Correlations Have Personality, Too:

An Analysis of Correlations between Assets

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Abstract

The statistical measure "correlation" is one of the building blocks of creating a well-diversified portfolio. But what do we know about correlation? Many investment sources will compute the correlation of monthly returns between two asset classes. Others may use daily or other time-frames, while some do not even list the time-period used in their calculations. Does the time-period matter? We study correlation in a variety of ways to obtain a more intuitive feel – and a more meaningful understanding – of this elusive measure. In addition to examining the time-period parameter, we review the long-term cyclical nature of correlation between asset classes. The results show us the fickle behavior of the correlation statistic and suggest that an active approach to how we measure and apply correlation can improve portfolio optimization. Results are based on more than fifty years' worth of data, across several asset classes, including stocks, bonds, and commodities.

1. Introduction

Investment practitioners constantly strive to improve expected return given a certain level of risk. Some investment professionals focus on specific asset classes or investment strategies. Others state that a diversified portfolio's results are driven mainly by the asset allocation policy (Brinson, Hood, and Beebower 1986).

Portfolio construction decisions and asset allocation policies – are driven by risk, return, and correlation assumptions. In this research paper, we focus on the statistical measure of "correlation."

Correlation is one of the building blocks used to create a well-diversified portfolio. The correlation between two asset classes is typically based on monthly performance data. However, monthly correlation calculations are used mainly due to convenience. In this work, we study if "time-period matters" – and analyze how correlation varies as a function of time-period.

In addition, some analysts have shown that the correlations between various asset classes have drifted over time. Some investment practitioners say that a long-term perspective is warranted. Others say that perhaps the world has changed and that "this time is different." In this paper, we examine correlation in a variety of ways. In addition to investigating how correlation varies as a function of time-

frame, we also study the stability of the correlation statistic. Finally, we observe that correlations can be cyclical over longer-term time periods.

This correlation research will be of interest to a variety of investment practitioners, including portfolio managers, risk managers, and institutional investors. The "personality" of correlations may be of particular interest to asset allocation strategists because the research demonstrates that a more active approach to how we view and use the correlation statistic can materially impact results.

In addition, "risk parity" strategies have gained traction as a method of exploiting diversification and correlations – to better balance risk and gain excess returns (Callan 2010). Our research can be used in combination with well-known methods of asset allocation and Modern Portfolio Theory (MPT), introduced by Markowitz over 50 years ago (Markowitz 1952) – by combining and introducing industry best practices used by progressive endowments and pension funds, "quant" hedge funds, and other financial institutions.

2. Methodology: Assets and Data

We examine historical data to give us a framework of understanding – and to learn from history. Data for multiple asset classes and an alternative asset is obtained from a variety of sources. We thank Barclay Hedge (2012), Price Asset Management (2012), and Shiller (2012) for asset and investment data, and the Federal Reserve of St. Louis (2012) for macroeconomic data.

Performance data is analyzed for a variety of assets, including stocks, bonds, and an alternative asset. It is well-established that alternative investment strategies offer good diversification benefits for a portfolio of stocks and bonds (Lintner 1983, Chin 2010). In this paper, we use commodities as our alternative asset class because we are able to study historical data going back to 1960 for all three assets.

3. Correlation

One of the key drivers for portfolio construction, based on concepts of Modern Portfolio Theory, is the correlation of asset returns. Correlation is a statistical measure ranging from -1.00 to +1.00 – that expresses the linear relationship between two asset classes. For instance, small-cap stocks and the S&P 500 might have a relatively high correlation of around 0.82. This means that if the S&P 500 drops, small-cap stocks are very likely to decline as well.

Earlier, we stated that most analysts compute monthly or daily correlations. We posed the question, "Does the time-period matter?" First, we study correlation as a function of time-frame – for various assets. Then, we study the stability and cyclical nature of the correlation measure.

4. Correlation and Time-Frame

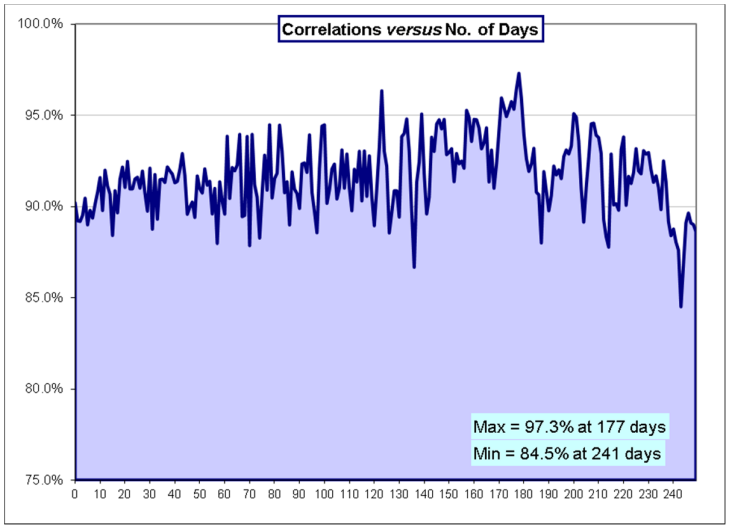
Here, we study how correlations vary as a function of time-frame, measured by the number of days. More specifically, we measure correlation for the same set of data, while varying the time-frame from 1 day, to 2 days, and so on.

Interestingly, both the minimum and maximum correlation measures – for the same data set – can vary tremendously. Below are charts of correlations between several sets of common and popular assets over the past ten years – as a function of time-frame.

S&P 500 and Small Stocks

Historically, large-cap and small-cap stocks have had a relatively high correlation, and the graph below shows this to be true. Note, however, how the correlation statistic can vary depending on the number of days used to compute this measure. The correlation over the past ten years varies from a minimum of 84.5% at 241 days, to a maximum of 97.3% at 177 days. This made us wonder, "How would the results look if there is 'less of a relationship' between the asset classes?"

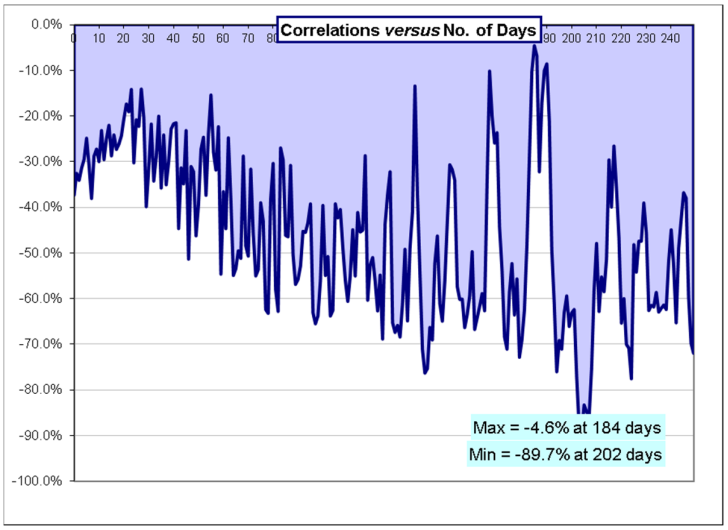
Chart 1: Correlation as a Function of Time-Frame
(S&P 500 and Small Cap Stocks)



S&P 500 and Bonds

Historically, bonds and stocks have had a positive relationship, with correlations on the order of 0.40. However, over the past ten years, stocks have struggled during various financial crises, while interest rates have declined (and bonds have risen) during the same period. As a result, stocks and bonds have had a negative correlation over the past ten years. In the chart below, note the increased variance of correlation as a function of the measured time-period (number of days).

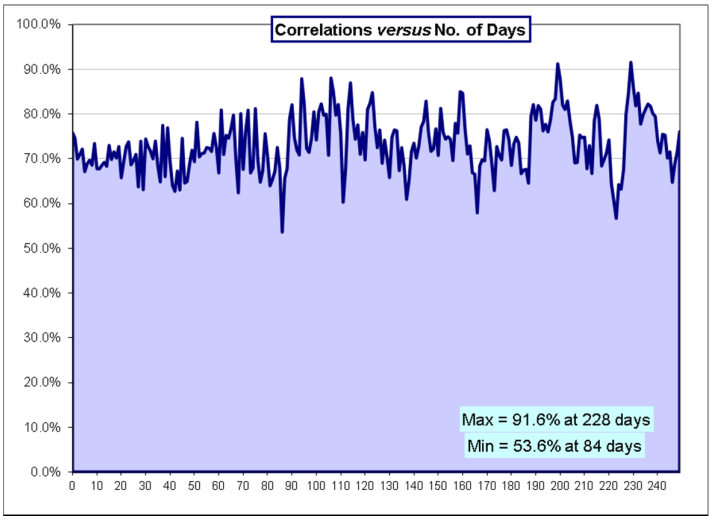
Chart 2: Correlation as a Function of Time-Frame
(S&P 500 and Bonds)



S&P and Japanese Stocks

Correlations amongst global stocks have risen over the years, along with increased globalization. In this case, the correlations are relatively stable as a function of number of days.

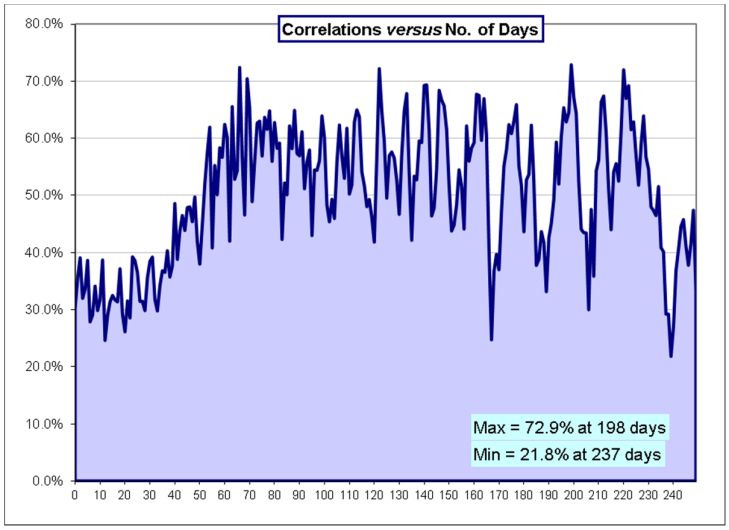
Chart 3: Correlation as a Function of Time-Frame
(S&P 500 and Japanese Stocks)



S&P 500 and Commodities

The relationship between stocks and commodities can be described by relatively low correlations – that are fairly variable and volatile (as a function of number of days). Again, we see a large variation in correlation computations.

Chart 4: Correlation as a Function of Time-Frame
(S&P 500 and Commodities)



5. Correlation and Time-Frame: Takeaways

Based on the charts above, we can see that correlation definitely has a "personality" of its own based on the asset classes that are compared. Here are some notes:

- If we compute correlation using a relatively long time-period (such as one-year, as opposed to monthly, correlation), we will have correspondingly fewer data points, which could result in instability. As a result, we may prefer to use correlation over shorter time-periods to obtain more data points and stability.
- Based on the graphs above, we can see that the correlation of monthly returns (note that one month has about 20 trading days) may be conservative (lower correlations than longer-term, and average, calculations). Practitioners of Modern Portfolio Theory and strategic asset allocation may appreciate this conservatism so that they are not lulled into a false sense of "diversification security."
- Others may see that a slightly longer-term perspective such as 60-trading-days (or quarterly performance) gives a better picture – and perhaps captures more meaningful relationships – amongst asset classes.

6. Correlation Distributions and Variability

It is useful to study historical results to see what lessons the data can teach us – and discover information from patterns. Financial professionals who have invested through several market cycles will be pleased that our dataset includes major financial crises such as the 1973-74 and 1987 stock market crashes, the internet bubble and sustained stock market malaise since 2000, and the recent recession – including the 2008 financial stock market stock.

Based on the charts above, we can see that correlation can fluctuate quite dramatically by changing the computation period just by a few days. Here, we display the distribution of correlations graphically – and try to give a more complete picture of what the data is saying. Over the years, some correlations and relationships have remained more stable than others.

For instance, the charts below show the distribution of correlations from selected assets above. In particular, please note the summary statistics that describe the "mean correlation" between the given assets – as well as the "standard deviation" of the correlation measures. Note the tighter distribution (and scale) for the top chart (S&P 500 and Small Stocks) versus the bottom chart (S&P 500 and Commodities).

Chart 5: Correlation Distribution or Variability
(S&P 500 and Small Stocks)

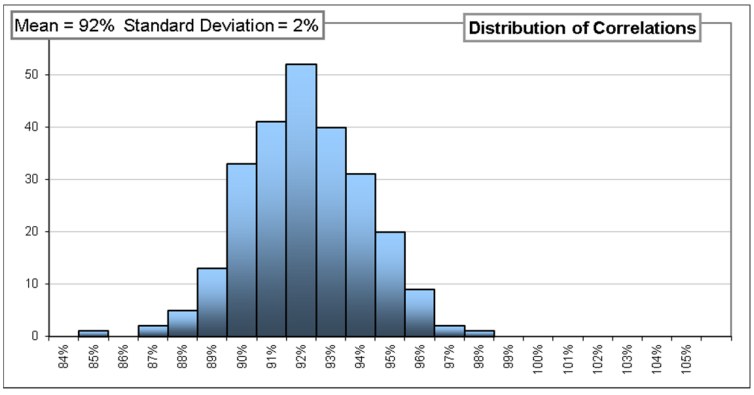
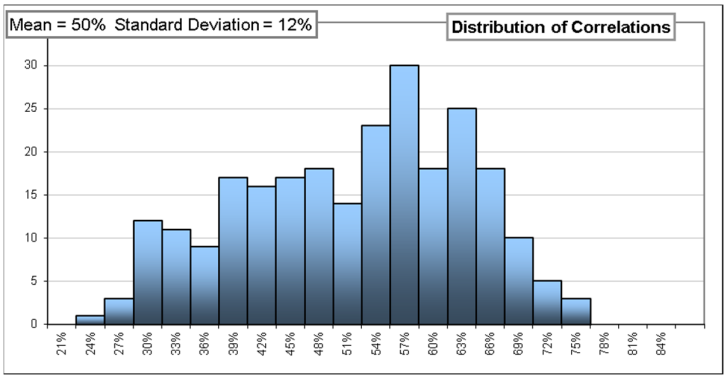


Chart 6: Correlation Distribution or Variability
(S&P 500 and Commodities)



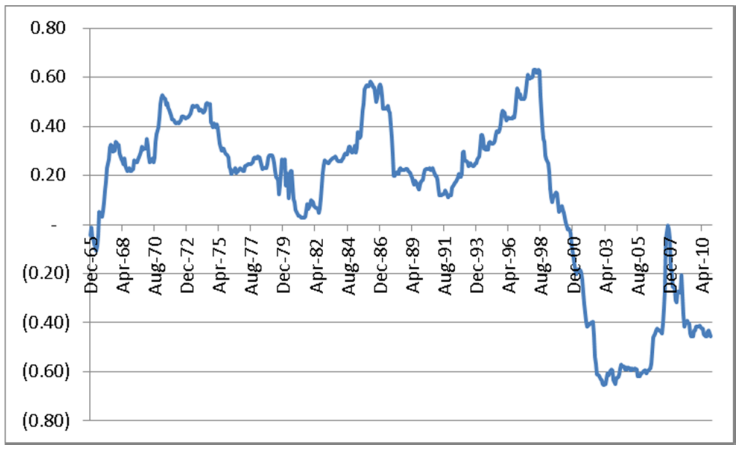
The standard deviation – as well as the difference in scale – is quite dramatic, with the distribution of correlations between commodities and stocks being much wider. These charts tell the story of the much greater dispersion of correlation between the S&P 500 and commodities versus that of the S&P 500 and small stocks.

In addition, it is notable that correlations can be a moving target. That is, over time, the benefits of some asset classes may drift and even converge towards 1.00. We have seen this with global stocks, as the world's economy has become increasingly global – and more highly-correlated over time (Chin 2010). In addition, the past few financial crises have reminded portfolio managers that distress in the financial markets typically drives correlations higher during times of economic stress.

7. Correlations can be Cyclical

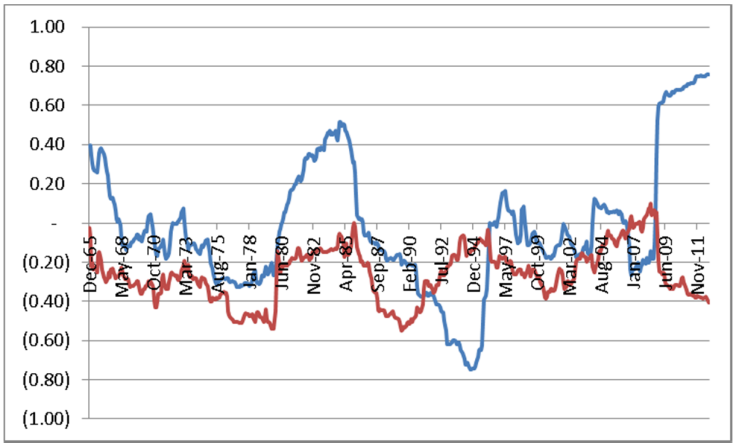
In addition to computing correlation as a function of "number of days" – we also review how correlations can vary over many years of historical data, and through several market cycles. Below, we display the rolling five-year correlations of quarterly performance between several sets of assets.

Chart 7: Correlation between Stock & Bonds
(5-Year Rolling Correlations of Quarterly Performance since 1960)



Below is a chart that shows the correlation between commodities and stocks (blue line) and bonds (red line).

Chart 8: Correlation between Commodities and Stock & Bonds
(5-Year Rolling Correlations of Quarterly Performance since 1960)
(Commodities-Stocks = Blue; Commodities-Bonds = Red)



By taking a long-term historical perspective, we can see that correlations amongst asset classes have a personality of their own (that can add diversification to a portfolio). Indeed, correlations between assets that are not very related move in cycles depending on market cycles and market events.

During the recent period of low interest rates, some investors decried the usage of bonds in diversified portfolios. However, bonds have proven to be both a good investment and a good diversifier in recent years. In the current market cycle, bonds have actually had a negative correlation to stocks.

Similarly, some investors are questioning the usefulness of commodities in a diversified portfolio, and point to the recent high correlations between stocks and commodities. Results suggest, however, that correlations between assets comprised of different building blocks – such as stocks and commodities – move in a fairly wide cyclical range over time.

8. Implications for Asset Allocation Models

When devising asset allocation models, investment practitioners prefer to be conservative in their assumptions and modeling. For instance, it is well-known that correlations amongst asset classes often rise during financial crises due to the rush towards liquidity.

At the same time, however, many analysts would prefer to capture the "most information" for their portfolio construction efforts. We have gained a more intuitive feel for how correlations and inter-relationships amongst assets behave. As the investment industry continues to develop asset allocation and portfolio construction tools, a more intense focus on time-frame and correlation assumptions can add value.

The extreme volatility suffered by the financial markets has caused some to declare that buy and hold is dead (Lo 2012). Much work has been done on active versus passive management over the years (Chin 2011) as well as other aspects of asset allocation, including risk parity and leverage aversion (Asness 2011 and Dalio

2010). While many investment practitioners focus on risk and return assumptions, a more active stance on correlation assumptions is warranted.

9. Conclusions

We have studied the correlation statistic in several different ways, and have learned more about the behavior of correlations amongst various assets. In particular:

- Correlation between two assets can vary widely depending on the time-frame of the measurement period (daily, weekly, monthly, etc.).
- The dispersion of correlations, based on time-frame, was also measured.
- Over a long time period and several market cycles, correlations between certain assets are cyclical.

Our work shows that a more active approach on how we measure and apply correlation can lead to material improvements in portfolio construction. Some practitioners may take this a step further and use this type of analysis to forecast correlations for use in asset allocation models.

10. Future Work

We have analyzed correlation statistics between various asset classes and have learned more about the behavior of this measure. Correlations between asset classes are sometimes more or less stable than between other assets. In addition,

correlations are often cyclical over longer-term time periods. These correlation results can be applied to portfolio optimization tools.

Hedge fund managers and portfolio strategists strive to achieve positive skew and kurtosis – and apply risk management approaches and investment strategies to avoid negative surprises. The goal of our research is to improve our understanding of the financial markets and apply the results to improve forward information. Today's investment strategies require the use of downside risk measures, and future research should include improved correlation analyses.

Future research based on downside risk measures and downside correlations should be performed. Indeed, it would be interesting to quantify the correlation between two assets when one asset declines over a given time period, a measure we call downside or semi-correlation (Chin 2010). These tools are particularly important given today's financially-engineered products.

In a recent poll by the *Economist Intelligence Unit* commissioned by State Street Global Advisors (2012), more than 70% of institutional investors believe it is "likely" that a significant tail risk event will occur over the next 12 months. The main worries include the Eurozone crisis, the prospect of a global or European recession, and the slowdown in China. It would be interesting to quantify the "event risk capture" of asset classes such as commodities and managed futures – based on downside correlation measures.

Risk Disclosure

Investing in commodities, managed futures or other alternative investment products or accounts can involve a high degree of risk. Such investments can be illiquid, speculative, volatile, or employ significant leverage and can have no secondary or a limited secondary market for an investor's interest.

PAST RESULTS ARE NOT NECESSARILY INDICATIVE OF FUTURE RESULTS.

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