMPLE
No representation is being made that any account, product, or strategy will or is likely to achieve profits, losses, or results similar to those shown. Hypothetical or simulated performance results have several inherent limitations. Unlike an actual performance record, simulated results do not represent actual performance and are generally prepared with the benefit of hindsight. There are frequently sharp differences between simulated performance results and the actual results subsequently achieved by any particular account, product, or strategy. In addition, since trades have not actually been executed, simulated results cannot account for the impact of certain market risks such as lack of liquidity. There are numerous other factors related to the markets in general or the implementation of any specific investment strategy, which cannot be fully accounted for in the preparation of simulated results and all of which can adversely affect actual results.

INVESTMENT STRATEGY
There is no guarantee that these investment strategies will work under all market conditions and each investor should evaluate their ability to invest for a long-term especially during periods of downturn in the market.

PORTFOLIO ANALYSIS
The portfolio analysis is based on the 2013 NACUBO-Commonfund Study of Endowments and no representation is being made that the structure of the average portfolio or any account will remain the same or that similar returns will be achieved. Results shown may not be attained and should not be construed as the only possibilities that exist. Different weightings in the asset allocation illustration will produce different results. Actual results will vary and are subject to change with market conditions. There is no guarantee that results will be achieved. No fees or expenses were included in the estimated results and distribution. The scenarios assume a set of assumptions that may, individually or collectively, not develop over time. The analysis reflected in this information is based upon data at time of analysis. Forecasts, estimates, and certain information contained herein are based upon proprietary research and should not be considered as investment advice or a recommendation of any particular security, strategy or investment product.

PIMCO routinely reviews, modifies, and adds risk factors to its proprietary models. Due to the dynamic nature of factors affecting markets, there is no guarantee that simulations will capture all relevant risk factors or that the implementation of any resulting solutions will protect against loss. All investments contain risk and may lose value. Simulated risk analysis contains inherent limitations and is generally prepared with the benefit of hindsight. Realized losses may be larger than predicted by a given model due to additional factors that cannot be accurately forecasted or incorporated into a model based on historical or assumed data.
RISK
Absolute return portfolios may not fully participate in strong positive market rallies. Investing in the bond market is subject to risks, including market, interest rate, issuer, credit, inflation risk, and liquidity risk. The value of most bonds and bond strategies are impacted by changes in interest rates. Bonds and bond strategies with longer durations tend to be more sensitive and volatile than those with shorter durations; bond prices generally fall as interest rates rise, and the current low interest rate environment increases this risk. Current reductions in bond counterparty capacity may contribute to decreased market liquidity and increased price volatility. Bond investments may be worth more or less than the original cost when redeemed. Investing in foreign denominated and/or domiciled securities may involve heightened risk due to currency fluctuations, and economic and political risks, which may be enhanced in emerging markets. Equities may decline in value due to both real and perceived general market, economic, and industry conditions. Tail risk hedging may involve entering into financial derivatives that are expected to increase in value during the occurrence of tail events. Investing in a tail event instrument could lose all or a portion of its value even in a period of severe market stress. A tail event is unpredictable; therefore, investments in instruments tied to the occurrence of a tail event are speculative. Derivatives may involve certain costs and risks such as liquidity, interest rate, market, credit, management and the risk that a position could not be closed when most advantageous. Investing in derivatives could lose more than the amount invested. Derivatives may involve certain costs and risks such as liquidity, interest rate, market, credit, management and the risk that a position could not be closed when most advantageous. Investing in derivatives could lose more than the amount invested. Investor should consult their investment professional prior to making an investment decision.

VOLATILITY (ESTIMATED)
We employed a block bootstrap methodology to calculate volatilities. We start by computing historical factor returns that underlie each asset class proxy from January 1997 through the present date. We then draw a set of 12 monthly returns within the dataset to come up with an annual return number. This process is repeated 25,000 times to have a return series with 25,000 annualized returns. The standard deviation of these annual returns is used to model the volatility for each factor. We then use the same return series for each factor to compute covariance between factors. Finally, volatility of each asset class proxy is calculated as the sum of variances and covariance of factors that underlie that particular proxy. For each asset class, index, or strategy proxy, we will look at either a point in time estimate or historical average of factor exposures in order to determine the total volatility. Please contact your PIMCO representative for more details on how specific proxy factor exposures are estimated.

It is not possible to invest directly in an unmanaged index.

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