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# Of Commodities and Correlations

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Proponents of commodity investing typically point to the overall low correlation between commodities and other asset classes as one of the three main benefits of commodity investing (the other two being equity-like returns and a positive correlation with inflation).[1] Over the last fifty years, the stock-commodity and stock-bond correlations have been close to zero. However, these point estimates conceal wide degrees of variation. For instance, the annual correlation between stocks and commodities has ranged from -0.39 to 0.76.[2]

As has been widely noted, the recent stock-commodity correlation has visited the upper end of its historic range. Less widely discussed, the bond-commodity correlation has been at the lower end of its historic range. This situation has led some to wonder whether the relationship between stock and commodity returns has permanently changed, with some suggesting that increased investor interest has led to a higher correlation between stocks and commodities.

In this article we explore the evolution of the stock-commodity and bond-commodity correlation. We also explore the evolution of the correlation of commodities to each other. In particular, we are interested in whether these correlations have changed over time and whether variation in the correlations is affected by underlying economic conditions.

We find that the stock-commodity correlation and the intra-commodity correlation have a business cycle component, i.e. these correlations increase during the periods of economic distress; however, the stock-bond correlation does not display a similar relationship. All three correlations are highly persistent, meaning that shocks to these correlations last a long time. For instance, one standard deviation shocks to stock-commodity and bond-commodity correlations have half-lives of 9.3 and 6.9 months, respectively, while shocks to intra-commodity correlation have half-lives of 20.8 months.[3]

**Data and summary statistics**

The commodities we study are those contained in either the Dow Jones-UBS Commodity Index or the S&P-GSCI (the former Goldman Sachs Commodity Index), omitting duplicates (e.g. we include WTI crude oil, but not Brent crude oil), and including tin, platinum, and soybean meal, based on the subjective assessment that they are important economically, have liquid futures markets, and are of interest to investors.[4] We construct (excess) investment returns for futures by taking a long position at the end of each week in the nearest to expiry future that does not have its first notice date or expiration date in the next month. We construct an equal weighted index and from this construct weekly returns.

For the stock-commodity correlation, we compute realized correlations between weekly stock[5] and commodity returns. We use the same method for the bond-commodity correlation. Weekly bond returns are based on 10 year Treasury yields available from the Federal Reserve. Total returns are computed assuming the bond has 10 years to maturity, the coupon is equal to the initial yield, and interest is compounded semi-annually. For the

[1] See Gorton and Rouwenhorst (2006).

[2] We use weekly asset returns to generate realized correlations over annual windows. For a detailed discussion of the methodology, see Bhardwaj and Dunsby (2012), available at https://www.summerhavenim.com/guest/our-research.html

[3] Estimates of half-life are based on the regression results reported below.

[4] For a complete list of commodities and the period of data availability of individual commodities, see Bhardwaj and Dunsby (2012). In 1962, when this study starts, there are nine commodities in the sample. This number grows to twenty-five with the addition of the natural gas in May 1990.

[5] For stocks we use the percent change in the S&P 500 price index. Dividends are not included.

average intra-commodity correlation, we take the average of the realized correlations of all the commodity pairs measured over annual horizons. For simplicity, we sometimes refer to this as the intra-commodity correlation.

Table 1 displays summary statistics for correlations computed over annual windows (again, using weekly returns). Over the period 1962 to 2012, the average stock-commodity correlation is moderately positive, 0.13. The average bond-commodity correlation is a moderately negative -0.09, the average correlation of commodities to each other is surprisingly low, 0.15 in our sample. The medians of these distributions are all reasonably close to the means.

**Table 1: Realized annual correlations, Q1 1962 – Q4 2012**

| | Stock-commodity correlation | Bond-commodity correlation | Intra-commodity correlation |
|---|---|---|---|
| Mean | 0.13 | -0.09 | 0.15 |
| Minimum | -0.39 | -0.53 | 0.04 |
| 25th Percentile | -0.03 | -0.22 | 0.09 |
| Median | 0.11 | -0.07 | 0.12 |
| 75th Percentile | 0.24 | 0.03 | 0.21 |
| Max | 0.76 | 0.36 | 0.44 |

Source: SummerHaven calculations based on; Commodity Futures Prices - Commodity Research Bureau (CRB), Bloomberg and London Metals Exchange; S&P 500 price index – Bloomberg; and market yield on constant maturity 10 Year U.S. Treasury bond – Federal Reserve.

Despite having average correlations not far from zero, all correlation pairs exhibit wide variation. The stock-commodity correlation ranges from -0.39 to 0.76, the bond-commodity correlation ranges from -0.53 to 0.36 and the average intra-commodity correlation ranges from 0.04 to 0.44.

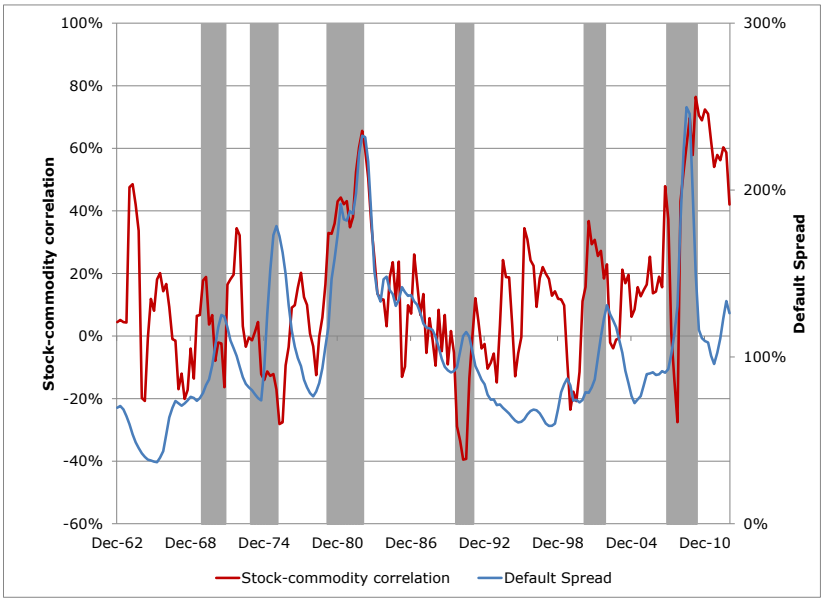
**Correlation to other asset classes**

Figure 1 displays the stock-commodity correlation (quarterly data with annual correlation window) from 1962 to 2012. The figure also displays recessions as identified by the NBER and the average default spread—a real-time indicator of economic strength—over the twelve month period.[6] Most salient, the two biggest spikes in the correlation between stocks and commodities correspond to the two deepest recessionary periods: the early 1980s and the late 2000s. In the fourth quarter of 1982 the rolling annual stock-commodity correlation reached 66%. Real GDP shrank 1.4% in 1982. Stock-commodity correlation spiked to 76% during and just after the seven quarter recession that began in Q4 2007. Spikes in correlation also correspond to the recessions of the early 1970s and the early 2000s. However, the relation is far from perfect. The correlation reached its lowest levels during the recession of the early 1990s. Though the correlation reached its all-time highs during the recession of 2008, it was significantly negative during a portion of that recession. Additionally, the correlation rose in late 1963, a period of strong growth.

The stock-commodity correlation tracks the default spread. From the late 1970s through the early 1990s the relation between the default spread and stock-commodity correlation is remarkably tight. These graphical results suggest a business cycle component to the stock-commodity correlation.

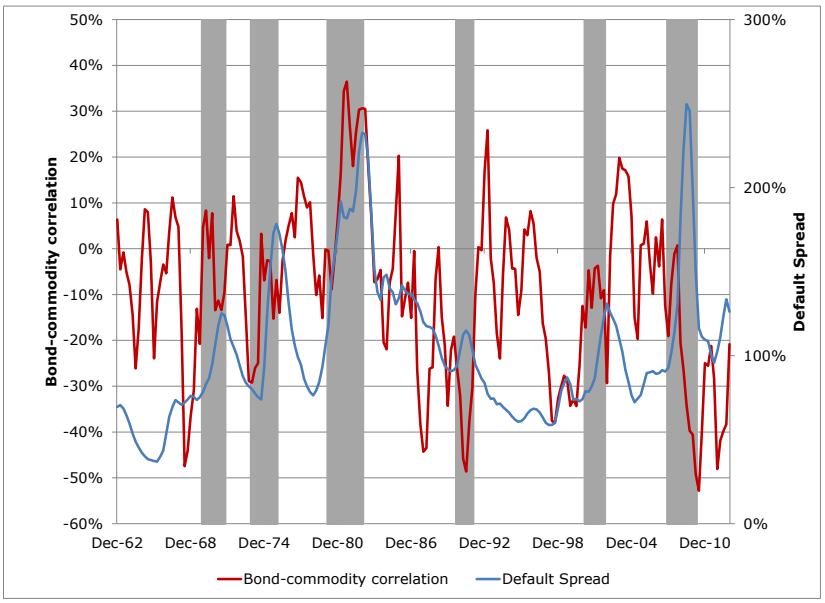
[6] A twelve month period is identified as recessionary if it contains at least one recessionary month. This is why the entire period January 1980 through November 1982 is greyed, even though it contains two distinct recessions. Default spread is defined as a the average of difference of Moody's Seasoned Baa Corporate Bond Yield (BAA), and Moody's Seasoned Aaa Corporate Bond Yield (AAA).

**Figure 1: Stock–commodity correlation, overlapping annual data: Q1 1962 – Q4 2012**




Source: SummerHaven calculations based on; Moody's Seasoned Baa Corporate Bond Yield (BAA), and Moody's Seasoned Aaa Corporate Bond Yield (AAA) – Federal Reserve; recession Dates - NBER (shaded Region). For commodity and stock data, see notes to Table 1

**Figure 2: Bond–commodity correlation, overlapping annual data: Q1 1962 – Q4 2012**




Source: Bond returns are based on the market yield on constant maturity 10 Year U.S. Treasury bond – Federal Reserve. See notes to Table 1 and Figure 1.

Figure 2 displays the bond-commodity correlation along with the default spread and recessions. Compared to the stock-commodity correlation, the bond-commodity correlation has more muted upside spikes and does not display the same pattern with regard to the business cycle. While the bond-commodity correlation spikes to its

historic highs of 36% in the early 1980s, it plunged during the 2008 recession. While the stock-commodity correlation is currently close to its historic highs, the bond commodity correlation is close to its historic lows.

In order to more deeply understand the relation between the stock-commodity correlation and the business cycle we employ a regression analysis. The first three columns of table 2 display the results of regressing stock-commodity correlation on lagged stock-commodity correlation, real GDP growth, and the contemporaneous default spread. The coefficient on lagged correlation is 0.41 with a t-statistic of 3.32. The correlation between stocks and commodities is persistent, implying a half-life of 9.3 months for a one standard deviation shock to the stock-commodity correlation. Regression (II) adds contemporaneous real GDP growth. The coefficient is negative with a t-statistic slightly below standard significance levels. Regression (III) drops GDP and adds the default spread. The coefficient on the default spread is 0.166 with a statistically significant t-statistic of 2.48. These results broadly confirm the picture in Figure 1: When the economy is weak, especially as measured by the default spread, the correlation between and stocks and commodities is high.

**Table 2 Stock-commodity/Bond-commodity correlation regressions**

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| | Stock-commodity Correlation | | | Bond-commodity Correlation | | |
| Variable | (I) | (II) | (III) | (I) | (II) | (III) |
| Constant | 0.081 | 0.081 | -0.084 | -0.069 | -0.069 | -0.112 |
| | (3.03) | (3.04) | (-1.32) | (-3.02) | (-2.98) | (-1.76) |
| Correlation (previous year) | 0.415 | 0.416 | 0.350 | 0.301 | 0.305 | 0.284 |
| | (3.32) | (3.56) | (2.56) | (2.88) | (2.84) | (2.88) |
| Real GDP Growth | | -0.051 | | | -0.005 | |
| | | (-1.70) | | | (-0.23) | |
| Default Spread | | | 0.166 | | | 0.040 |
| | | | (2.48) | | | (0.62) |
| Number of Observations | 201 | 201 | 201 | 197 | 197 | 197 |
| Rbar-squared | 0.16 | 0.20 | 0.24 | 0.08 | 0.08 | 0.09 |

Note: Dependent variable for these regressions is Stock-commodity/Bond-commodity correlation measured over annual horizon. Table reports the least square estimates, the numbers in brackets are t-statistics for test of significance. T-statistics reported are based on Newey-West heteroscedasticity and autocorrelation consistent standard errors. GDP growth is measured over the same period as the dependent variable. Default spread is the average of monthly default spread (Baa-Aaa yield) over the same time period as the dependent variable. Source: See notes to Table 1 and Figure 1.

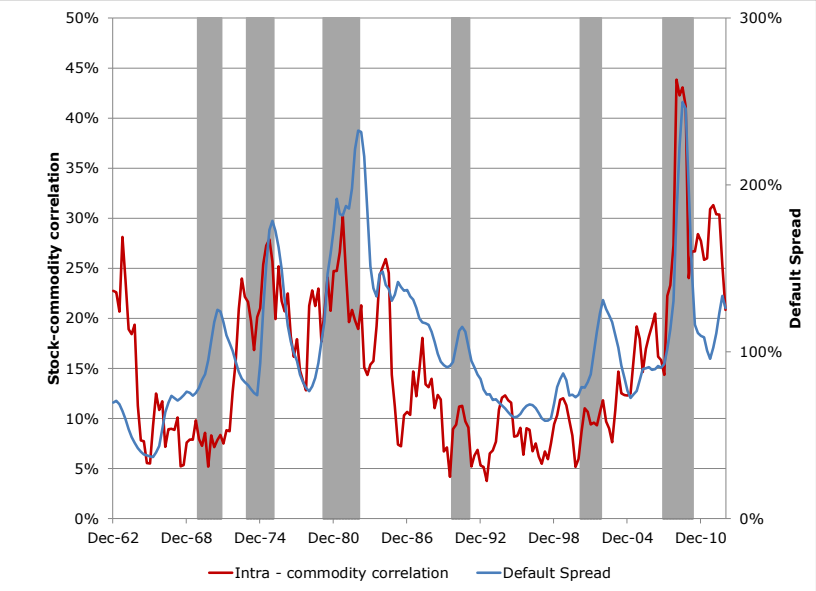
The last three columns of table 2 display the results for the same regression analysis using the bond-commodity correlation. The bond-commodity correlation is persistent with a coefficient 0.301 (a bit less than the stock-commodity correlation) and a t-statistic of 2.88. However, the coefficients on the business cycle variables are close to zero and statistically insignificant. The bond-commodity correlation does not seem to have a business cycle component.

**Intra-commodity correlation**

The correlation of commodities to one another is important to investors because lower intra-commodity correlation means that a portfolio of commodities will have more diversification and thus lower volatility. Conversely, high intra-commodity correlation means lower diversification and higher volatility. Erb and Harvey

(2006) show that the historical correlation of commodities to each other is low (0.09). Tang and Xiong (2011) show that intra-commodity correlation varies over time, increasing from 2007 through the end of their sample in 2010, and that the correlation between oil and several other commodities has increased since the beginning of their sample in the mid-1980s.

**Figure 3: Intra–commodity correlation, overlapping annual data: Q1 1962 – Q4 2012**




Note: Intra-commodity correlation is based on the average of the realized correlations of all the commodity pairs measured over annual horizons. Source: See notes to Table 1 and Figure 1.

Figure 3 displays the average intra-commodity correlation for the commodities in our dataset.[7] The business cycle pattern previously seen in the correlation between stocks and commodities is apparent in the intra-commodity correlation series. During periods of economic weakness, intra-commodity correlation is highest. Also, as with the correlation between stocks and commodities, the two highest peaks of intra-commodity correlation occur during the 2008 recession and the recessionary period of the early 1980s. The intra-commodity correlation also shows a pronounced spike during the recessionary period of the early 1970s—a pattern less pronounced in the stock-commodity correlation.

Table 3 displays the regression results of the intra-commodity correlation. The pattern of results is very similar to those seen in the stock-commodity correlation regressions. The average intra-commodity correlation is highly persistent (coefficient of 0.664, t-statistic 8.82) and is higher during periods of economic weakness. In regression (II) the coefficient on real GDP is -0.018 with a t-statistic of -1.67. In regression (III) the coefficient on the default spread is 0.067 with a t-statistic of 2.65.

[7] Figure 3 retains its same basic shape if only the nine commodities that exist for the entire sample are included, though the overall level of correlation is higher since most of the full sample commodities are agriculturals.

**Table 3 Intra-commodity correlation regressions**

| Variable | (I) | (II) | (III) |
|---|---|---|---|
| Constant | 0.051 | 0.058 | 0.007 |
| | (4.82) | (4.79) | (0.37) |
| Intra-commodity correlation (previous year) | 0.664 | 0.618 | 0.490 |
| | (8.82) | (8.42) | (5.60) |
| Real GDP Growth | | -0.018 | |
| | | (-1.67) | |
| Default Spread | | | 0.067 |
| | | | (2.65) |
| Number of Observations | 197 | 197 | 197 |
| Rbar-squared | 0.43 | 0.47 | 0.52 |

Note: Dependent variable for these regressions is Intra-commodity correlation measured over annual horizon. Table reports the least square estimates, the numbers in brackets are t-statistics for test of significance. T-statistics reported are based on Newey-West heteroscedasticity and autocorrelation consistent standard errors. GDP growth is measured over the same period as the dependent variable. Default spread is the average of monthly default spread (Baa-Aaa yield) over the same time period as the dependent variable. Source: See notes to Table 1 and Figure 1.

**Discussion and interpretation of results**

That stock-commodity and intra-commodity correlations have recently visited historic highs has been widely noted. Conversely, bond-commodity correlations are at historic lows. However, these historic levels are not unprecedented. Both the stock-commodity and intra-commodity correlation spiked to similar levels in the early 1980s. Both these periods, the early 1980s and the late 2000s, contain the two deepest recessions of the last fifty years. Regression analysis further suggests that the stock-commodity and the intra-commodity correlations are inversely related to economic strength. This result is strong when economic strength is proxied for by the default spread. Commodities are more correlated to stocks and each other, but not bonds, during bad economic times.

Why might the stock-commodity correlation have a business cycle component? There are at least two possible explanations: one based on firm behavior, one based on investor behavior. In bad times, firms will be quick to cut variable costs in order to avoid bankruptcy or in response to constrained credit conditions[8]. Further, when times are bad, firms may take falling stock prices as a signal that things are getting worse (and vice versa), leading to an increase in the stock-commodity correlation. Firms quickly cutting variable costs during bad times can also motivate a business cycle effect on intra-commodity correlation. The argument is the same: in bad times firms will cut variable costs more quickly than in good times in order to avoid bankruptcy, causing commodities—the variable inputs—to co-move more tightly. This explanation also explains why the bond-commodity correlation does not have a business cycle component. The future pay-offs of Treasury bonds are not tied to economic strength or weakness, thus companies will not interpret their movements as indicators of future economic states.

An alternative investor-based explanation of the time-varying correlation between stocks and commodities is that in bad times investor risk aversion is high, and that in these periods investors move in or out of risky assets

[8] See the models of Bernanke et al. (1996), and Kiyotaki and Moore (1997)

as a group, leading all risky assets to move together. This notion is captured in the common statement that when bad things happen "all correlations all go to one," or that bad times are more subject to "risk on, risk off" scenarios.

Another motivation that also works through the channel of investors is the "financialization" of commodities hypothesis discussed by Masters (2008), Tang and Xiong (2010), to name a few. According to the financialization hypothesis, the correlation between stocks and commodities has permanently increased due to heightened investor involvement in commodity markets. However, the financialization hypothesis has difficulty explaining the spike in commodity correlations in the early 1980s, since investor interest in commodities was limited at that point in time.

**How well does the model fit?**

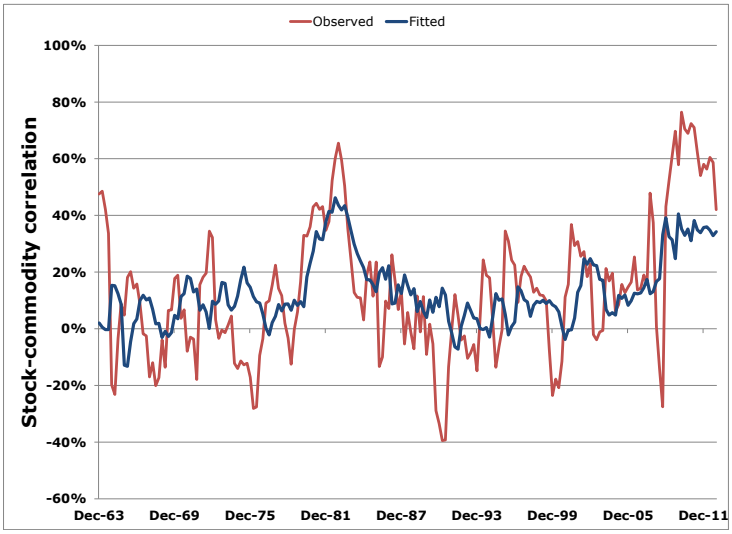
Figure 4 plots the stock-commodity correlation along with the fitted line from regression (III), in which the independent variables are lagged correlation and the default spread. The fitted line tracks observed stock-commodity correlation reasonably well over the entire sample. At Q4 2012, the final point in the sample, the model line is well over its average (34% compared to 13%) but does not reach the final observed value of 42%. Figure 5 displays the observed intra-commodity correlation and the fitted line from regression (iii)[9]. The fit is quite good. The modeled and the actual correlation match closely, 21%, at the most recent point in the sample, Q4 2012.

**Conclusion**

In recent years, the stock-commodity correlation and average intra-commodity correlation have hit historic highs, while the bond-commodity correlation has hit historic lows. Though extreme, recent levels have been reached (or nearly so) in the past. In particular, both the stock-commodity and intra-commodity correlation spiked in the early 1980s, the period of the deepest recession in the sample prior to the recession of 2007-2009.

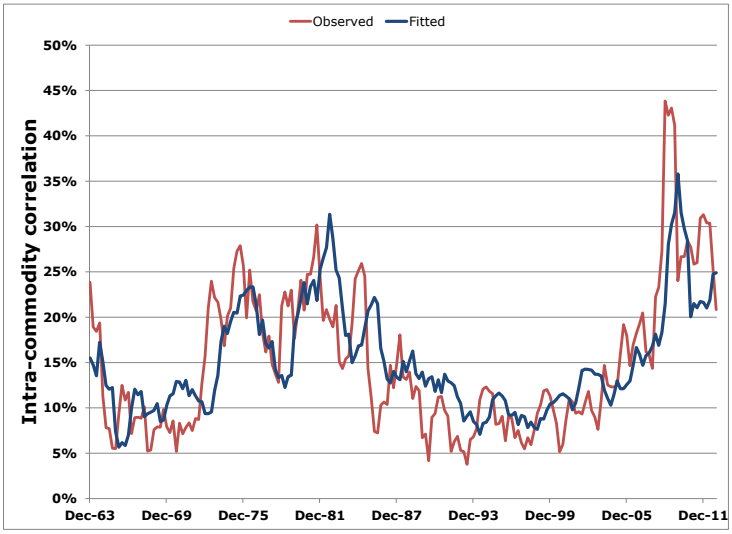
[9] We don't include a similar analysis for the bond-commodity correlation since this series does not exhibit a business cycle component.

**Figure 4: Observed and model fitted Stock–commodity correlation**




Note: The fitted values are based on the regression reported in the third column of table 2. The regression has two explanatory variables, lagged stock-commodity correlation, and the contemporaneous default spread.

**Figure 5: Observed and model fitted Intra–commodity correlation**




Note: The fitted values are based on the regression reported in the third column of table 3. The regression has two explanatory variables, lagged intra-commodity correlation, and the contemporaneous default spread.

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