Risk On, Risk Off

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The phrase "Risk On, Risk Off" may have become ingrained in the vernacular of global investors. We attempt to crystallize what "Risk On, Risk Off" really means by analyzing an extreme state of the market when correlation of all assets are perfect. We derive a set of *normative* results in relation to the investment opportunity set on how assets *should* behave. While our results do not provide guidance on interpolation between a particular state and the extreme state of perfect correlation, we believe that our analysis can serve as a compass for our investment decision-making process in the event we believe that we are moving towards or away from a "Risk On, Risk Off" environment. Investment implications in relation to a risk-parity portfolio, global asset allocation, and active portfolio management are discussed.

Ever since the global financial crisis came to a head in 2008, "Risk On, Risk Off" and "correlations go to one" have become the most widely used phrases in describing investment and asset price behavior. Generally speaking, 2008 was a "risk off" year in which investors were said to "de-risk" either by deleveraging or by selling existing risky positions across the board and going to cash. For a large part of the year, 2009 was a "risk on" year during which some investors' appetite for risk was back, leading to a synchronized strong rebound in returns of risky assets ranging from global equities, credit, emerging market debt to commodities and others. Most recently, the downgrade of the long-term sovereign credit rating of the United States by Standard & Poor's on August 5, 2011—in the middle of a global growth slowdown—triggered a massive global sell-off of risky assets for days, a "risk off" scenario.

But what does "Risk On, Risk Off" really mean? Based on our anecdotal observations, "Risk On, Risk Off" generally refers to an investment environment in which asset price behavior is largely driven by how the appetite for risk advances or retreats over time, usually in a synchronized way across global regions and assets at a faster-than-normal pace. Depending on the environment, investors will tend to buy or sell risky assets across the board, paying less attention to the unique characteristics of these assets. Volatilities and, most noticeably, correlations of assets that are perceived as risky jump, particularly during the "risk off" periods, as we often hear the comment "correlations go to one," during a crisis. On the other hand, assets such as U.S. Treasury bonds and some currencies such as the Japanese yen tend to move in the opposite direction of risky assets, as they are generally perceived as the safer assets to hold in the event of a flight to safety.

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In this paper, we attempt to put more formality on "Risk On, Risk Off," analyzing this widely accepted phrase in describing investment behavior in conjunction with jumps in correlations. In doing so, we formulate a situation where we push the markets to an extreme in which assets are perfectly correlated, that is, where "correlations go to one." We acknowledge that such a world does not exist. However, by analyzing this extreme state of the market, we derive a set of *normative* results in relation to the investment opportunity set on how assets *should* behave. While our results do not provide guidance on interpolation between a particular state and the extreme state of perfect correlation, we believe that our analysis can serve as a compass for our investment decision-making process in the event we believe that we are moving towards or away from a "Risk On, Risk Off" environment. We demonstrate in a normative sense that expectations of perfect correlation imply that expected Sharpe ratios of all assets must be identical. In such a world, all assets are statistically redundant. Implications for investments are also discussed.

Given a goal of outperforming the market capitalization-weighted index in the active investment industry, professional investors often comment that there are not many opportunities to add alpha when stocks are highly correlated—"it is a macro-driven market" is a common response to such an environment. For example, in his August 11, 2011 report, Mezrich (2011, p.2) wrote "Stock correlation is now at the highest level since January 1987, posing yet another challenge to equity investing. U.S. stocks are moving together in lockstep fashion, rendering stock selection extremely difficult." If the conventional wisdom is true, how do some managers outperform in such a highly correlated world? In addressing this question, we turn the established framework into a linear factor model structure. Through this structure of correlation and volatilities, we derive that, indeed, when all assets are highly correlated, the only way to outperform is to successfully estimate the factor structure, time the factor returns, and then adjust the portfolio's factor exposures accordingly.

WHEN CORRELATIONS GO TO ONE

In this section, we study what the investment opportunity set should be like when assets are expected to be perfectly correlated. All performance statistics in this paper are conditional expectations based on the investor's information set, unless otherwise stated. Without loss of generality, we analyze a world with only two assets. Our results and the implications can easily be generalized to a world with multiple assets.

Let x and y be two risky assets with returns μ_x and μ_y, volatilities σ_x and σ_y where $\sigma_y > \sigma_x$, with correlation coefficient ρ. The risk-free rate of return is denoted by r. In the appendix, we demonstrate that Sharpe ratios of two perfectly correlated assets must be identical. That is,

$$(1)\qquad \frac{\mu_x - r}{\sigma_x} = \frac{\mu_y - r}{\sigma_y} \quad \text{if} \quad \rho = 1$$

Therefore, when the two assets are perfectly correlated,

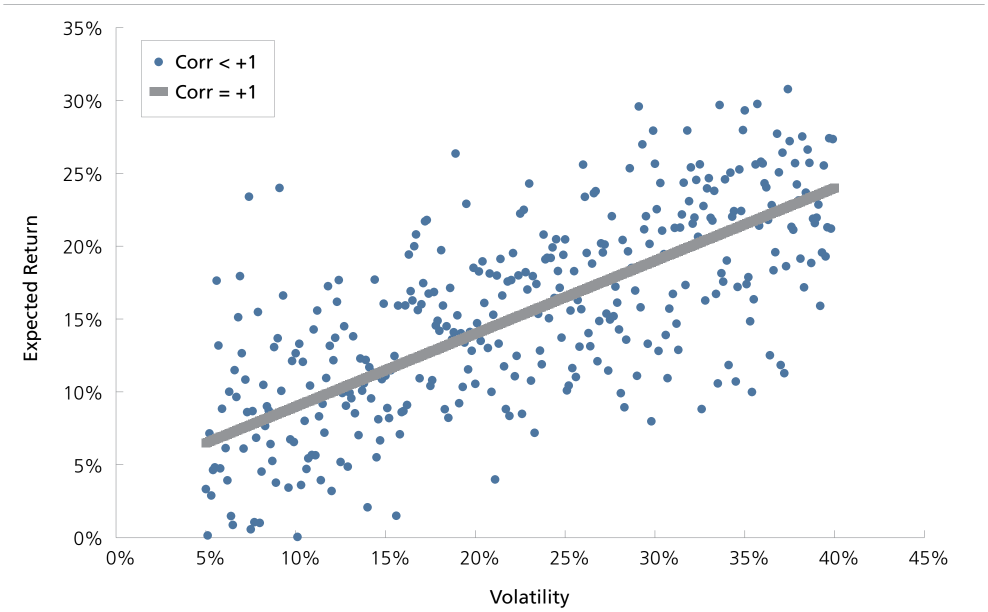
$$(2)\qquad \mu_x = \frac{\sigma_x}{\sigma_y}\mu_y + \left[1 - \frac{\sigma_x}{\sigma_y}\right] r$$

In other words, when correlation is perfect, one asset, the less risky asset x in the case of equation (2), can be synthetically created by a portfolio of another asset, the more risky asset y in this case, and the risk-free asset. The weight of y in the synthetic portfolio is equal to the ratio of the volatility of x to be replicated to the volatility of y, while the rest of the portfolio goes to the risk-free asset, r. Similarly, the more risky asset y can also be synthetically created by a leveraged investment into x, with the weight of x higher than one and a negative weight on the risk-free asset representing borrowing. The degree of leverage is determined by the ratio of their volatilities. Put another way, assets x and y are statistically redundant since one can be synthetically created by a portfolio of the other and the risk-free asset. For example, suppose the volatility of y is twice the volatility of x. According to equation (2), x can be created by a portfolio with 50% invested in y and 50% invested in the risk-free asset. Similarly, y can be created by borrowing at the risk-free rate and investing 200% in x. Linking this result to the real world when correlations increase—albeit not to a perfectly correlated state—means that assets are perceived to be very similar in terms of the tradeoff between their returns and risks. Therefore, investors tend to buy or sell across the board; in other words, they exhibit the "Risk On, Risk Off" behavior.

Exhibit 1 graphically illustrates, hypothetically, the different investment opportunity set when the market is in a normal state with correlation less than one versus the extreme "Risk On, Risk Off" state with perfect correlation among all assets. In the normal state, assets will offer different return-risk tradeoffs, or Sharpe ratios, and different correlations. As correlations go to one, either returns or risks, or both returns and risks, of all assets will adjust to an extent such that their return-risk profiles fall on a straight line on this chart, offering the same Sharpe ratio.

EXHIBIT 1: HYPOTHETICAL INVESTMENT OPPORTUNITY SET

Normal Scenario: Correlation < +1 vs. "Risk On, Risk Off" State: Correlation = +1



Source: Neuberger Berman Quantitative Investment Group.

ALPHA IN A "RISK ON, RISK OFF" WORLD

When one hears the term "alpha" in the investment industry, clarification should follow. Unlike in the academic literature in which "alpha" is understood to be risk-adjusted, such as Jensen's alpha being adjusted for the market premium or, the intercept term in the regression of portfolio return on the Fama-French factors (Fama and French, 1992), "alpha" in the investment management industry often refers to the difference of return of a portfolio versus its benchmark. Presumably and loosely speaking, one can deliver "alpha" just by taking more risks when risks are rewarded, and vice versa. Along the same line of argument, the "alpha" of asset y over asset x, defined as the difference of their returns, in a "Risk On, Risk Off" environment so that their Sharpe ratios are identical as in equation (2), is given by,

$$(3) \qquad \alpha_{xy} = \mu_y - \mu_x = (\sigma_y - \sigma_x)\left[\frac{\mu_y - r}{\sigma_y}\right]$$

Since $\sigma_y > \sigma_x$, thus, $\mu_y - \mu_x > 0$ when $\mu_y > r$ and the "alpha" of y over x is therefore positive when y delivers positive premium over the risk-free rate. However, as made clear by equation (3), the apparent "alpha" of y over x is merely a result of the fact that y is more risky than x, and indeed there is no outperformance from a risk-adjusted perspective as measured by their identical Sharpe ratios, since the two assets are statistically redundant, as discussed above. The case of $\mu_y < r$ can be interpreted similarly.

Consider the real world, when conventional wisdom often says "there is no opportunity when correlations go to one." While we have established the result that in a perfectly correlated world Sharpe ratios of all assets are identical and, therefore, there is no risk-adjusted outperformance of any assets over the others, it is still entirely possible to see different returns achieved by different assets as long as the risks of these assets are not the same; see equation (3). In other words, an investor can achieve a higher return, or outperformance, simply by holding more (less) risky assets in her portfolio when risky assets have positive (negative) returns. Higher return or outperformance in such a world can, however, also be achieved simply by leveraging up (down) any asset in this universe. Does this necessarily mean that the higher return has nothing to do with investment skill and, therefore, the investor should not be compensated?

THE REAL WORLD: A "MACRO-DRIVEN" MARKET WITH HIGH CORRELATIONS

In an attempt to answer the question above, we move back to the real world in which correlations can at times be very high, but never really be perfect at a value of +1. To provide a framework for tractable analysis, we make use of a factor model that drives asset returns and risks. In the appendix, we provide a more formal description of the framework in a realistic, multi-asset, multi-factor world, and delineate how correlations are driven by the systematic, factor-related components versus the nonsystematic, idiosyncratic components. For ease of illustration and without loss of generality, below we consider a world with only one factor. An example is the market factor in the Capital Asset Pricing Model (CAPM). The only factor exposures in this case are the market betas, β_i. That is, for any asset i, its excess return can be represented as

$$(4) \qquad R_i - r = \beta_i (R_f - r) + \varepsilon_i$$

Where R_i is the return of asset i, ε_i is the idiosyncratic return of asset i with idiosyncratic volatility σ_{ε_i} which is independent of the factor f, and R_f is the factor return with factor volatility σ_f. The covariance matrix and correlation for two assets, asset 1 and asset 2, can be given as, respectively,

$$(5) \qquad \Sigma = \begin{bmatrix} \sigma_1^2 & \rho_{12}\sigma_1\sigma_2 \\ \rho_{12}\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix} = \begin{bmatrix} \beta_1^2\sigma_f^2 + \sigma_{\varepsilon_1}^2 & \beta_1\beta_2\sigma_f^2 \\ \beta_1\beta_2\sigma_f^2 & \beta_2^2\sigma_f^2 + \sigma_{\varepsilon_2}^2 \end{bmatrix}$$

$$(6) \qquad \rho_{12} = \frac{\beta_1 \beta_2 \sigma_f^2}{\sqrt{(\beta_1^2 \sigma_f^2 + \sigma_{\varepsilon_1}^2)(\beta_2^2 \sigma_f^2 + \sigma_{\varepsilon_2}^2)}}$$

Consider the extreme case when $\sigma_{\varepsilon_1}^2 = \sigma_{\varepsilon_2}^2 = 0$ where volatilities of assets are all attributable to their factor-related components, as there is no idiosyncratic risk. Equation (6) demonstrates that the correlation between the two assets must be perfect at +1. This is intuitive as when assets are completely driven by the same common factor, and there is absolutely nothing unique about these assets to have any impact on their return dynamics, then their correlation must be perfect. As discussed in the previous section, the Sharpe ratios of the two assets must be identical in this case.

Equation (6) also demonstrates that when magnitudes of idiosyncratic risks are dominated by the factor-related risks, correlations among assets are higher. For example, consider the universe of individual stocks and suppose the factors are sectors. Investors often refer to an environment when risks of stocks are largely driven by sector exposures—particularly during distinct economic regimes—as a "macro-driven market." For instance, during an economic upturn, cyclical sectors such as Industrial and Consumer Discretionary tend to outperform. During an economic downturn, investors prefer to hold more defensive sectors such as Utilities. In this market environment, performance of a portfolio is largely determined by exposures to sectors that are out- or underperforming, and individual stock selection within sectors can become less of a concern.

In other words, in a world with highly correlated assets when risks and correlations are largely dictated by their factor-related components, investment performance becomes increasingly driven by factors. In order to outperform in such an environment, the two key investment skills are (1) precise estimation of the factor structure, including identification of factors, estimation of factor exposures, and estimation of the factor covariance matrix;[1] and (2) factor timing.

As an example, consider the one-factor CAPM world again in which assets are highly correlated such that the idiosyncratic components are insignificant in determining returns of assets. In order to outperform in this world, the investor, having correctly identified the market factor as the only factor, must precisely estimate asset betas as well as the sign of the market factor return. If the investor is bullish on the market factor, the portfolio should be steered to hold high beta and, therefore, high risk assets, and vice versa. Similarly, when assets are highly correlated in a multi-factor world, with factors including sectors and other characteristics, the investor must shift efforts into factor-related research, including estimation and timing, in order to outperform. Carrying the argument to the extreme case, the only skill that should be rewarded when correlations go to one is factor timing.

INVESTMENT IMPLICATIONS

Derman (2010) made the following observations:

- "The world is multi-dimensional. Models allow us to project the object into a smaller space and then extrapolate or interpolate within it. At some point the extrapolation will break down."
- "Theories tell you what something *is*. Models tell you only what something is *more or less* like."

- "The one law you can rely on in finance is the law of one price, … The law of one price is not a law of nature. It's a general reflection on the practices of human beings, who, when they have enough time and enough information, will grab a bargain when they see one. The law usually holds in the long run, in well-oiled markets with enough savvy participants, but there are always short- or even longer-term exceptions that persist."

The world with perfect correlations and identical Sharpe ratios does not exist. Even if it did, and our set of normative results in such a state were indeed derived in the spirit of the law of one price, it could not be done without the same set of assumptions on human beings' behavior underlying the Modern Portfolio Theory. As Derman pointed out, exceptions can persist for various reasons. Furthermore, our analysis only offers insights into the end point—the scenario of perfectly correlated assets—and tells us nothing about the scenarios approaching such an end point. Therefore, this paper does not provide any guidance for interpolation. Nevertheless, we take the insights developed so far as our compass and apply them to three different cases that we believe are of interest. We leave the interpolation exercise to the creativity of the readers.

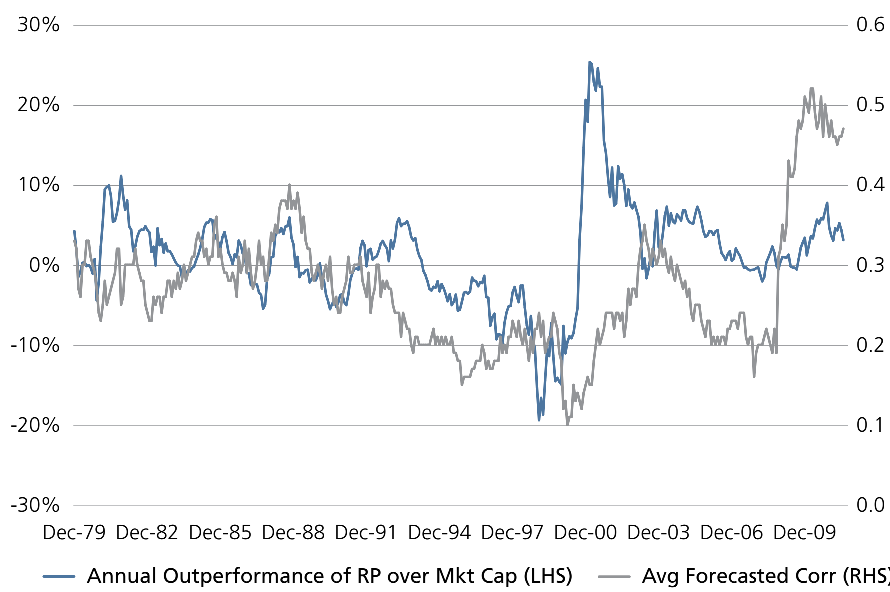
Case 1: Risk Parity

In Kaya and Lee (2011), the risk-parity portfolio in which all assets contribute equal risk is determined to be the mean-variance optimal portfolio when (1) correlations of all assets are the same, and (2) Sharpe ratios are identical. Note that the optimality of risk parity does *not* require perfect correlations. But in the very special case with perfect correlations among all assets, which means correlations are the same by definition, we have shown above that Sharpe ratios of all assets must be identical. Therefore, optimality conditions of the risk-parity portfolio are satisfied in this case. In other words, in this nonexistent world, one can argue that the risk-parity portfolio is the mean-variance optimal portfolio. However, as all assets are statistically equivalent in this special case, portfolios of these assets, regardless of their weights, are also statistically equivalent to the single, nonredundant asset. Therefore, any portfolio in such a world must also satisfy the risk parity efficiency conditions, as risks in all portfolios are derived from one nonredundant asset. In this paper, we make no predictions on the efficiency of risk parity as a function of the level and direction of correlations. Kaya and Lee (2011) shows that the relative efficiency of risk parity can depend on a number of parameters in the underlying multivariate return distribution, including the Sharpe ratios, correlations, volatilities, deviation from the normal distribution, uncertainty of parameters estimates, among others. We leave the more in-depth analysis of empirical performance of the risk-parity portfolios under different conditions to future research.

Instead, we construct a risk-parity (RP) portfolio in the universe of the largest 500 stocks at the end of each calendar year in the U.S. stock market from 1979 to July 2011 by using the Barra USE3L model as our covariance matrix.[2,3] The RP portfolio is rebalanced at the beginning of every month. Following Lee (2011), we do not impose any constraints on the portfolio construction process in order to preserve the original characteristics of the portfolio. The average turnover per month of the unconstrained RP portfolio is about 6%, which makes it a very reasonable and implementable portfolio. The widely applied W statistic of Gibbons, Ross, and Shaken (1989) provides a formal test of portfolio efficiency based on Sharpe ratio. However, a large number of observations is required in order to achieve certain statistical power with such test. Given that we are more interested in the state of changing correlations and portfolio efficiency, we do not conduct such a formal test. Instead, we simply report some performance statistics of the RP portfolio versus the market capitalization-weighted portfolio (MC) of the same 500 names. Although our insights say nothing about the efficiency of the RP portfolio versus the MC portfolio, we believe that the latter is a natural anchor point of reference, given that it is *the* market-clearing equilibrium. During this sample period, the RP portfolio has a geometric average annual return of 12.84% and volatility of 14.56%, versus the 11.27% return and 15.38% volatility of the MC portfolio. The two portfolios have a correlation of 0.96.

Exhibit 2 plots the rolling 12-month performance of the RP portfolio versus the MC portfolio. It is interesting to observe that the RP portfolio outperformed the MC portfolio most of the time, with the growth bubble period during the second half of the 1990s as the exception. For reference, we also plot the average forecasted pairwise correlation of the same 500 names. Interestingly, the average forecasted correlation was at its all-time low of 0.2 or below during the second half of the 1990s when RP underperformed. Not surprisingly, the average forecasted correlation jumped after September 2008 to its all-time high, and it remains at a very high level at the time of this writing, although still below its peak.

EXHIBIT 2: ROLLING 1-YEAR OUTPERFORMANCE OF RISK-PARITY PORTFOLIO VS. MARKET CAPITALIZATION-WEIGHTED PORTFOLIO AND AVERAGE FORECASTED CORRELATION OF BARRA USE3L

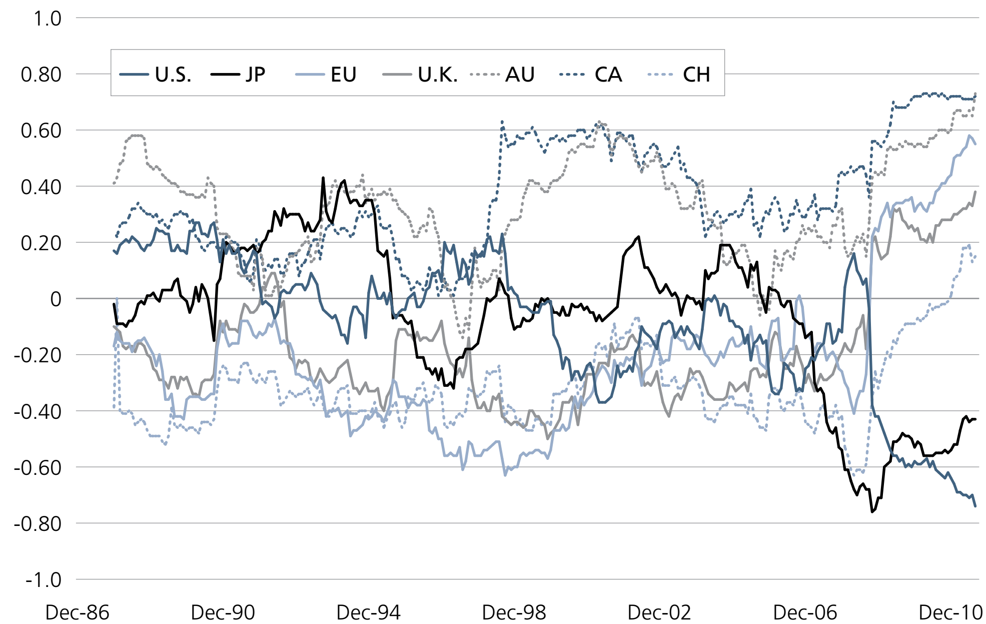


Sources: Neuberger Berman Quantitative Investment Group, IDC.

Case 2: Asset Allocation

Exhibit 3 plots the rolling 3-year correlation between the stock market and the currency returns in each region, including the United States (U.S.), Japan (JP), Europe ex-U.K. (EU), the United Kingdom (U.K.), Australia (AU), Canada (CA), and Switzerland (CH). The sample period is from January 1985 to August 2011. Monthly stock index returns are from MSCI, while currency returns versus the U.S. dollar are from Bloomberg. For the return of the U.S. dollar, we simply average the individual returns of the U.S. dollar versus each currency in this universe.

EXHIBIT 3: ROLLING 3-YEAR CORRELATION OF STOCK MARKET AND CURRENCY RETURNS



Sources: Neuberger Berman Quantitative Investment Group, MSCI, Bloomberg.

At first glance, Exhibit 3 suggests that correlations between regional stock markets and their respective currencies have been unstable. A more careful look, however, suggests that the pattern in the past few years is unique. During the month of September 2008, with the exception of Japan, there were sudden jumps in correlation between stock and currency returns in every region. In the case of the U.S., correlation suddenly jumped from near zero to -0.5, and has continued to trend in negative territory since then. In all other regions, correlations suddenly jumped; in the case of Switzerland, correlation has become less negative; and in all other regions, correlations are much more positive. As a matter of fact, as of the last observation of August 2011, correlations in Canada, Australia, Europe ex-U.K., U.K., and Switzerland are positive and at their all-time highs, while correlation in the U.S. is negative and at its all-time low in this sample period. While correlation in Japan was moving around zero during earlier years, it has been negative since 2006. Clearly, regions in this universe have migrated to two clusters, the U.S. and Japan as one cluster with negative correlation between stock and currency, while all other regions comprising another cluster with positive correlation between stock and currency.[4] What drove them into these two clusters?[5]

Given the prolonged period of its low yield, the Japanese yen has been used as a low-yield funding currency in carry trades for nearly decades. It is generally observed that when risk appetite is fading to the extent that investors cut risk, they tend to unwind their carry trade by buying the yen. Moreover, during volatile periods such as the global financial crisis or the earthquake in Japan in March 2011, the yen tends to appreciate. As a result, the yen has been widely accepted as a flight-to-safety asset for years and, in turn, the correlation between the Japanese stock market and currency returns remains negative.

The U.S. dollar has become one of the lowest-yielding currencies in this universe in the wake of the quantitative easing programs and is also perceived as a flight-to-safety asset. As a result, when stock markets are going down and risk appetite is fading, we tend to see the dollar appreciate, and vice versa. Considering that the correlation between stock and currency returns in the U.S. is at its most negative during this sample period and that since September 2008, the correlation in Japan has become less negative, one may deduce that the world may increasingly see the dollar as the preferred flight-to-safety asset, the asset one wants to hold during "Risk Off."

The Swiss franc provides another interesting observation. It has been one of the lowest-yield funding currencies in the carry trade and, therefore, can act as another flight-to-safety asset, in theory. The franc's correlation with its stock market was negative for the most part during this sample period. However, the correlation has jumped since September 2008 to become less negative and, since then, has been moving up. In fact, it turned positive in 2011 for the first time in this sample period.

What does all this mean for global macro investing? Consider a hypothetical global macro fund that includes a global stock portfolio that takes long and short positions on stock markets in an attempt to capture relative returns among these stock markets, and a global currency portfolio that takes long and short positions on currencies, as well as a long or short directional trade on global stocks. In the investment world, it is not atypical to see these two different asset classes covered by two different teams of specialists. As examples, the stock strategist may focus on different valuation and earnings growth prospects of the markets, while the currency strategist may focus on purchasing power parity and current accounts. As a result, one can fairly expect diversification benefits of running both portfolios to enhance the overall performance of the global macro fund. Now let's take this to an extreme case of "Risk On, Risk Off." Suppose for some reason that the stocks and currency in the same region have become perfectly correlated, suggesting that both assets are now driven by the same set of factors in determining their returns and risks, rather than by the unique characteristics of these different asset classes analyzed by the strategists. The same can be said of those regions where their stocks and currencies are now perfectly negatively correlated, except that the stocks and currencies have opposite exposures to the same set of common factors. In this case, there is no more diversification benefit between the strategies of taking net long or short positions on the stocks and currency in the same region, as performance of each is entirely driven by the skill of timing the same set of factors that is driving the two different asset classes.

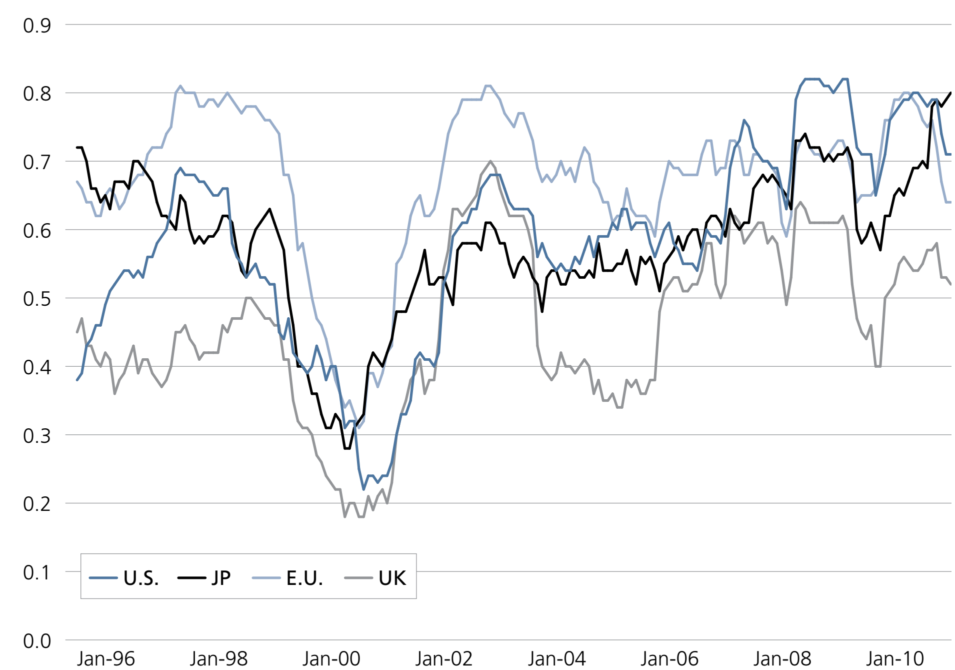
For Japan and the U.S., stocks typically move in the opposite direction of their respective currencies, while for all other regions the reverse is true, and stocks generally move in the same direction as currencies. As a result, performance of the two strategies depends entirely on whether the investor correctly identifies the set of common factors driving the two asset classes, as well as taking positions that are consistent with the investor's view on how assets will behave as these factors change. Furthermore, stock market selection and currency selection also collapse into the same strategy when the two assets in the same region are perfectly correlated and, therefore, have identical Sharpe ratios. In this environment, for those investors who continue to maintain their distinct processes of managing stocks and currencies, their performance may be confined to a relatively narrow range, as the chance of getting both stock and currency strategies right or wrong at the same time is lower given that the two strategies' underlying investment processes are not built upon an identical set of factors.

The existence of investors who can switch their focus from a diversified set of factors to a common set of factors, assuming that such sets of factors can be precisely identified, may have implications for the dispersion in performance among global macro managers. Some investors may time the factors correctly—and therefore perform well in both strategies—while others may fall short on factor-timing and suffer poor performance in both strategies concurrently. Given that the hit ratio can be low of timing a set of factors—a set which is likely to be small in number during "Risk On, Risk Off"—it is likely to be observed that the performance of a particular investor over time can look episodic, performing well during one period followed by possibly subpar performance in the following period.

Case 3: Active Portfolio Management

To provide some insight into the state of active portfolio management specifically with respect to stock selection, we analyze the history of correlations among sectors and individual stocks in four global regions: the U.S., Japan, Europe ex-U.K., and the U.K. Daily returns of the ten MSCI sectors since 1995 are collected from Bloomberg, while daily individual stock returns since 1980 for the U.S., and since 1985 for other regions, are sourced from the International Data Corporation (IDC). The universes for individual stocks are the top 500, 1,600, 350, and 1,000 names by market capitalization at the end of each year in each of these regions, respectively. Within the region Europe ex-U.K., sector returns are calculated based on euro denomination, while returns of individual stocks in the other regions are denominated in their local currencies.

EXHIBIT 4: MEDIAN OF 250-DAY PAIRWISE CORRELATIONS OF SECTORS WITHIN REGIONS (JANUARY 1996–JULY 2011)

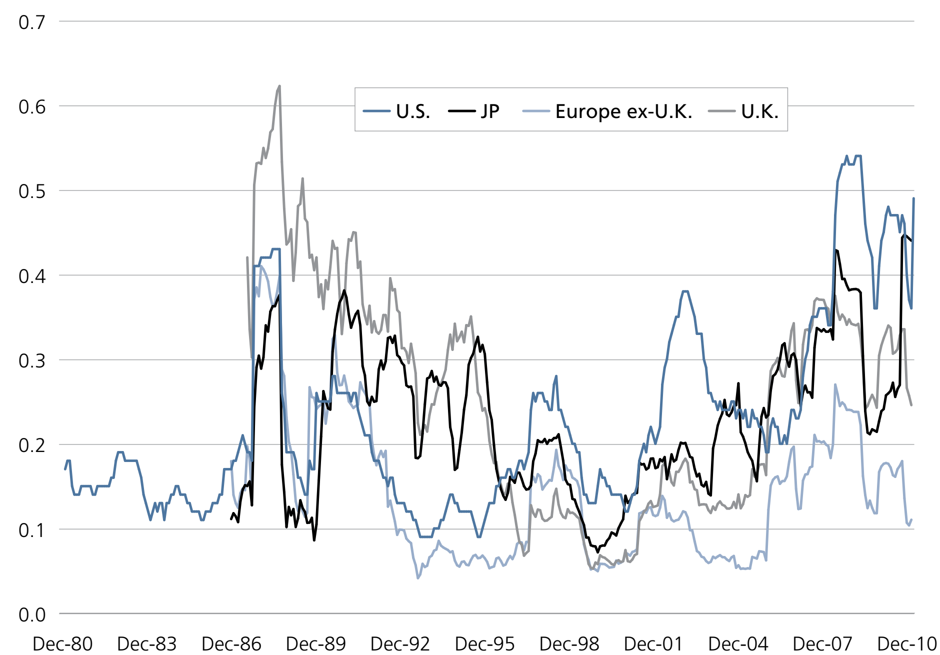


Sources: Neuberger Berman Quantitative Investment Group, Bloomberg.

Exhibit 4 plots the medians of the 250-day pairwise correlations of the ten MSCI sectors within each region. Sector correlations in all regions appear to share similar patterns and are currently either at or close to the all-time high after the global financial crisis of 2008.

Exhibit 5 plots the medians of the 250-day pairwise correlations of all the individual stocks within the universe of each region. Note that correlations are computed across all stocks in the universe irrespective of their sector classification, unlike Mezrich (2011) which computes correlations of stocks within sectors only. As a result, the patterns in Exhibit 5 should somewhat preserve the patterns of sector correlations in Exhibit 4. Some observations are noteworthy.

EXHIBIT 5: MEDIAN 250-DAY PAIRWISE CORRELATION OF STOCKS WITHIN REGIONS (JANUARY 1981–JULY 2011)



Sources: Neuberger Berman Quantitative Investment Group, IDC.

Based on the factor model framework and its implications discussed earlier, one can deduce that the capability of identifying and estimating the factor structure that drives the systematic risks of stocks has become increasingly important in active portfolio management. These factors can be sectors or industry groups, for example, or other fundamental characteristics such as value, momentum, leverage, and the like, which are popular among risk-model specialists and are widely used by portfolio managers. On the contrary, the stock-picking approach, which in the strict sense refers to forecasting idiosyncratic stock returns, may have become more challenging than before. Quantitative investors who use systematic, model-driven approaches tend to pay a disproportionate amount of attention to factor-related components, while fundamental investors normally focus more on stock-picking. However, as shown in Lam and Lee (2005), the difference between the two approaches can be obscure at times, as an investment view that is believed to be driven by fundamental, stock-picking insights can have significant factor exposures. Nevertheless, we believe that with a universe of highly correlated stocks, investors who have the capability to identify and, more importantly, to predict the factor returns likely have a competitive advantage, relatively speaking.

REMARKS

The Fundamental Law of Active Management of Grinold and Kahn (1989) provides a framework to understand the potential reward and risk of active management. Information ratio, defined as the ratio of active return to active risk, is a function of the quality of information as measured by the information coefficient, and the quantity of information as measured by the square root of the number of independent decisions known as breadth. Given that the number of factors is typically substantially lower than the number of individual assets, the breadth of decisions with respect to factor timing is known to be relatively limited. When correlations of assets converge to one—that is, the "Risk On, Risk Off" world—factor structure estimation and timing become the dominant skills in determining relative performance of investors. Therefore, in a highly correlated world, investors do not have sufficient degrees of freedom to diversify their active investment decisions but, instead, have to rely on the quality of their factor information. It is generally agreed that factor timing, such as market timing, has a lower hit ratio and it is more difficult to have persistent success. Moreover, the relatively low number of factors in normal states may most likely further collapse to an even smaller number in a "Risk On, Risk Off" state. To this end, it is our view that in a highly correlated world, some investors can, and will, outperform by taking more concentrated positions. Persistence of their outperformance, however, is likely to be weaker than normal. Investors with a similarly concentrated focus but who make the wrong calls will, in contrast, deliver poor performance. As a result, and because of the low hit ratio and weak persistence of success in factor timing, it is more likely that a wider dispersion of returns from different investors of this sort will be seen during a period with high correlation, as well as weaker persistence of outperformance by the same investors. On the other hand, for those investors who maintain a diversified investment approach based on the analysis of a wider spectrum of information during such extreme states of the market, their performance will likely stay in a relatively narrower range. From an ex-ante, risk-adjusted sense, every investor is challenged in a "Risk On, Risk Off" state.

APPENDIX

Perfect Correlation and Sharpe Ratio

This section provides the proof that perfect correlation between two assets, x and y, is a sufficient condition that their Sharpe ratios must be identical.

All statistics in this paper are understood to be conditional expectations unless otherwise stated. Let x and y be two risky assets with expected returns μ_x and μ_y, volatilities σ_x and σ_y, and correlation coefficient ρ. The risk-free rate of return is denoted by r.

Suppose $\sigma_y > \sigma_x$. A portfolio of x and y, denoted as p, has weights in x and y as $\left[\frac{\sigma_y}{\sigma_y - \sigma_x}, \frac{-\sigma_x}{\sigma_y - \sigma_x}\right]$.

The position in x is a positive, long position while the position in y is a negative, short position. The variance of portfolio p is given by

$$\sigma_P^2 = \left[\frac{\sigma_y}{\sigma_y\text{-}\sigma_x}\right]^2 \sigma_x^2 + \left[\frac{\sigma_x}{\sigma_y\text{-}\sigma_x}\right]^2 \sigma_y^2 \text{-}2\,\frac{\rho\sigma_x^2\sigma_y^2}{(\sigma_y\text{-}\sigma_x)^2}$$

Or,

$$\sigma_P^2 = 2\,\frac{\sigma_x^2\sigma_y^2}{(\sigma_y\text{-}\sigma_x)^2}(1\text{-}\rho)$$

When $\rho = 1$, $\sigma_P^2 = 0$ and, therefore, the portfolio p must be a synthetic risk-free asset with return equal to r to rule out arbitrage. That is, return of p is given by

$$\mu_p = \frac{\sigma_y}{\sigma_y\text{-}\sigma_x}\mu_x - \frac{\sigma_x}{\sigma_y\text{-}\sigma_x}\mu_y = r$$

Rearranging, we get

$$\frac{\mu_x - r}{\sigma_x} = \frac{\mu_y - r}{\sigma_y}$$

That is, the Sharpe ratios of x and y are identical when x and y are perfectly correlated.

Multifactor Specification

Suppose there are N risky assets and k factors.

Notations:

R	N x 1 vector of asset returns
X	N x k matrix of factor exposures
f	k x 1 vector of factor returns
ε	N x 1 vector of idiosyncratic returns; non-zero means represent factor-independent "alphas" of the assets
Σ	N x N covariance matrix of the asset returns
F	k x k covariance matrix of factor returns
Δ	N x N diagonal matrix of idiosyncratic variance
ω_i	N x 1 vector of portfolio weights with one in element i and zero otherwise, representing asset i

Asset returns can be represented by a linear factor model as

$R = Xf + \varepsilon$

and their covariance matrix is given by

$\Sigma = XFX' + \Delta$

Correlation between two assets, i and j, can be computed as

$$\rho_{ij} = \frac{\varpi_i'\Sigma\varpi_j}{\sqrt{\varpi_i'\Sigma\varpi_i}\ \sqrt{\varpi_j'\Sigma\varpi_j}}$$

Substituting the covariance structure of equation (5) into equation (6), we get

$$\rho_{ij} = \frac{\varpi_i'XFX'\varpi_j + \varpi_i'\Delta\,\varpi_j}{\sqrt{\varpi_i'XFX'\varpi_i + \varpi_i'\Delta\,\varpi_i}\ \sqrt{\varpi_j'XFX'\varpi_j + \varpi_j'\Delta\,\varpi_j}}$$

Co-movements of assets are driven by their factor exposures and the factor covariance matrix, but are also dependent on the idiosyncratic shocks that drive the risk of assets independently.

ENDNOTES:

1. Since the global financial crisis of 2008, we have seen more discussions on uses of risk factors versus asset classes in the practice of asset allocation. See Page and Taborsky (2011), and also Kaya, Lee, and Wan (2011) on discussion and comparison of asset class versus risk class modeling.
2. I would like to thank Alex Da Silva and Hakan Kaya for providing this simulation.
3. The Barra USE3L was launched in the late 1990s. The more recent revisions include the introduction of the Internet and the Equity Real Estate Investment Trusts industries in April 2000, and the Biotech industry in June 2002.
4. It is not uncommon to hear from global equity investors that they do not hedge currencies, as correlations between stocks and currencies are unstable and weak over time. Exhibit 3 somewhat supports this claim, but only until September 2008 at best.
5. If one prefers working with positive correlations only for the sake of simplicity, correlations between the stock returns and returns of shorting the currencies in the cases of the U.S. and Japan would have been positive.
6. In its survey of the literature, Luo, et al (2010) discusses three schools of thought on the drivers of correlations, namely, Fundamentals, Category-based, and Habitat-based. Xiong and Sullivan (2011) reports and attributes the increase in stock correlations to the popularity of passive equity investing. While these discussions focus on trends in correlations, our area of interest is more on jumps in correlations in relation to the attitude towards risk.
7. Another statistic that can be informative on the degree of co-movement of stocks is the absorption ratio in Kritzman, et al (2011). According to the analysis, the absorption ratio of the fifty-one industries in the U.S. was near its all-time high in 2010.

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