



Correlation and Asset Management

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What Return Correlations Do Asset Managers Care About?

Institutional Investors

Asset owners' most important function is allocating capital across asset classes, seeking best risk-adjusted return within a risk budget

They seek diversification asset classes and across geographies

Active Managers

Active management within an asset class seeks to add value versus a benchmark portfolio of the same asset class

Leveraged Fund Managers

Hedged portfolios rely on offsetting return characteristics of long/short positions, the persistence of which maintains risk control

For leveraged, unhedged portfolios, maintaining risk control may have greater dependency on asset volatility than correlation

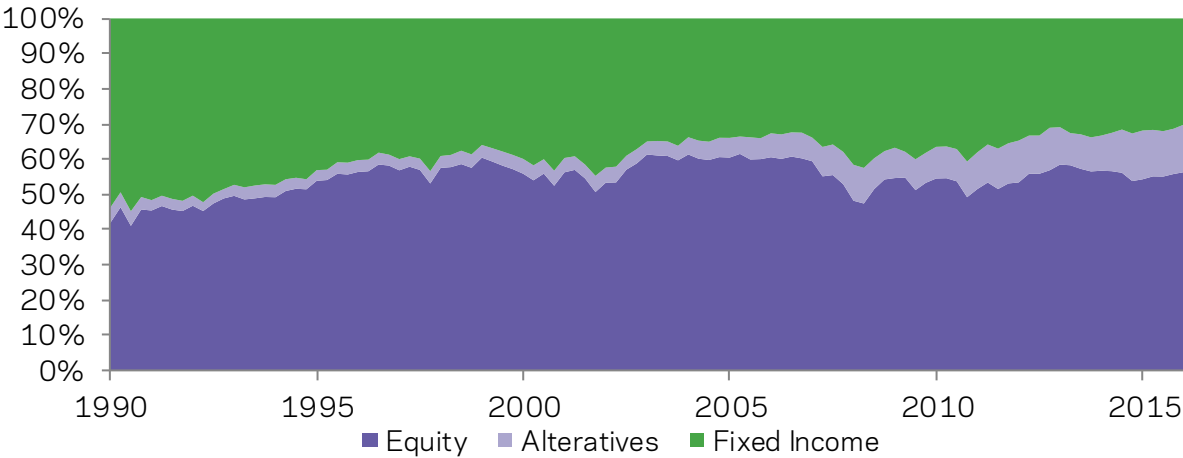


Institutional Asset Allocations Have Evolved, but Slowly

The Allocation to Riskier Assets Has Generally Increased

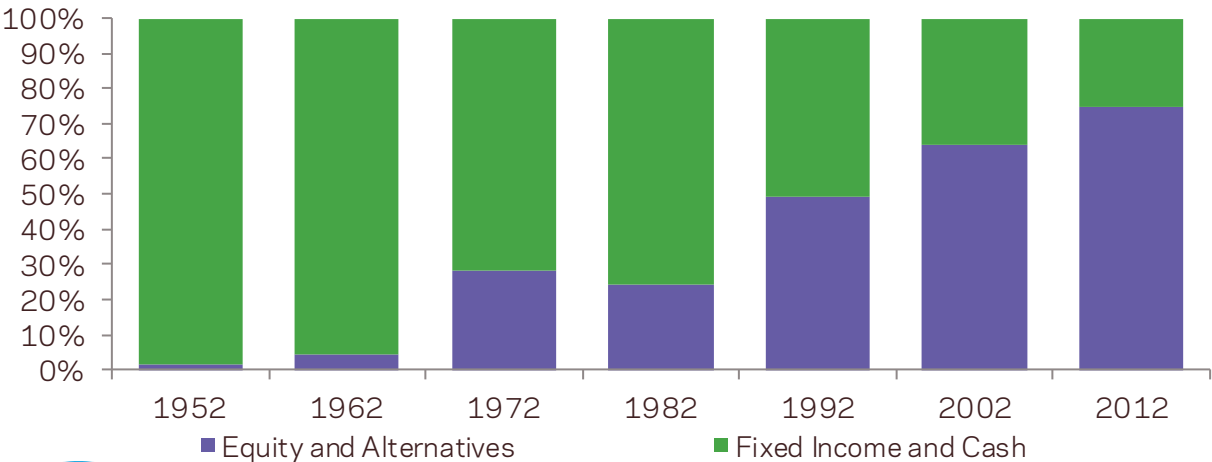
U.S. Public Pension Asset Allocation

Callan Associates Public Pension Asset Allocation



Has the shift to riskier assets been driven by changes in correlation?

Pew Analysis of Financial Accounts of U.S.



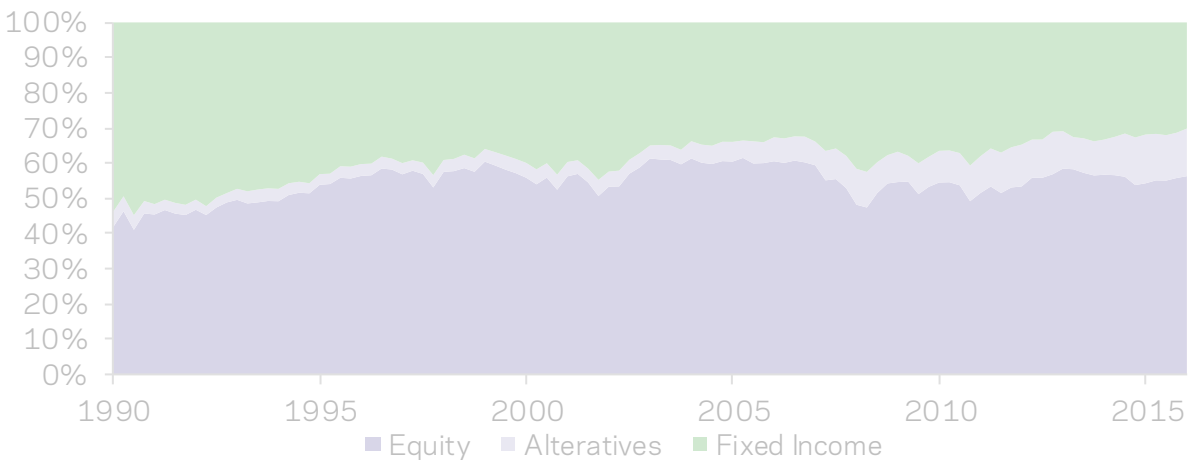
Source: AQR. U.S. Board of Governors of the Federal Reserve System, Financial Accounts of the United States, 1952 to 2012; Pew Analysis of State Financial Reports. Callan Associates Public Pension Asset Allocation Data, 1990 to 2016. Please read important disclosure in the Appendix.

Lower Asset Class Correlations Didn't Motivate the Shift to Stocks

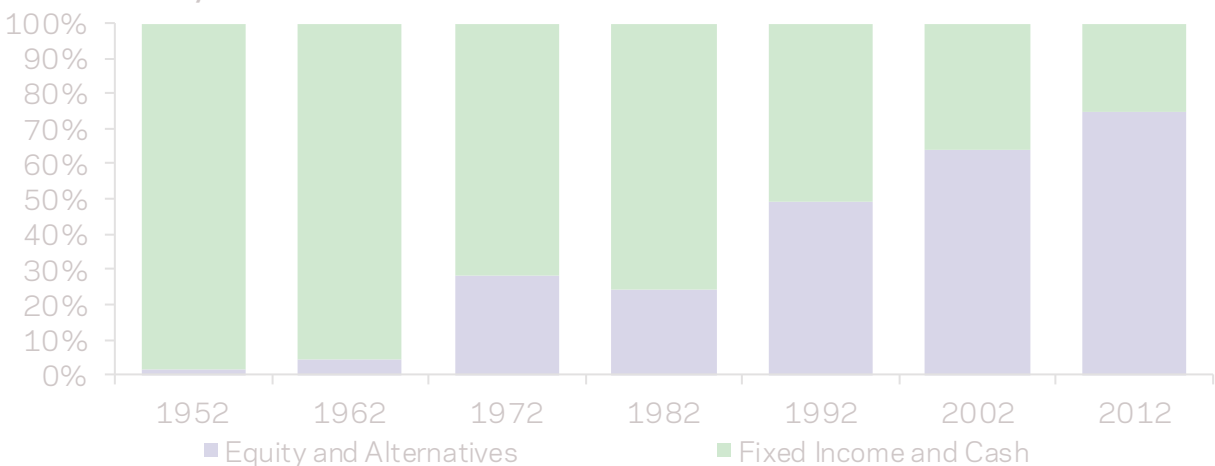
Regulations, Demographics, and Markets May Be More Likely Drivers

U.S. Public Pension Asset Allocation

Callan Associates Public Pension Asset Allocation

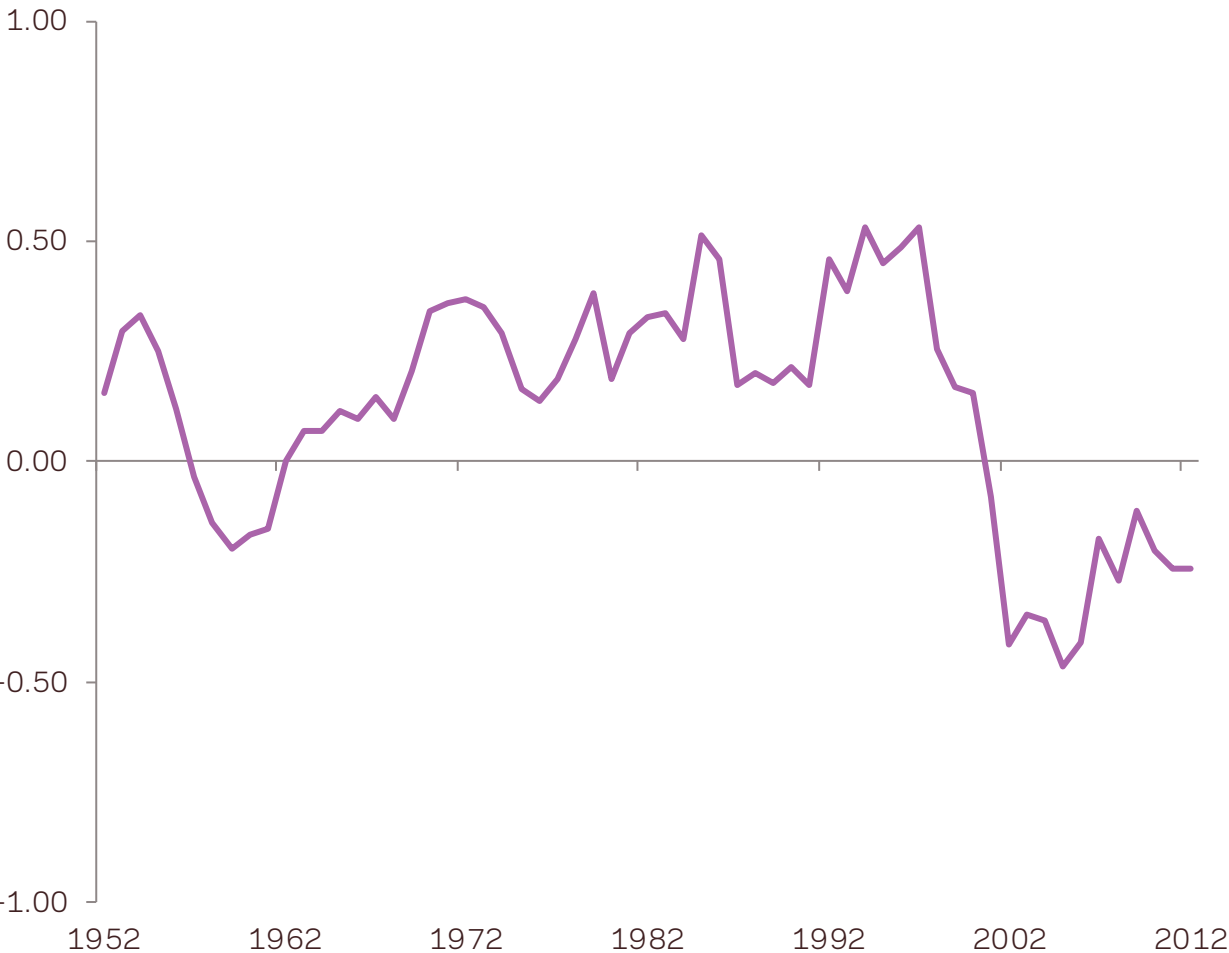


Pew Analysis of Financial Accounts of U.S.



Correlation of Monthly Returns of Stocks/Bonds

Rolling 5-Year Window



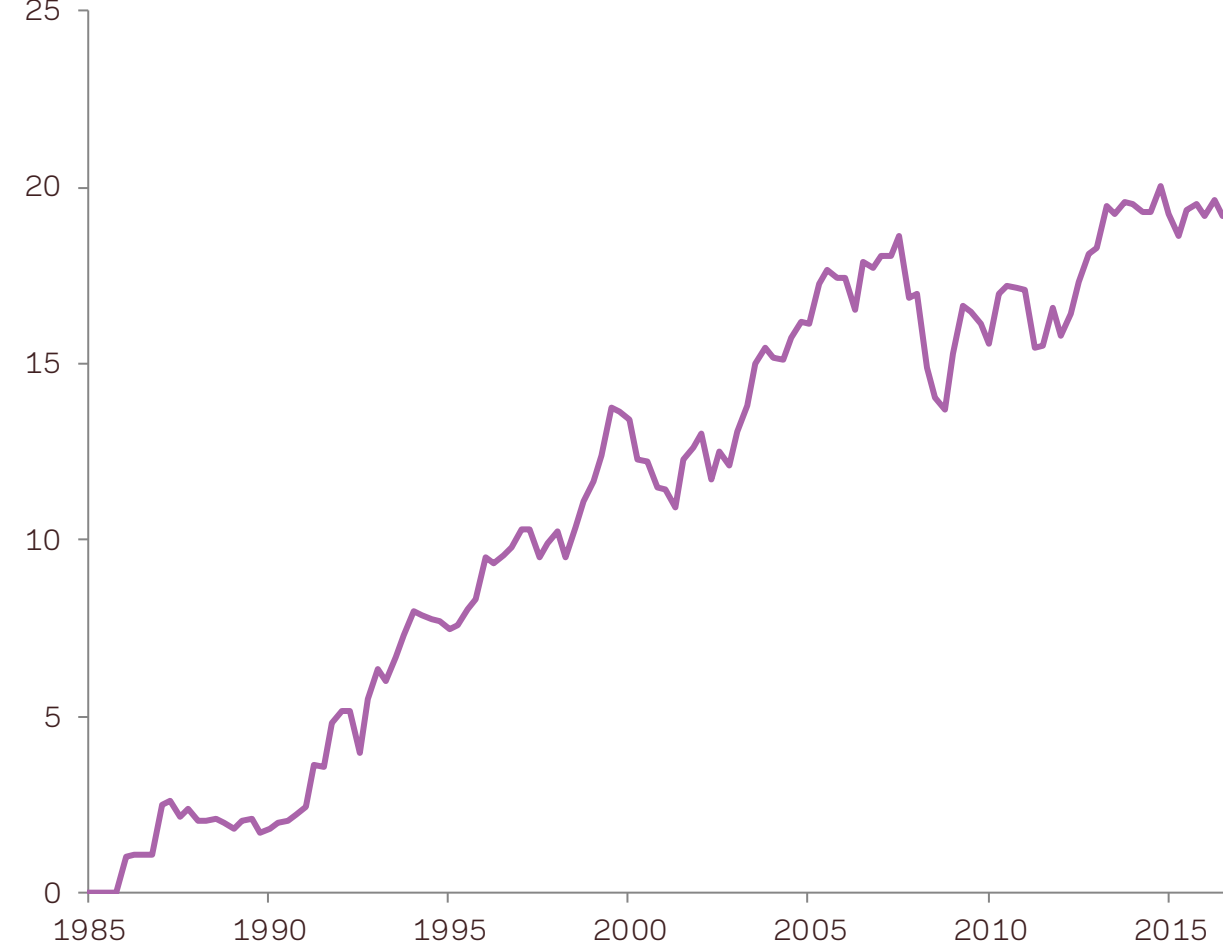
Source: AQR. U.S. Board of Governors of the Federal Reserve System, Financial Accounts of the United States, 1952 to 2012; Pew Analysis of State Financial Reports. Callan Associates Public Pension Asset Allocation Data, 1990 to 2016. US stock and US bond correlation based on rolling 60 month S&P 500 Index Futures and 10 Year Treasuries. Please read important disclosures in the Appendix.

Institutional Investors Have Gone Global in the Last Thirty Years

Broad Globalization of Investment in All Asset Classes

International Allocations of U.S. Public Pensions

% Non-US Stocks and Bonds



Did changes in the correlation of returns across countries drive this globalization?



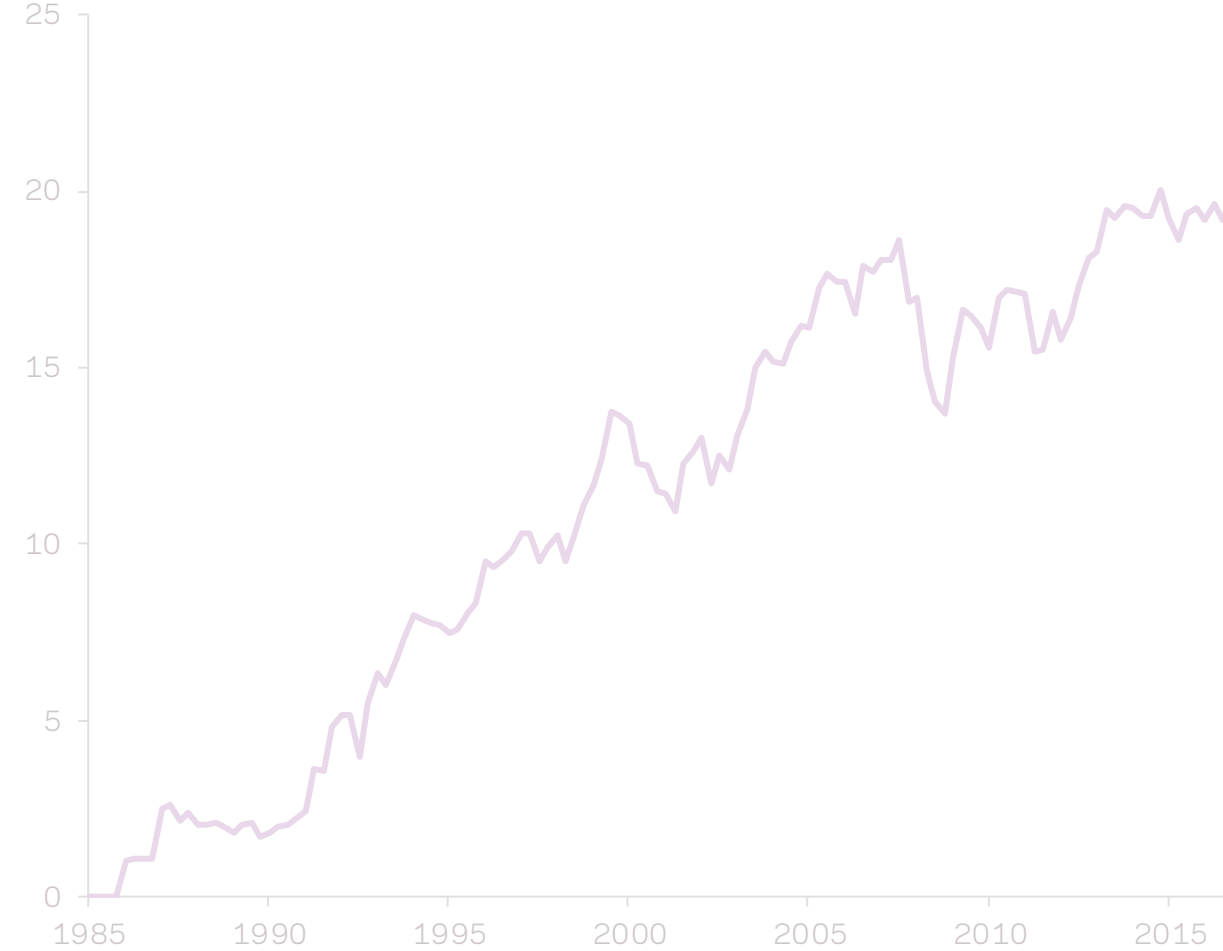
Source: AQR. Callen Associates Public Pension Asset Allocation Data, 1985 to 2016. Please read important disclosures in the Appendix.

Both Correlation and Global Allocation Rose During This Period

Globalization Grew in Spite of a Reduced Diversification Benefit

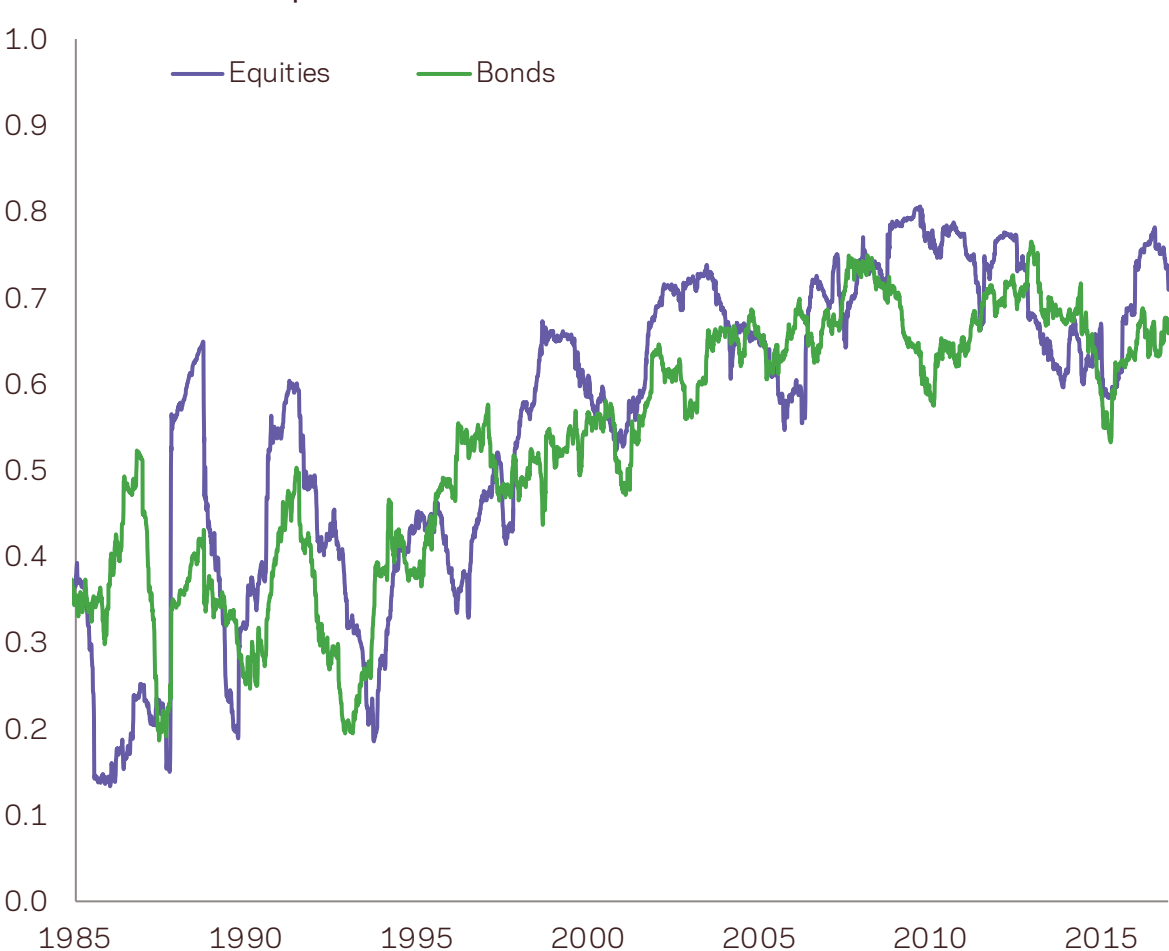
International Allocations of U.S. Public Pensions

% Non-US Stocks and Bonds



1- Yr Average Correlation of Weekly Returns

Across Developed Stock Markets and Bond Markets



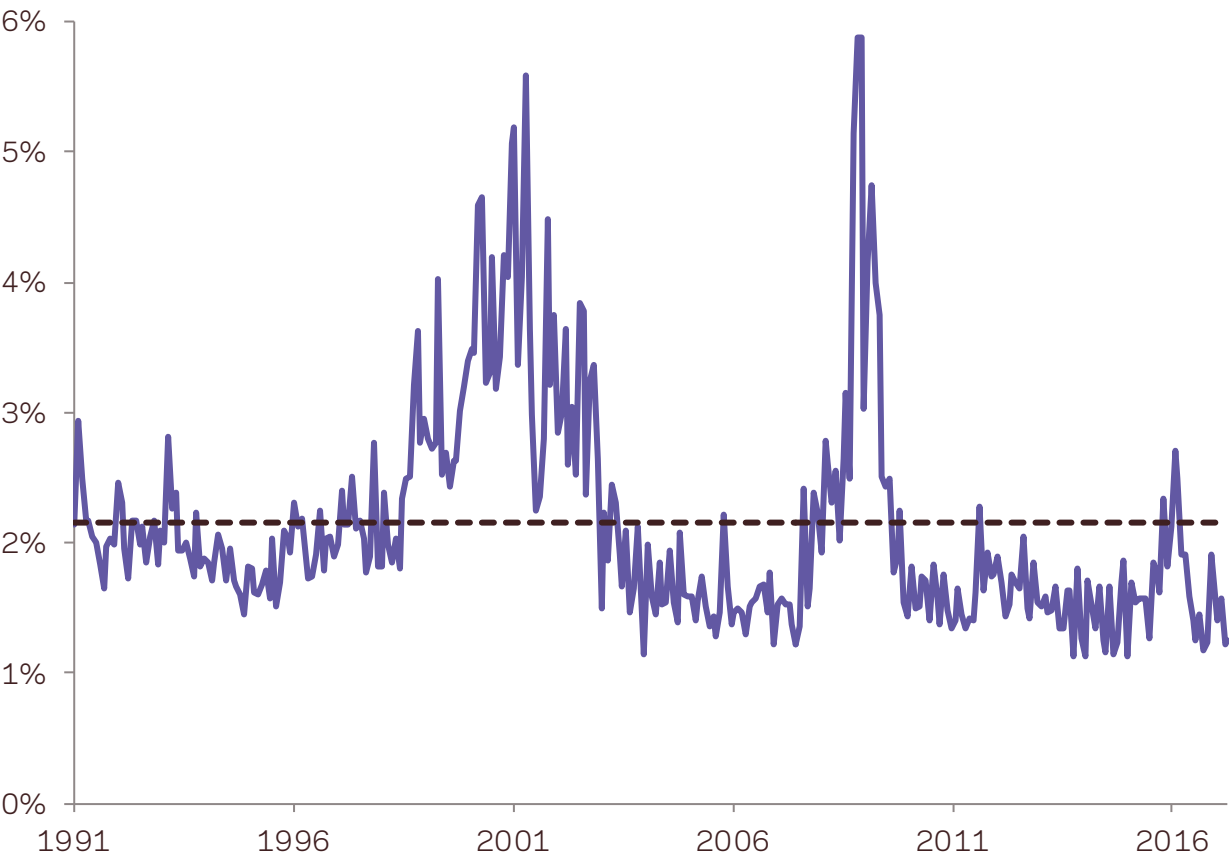
Source: AQR. Callen Associates Public Pension Asset Allocation Data, 1985 to 2016. Global equities 1-year correlations are the primary equity index for 10 developed countries. Global bond 1-year correlations are 10 Year government bonds for 6 developed countries. . Developed equities data includes the broad market-cap weighted indices which are sufficiently liquid to trade in each of the following countries/regions: Australia, Canada, France, Germany, Hong Kong, Italy, Japan, Netherlands, Spain, Switzerland, United Kingdom, United States, and continental Europe. Developed bonds data includes GDP-weighted government bonds from the following countries: Australia, Canada, Germany, Japan, United Kingdom, United States. Please read important disclosures in the Appendix.

Active Equity Managers Too Often Fail to Outperform Benchmarks

Dispersion of Returns Represents the Opportunity for Performance

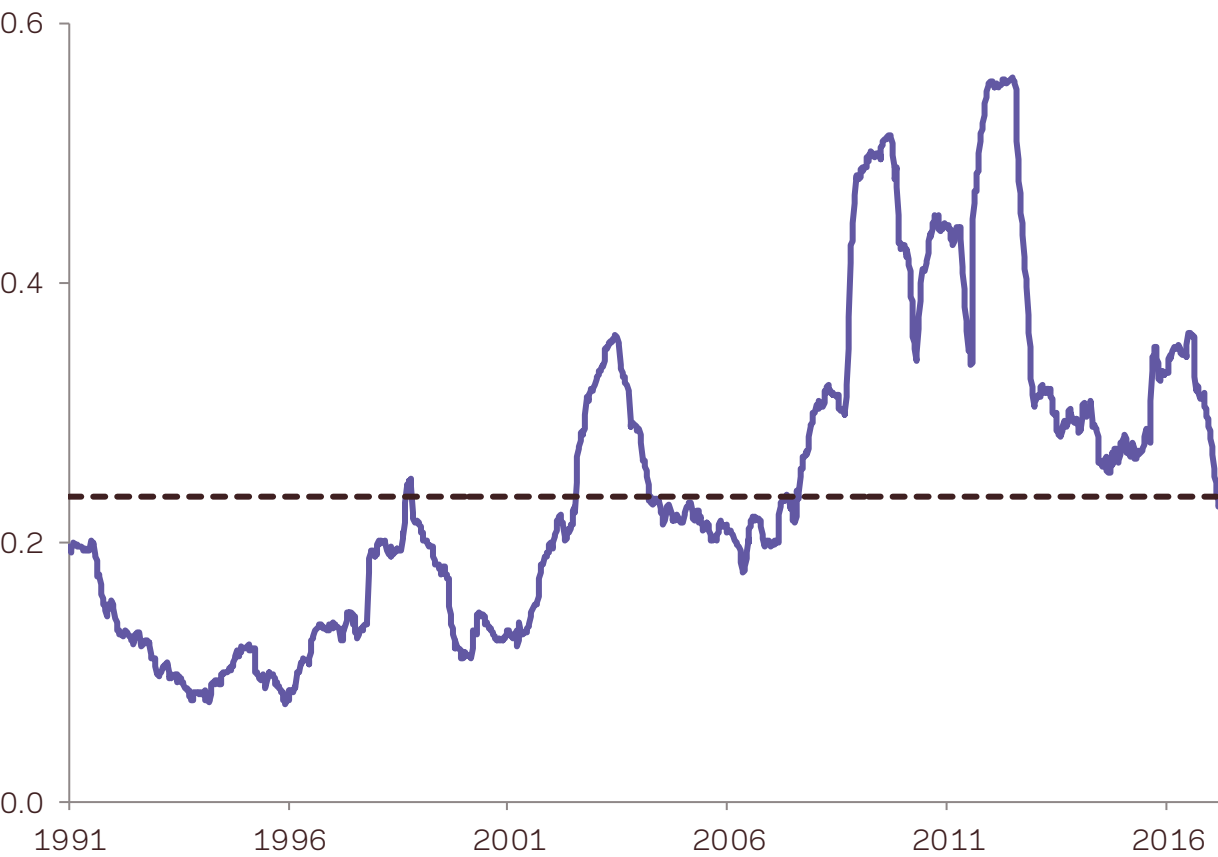
Cross Sectional Dispersion of Returns

Russell 1000 Stocks



Average Pairwise Correlation of Daily Returns

Russell 1000 Stocks, Rolling 1-Year



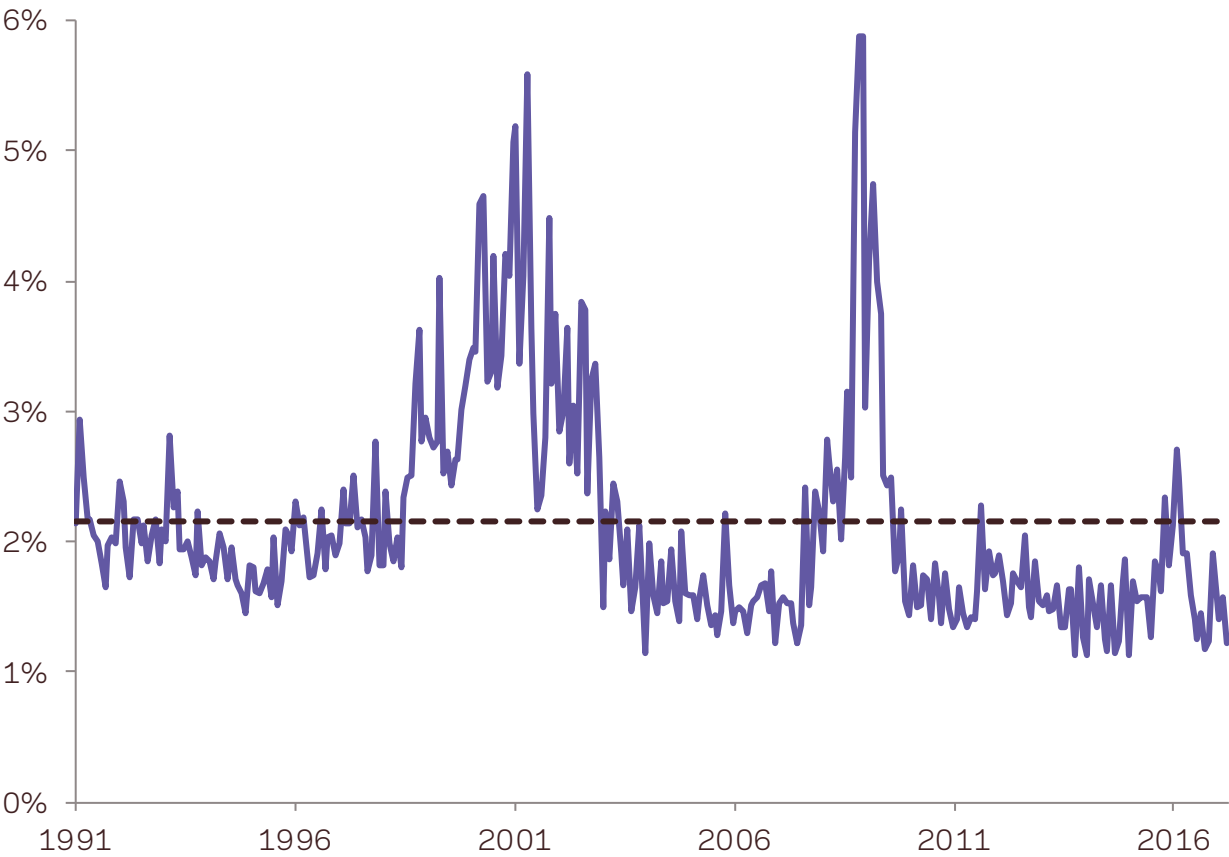
Source: AQR. Russell 1000 individual stock return data from 1991 to 2016 . Stock dispersion is the daily standard deviation of returns at each point in time, sampled weekly. Cross sectional correlation is the 1-year average correlation of all the stocks in the Russell 1000 index at each point in time, sampled weekly. Please read important disclosures in the Appendix.

Active Equity Managers Too Often Fail to Outperform Benchmarks

Low Market Volatility Creates Low Dispersion and Less Opportunity

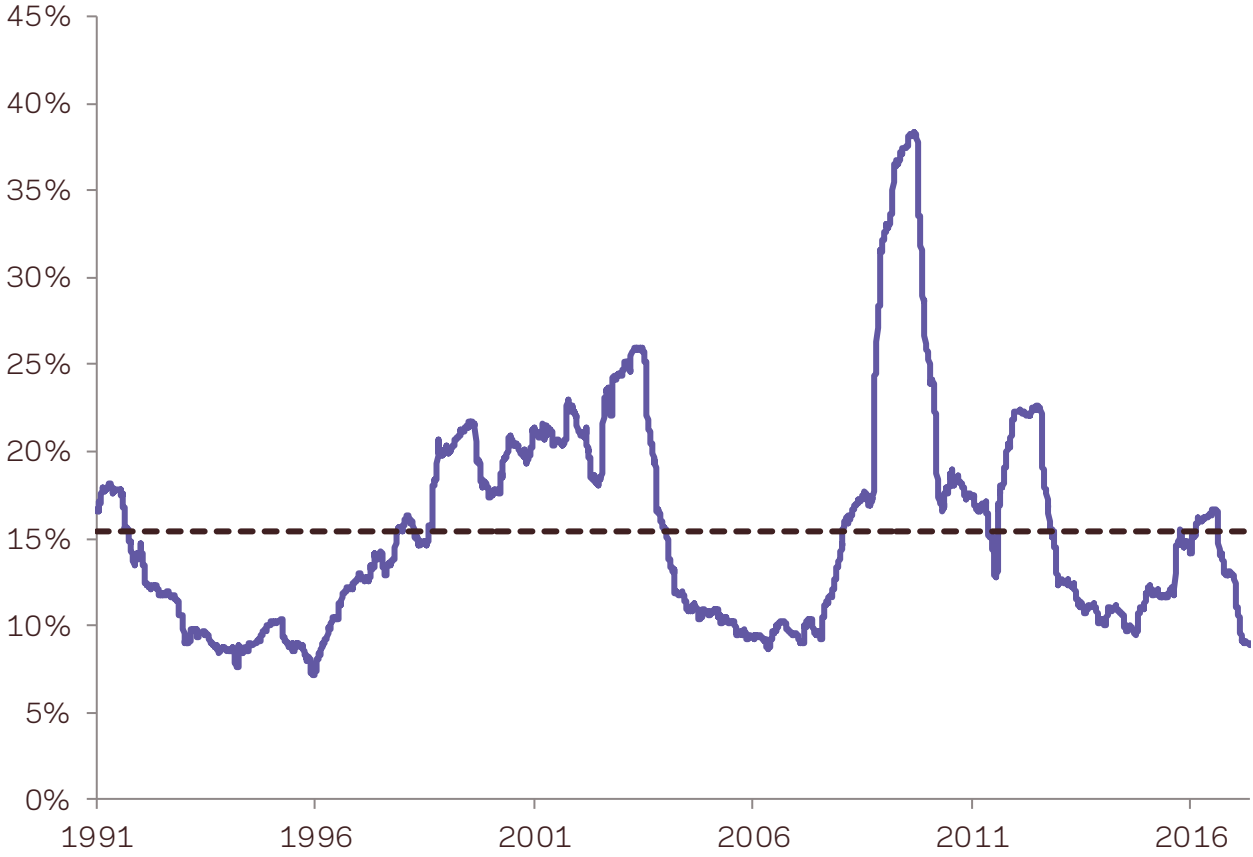
Cross Sectional Dispersion of Returns

Russell 1000 Stocks



1-Year Realized Volatility of Weekly Returns

Russell 1000 Stocks



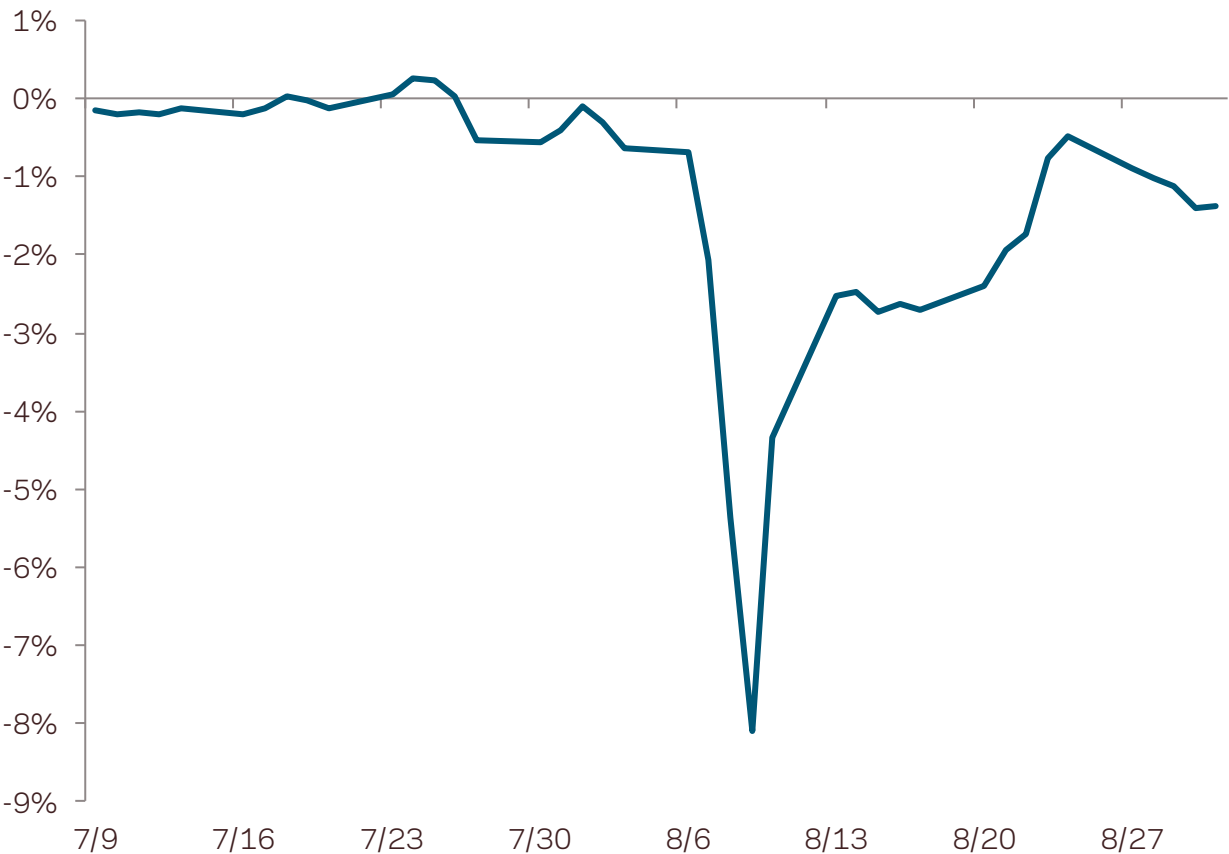
Source: AQR. Russell 1000 individual stock return data from 1991 to 2016 . Stock dispersion is the daily standard deviation of returns at each point in time, sampled weekly. Realized volatility calculated using the standard deviation of Russell 1000 Index 5-day overlapping returns. Please read important disclosures in the Appendix.

The Significance of Correlation Could Be Different for Levered Funds

Long/Short Strategies Depend on Factor Correlation to Control Risk

Cumulative Return of Market Neutral Equity

Hypothetical Strategy from July – August 2007



How much of the market neutral equity drawdown was related to sudden changes in expected long/short relationships?



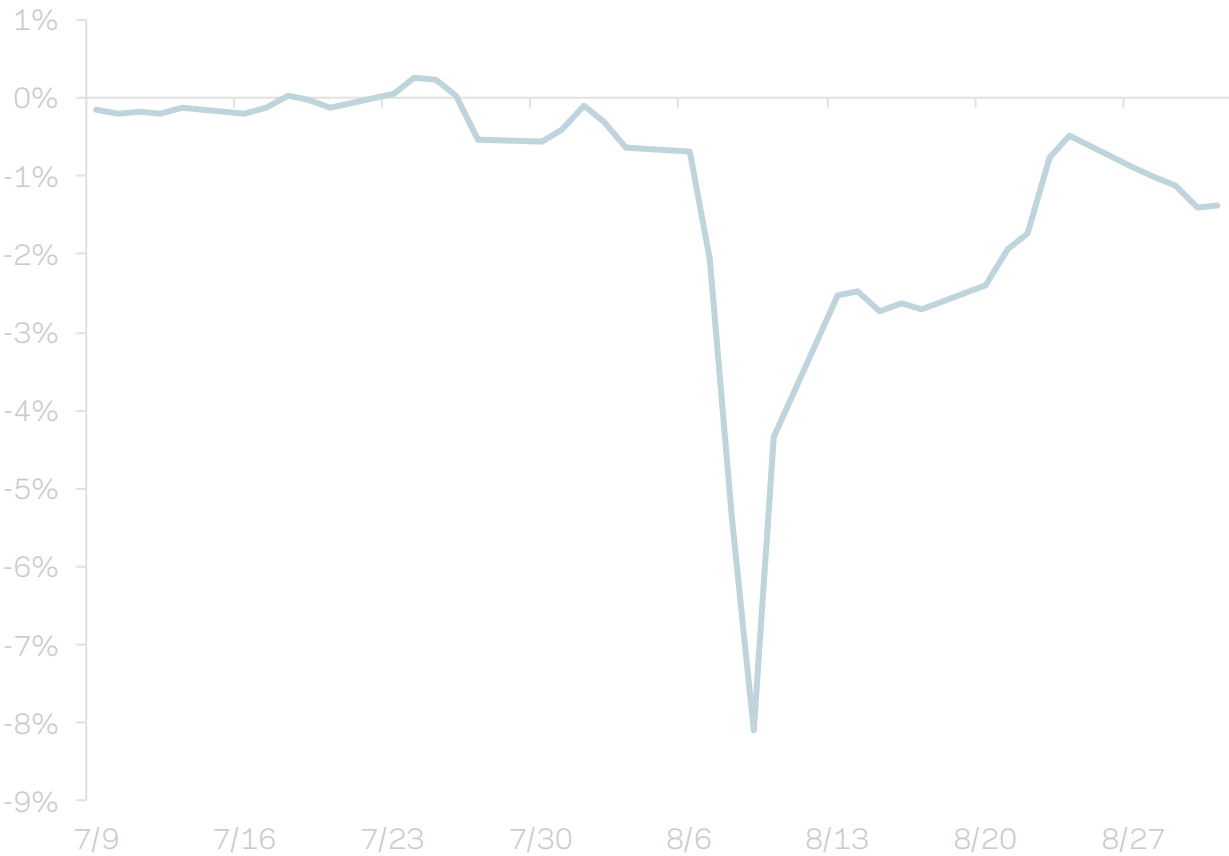
Source: AQR. For illustrative purposes only and not representative of an actual portfolio AQR manages. Cumulative return of an equal weight portfolio based on long and short positions from a hypothetical diversified market neutral equity strategy which incorporates factors like value, momentum, defensive and quality to determine if attractive (long) or unattractive (short) from July 9, 2007. The investment universe includes all U.S. publicly traded stocks of which only a sub-set are included based on total attractiveness of aforementioned factors. Please read important disclosures in the Appendix. Hypothetical data has certain inherent limitations, some of which are discussed in the Appendix.

The Relationship Between Long/Short Factors Broke Down

We Can Identify the Cause of the Correlation Change - a Liquidation

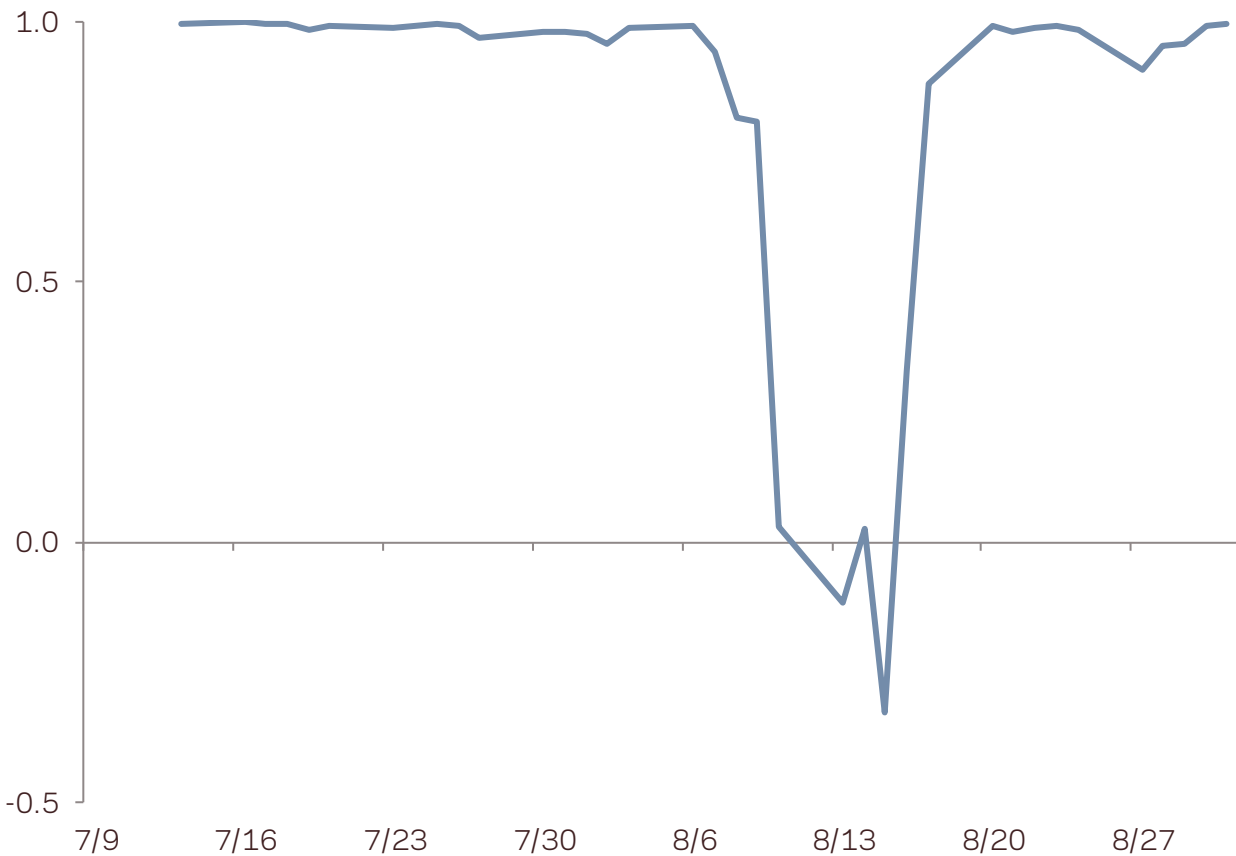
Cumulative Return of Market Neutral Equity

Hypothetical Strategy from July - August 2007



5-Day Correlation of Long and Short Positions

Hypothetical Strategy from July - August 2007



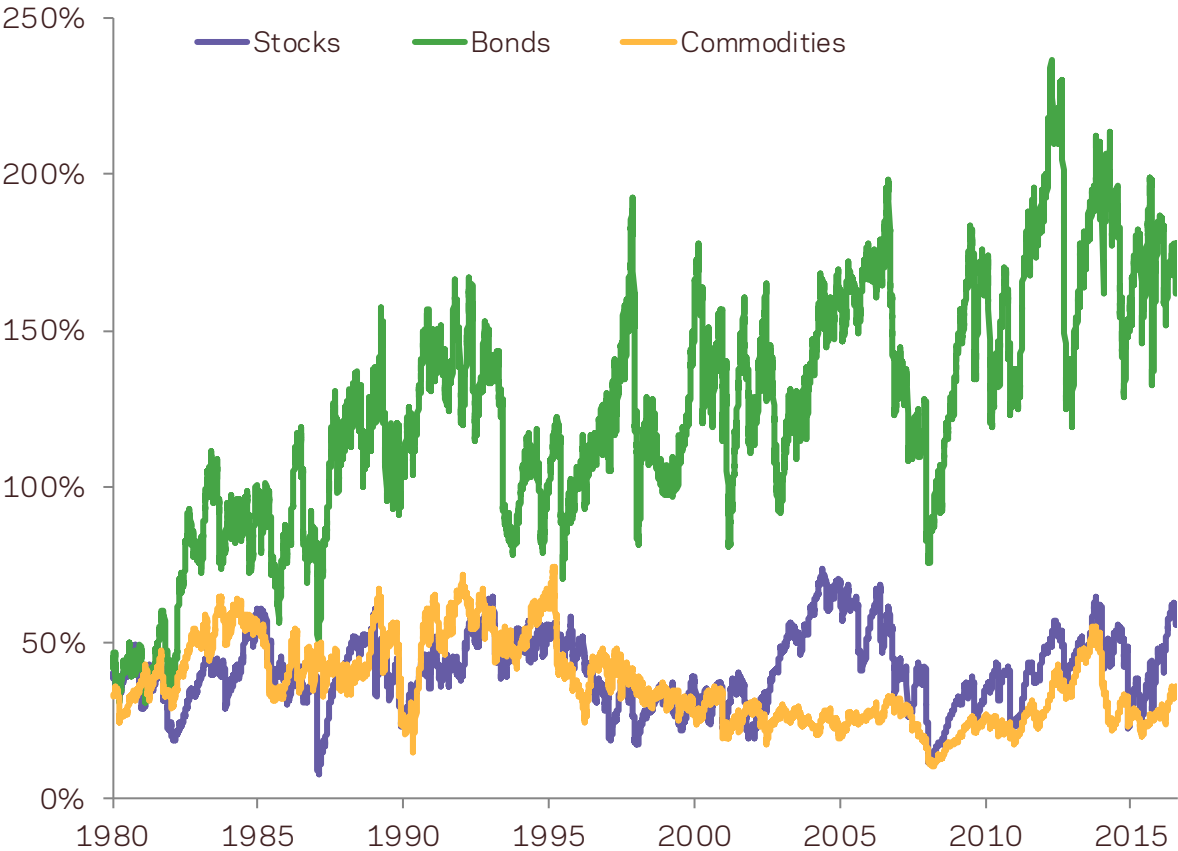
Source: AQR. For illustrative purposes only and not representative of an actual portfolio AQR manages. Cumulative return of an equal weight portfolio based on long and short positions from a hypothetical diversified market neutral equity strategy which incorporates factors like value, momentum, defensive and quality to determine if attractive (long) or unattractive (short) from July 9, 2007. The investment universe includes all U.S. publicly traded stocks of which only a sub-set are included based on total attractiveness of aforementioned factors. The rolling 5-day correlation is between the equal weighted long and short portfolios daily returns. Please read important disclosures in the Appendix. Hypothetical data has certain inherent limitations, some of which are discussed in the Appendix.

Exposures in Risk Parity Are Driven by Volatility and Correlation

Managers May Change Positioning as Covariance Estimates Change

Hypothetical Risk Parity Exposures

Using EWMA Volatility and Correlation Model*



How much do correlation estimates matter in determining risk parity positioning?



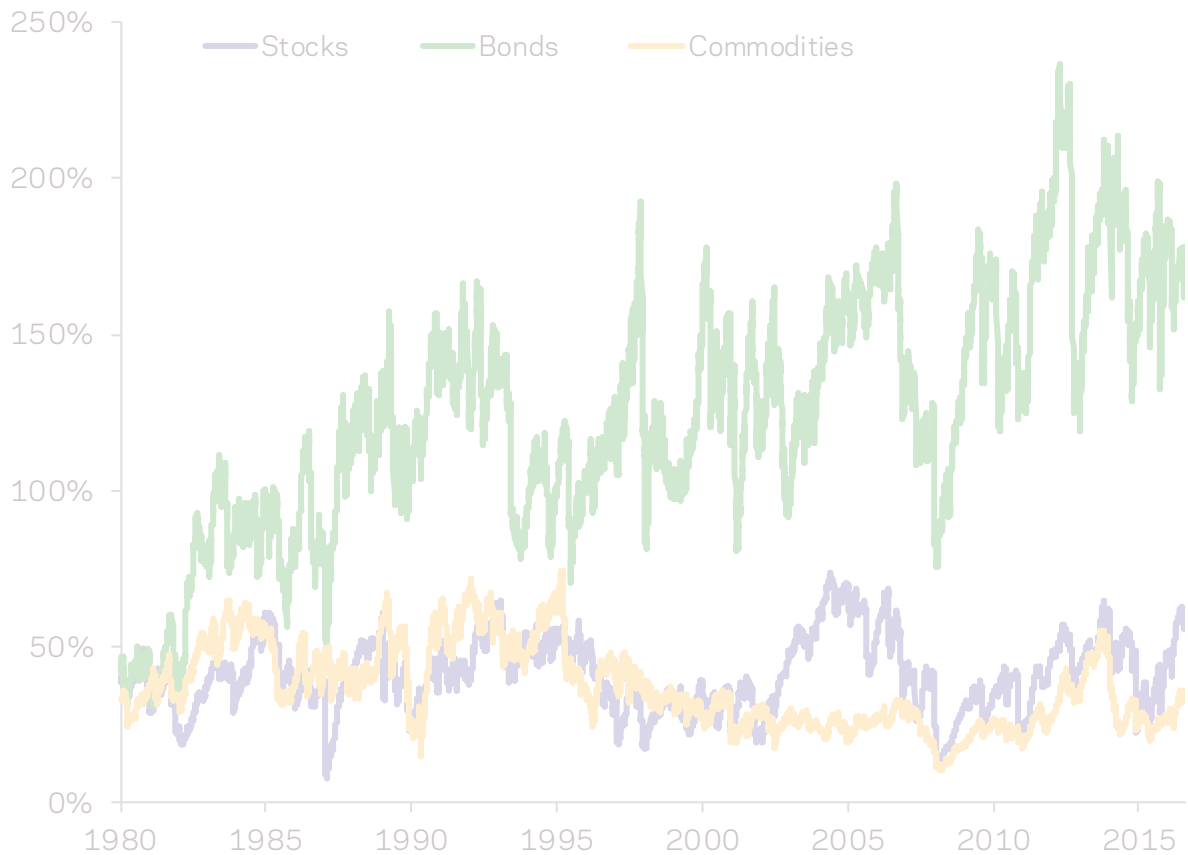
Source: AQR, Morgan Markets, Bloomberg, MSCI, Barclays Live, Datastream, Reuters, Markit, Credit Suisse, Citi Velocity. The above exposure examples are based on a hypothetical 3-asset class risk parity strategy, which is not representative of an actual AQR strategy, and are for illustrative purposes only, from 1980 to 2016. The hypothetical asset class exposures shown are calculated using the volatility forecasts and volatility targets of three asset classes (developed equities, developed bonds and commodities). The volatility targets are sized using asset class correlation forecasts such that the risk contribution across asset classes is equal and the hypothetical strategy targets 10% annualized volatility, as asset class volatility forecasts evolve across the different periods, so do the exposures. The methodology used to calculate the asset class volatility and correlation forecasts are commensurate with those used in all AQR risk parity strategies, and the data reflects the historical data represented by the securities for the respective asset classes. Developed equities data includes the broad market-cap weighted indices which are sufficiently liquid to trade in each of the following countries/regions: Australia, Canada, France, Germany, Hong Kong, Italy, Japan, Netherlands, Spain, Switzerland, United Kingdom, United States, and continental Europe. Developed bonds data includes GDP-weighted government bonds from the following countries: Australia, Canada, Germany, Japan, United Kingdom, United States. Commodities data includes individual futures consistent with the weighting and composition of the S&P GSCI Commodity Index. Hypothetical data has certain inherent limitations, some of which are discussed in the Appendix.

Exposures in Risk Parity Are Driven by Volatility and Correlation

Alternative Correlation Models Don't Strongly Affect Positioning

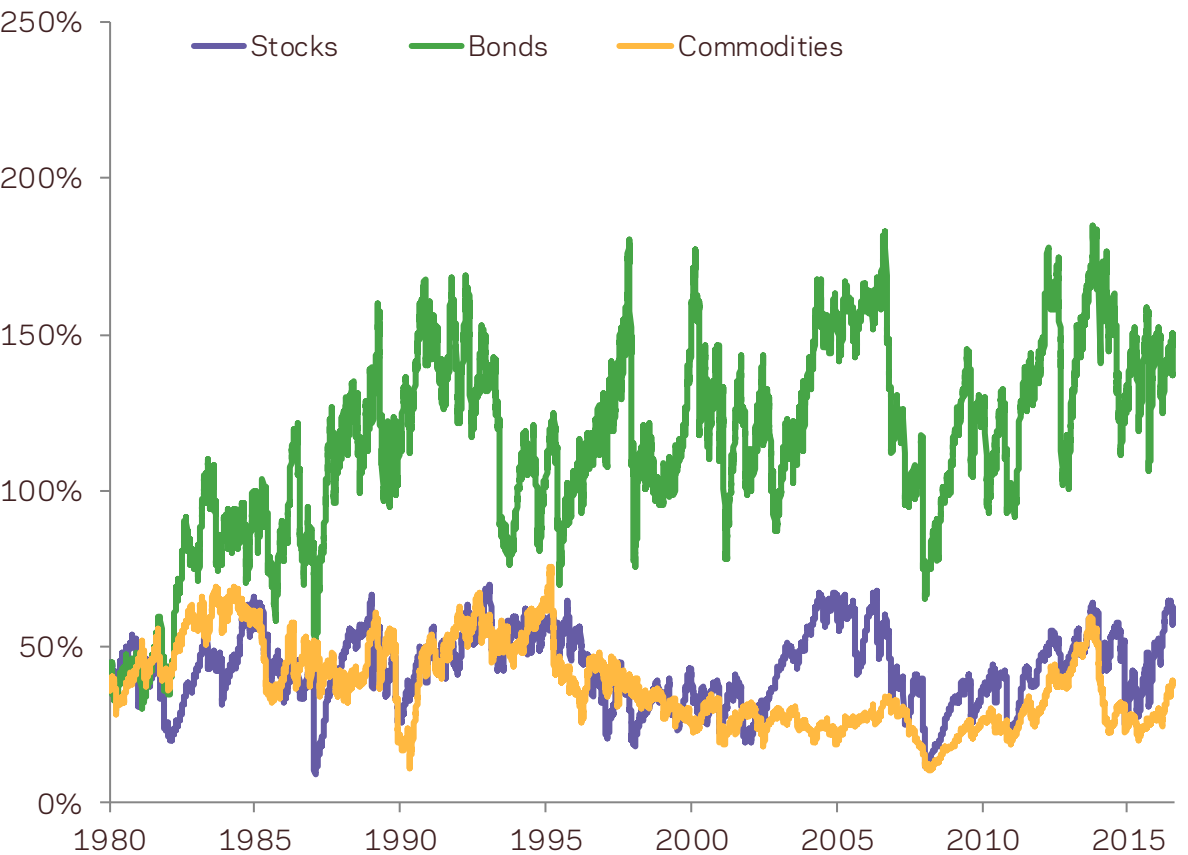
Hypothetical Risk Parity Exposures

Using EWMA Volatility and Correlation Model



Hypothetical Risk Parity Exposures

Using EWMA Volatility and Constant Correlation Model



Source: AQR. Morgan Markets, Bloomberg, MSCI, Barclays Live, Datastream, Reuters, Markit, Credit Suisse, Citi Velocity. The above exposure examples are based on a hypothetical 3-asset class risk parity strategy, which is not representative of an actual AQR strategy, and are for illustrative purposes only, from 1980 to 2016. The hypothetical asset class exposures shown are calculated using the volatility forecasts and volatility targets of three asset classes (developed equities, developed bonds and commodities). The volatility targets are sized using asset class correlation forecasts such that the risk contribution across asset classes is equal and the hypothetical strategy targets 10% annualized volatility, as asset class volatility forecasts evolve across the different periods, so do the exposures. The methodology used to calculate the asset class volatility and correlation forecasts are commensurate with those used in all AQR risk parity strategies, and the data reflects the historical data represented by the securities for the respective asset classes. Developed equities data includes the broad market-cap weighted indices which are sufficiently liquid to trade in each of the following countries/regions: Australia, Canada, France, Germany, Hong Kong, Italy, Japan, Netherlands, Spain, Switzerland, United Kingdom, United States, and continental Europe. Developed bonds data includes GDP-weighted government bonds from the following countries: Australia, Canada, Germany, Japan, United Kingdom, United States. Commodities data includes individual futures consistent with the weighting and composition of the S&P GSCI Commodity Index. Hypothetical data has certain inherent limitations, some of which are discussed in the Appendix.

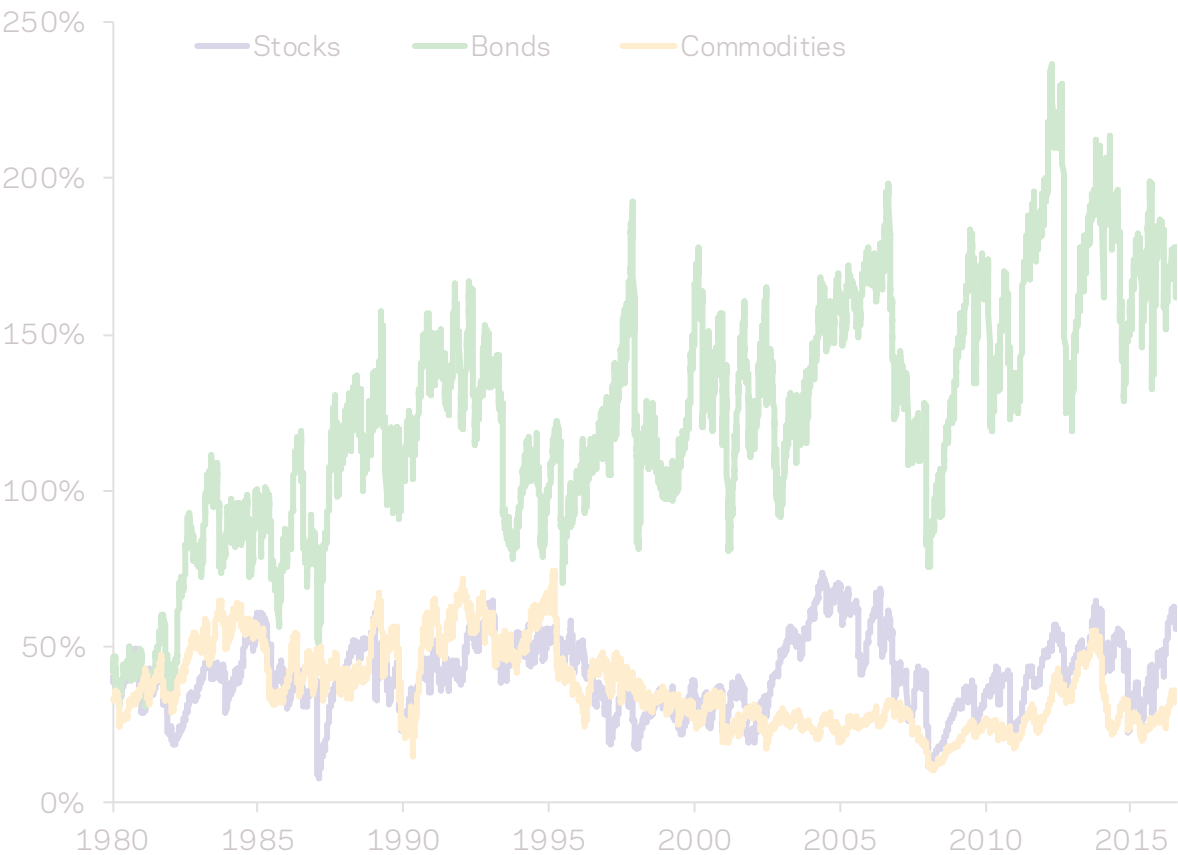


Exposures in Risk Parity Are Driven by Volatility and Correlation

Most of the Changes in Positioning Are Explained By Volatility

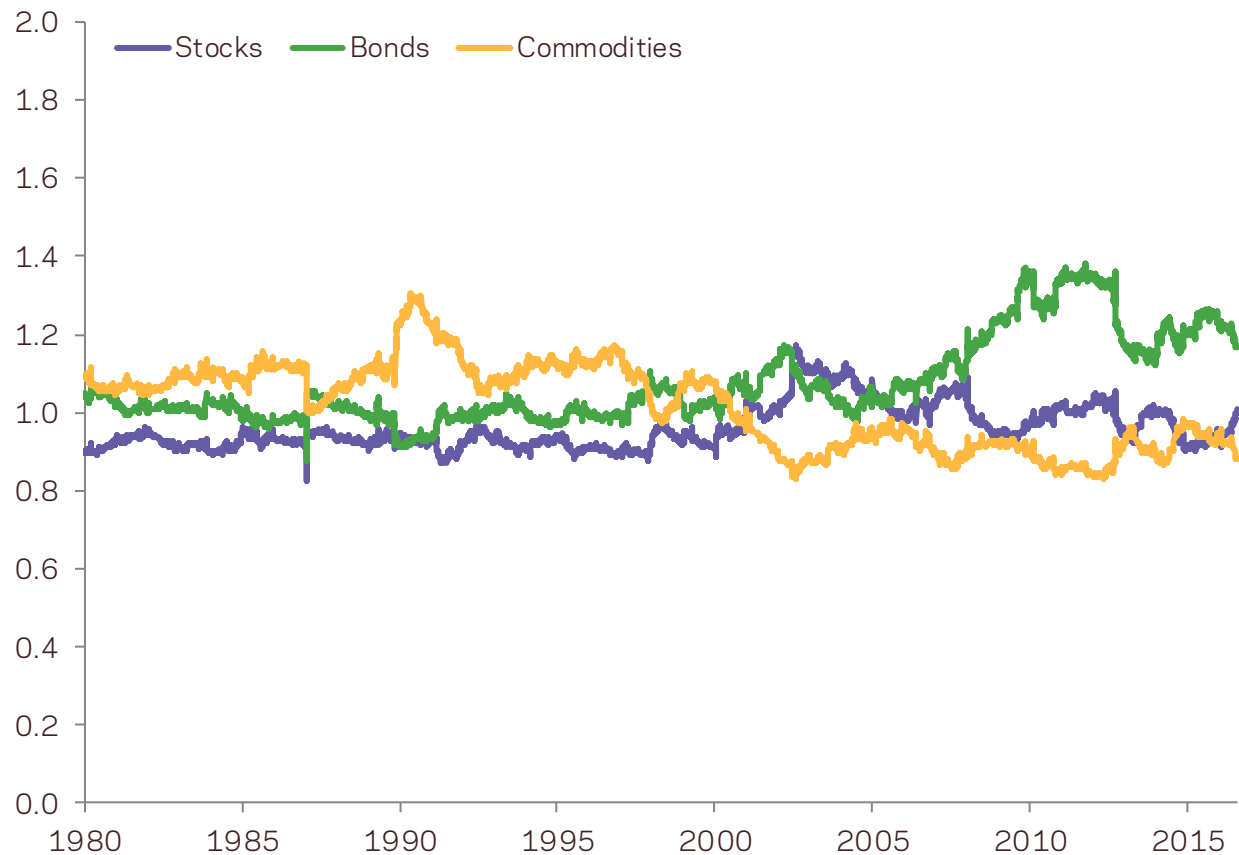
Hypothetical Risk Parity Exposures

Using EWMA Volatility and Correlation Model



Exposures With Different Correlation Models

Relative Exposures With EWMA and Constant Correlation Models



Source: AQR. Morgan Markets, Bloomberg, MSCI, Barclays Live, Datastream, Reuters, Markit, Credit Suisse, Citi Velocity. The above exposure examples are based on a hypothetical 3-asset class risk parity strategy, which is not representative of an actual AQR strategy, and are for illustrative purposes only, from 1980 to 2016. The hypothetical asset class exposures shown are calculated using the volatility forecasts and volatility targets of three asset classes (developed equities, developed bonds and commodities). The volatility targets are sized using asset class correlation forecasts such that the risk contribution across asset classes is equal and the hypothetical strategy targets 10% annualized volatility, as asset class volatility forecasts evolve across the different periods, so do the exposures. The methodology used to calculate the asset class volatility and correlation forecasts are commensurate with those used in all AQR risk parity strategies, and the data reflects the historical data represented by the securities for the respective asset classes. Developed equities data includes the broad market-cap weighted indices which are sufficiently liquid to trade in each of the following countries/regions: Australia, Canada, France, Germany, Hong Kong, Italy, Japan, Netherlands, Spain, Switzerland, United Kingdom, United States, and continental Europe. Developed bonds data includes GDP-weighted government bonds from the following countries: Australia, Canada, Germany, Japan, United Kingdom, United States. Commodities data includes individual futures consistent with the weighting and composition of the S&P GSCI Commodity Index. Hypothetical data has certain inherent limitations, some of which are discussed in the Appendix.



Summary: How Does Changing Correlation Affect Investment?

Institutional Investors

Asset allocation has meaningfully evolved but doesn't seem to have been based on correlation changes

Globalization of allocations grew in spite of increasing correlations; the benefits were still substantial and underutilized

Active Managers

The dispersion of returns is lower, but it's not because of abnormally high correlation. Lower market volatility may make it more difficult to outperform, post transaction costs

Levered Fund Managers

Long/short portfolios have more critical dependency on the realization of correlations within a tolerable range

For leveraged, but unhedged portfolios, the relative importance of volatility and correlation may be more tilted toward volatility



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Gross performance results do not reflect the deduction of investment advisory fees, which would reduce an investor's actual return. For example, assume that \$1 million is invested in an account with the Firm, and this account achieves a 10% compounded annualized return, gross of fees, for five years. At the end of five years that account would grow to \$1,610,510 before the deduction of management fees. Assuming management fees of 1.00% per year are deducted monthly from the account, the value of the account at the end of five years would be \$1,532,886 and the annualized rate of return would be 8.92%. For a ten-year period, the ending dollar values before and after fees would be \$2,593,742 and \$2,349,739, respectively. AQR's asset based fees may range up to 2.85% of assets under management, and are generally billed monthly or quarterly at the commencement of the calendar month or quarter during which AQR will perform the services to which the fees relate. Where applicable, performance fees are generally equal to 20% of net realized and unrealized profits each year, after restoration of any losses carried forward from prior years. In addition, AQR funds incur expenses (including start-up, legal, accounting, audit, administrative and regulatory expenses) and may have redemption or withdrawal charges up to 2% based on gross redemption or withdrawal proceeds. Please refer to AQR's ADV Part 2A for more information on fees. Consultants supplied with gross results are to use this data in accordance with SEC, CFTC, NFA or the applicable jurisdiction's guidelines.

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Investment factors include: Value which is the tendency for relatively cheap stocks to outperform relatively expensive ones, momentum which is the tendency for an asset's recent relative performance to continue in the near future, defensive which is the tendency for lower-risk stocks to generate higher risk-adjusted returns, and quality which is the tendency for higher-quality stocks to generate higher returns than lower-quality stocks

There is a risk of substantial loss associated with trading commodities, futures, options, derivatives and other financial instruments. Before trading, investors should carefully consider their financial position and risk tolerance to determine if the proposed trading style is appropriate. Investors should realize that when trading futures, commodities, options, derivatives and other financial instruments one could lose the full balance of their account. It is also possible to lose more than the initial deposit when trading derivatives or using leverage. All funds committed to such a trading strategy should be purely risk capital.

