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Digging into Commodities*

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Abstract

We investigate the determinants of aggregate commodity returns and establish the following findings. (1) Common predictors of bond and stock returns, such as the short rate and the yield spread, also predict commodity returns. A high yield spread predicts low commodity returns, consistent with commodities being a hedge for market fluctuations. (2) Even controlling for these common predictors, a low aggregate basis (the ratio of futures to spot price averaged across commodities) predicts high returns on being long commodity futures, consistent with the theory of backwardation. A low aggregate basis also predicts low spot-price growth, consistent with the theory of storage. The component of aggregate basis that is orthogonal to these common predictors does not predict bond or stock returns, suggesting that aggregate basis is a predictor that is local to the commodity market. (3) Aggregate basis explains as much of the variation in expected commodity returns as the common predictors. (4) Recent evidence suggests that aggregate basis has become a more important determinant of commodity returns relative to the common predictors.

JEL classification: G12; G13; E31; E37

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1. Introduction

The recent volatility of commodity prices has renewed interest in the behavior of commodity markets, which has not been seen since the energy crisis of the seventies. Once ignored, commodities have emerged as an important asset class for many investors. By some estimates, commodity index investment increased from $13 billion in 2003 to $317 billion just prior to the collapse of commodity prices in 2008 (see Masters and White, 2008). During this period, the influx of new investors led some to argue that there was a bubble in the commodity market, similar to that in the stock market during the earlier decade. For instance, George Soros said on April 17, 2008, "You have a generalized commodity bubble due to commodities having become an asset class that institutions use to an increasing extent." Others in contrast argued that the movements of commodity prices were mostly driven by fundamentals such as the emergence of China and India.

Understanding the determinants of commodity price fluctuations is important not only for investors but also for policymakers. This is underscored by Congressional hearings during the last boom on whether excessive speculation had an impact on the commodity market. Academic research on the predictability of aggregate stock returns greatly shaped public dialogue on market valuations during the dot-com era and continues to be influential during the present financial crisis. In contrast, academic research on the predictability of aggregate commodity returns has been limited with a few notable exceptions. As such, this paper asks, what are the determinants of time variation in expected aggregate commodity returns?

Theories of commodity price fluctuations can be roughly categorized into two strands. The first strand hypothesizes that commodity prices are driven by common predictors (such as the short rate, the yield spread, and the dividend yield) that influence portfolio allocation decisions across different asset classes. Hence, time-varying investment opportunities reflected by the yield spread, for example, should also predict aggregate commodity returns. An implication of this theory is that expected commodity returns would reflect the ability of commodities to hedge market fluctuations. The most extreme example is the belief among some investors that commodities such as gold provide insurance for economic disasters, in the spirit of the consumption-based CAPM. Hence, commodity prices are high and its expected returns are low when such hedging motives are important.[1]

The second strand hypothesizes that commodity markets are segmented to some degree, and that commodity prices are driven by predictors that are local to the commodity market. The basis, defined as the ratio of futures to spot price, emerges as a particularly important variable of interest in these theories. In the theory of backwardation, risk averse speculators demand compensation to take (either long or short) futures positions to share the price risk with hedgers, and hence hedging pressure drives the variation in the ratio of futures to spot price. A low basis implies high returns on being long commodity futures.[2] In the theory of storage, a low inventory leads to a low basis, and subsequently low returns to owning the physical commodity as the demand-supply imbalances correct (e.g., Deaton and Laroque, 1992, 1996).

Our point of departure from the previous literature is the observation that empirical studies have for the most part examined these two strands of theories in isolation. Most previous papers examine the predictability of returns on individual commodities (as opposed to a portfolio or an index of commodities), using either common predictors such as the short rate or commodity-specific predictors such as the basis. In contrast, we examine the predictability of returns on a portfolio of commodities (as opposed to individual commodities), using both common and commodity-specific predictors. Our commodity-specific predictor is aggregate basis, constructed as the basis averaged across all commodities.

[1] Models in which futures prices depend only on the degree of covariance between futures prices and changes in economic state variables (i.e., systematic risk) include Black (1976), Breeden (1980), and Richard and Sundaresan (1981).

[2] In the theory of backwardation of Keynes (1923) and Hicks (1939), producers short commodity futures to hedge their long positions in the underlying spot. Their supply of futures, or hedging pressure, tends to drive down the futures price relative to the expected value of the future spot price. Hence, risk-averse speculators who are long futures earn a positive expected return for providing risk-sharing services. A substantial literature has since generalized the Keynes-Hicks theory in a number of directions such as allowing for (1) producers to face quantity risk as well as price risk (e.g., Newbery and Stiglitz, 1979; Rolfo, 1980), (2) multiple consumption goods (e.g., Britto, 1984), and (3) a stock market or the tradability of equity claims to the producers' future revenues (e.g., Stoll, 1979; Hirshleifer, 1988a,b).

Our integrated analysis of commodity returns, using both common and commodity-specific predictors, is important for two reasons. First, previous studies have found that common predictors of bond and stock returns can be correlated with the basis (e.g., Fama and French, 1988a; Bailey and Chan, 1993). For example, the basis is high when interest rates are high because of storage costs. Second, and more importantly, our approach allows us to quantify the relative importance of common versus commodity-specific predictors in explaining aggregate commodity returns.

Using data on 34 commodities (covering the four sectors of agriculture, energy, livestock and metals) for the period 1965–2008, we establish four main findings. First, common predictors of bond and stock returns, such as the short rate and the yield spread, also predict aggregate commodity returns. The short rate predicts aggregate commodity returns with the same sign as that for bond and stock returns. More interestingly, the yield spread predicts aggregate commodity returns with the opposite sign than that for bond and stock returns. A high yield spread, which tends to coincide with recessions, predicts low commodity returns. This finding is consistent with investors using commodities to hedge market fluctuations. The explanatory power of these forecasting regressions for commodity returns is similar to that for bond and stock returns.

Second, even controlling for these common predictors, a low aggregate basis predicts high returns on being long commodity futures. This finding is consistent with the theory of backwardation or hedging pressure. A low aggregate basis also predicts low spot-price growth, which is consistent with the theory of storage since a low basis reflects a high convenience yield. The component of aggregate basis that is orthogonal to the common predictors does not predict bond and stock returns, which suggests that aggregate basis is a predictor that is local to the commodity market.

Third, we use these forecasting regressions to assess the relative importance of common versus commodity-specific predictors in explaining aggregate commodity returns. A variance decomposition of expected commodity returns shows that aggregate basis explains as much of the variation as the common predictors. Fourth, recent evidence suggests that aggregate basis has become a more important determinant of commodity returns relative to the common predictors.

In parallel to the two strands of theories discussed above, the empirical literature on commodity prices can be roughly divided into two strands. The first strand focuses on developing and testing models in the spirit of the consumption-based or the intertemporal CAPM. A number of these studies focus on explaining the unconditional risk premium with these models, for which evidence is mixed at best (e.g., Dusak, 1973; Hodrick and Srivastava, 1984; Jagannathan, 1985).

More relevant for our paper are a few studies that document evidence for time variation in expected commodity returns. Most notably, Bessembinder and Chan (1992) are the first to establish that the same predictors that predict the market (such as the interest rate, the default spread, and the dividend yield) also predict commodity returns. Subsequent work by Bjornson and Carter (1997) confirm these findings. Relative to Bessembinder and Chan (1992), who focus on a handful of commodities and currencies, and Bjornson and Carter (1997), who focus mostly on the agriculture and livestock sectors, Gorton and Rouwenhorst (2006) examine a more comprehensive set of commodities. Gorton and Rouwenhorst (2006) argue that commodities provide a high Sharpe ratio that is comparable to the stock market, but they play down the role that commodities play in hedging time-varying expected stock returns.

We use the same database and sample as Gorton and Rouwenhorst (2006) and confirm their finding that commodities have a high historical Sharpe ratio, comparable to that of the stock market. In addition, we find substantial predictability of aggregate commodity returns by the common predictors. Our predictability findings are even stronger than those found in previous studies. A more comprehensive set of commodities and a longer sample period allow us to estimate the coefficients describing the predictability of commodity returns more precisely than previously possible. Most importantly, we assess the relative importance of common versus commodity-specific predictors in explaining aggregate commodity returns, which the previous literature does not address.

The second strand of the literature focuses on how expected commodity returns depend on commodity-specific predictors such as the basis. The evidence that basis predicts returns on commodity futures is mixed. Fama and French (1987) find some evidence that basis predicts returns for some types of commodities. More recently, Gorton and Rouwenhorst (2006) use a much bigger sample to document a high Sharpe ratio on a broad portfolio of commodity futures, thereby providing support for the theory of backwardation. A number of papers have documented some mixed evidence that the net holdings of hedgers significantly affect returns on commodity futures, even after controlling for systematic risk, consistent with the theory of hedging pressure (e.g., Carter, Rausser, and Schmitz, 1983; Chang, 1985; Bessembinder, 1992; de Roon, Nijman, and Veld, 2000).

In contrast to our paper, these papers do not consider the joint analysis of the common predictors and the aggregate basis. Specifically, we are the first to show that aggregate basis accounts for a substantial amount of time variation in expected commodity returns, even after controlling for the common predictors. Relative to the previous literature, we provide a richer analysis of how the common and commodity-specific predictors jointly determine expected commodity returns.

The rest of the paper proceeds as follows. Section 2 describes the commodity data and the construction of the key variables used in our empirical analysis. Section 3 reports summary statistics for returns and the predictor variables. Section 4 briefly discusses the methodology used to decompose the variance of expected commodity returns into parts explained by common versus commodity-specific predictors. Section 5 presents our main findings on the predictability of aggregate commodity returns. Section 6 concludes with our thoughts on the recent boom and bust of commodity prices in light of our findings.

2. Commodity data and variable definitions

2.1. Commodity data

Our data on commodity prices comes from the Commodities Research Bureau, which has daily prices for individual futures contracts as well as spot prices for many commodities beginning in December 1964. Gorton and Rouwenhorst (2006) also use this database, and details can be found in the appendix to their paper. As they point out, the Commodity Research Bureau database mostly contains data for contracts that have survived until the present, or were in existence for extended periods between 1965 and the present. Many different types of contracts fail to survive because of lack of interest on the part of market participants, and they are consequently not recorded in the database. It is not clear how survivorship bias affects the computed returns on commodity futures.

We follow Gorton and Rouwenhorst (2006) in working with a broad set of commodities represented in the database. Table 1 is a list of the commodities analyzed in this paper, together with the date of the first observation for each commodity. We categorize commodities into four broad sectors. Agriculture is comprised of 17 commodities, and this sector tends to include the oldest contracts. Energy is comprised of five commodities. The oldest contract in energy is heating oil, which starts in November 1978. Data for crude oil is available only since March 1983. Livestock and metals are each comprised of six commodities. A potential concern with a broad set of commodities is that not all contracts are liquid. In results that are not reported in this paper, we have confirmed our main findings on a subset of 17 relatively liquid commodities that are in the AIG Commodities Index.

Following Gorton and Rouwenhorst (2006), we exclude commodity futures with one month or less to maturity. These contracts are typically illiquid because futures traders do not want to take delivery of the underlying physical commodities. We therefore rule out investment strategies that require holding futures contracts to maturity. While Gorton and Rouwenhorst (2006) isolate the contract that is closest to maturity for each commodity, we include all contracts with more than one month to maturity.

2.2. Commodity market variables

2.2.1. Return on fully collateralized commodity futures

We compute the return on a fully collateralized commodity futures contract, assuming that the collateral earns the T-bill rate. Let $R_{f,t}$ be the monthly gross return on the one-month T-bill in month t. Let $F_{i,t,T}$ be the price of a futures contract on commodity i at the end of month t, which matures at the end of month T. The monthly gross return on a fully collateralized long position in commodity i with maturity $T-t$ is

$$R_{i,t,T} = \frac{F_{i,t,T} R_{f,t}}{F_{i,t-1,T}}. \tag{1}$$

2.2.2. Spot-price growth

We also compute the spot-price growth for each commodity. Let $S_{i,t}$ be the spot price of commodity i at the end of month t. The monthly spot-price growth for commodity i is

$$G_{i,t} = \frac{S_{i,t}}{S_{i,t-1}}. \tag{2}$$

Spot-price growth is economically different from the return on commodity futures for two important reasons. First, in contrast to holding physical commodities, commodity futures are financial contracts and are investable in a similar manner to bonds and stocks. Second, as we discussed in the introduction, the theory of storage is about spot-price movements, whereas the theory of backwardation or hedging pressure is about futures-price movements. In order to tests these two theories, we must examine spot-price growth separately from the return on commodity futures.

2.2.3. Basis and adjusted basis

We define the basis for each commodity i with maturity $T - t$ as

$$\text{Basis}_{i,t,T} = \left(\frac{F_{i,t,T}}{S_{i,t}}\right)^{\frac{1}{T-t}} - 1. \tag{3}$$

Basis is simply the implied net convenience yield derived from the cost-of-carry relationship. Recall that net convenience yield is defined as the riskless interest rate, plus additional storage costs, minus the convenience usage obtained from owning the spot. For our discussions below, we also define an adjusted basis for each futures contract as the basis minus the one-month T-bill rate, that is

$$\text{AdjBasis}_{i,t,T} = \left(\frac{F_{i,t,T}}{S_{i,t}}\right)^{\frac{1}{T-t}} - R_{f,t}. \tag{4}$$

While the Commodity Research Bureau has a reliable record of spot prices, a spot price is not always available on the same trading day as a recorded futures price. In instances where the spot price is missing, we first try to use an expiring futures contract to impute the spot price. If an expiring futures contract is not available, we then use the last available spot price within 30 days to compute the basis. For example, if we have a futures price on December 31, but the last available spot price is from December 30, we compute the basis as the ratio of the futures price on December 31 to the spot price on December 30.

Note that the basis picks up two types of shocks. On the one hand, the basis picks up transitory shocks to the futures price according to the theory of backwardation. According to this theory, variation in the basis reflects hedging pressure and the availability of speculator capital. The basis should therefore predict returns on commodity futures. On the other hand, the basis picks up transitory shocks to the spot price according to the theory of storage. According to this theory, variation in the basis reflects stock outs or inventory effects. The basis should therefore predict spot-price growth. To summarize, a low basis should predict high returns on being long commodity futures, but low spot-price growth.

2.3. Aggregate commodity returns

2.3.1. Return on a portfolio of fully collateralized commodity futures

We sort the universe of commodity futures into four sectors and two levels of maturity. We define short maturity contracts as those with more than one but no more than three months to maturity, and long maturity contracts are those with more than three months to maturity. We then construct eight equal-weighted portfolios of commodity futures, corresponding to two levels of maturity for each of the four sectors. For each portfolio, we compute its monthly gross returns through an equal-weighted average of returns on fully collateralized commodity futures given by equation (1).

Using the eight portfolios, we construct four sector portfolios as an equal-weighted portfolio of the short- and long-maturity portfolio for each sector. For example, the agriculture portfolio is an equal-weighted portfolio of the short-maturity agriculture portfolio and the long-maturity agriculture portfolio. Using the eight portfolios, we also construct two maturity-sorted portfolios as an equal-weighted portfolio of the four sector portfolios for each level of maturity. For example, the short-maturity portfolio is an equal-weighted portfolio of the short-maturity portfolio for agriculture, energy, livestock, and metals. Finally, we construct an aggregate portfolio of all commodities as an equal-weighted portfolio of the four sector portfolios. The aggregate commodity portfolio that results from this construction is approximately neutral with respect to sector and maturity.

Our construction of the aggregate commodity portfolio differs from that of Gorton and Rouwenhorst (2006), who construct a portfolio by equal-weighting all 34 commodities. The advantage of our approach is that the sectors are always equal-weighted, and hence no sector dominates even as the number of contracts in each sector changes over time. Despite the differences in the construction of the aggregate commodity portfolio, our summary statistics reported in Section 3 are very close to those reported in Gorton and Rouwenhorst (2006).

For most of this paper, we examine the predictability of aggregate commodity returns. To examine the robustness of our main findings, we also examine the four sector portfolios and the two maturity-sorted portfolios. In all of our analysis, we work with excess returns over the one-month T-Bill rate.

2.3.2. Aggregate spot-price growth

Using spot-price growth given by equation (2), we construct aggregate spot-price growth following the same procedure as that used to construct the portfolio of fully collateralized commodity futures. We first compute an equal-weighted average of spot-price growth for each sector. We then compute aggregate spot-price growth as an equal-weighted average of the four sectors. In all of our analysis, we subtract the one-month T-bill rate from aggregate spot-price growth.

2.3.3. Bond and stock returns

Bond returns are monthly returns on the ten-year Treasury bond. Stock returns are monthly returns on the CRSP value-weighted market portfolio for NYSE, AMEX, and Nasdaq stocks. The predictability of excess returns on long-term bonds and stocks are well documented in the literature. We merely include them here for the purposes of comparison to our main findings for commodity returns.

2.4. Predictor variables

2.4.1. Common predictors

Our analysis focuses on three predictor variables that are known to predict the common variation in bond and stock returns: the short rate, the yield spread, and the dividend yield (e.g., Fama and Schwert, 1977; Campbell, 1987; Campbell and Shiller, 1988; Fama and French, 1988b, 1989). The short rate is the monthly average yield on the one-month T-bill. The yield spread is the difference between Moody's Aaa corporate bond yield and the short rate. The dividend yield is that for a value-weighted portfolio of NYSE, AMEX, and Nasdaq stocks, adjusted for repurchases and issuances (see Boudoukh, Michaely, Richardson, and Roberts, 2007; Larrain and Yogo, 2008).

In analysis that is not reported in this paper, we have also experimented with other predictor variables. In particular, we have tried the default spread (the difference between Moody's Baa corporate bond yield and the Aaa corporate bond yield) and measures of aggregate stock market volatility (both realized volatility and the VIX). Although these variables also predict returns, the evidence for predictability is overall weaker than that for our main variables.

2.4.2. Aggregate basis and adjusted aggregate basis

We construct aggregate basis in analogy to the construction of aggregate commodity returns. First, we compute the median of basis given by equation (3) within each of eight portfolios, corresponding to four sectors and two levels of maturity. We use the median, rather than the mean, because it is less sensitive to outliers in the basis for individual futures contracts. We then compute aggregate basis through an equal-weighted average of basis across the eight portfolios. Adjusted aggregate basis is simply the aggregate basis minus the one-month T-bill rate.

3. Summary statistics

3.1. Commodity returns

Panel A of Table 2 reports the summary statistics for monthly excess returns over the one-month T-bill rate. The monthly excess return on the aggregate commodity portfolio had a mean of 0.59 percent and a standard deviation of 4.08 percent. This corresponds to an annualized average excess return of 7.08 percent, and an annualized standard deviation of 14.13 percent. During the same period, stocks had an annualized average excess return of

4.32 percent, and an annualized standard deviation of 15.66 percent. The Sharpe ratio for the aggregate commodity portfolio was higher than that for the stock market in this sample period, which is a point that is emphasized by Gorton and Rouwenhorst (2006).

The table also reports the autocorrelation and the cross correlation of excess returns. The first-order autocorrelation for aggregate commodity returns is 0.08, which is comparable to that for stock and bond returns. Aggregate commodity returns are slightly negatively correlated with bond returns, and slightly positively correlated with stock returns.

The table also reports the summary statistics for each of the four sector portfolios. Both the mean and the standard deviation of excess returns have the same ordering across sectors. Agriculture had the lowest average excess return at 0.27 percent per month, and the lowest standard deviation at 4.27 percent per month. Energy had the highest average excess return at 0.90 percent per month, and the highest standard deviation at 8.07 percent per month.

3.2. Predictor variables

Table 3 reports the summary statistics for the predictor variables. Aggregate basis has a mean of 0.24 percent and a standard deviation of 0.87 percent. Its autocorrelation is 0.69, which is lower than that for the short rate, the yield spread, and the dividend yield. This suggests that aggregate basis is a predictor variable that operates at higher frequency than the common predictors.

Aggregate basis is positively correlated with the short rate (0.24), negatively correlated with the yield spread (−0.11), and positively correlated with the dividend yield (0.10). The reason for these correlations is that aggregate basis is simply the average net convenience yield across commodities. The net convenience yield (defined as the riskless interest rate, plus additional storage costs, minus the convenience usage obtained from owning the spot) is positively related to the T-bill rate. Note that the yield spread and the short rate are negatively correlated, while the dividend yield and the short rate are positively correlated. This leads to a negative correlation between the aggregate basis and the yield spread, and a positive correlation between the aggregate basis and the dividend yield.

Because of the correlation between the aggregate basis and the common predictors, we must control for the common predictors in order to test whether the aggregate basis predicts commodity returns. In order to obtain a clean interpretation of the forecasting regressions, it is convenient to orthogonalize aggregate basis so that it is uncorrelated with the common predictors. A simple transformation that achieves this goal is to subtract the one-month T-bill rate from the aggregate basis. The adjusted aggregate basis, which is the aggregate basis minus the one-month T-bill rate, is essentially uncorrelated with the common predictors as shown in Table 3.

Figure 1 shows the aggregate basis together with the spot-price index for an equal-weighted portfolio of commodities. The spot-price index is the cumulative growth rate of aggregate spot-price growth, deflated by the consumer price index. Note that movements in the spot-price index tend to be inversely related to movements in the aggregate basis. When the spot-price index rises, aggregate basis tends to fall. The reason is that there is mean reversion in spot prices. An increase in the spot price, due to a transitory demand shock for instance, will not lead to a one-for-one movement in the futures price because the futures market anticipates mean reversion.

Figure 2 plots the basis and the spot-price index for an equal-weighted portfolio of commodities, separately by sector. The scale of the figures makes it clear that the basis is far more volatile for energy and livestock than it is for agriculture and metals. In other words, there is more mean reversion in energy and livestock, compared to agriculture and metals. This has important implications for the differential ability of aggregate basis to predict futures and spot prices across sectors. Because there is more mean reversion in energy and livestock, futures and spot prices should be more predictable in these sectors.

4. Variance decomposition of expected returns

In this section, we briefly describe our empirical methodology, namely a return forecasting regression and a variance decomposition of expected returns implied by the regression.

Let x_t be a vector of common predictors (such as the short rate, the yield spread, and the dividend yield) observed at the end of month t. Let AdjBasis_t be the adjusted aggregate basis observed at the end of month t. We predict excess returns using the regression model

$$R_t - R_{f,t} = \alpha + \beta' x_{t-1} + \gamma \text{AdjBasis}_{t-1} + e_t. \tag{5}$$

This model implies that expected returns is

$$\mathbf{E}_{t-1}[R_t - R_{f,t}] = \alpha + \beta' x_{t-1} + \gamma \text{AdjBasis}_{t-1}. \tag{6}$$

We can therefore decompose the variance of expected returns as

$$\begin{aligned} \text{Var}(\mathbf{E}_{t-1}[R_t - R_{f,t}]) =& \beta' \text{Var}(x_{t-1}) \beta + \gamma^2 \text{Var}(\text{AdjBasis}_{t-1}) \\ &+ 2\beta' \gamma \text{Cov}(x_{t-1}, \text{AdjBasis}_{t-1}). \end{aligned} \tag{7}$$

In words, the variance of expected returns is the sum of the parts explained by (1) the common predictors, (2) the adjusted aggregate basis, and (3) the covariance between the two sets of predictors. Because the adjusted aggregate basis is essentially uncorrelated with the common predictors, the covariance part will be negligible in our analysis. We are primarily interested in comparing the relative magnitudes of the part explained the common predictors versus the part explained by adjusted aggregate basis.

5. Predictability of commodity returns

In this section, we first examine whether the common predictors (i.e., the short rate, the yield spread, and the dividend yield) predict returns on the portfolio of fully collateralized commodity futures. We also examine the ability of these common predictors to predict aggregate spot-price growth. In practice, it is important to treat returns on commodity futures separately from spot-price growth since commodity futures are financial investments like bonds and stocks, unlike investments in physical commodities. From the perspective of the theory of asset allocation, however, both futures and spot prices should be driven by the same common predictors. In other words, one can hedge market fluctuations by entering futures contracts or by holding physical commodities. Consequently, the theory suggests that the common predictors should predict returns on commodity futures and spot-price growth with similar sign and magnitude.

We also examine whether the aggregate basis predicts returns on commodity futures and spot-price growth, controlling for the common predictors. Here, the theory of backwardation has very different implications from the theory of storage. On the one hand, the theory of backwardation hypothesizes that a low basis predicts high returns on commodity futures, but the theory remains silent about spot-price movements. According to this theory, a low basis signals that the futures price is low relative to the expected future spot price, due to risk aversion or limited speculator capital. On the other hand, the theory of storage hypothesizes that a low basis predicts low spot-price growth, but the theory remains silent about futures-price movements. According to this theory, a low basis signals a shortage in physical commodities, and the spot price should mean revert once the demand-supply imbalances correct. In summary, we expect the aggregate basis to predict commodity futures returns and spot-price growth with the opposite signs.

5.1. Main empirical findings

5.1.1. Commodity returns

Columns (1) and (2) of Table 4 examine the predictability of aggregate commodity returns. In column (1), we predict commodity returns using only the common predictors, which are the short rate, the yield spread, and the dividend yield. The short rate has a coefficient of -2.64 with a t-statistic of -2.73. Therefore, a standard deviation increase in the short rate (by 0.22 percent) implies a decrease in monthly expected return of $-2.64 \times 0.22 = 0.59$ percent. This figure corresponds to roughly 14 percent of the standard deviation of monthly commodity returns, which is 4.08 percent. This back-of-the-envelope calculation shows that the short rate explains an economically important amount of predictability in commodity returns. The fact that the short rate, or the inflation rate, predicts asset returns with a negative coefficient is well known since Fama and Schwert (1977). However, there is no consensus on its economic interpretation.

A more interesting and novel result in our view is the coefficient for the yield spread. The yield spread predicts aggregate commodity returns with a coefficient of -3.46 and a t-statistic of -2.49. Following the same back-of-the-envelope calculation, a standard deviation increase in the yield spread (by 0.13 percent) implies a decrease in monthly expected return of 0.45 percent. This figure corresponds to roughly 11 percent of the standard deviation of monthly commodity returns. The fact the coefficient for the yield spread is negative and significant for commodities is in sharp contrast to the positive coefficient for bonds and stocks (see columns (3) and (5) of Table 4). The usual interpretation of bond and stock markets is that when the yield spread is high, which coincides with recessions when investors are risk averse, the risk premia on all risky assets are high. In contrast, the expected return on commodities is low, or alternatively commodity prices are high, when the yield spread is high. This finding is consistent with commodities being a hedge for market fluctuations.

The dividend yield has virtually no explanatory power for aggregate commodity returns once we include the short rate and the yield spread in the forecasting regression. Overall, the R^2 from the forecasting regression is 1.69 percent.

In column (2), we introduce the adjusted aggregate basis to see whether it has incremental power to predict aggregate commodity returns. Note that the coefficients for the common predictors are virtually unchanged from column (1) because by construction, the adjusted aggregate basis is essentially uncorrelated with the common predictors. The adjusted aggregate basis has a coefficient of -0.60 and a t-statistic of -2.62. A low adjusted aggregate basis predicts high returns on being long commodity futures, consistent with the theory of backwardation. Following the same back-of-the-envelope calculation, a standard deviation increase in the adjusted aggregate basis (by 0.84 percent) implies a decrease in expected return which is roughly 13 percent of the standard deviation of aggregate commodity returns. Importantly, the introduction of the adjusted aggregate basis nearly doubles the R^2 of the forecasting regression from 1.69 to 3.25 percent. In other words, the adjusted aggregate basis has as much explanatory power as the common predictors combined.

To formally quantify the relative importance of adjusted aggregate basis, we perform a variance decomposition of expected commodity returns into three parts: the part explained by the common predictors, the part explained by the adjusted aggregate basis, and the part explained by the covariance between the two sets of predictors. We find that the common predictors explain 51 percent of the variation in expected commodity returns, while the adjusted aggregate basis explains 48 percent. A negligible portion is explained by the covariance between the two sets of predictors.

Our findings here convey a main point of the paper. Because the adjusted aggregate basis is uncorrelated with the common predictors and has little explanatory power for bond and stock returns (as we show next), we interpret the adjusted aggregate basis as a predictor that is local to the commodity market. The variance decomposition shows that the commodity-specific predictor is as important as the common predictors in explaining the movements in aggregate commodity prices.

5.1.2. Bond returns

We now turn to columns (3) and (4) of Table 4, which report analogous forecasting regressions for bond returns. Although these results are well known, they are helpful for interpreting our findings for aggregate commodity returns. In column (3), we examine the explanatory power of the three common predictors. The short rate has a positive coefficient of 0.62, but it is statistically insignificant. The yield spread has a coefficient of 3.44 with a t-statistic of 3.48. The dividend yield has a coefficient of 0.67, but it is also statistically insignificant. The results here are in line with those in the existing literature, and any differences in statistical significance are mostly due to the sample period.

In column (4), we introduce the adjusted aggregate basis to see whether it has incremental power to predict bond returns. The adjusted aggregate basis has a coefficient of −0.14, which is statistically insignificant. The R^2 is virtually identical in columns (3) and (4), increasing only slightly from 3.45 to 3.70 percent as we introduce the adjusted aggregate basis. The variance decomposition shows that the common predictors explain 95 percent of the variation in expected bond returns, while the adjusted aggregate basis only explains 7 percent. The important inference that we draw from these results is that the adjusted aggregate basis has no explanatory power for bond returns, in contrast to aggregate commodity returns. This lends support to the view that the adjusted aggregate basis is a predictor that is local to the commodity market.

5.1.3. Stock returns

We now turn to columns (5) and (6) of Table 4, which report analogous forecasting regressions for stock returns. The ability of the common predictors to predict aggregate stock returns is also well known. In column (5), the short rate has a negative coefficient of −0.60, but it is statistically insignificant. The yield spread has a coefficient of 3.35 with a t-statistic of 2.03. The dividend yield has a coefficient of 1.71 with a t-statistic of 1.14. These findings are consistent with those in the literature, with differences in statistical significance explained by the sample period. The R^2 of this forecasting regression is 1.59 percent, which is similar to the R^2 for aggregate commodity returns in column (1).

Since the volatility of aggregate commodity returns and stock returns are comparable, both around 4 percent monthly, we conclude that the common predictors do as well in explaining commodity returns as they do in explaining stock returns. The results here are supportive of the asset allocation view of commodity returns. In particular, the fact that the yield spread predicts aggregate commodity returns with a negative coefficient and stock returns with a positive coefficient supports the view that commodities hedge market fluctuations.

In column (6), we introduce the adjusted aggregate basis to see whether it has incremental power to predict stock returns. The coefficient is 0.14 with a t-statistic of 0.61. The R^2 increases only slightly relative to column (5). The variance decomposition shows that the common predictors explain 95 percent of the variation in expected stock returns, while the adjusted aggregate basis explains only 4 percent. We conclude that the adjusted aggregate basis has no explanatory power for stock returns.

5.1.4. Spot-price growth

Finally, columns (7) and (8) of Table 4 examine the predicability aggregate spot-price growth. In column (7), we predict aggregate spot-price growth using only the common predictors. The short rate has a coefficient of -2.41 with a t-statistic of -2.48, which is similar to the finding for aggregate commodity returns in column (1). The yield spread has a coefficient of -2.77 with a t-statistic of -2.04, which is again comparable to the finding in column (1). The dividend yield has no explanatory power for aggregate spot-price growth. The R^2 of this forecasting regression is 1.63 percent, which is comparable to that for aggregate commodity returns in column (1). Altogether, these results support the asset allocation view of commodities, that both futures and spot prices are driven by common predictors.

In column (8), we include the adjusted aggregate basis to see whether it has incremental power to predict aggregate spot-price growth. The adjusted aggregate basis has a coefficient of 0.47 with a t-statistic of 1.90. Note that the sign of the coefficient is the opposite of that for aggregate commodity returns in column (2). Here, a low basis (a low futures price relative to the spot price) predicts low aggregate spot-price growth, consistent with the theory of storage. A standard deviation increase in the adjusted aggregate basis implies an increase in expected spot-price growth of $0.47 \times 0.84 = 0.40$ percent, which is about 10 percent of the standard deviation of aggregate spot-price growth. Importantly, the introduction of the adjusted aggregate basis increases the R^2 of the forecasting regression from 1.63 to 2.69 percent, which suggests that the adjusted aggregate basis has as much explanatory power as the common predictors combined. To see this more clearly, we compute the variance decomposition of expected spot-price growth. The common predictors explain 63 percent of the variation in expected spot-price growth, while the adjusted aggregate basis explains 37 percent. A negligible portion is explained by the covariance between the two sets of predictors. The adjusted aggregate basis, which is a predictor local to the commodity market, explains a substantial portion of the spot-price movements. This is similar to the our findings for commodity futures.

We summarize the main findings from Table 4 as follows. First, standard predictors of bond and stock returns have comparable explanatory power for movements in both commodity futures and spot prices. A key finding is that the yield spread predicts movements in both futures and spot prices with a negative coefficient, which is the opposite of that for stocks, suggesting a hedging role of commodities. Second, the aggregate basis also has substantial explanatory power for futures prices (consistent with the theory of backwardation) and spot prices (consistent with the theory of storage). The aggregate basis does not predict either bond or stock returns, which suggest that it is a commodity-specific predictor. Third, the aggregate basis has as much explanatory power for commodity prices as the common predictors combined. This importance of the commodity-specific predictor supports the theory of backwardation, which emphasizes the role of market segmentation and hedging pressure.

5.2. Robustness of the empirical findings

In this section, we examine the robustness of our findings from Table 4 in a number of ways. We first repeat the same exercise separately by sector, then by maturity of futures contracts, and finally by subsample.

5.2.1. Predictability of commodity returns by sector

In Panel A of Table 5, we examine the predictability of the four sector portfolios, comparing the relative explanatory power of the common predictors versus the adjusted aggregate basis. Note that the adjusted aggregate basis that we use here is the same variable that we used in Table 4, which is an average of the basis across all four sectors. As discussed in Section 2, the basis picks up transitory shocks in both futures and spot prices. Since the aggregate basis only picks up systematic shocks across the entire commodity market, it may not predict individual commodity markets. In other words, the aggregate basis may be a better predictor of returns on commodity futures in one sector, and a better predictor of spot-price growth in another. The purpose of this section is to examine these issues in more detail.

Columns (1) and (2) present the results for agriculture. As shown in column (1), the coefficients for the short rate and the yield spread are similar to those for the aggregate commodity portfolio, both in terms of the signs and the magnitudes. The coefficient for the dividend yield is statistically insignificant, as it was for the aggregate commodity portfolio. In column (2), we introduce the adjusted aggregate basis, which has no explanatory power for returns on the agriculture portfolio. The variance decomposition shows that the common predictors explain all of the variation in expected returns.

Columns (3) and (4) present the results for energy, which is a sector of particular interest in light of our introduction. Column (3) shows that the short rate and the yield spread again enter with the same signs as those for the aggregate commodity portfolio, while the dividend yield is again statistically insignificant. Interestingly, the yield spread is a very strong predictor of returns on the energy portfolio, more so than for the aggregate commodity portfolio. Although the overall volatility of the energy portfolio is twice that of the aggregate commodity portfolio (about 8 percent and 4 percent per month, respectively), the coefficient for the yield spread is three times larger than that for the aggregate commodity portfolio. In column (4), we find that the adjusted aggregate basis predicts returns on the energy portfolio with the same sign as that for the aggregate commodity portfolio. A high adjusted aggregate basis predicts low returns on being long energy futures. Importantly, the R^2 increases from 1.79 to 3.73 percent with the introduction of the adjusted aggregate basis. The variance decomposition shows that the adjusted aggregate basis explains 60 percent of the variation in expected returns, while the common predictors explain 38 percent.

Columns (5) and (6) present the results for livestock. The short rate is again statistically significant, but the yield spread and the dividend yield are not. In column (6), the coefficient for the adjusted aggregate basis is negative and statistically significant. The R^2 increases substantially from 0.67 to 3.68 percent with the introduction of the adjusted aggregate basis. The variance decomposition shows that the adjusted aggregate basis explains 82 percent of the variation in expected returns.

Columns (7) and (8) present the results for metals. The short rate and the yield spread are again statistically significant and enter with the same signs as those for the aggregate commodity portfolio. The adjusted aggregate basis has a coefficient of -0.37, which is statistically insignificant. The R^2 is virtually unchanged when we introduce the adjusted aggregate basis. This is confirmed by the variance decomposition, which shows that the common predictors explain 89 percent of the variation in expected returns, while the adjusted aggregate basis only explains 10 percent.

In summary, Panel A shows that the short rate and the yield spread have explanatory power for each of the sector portfolios, except for livestock where only the short rate seems to play a role. The adjusted aggregate basis has the most explanatory power for returns on commodity futures in energy and livestock, and less so in agriculture and metals.

In Panel B, we estimate similar forecasting regressions for spot-price growth by sector.

The picture that emerges is similar to Panel A. The short rate and the yield spread have the same signs as those for the aggregate commodity portfolio, and they remain important predictors of spot-price growth. With the exception of livestock, these common predictors explain most of the variation in expected spot-price growth. The coefficient for the adjusted aggregate basis is positive for all sectors as expected, except for energy. The adjusted aggregate basis is an important predictor for livestock and metals, accounting for 73 percent and 38 percent of the variation in expected spot-price growth, respectively. It is less important for agriculture and energy, accounting for only 7 percent and 12 percent of the variation in the expected spot-price growth, respectively.

5.2.2. Predictability of commodity returns by maturity

In Table 6, we examine the predictability of a portfolio of short-maturity futures contracts separately from a portfolio of long-maturity futures contracts. Short maturity refers to futures contracts with three months or less to maturity, and long maturity refers to futures contracts with more than three months to maturity. Columns (1) and (2) report the results for the short-maturity portfolio, and columns (3) and (4) report the results for the long-maturity portfolio. The results for these two portfolios are very similar to those for the aggregate commodity portfolio in Table 4. In particular, these results show that our main findings are not driven by long-maturity futures contracts that are potentially less liquid than short-maturity futures contracts.

5.2.3. Predictability of commodity returns by subsample

In Table 7, we examine the predictability of aggregate commodity returns and spot-price growth by subsample. We split our sample into two halves, 1965–1986 and 1987–2008. The first thing to note is that the coefficients in the forecasting regressions are similar across the two subsamples, especially the coefficient for the adjusted aggregate basis. This indicates that overall our results are not driven by a particular period in the sample.

Interestingly, the common predictors have a somewhat greater explanatory power than the adjusted aggregate basis in the earlier subsample, which is reversed in the later subsample. For example, the results for aggregate commodity returns in Panel A shows that the common predictors explain 66 percent of the variation in expected commodity returns during the earlier subsample, but only 33 percent of the variation in the later subsample. Similarly, the results for aggregate spot-price growth in Panel B shows that the common predictors explain 77 percent of the variation in expected spot-price growth in the earlier subsample, but only 39 percent of the variation in the later subsample. These differences are economically significant. In summary, it appears that commodity-specific predictors have become more important recently in explaining commodity price movements.

6. Conclusion

In this paper, we assess the relative importance of the various determinants of time-varying expected commodity returns. We establish the following key findings. Common predictors of bond and stock returns also predict commodity returns. Consistent with commodities being a hedge for market fluctuations, a high yield spread predicts low commodity returns. Even controlling for these common predictors, a low aggregate basis (the ratio of futures to spot price averaged across commodities) predicts high returns on being long commodity futures and low spot-price growth. Aggregate basis is a commodity-specific predictor because it does not predict bond or stock returns after controlling for the common predictors. Interestingly, aggregate basis explains as much of the variance in expected commodity returns as the common predictors, and its relative importance has increased in the recent period. These findings provide support for the role of commodities as a hedge for market fluctuations. At the same time, the importance of aggregate basis in the pricing commodities suggests that the commodity market remains segmented to a large degree.

Related to the theme of commodity-specific predictors being important, we note in Figure 1 a striking break in the historical relationship between the spot price and the aggregate basis during the recent run-up in commodity prices. Historically, movements in the spot price and the basis are negatively correlated because spot-price shocks typically mean revert, and futures prices do not move one-for-one with spot-price shocks. Since 2004, however, commodity prices have appreciated considerably, and aggregate basis has fallen (if anything), suggesting that futures prices have responded at least (if not more than) one-for-one with spot-price shocks. This could reflect the belief among investors that these price shocks are permanent or highly persistent. This is however unprecedented since even during the energy crisis of the seventies, one did not see such a striking movement in futures prices. This finding could instead reflect the conventional wisdom that lots of new indexed money flowed into commodity futures (as opposed to the spot market), chasing returns during this period. More detailed research into the market structure of commodities is necessary to understand the dramatic price movements in the recent years.

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Table 1: List of commodities in the portfolio

Our analysis focuses on 34 commodities for which futures and spot prices are available through the Commodity Research Bureau. The sample period starts in December 1964, after which prices are available for many commodities.

Sector	Commodity	Symbol	First observation
Agriculture	Barley	WA	August 1989
	Butter	02	November 1996
	Canola	WC	September 1974
	Cocoa	CC	December 1964
	Coffee	KC	December 1972
	Corn	C-	December 1964
	Cotton	CT	December 1964
	Flaxseed	WF	November 1980
	Lumber	LB	March 1970
	Oats	O-	December 1964
	Orange Juice	JO	May 1967
	Rough Rice	RR	August 1986
	Soybean Meal	SM	December 1964
	Soybean Oil	BO	December 1964
	Soybeans	S-	December 1964
	Sugar	SB	December 1964
	Wheat	W-	December 1964
Energy	Crude Oil	CL	March 1983
	Gasoline	RB	December 1984
	Heating Oil	HO	November 1978
	Natural Gas	NG	October 1993
	Propane	PN	September 1987
Livestock	Broilers	BR	February 1991
	Feeder Cattle	FC	March 1972
	Lean Hogs	LH	April 1966
	Live Cattle	LC	January 1965
	Live Hogs	LG	April 1966
	Pork Bellies	PB	December 1964
Metals	Aluminum	AL	December 1983
	Copper	HG	December 1964
	Gold	GC	December 1974
	Palladium	PA	January 1977
	Platinum	PL	April 1968
	Silver	SI	December 1964

Table 2: Descriptive statistics for commodity, bond, and stock returns

Panel A reports the mean and the standard deviation of monthly excess returns over the one-month T-bill rate. It also reports the autocorrelation and the pairwise correlation of excess returns. The assets are an equal-weighted portfolio of fully collateralized commodity futures, separately by sector; the ten-year Treasury bond; and the CRSP value-weighted stock portfolio. Panel B reports the same statistics for monthly spot-price growth for an equal-weighted portfolio of commodities, separately by sector. The sample period is 1965:1–2008:12 (1978:12–2008:12 for energy only).

Return on	Mean (%)	Standard deviation (%)	Autocorrelation	Correlation with					
				Commodity portfolio	Agriculture	Energy	Livestock	Metals	Ten-year bond
Panel A: Commodity, bond, and stock returns									
Commodity portfolio	0.59	4.08	0.08						
Agriculture	0.27	4.27	0.04	0.64					
Energy	0.90	8.07	0.15	0.68	0.06				
Livestock	0.53	5.01	0.03	0.57	0.35	0.03			
Metals	0.59	7.41	0.06	0.74	0.35	0.15	0.17		
Ten-year bond	0.17	2.31	0.08	-0.11	-0.10	-0.04	-0.07	-0.08	
Stock portfolio	0.36	4.52	0.09	0.06	0.03	0.01	0.04	0.11	0.18
Panel B: Spot-price growth									
Commodity portfolio	0.32	4.01	0.06						
Agriculture	0.18	4.62	0.01	0.49					
Energy	0.72	11.32	0.03	0.76	-0.03				
Livestock	0.26	7.01	-0.02	0.59	0.17	0.03			
Metals	0.19	5.04	0.09	0.51	0.22	0.14	0.06		

Table 3: Descriptive statistics for the predictor variables

The table reports the mean, the standard deviation, the autocorrelation, and the pairwise correlation of the predictor variables. The short rate is the monthly average yield on the one-month T-bill. The yield spread is the difference between Moody's Aaa corporate bond yield and the short rate. The dividend yield is that for a value-weighted portfolio of NYSE, AMEX, and Nasdaq stocks, adjusted for repurchases and issuances. Adjusted aggregate basis is aggregate basis minus the short rate. The sample period is 1965:1–2008:12.

Variable	Mean (%)	Standard deviation (%)	Autocorrelation	Correlation with			
				Short rate	Yield spread	Dividend yield	Basis
Short rate	0.46	0.22	0.97				
Yield spread	0.22	0.13	0.93	-0.52			
Dividend yield	0.09	0.18	0.99	0.35	-0.07		
Basis	0.24	0.87	0.69	0.24	-0.11	0.10	
Adjusted basis	-0.21	0.84	0.67	-0.02	0.03	0.01	0.97

Table 4: Predictability of commodity, bond, and stock returns

We test the predictability of returns on an equal-weighted portfolio of fully collateralized commodity futures, the ten-year Treasury bond, and the CRSP value-weighted stock portfolio. We regress monthly excess returns, over the one-month T-bill rate, onto one-month lags of the short rate, the yield spread, the dividend yield, and the adjusted aggregate basis. The table reports a variance decomposition of expected returns into the parts explained by (1) the common predictors, (2) the adjusted aggregate basis, and (3) the covariance between the two sets of predictors. In the last two columns, we test the predictability of monthly spot-price growth for an equal-weighted portfolio of commodities. The table reports point estimates with heteroskedasticity-robust t-statistics in parentheses. The sample period is 1965:1–2008:12.

Predictor	Commodity portfolio		Ten-year bond		Stock portfolio		Spot price	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short rate	-2.64	-2.64	0.62	0.62	-0.60	-0.60	-2.41	-2.41
	(-2.73)	(-2.76)	(0.85)	(0.85)	(-0.52)	(-0.52)	(-2.48)	(-2.49)
Yield spread	-3.46	-3.36	3.44	3.47	3.35	3.33	-2.77	-2.85
	(-2.49)	(-2.42)	(3.48)	(3.50)	(2.03)	(2.00)	(-2.04)	(-2.09)
Dividend yield	0.01	0.03	0.67	0.68	1.71	1.71	-0.52	-0.53
	(0.01)	(0.03)	(1.19)	(1.20)	(1.14)	(1.14)	(-0.44)	(-0.46)
Adjusted basis		-0.60		-0.14		0.14		0.47
		(-2.62)		(-1.31)		(0.61)		(1.90)
R^2 (%)	1.69	3.25	3.45	3.70	1.59	1.66	1.63	2.59
Variance decompostion (%):								
Common predictors		50.99		94.62		94.78		63.47
		(2.01)		(10.53)		(6.25)		(2.41)
Adjusted basis		48.03		6.67		4.20		37.36
		(1.89)		(0.67)		(0.31)		(1.40)
Covariance		0.99		-1.29		1.02		-0.83
		(1.02)		(-1.42)		(0.65)		(-0.82)

Table 5: Predictability of commodity returns by sector

In Panel A, we test the predictability of returns on an equal-weighted portfolio of fully collateralized commodity futures, separately by sector. We regress monthly excess returns, over the one-month T-bill rate, onto one-month lags of the short rate, the yield spread, the dividend yield, and the adjusted aggregate basis. The table reports a variance decomposition of expected returns into the parts explained by (1) the common predictors, (2) the adjusted aggregate basis, and (3) the covariance between the two sets of predictors. In Panel B, we test the predictability of monthly spot-price growth for an equal-weighted portfolio of commodities, separately by sector. The table reports point estimates with heteroskedasticity-robust t-statistics in parentheses. The sample period is 1965:1–2008:12 (1978:12–2008:12 for energy only).

Predictor	Agriculture		Energy		Livestock		Metals	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Commodity returns								
Short rate	-2.36	-2.36	-2.49	-3.50	-1.71	-1.70	-5.06	-5.06
	(-2.26)	(-2.26)	(-1.29)	(-1.81)	(-1.53)	(-1.58)	(-2.77)	(-2.77)
Yield spread	-2.21	-2.21	-9.43	-11.19	-0.06	0.11	-5.28	-5.22
	(-1.44)	(-1.43)	(-2.39)	(-2.72)	(-0.03)	(0.06)	(-1.95)	(-1.91)
Dividend yield	0.88	0.88	-0.75	-0.38	-0.41	-0.38	1.24	1.25
	(0.76)	(0.76)	(-0.31)	(-0.16)	(-0.35)	(-0.33)	(0.88)	(0.89)
Adjusted basis		0.00		-1.92		-1.03		-0.37
		(0.00)		(-2.35)		(-3.30)		(-0.81)
R^2 (%)	0.98	0.98	1.79	3.73	0.67	3.68	1.55	1.72
Variance decomposition (%):								
Common predictors		100.00		38.14		18.89		89.45
		(239.71)		(1.94)		(1.05)		(3.79)
Adjusted basis		0.00		59.59		81.94		10.23
		(0.00)		(3.00)		(4.66)		(0.44)
Covariance		0.00		2.27		-0.82		0.32
		(0.00)		(6.10)		(-0.75)		(0.52)
Panel B: Spot-price growth								
Short rate	-2.62	-2.62	-3.72	-4.08	-2.11	-2.11	-3.05	-3.05
	(-2.29)	(-2.30)	(-1.45)	(-1.53)	(-1.36)	(-1.36)	(-2.02)	(-2.02)
Yield spread	-1.05	-1.07	-13.04	-13.67	0.86	0.68	-3.37	-3.47
	(-0.63)	(-0.64)	(-2.45)	(-2.40)	(0.33)	(0.25)	(-1.74)	(-1.80)
Dividend yield	0.34	0.33	-0.74	-0.61	-0.37	-0.41	0.00	-0.01
	(0.28)	(0.27)	(-0.21)	(-0.17)	(-0.18)	(-0.20)	(0.00)	(-0.01)
Adjusted basis		0.16		-0.69		1.09		0.55
		(0.60)		(-0.66)		(2.22)		(2.38)
R^2 (%)	1.21	1.29	1.69	1.82	0.65	2.38	1.39	2.23
Variance decomposition (%):								
Common predictors		93.09		86.95		26.03		62.94
		(4.26)		(2.92)		(0.89)		(2.47)
Adjusted basis		6.61		11.53		72.81		37.81
		(0.31)		(0.41)		(2.43)		(1.45)
Covariance		0.29		1.53		1.16		-0.75
		(0.46)		(0.94)		(0.89)		(-0.63)

Table 6: Predictability of commodity returns by maturity

We test the predictability of returns on an equal-weighted portfolio of fully collateralized commodity futures, separately by maturity (greater than three months for long maturity). We regress monthly excess returns, over the one-month T-bill rate, onto one-month lags of the short rate, the yield spread, the dividend yield, and the adjusted aggregate basis. The table reports a variance decomposition of expected returns into the parts explained by (1) the common predictors, (2) the adjusted aggregate basis, and (3) the covariance between the two sets of predictors. The table reports point estimates with heteroskedasticity-robust t-statistics in parentheses. The sample period is 1965:1–2008:12.

Predictor	Short maturity		Long maturity	
	(1)	(2)	(3)	(4)
Short rate	-2.37	-2.37	-2.90	-2.90
	(-2.32)	(-2.36)	(-3.09)	(-3.10)
Yield spread	-2.95	-2.84	-3.98	-3.88
	(-2.02)	(-1.96)	(-2.84)	(-2.75)
Dividend yield	-0.49	-0.47	0.52	0.53
	(-0.44)	(-0.43)	(0.55)	(0.57)
Adjusted basis		-0.62		-0.59
		(-2.87)		(-2.16)
R^2 (%)	1.57	3.22	1.49	2.64
Variance decomposition (%):				
Common predictors		47.97		55.34
		(2.00)		(1.89)
Adjusted basis		51.16		43.61
		(2.13)		(1.49)
Covariance		0.87		1.05
		(0.81)		(1.23)

Table 7: Predictability of commodity returns by subsample

In Panel A, we test the predictability of returns on an equal-weighted portfolio of fully collateralized commodity futures, separately by subsample. We regress monthly excess returns, over the one-month T-bill rate, onto one-month lags of the short rate, the yield spread, the dividend yield, and the adjusted aggregate basis. The table reports a variance decomposition of expected returns into the parts explained by (1) the common predictors, (2) the adjusted aggregate basis, and (3) the covariance between the two sets of predictors. In Panel B, we test the predictability of monthly spot-price growth for an equal-weighted portfolio of commodities, separately by subsample. The table reports point estimates with heteroskedasticity-robust t-statistics in parentheses.

Predictor	1965–1986		1987–2008	
	(1)	(2)	(3)	(4)
Panel A: Commodity returns				
Short rate	-3.70	-3.40	-0.45	-1.18
	(-3.38)	(-3.11)	(-0.22)	(-0.58)
Yield spread	-2.34	-2.10	-1.94	-2.38
	(-1.04)	(-0.93)	(-0.99)	(-1.24)
Dividend yield	-2.74	-3.35	-0.36	-0.19
	(-0.90)	(-1.09)	(-0.31)	(-0.16)
Adjusted basis		-0.60		-0.57
		(-2.13)		(-1.68)
R^2 (%)	3.68	5.31	0.49	1.58
Variance decomposition (%):				
Common predictors		66.06		33.35
		(2.97)		(0.72)
Adjusted basis		31.00		74.85
		(1.41)		(1.48)
Covariance		2.94		-8.20
		(1.12)		(-0.24)
Panel B: Spot-price growth				
Short rate	-2.78	-2.98	-2.31	-1.28
	(-2.84)	(-3.00)	(-0.89)	(-0.50)
Yield spread	-1.55	-1.71	-3.97	-3.36
	(-0.82)	(-0.88)	(-1.55)	(-1.32)
Dividend yield	-1.32	-0.92	-0.64	-0.88
	(-0.52)	(-0.35)	(-0.42)	(-0.58)
Adjusted basis		0.40		0.81
		(1.42)		(1.82)
R^2 (%)	2.73	3.79	0.99	2.21
Variance decomposition (%):				
Common predictors		76.78		39.08
		(2.73)		(0.98)
Adjusted basis		28.27		59.62
		(0.92)		(1.53)
Covariance		-5.05		1.31
		(-1.24)		(0.06)

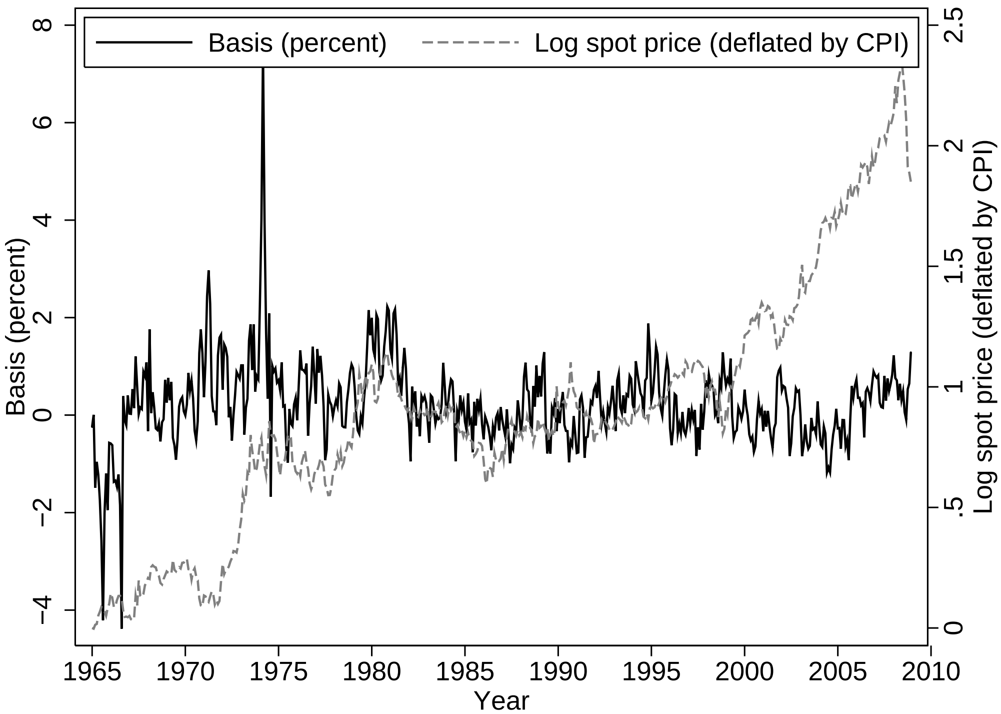

Figure 1: Aggregate basis and the spot-price index

The figure shows aggregate basis and the spot-price index for an equal-weighted portfolio of commodities. We construct aggregate basis as follows. We first compute basis for each futures contract as $(F_{i,t,T}/S_{i,t})^{1/(T-t)} - 1$. We then compute the median of basis within each of four sectors and two maturity levels (greater than three months for long maturity). We finally construct aggregate basis as an equal-weighted average of basis across all four sectors and two maturity levels. The spot-price index is deflated by the seasonally adjusted consumer price index for all items. The sample period is 1965:1–2008:12.

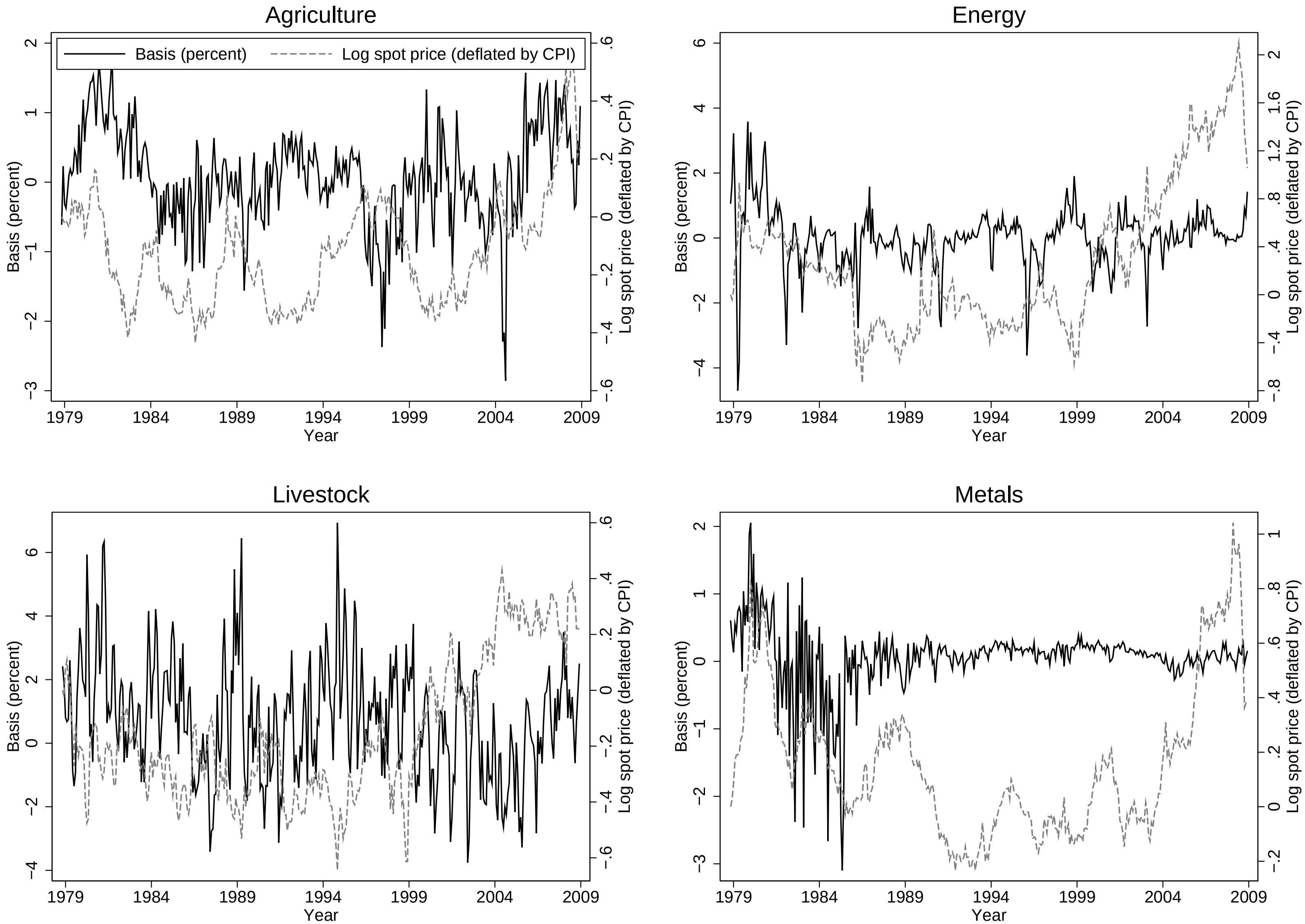

Figure 2: Basis and the spot-price index by sector

The figure shows the basis and the spot-price index for an equal-weighted portfolio of commodities, separately by sector. We construct basis for each sector as follows. We first compute basis for each futures contract as $(F_{i,t,T}/S_{i,t})^{1/(T-t)} - 1$. We then compute the median of basis within each of four sectors and two maturity levels (greater than three months for long maturity). We finally construct basis for each sector as an equal-weighted average of the short-maturity and long-maturity basis for each sector. The spot-price index is deflated by the seasonally adjusted consumer price index for all items. The sample period is 1978:11–2008:12.