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WHAT EVERY INVESTOR SHOULD KNOW ABOUT COMMODITIES

PART I: UNIVARIATE RETURN ANALYSIS

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What Every Investor Should Know About Commodities Part I: Univariate Return Analysis

Abstract

In this paper we study the univariate return properties of a large variety of commodity futures. Our analysis shows that the volatility of commodity futures is comparable to that of US large cap stocks. Yet, with the exception of energy, a consistently positive risk premium is lacking in commodity futures. We also find that for many commodities, futures returns and volatility can vary considerably over different phases of the business cycle, under different monetary conditions as well as with the shape of the futures curve. Skewness in commodity futures returns is largely insignificant, whereas kurtosis is significantly positive and comparable to that of US large cap stocks. In almost all commodities we find significant degrees of autocorrelation, which affects the properties of longer horizon returns.

Keywords: Commodities, commodity futures, risk premium, volatility, skewness, kurtosis, autocorrelation.

JEL Classifications: G11, E44, O13, Q19, Q49.

Introduction

Contrary to 6–7 years ago, when there seemed to be an abundance of money-making opportunities around, today's investors are having a hard time finding anything which promises an interesting return, especially where traditional asset classes are concerned. Stock markets have come down and are slow to recover. Interest rates are at historically low levels, suggesting that the only way forward is for rates to go up and bonds to go down. Increased interest in long-dated bonds by institutions has flattened the yield curve, thereby eliminating the term premium.

Lacking opportunities in traditional asset classes, investors are taking refuge in a range of alternative asset classes. Emerging markets, corporate bonds, private equity, real estate, and commodities have all seen very substantial inflows. Hedge funds in particular have attracted a lot of attention and, supported by aggressive marketing, a lot of money as well. Assets under management are said to have crossed $1 trillion, with the number of funds worldwide exceeding 9000. Over the last few years, hedge fund performance has deteriorated significantly, however, with, depending on the estimate used, the average fund of funds only producing a meagre 5–7% over 2005. As a result, an increasing number of hedge fund investors are getting restless. This is reflected by the fact that, according to HFR, during the third quarter of 2005 funds of hedge funds were confronted with their first net outflow of funds, in the amount of $1.2 billion[1].

Given the fact that investors typically gravitate towards the asset class with the best recent performance, two asset classes currently stand out. First, emerging markets have generated astonishing returns over the last three years. Over 2005, according to the MSCI Emerging Markets Indices, equity markets in Russia were up by 69%, in Jordan by 71% and in Egypt by 154%. Latin America and some Far Eastern markets posted similar results. Interest in emerging market sovereign debt has shown a similar development, with credit spreads dropping to levels not seen for a very long time.

Commodities have also shown remarkable performance over the last couple of years, with the Reuters / Jefferies – CRB index up 18.4% and Goldman Sachs' energy heavy GSCI returning in excess of 25% over 2005 alone. Although commodity markets have been around for centuries, investors' interest has always been quite limited. Over the last few years, however, the optimistic growth prospects of large

[1] Financial Times, Oct. 31, 2005. According to HFR, from the first to the second quarter of 2005 asset flows into hedge funds dropped by 60%, from $27.3 billion to $10.9 billion.

developing countries like Brazil, China and India, and the accompanying need for oil, industrial metals and construction supplies, as well as the relentless marketing efforts of George Soros' former partner Jim Rogers, have helped to convince many investors that the only way for commodities is up. In addition, recent price shocks in crude oil and copper have attracted a lot of attention and have made more investors aware of the profit potential in commodities. As a consequence, investment in commodities is growing at an unprecedented rate, with even pension funds making substantial allocations these days. In a recent institutional investor survey by Barclays Capital, 70% of the respondents expected to further increase their commodity exposure over the next three years[2]. In addition, more and more hedge funds are turning to the commodity markets in an attempt to make up for failing returns in other areas.

In comparison to financial markets, there has been relatively little research into commodity markets, with the majority of studies concentrating on contract specific issues over limited sample periods. As such, from an investors' viewpoint, a comprehensive in-depth investigation into commodities as an alternative asset class has been lacking. Two papers stand out though. Gorton and Rouwenhorst (2005) studied the long-term performance of an equally-weighted index of 36 commodities. They show that over the period 1959–2004 this index produced a risk premium comparable to that of equity, but with lower standard deviation and positive skewness. In addition, they found returns on their index to be negatively correlated with stocks and bonds, suggesting a high diversification potential. Not surprisingly, these results have been very much welcomed by commodity marketers and commodity fund operators and form the basis of many commodity sales pitches these days. A similar study, but somewhat more critical in nature and also studying some individual commodities, can be found in Erb and Harvey (2005). Contrary to Gorton and Rouwenhorst (2005), the latter find that on average commodities do not offer a risk premium.

Unfortunately, studies in this area often suffer from one or more shortcomings. First, most concentrate on weekly or monthly instead of daily data. As a result, they provide insufficient insight in the short-term return characteristics of commodity returns and possible peculiar inter-temporal relationships; knowledge which is essential from a short-term risk management perspective. Second, especially older studies rely on relatively short data series, which makes their conclusions somewhat doubtful. Third, by concentrating primarily on commodity index returns or on only a small selection of commodities, most studies do not account for the high degree of heterogeneity in commodities, i.e. the fact that there isn't

[2] As reported by Reuters, December 16th, 2005.

really such thing as the "average commodity". To make a well-informed investment in commodities and to be able to construct sensible portfolios, investors need to understand the differences between different (types of) commodities, know how they relate to each other as well as to other asset classes, and know whether and when active trading will add value over a passive buy-and-hold approach. We intend to provide exactly this type of insight in a series of four papers. Using daily data series on 142 different (including different trading locations for the same commodity) commodities, we will answer a set of questions that we believe to be important for everyone investing in or planning to invest in commodities. More in particular, in the present paper we will answer the following questions:

1. Do commodities offer a risk premium?
2. Are commodity returns excessively volatile?
3. Are commodity returns positively or negatively skewed?
4. Do commodity returns exhibit "fat tails"?
5. Are commodity returns autocorrelated?

In addition, we investigate how the answers to these questions depend on the state of the economy, i.e. the business cycle and the monetary environment, and the shape of the futures curve. In three forthcoming companion papers, we analyse the multivariate characteristics of commodity returns, including their relationship with stocks, bonds and inflation (Kat and Oomen, 2006a), the presence and impact of seasonality, and the importance of the trading location and the contract maturity (Kat and Oomen, 2006b), and the added value of active trading versus passive indexation (Kat and Oomen, 2006c).

Commodity Futures

Investment in commodities is typically done through the futures markets[3]. Commodity futures are not a recent invention. In the 19th century, agricultural futures were traded in many different locations. Corn and wheat futures have been trading at the CBOT since 1848 for example. Partly due to OECD governments' price support programs, however, which have substantially reduced the need for price risk management, most trading nowadays is concentrated at a relatively small number of exchanges,

[3]See Siegel and Siegel (1990) for a good introduction to futures markets and trading.

located mainly in the US and the UK.[4]

Trading futures instead of spot has many advantages. First, futures are exchange-traded, standardized contracts without counter-party risk. Second, since contracts can easily be closed out or rolled over, delivery can be avoided, meaning that shipping, storage, and insurance need not be an issue. Third, long and short positions are equally straightforward to put on. A fourth potential benefit is that futures returns do not just stem from movements in the underlying spot prices, but may contain a futures specific component as well, resulting from deviations of the futures price from the expected future spot price (to which the futures price will eventually converge as the contract matures). Obviously, when futures prices are a fair reflection of expected future spot prices, the expected futures return will be zero. When hedging demand is particularly strong, however, a discrepancy may arise, as hedgers may be willing to accept a less favourable futures price in return for being able to fix their future spot price. When hedgers on balance sell (buy) futures this puts downward (upward) pressure on the futures price. The result is a futures price, which is lower (higher) than the expected future spot price and which therefore offers buyers of the futures contract a positive (negative) premium.

Buying or selling a futures contract does not require any upfront payment other than posting initial margin.[5] Assuming 10% initial margin, this means that it only takes $10 to gain exposure to $100 worth of commodities. Although useful for speculation, this form of implied leverage makes futures quite risky, as a 5% change in the price of the underlying commodity will produce a 50% change in the value of the initial investment. To bring the risk of commodity futures in line with that of other asset classes, many investors therefore fully collateralise the contracts that they hold. Put simply, instead of 10%, they post 100% initial margin. Doing so, a 5% commodity price change also yields a 5% change in the value of their investment.

Apart from posting initial margin, investors holding futures positions are also confronted with variation margin, i.e. daily settlement of profits and losses. When the futures price goes up, instead of at expiration, investors who are long receive their profits right at the end of the day. These profits can be invested at market rates and the interest received adds to the total return on the investment. Of course,

[4] Most notably the CBOT, CME, NYMEX (inc. COMEX), NYBOT (incl. CSCE and NYCE), IPE, LIFFE (incl. LCE) and LME.

[5] Although small individual investors typically do not earn interest on their margin account, large investors will be paid money market rates or be allowed to put up T-bills, floating rate notes or other securities as margin.

in case the futures price drops, investors will have to fund their losses and the interest paid will come out of their total return.

It is customary to divide the total return, which an investor receives on a fully collateralised commodity futures investment into different components to separate out the return on collateral (including interest paid or received on variation margin flows) and the spot return:

$$\begin{aligned} \text{Total Return} &= \text{Collateral Return} + \text{Futures Return}, && (1) \\ &= \text{Collateral Return} + \text{Spot Return} + \text{Roll Return}. && (2) \end{aligned}$$

Roll return is defined by expression (2). Intuitively, it is the return one would make if at maturity the spot price was unchanged, i.e. the return from "rolling" up or down (depending on the shape of the curve) the futures curve. If the market expects spot prices to fall (rise) and, correctly reflecting expected future spot prices, the futures curve is therefore downward (upward) sloping, the expected roll return will be positive (negative). As such it compensates the negative (positive) expected spot return, resulting in a zero expected futures return. Only when futures prices deviate from expected future spot prices will the sum of expected roll return and expected spot return be different from zero. As we will see later, roll return explains on average no less than 50% of the variation in observed futures returns. For some commodities, this percentage is even substantially higher.

Assuming the investor uses T-bills or high-grade floating rate notes as collateral, the collateral return will be equal to the short rate. This implies that the excess return (over the short rate) on a fully collateralised commodity investment can be expressed as:

$$\text{Excess Return} = \text{Spot Return} + \text{Roll Return} = \text{Futures Return}. \quad (3)$$

That is, for a collateralized futures investment the excess return equals the futures return. The risk premium on a collateralized futures investment is therefore equal to the expected futures return, which, as mentioned, will be zero when futures prices correctly reflect expected future spot prices. Only when this is not the case can there be a non-zero risk premium. Since the collateral return is obtained completely separately from the futures return and also depends on the type of collateral used, in the analysis that follows we will concentrate on futures returns.

The Data

The database used in this study consists of daily settlement prices on 142 different (including different trading locations for the same commodity) commodity futures contracts trading on 26 different exchanges in 8 different countries, covering the period January 1965 – February 2005 (where available). For many of these futures contracts a wide range of maturities is available, ranging from the nearby to the ninth nearby contract (where available).

Given the daily settlement prices on the above futures contracts, we constructed 757 daily futures return series by rolling contracts over on the first day of the expiry month of the nearby contract.[6] For example, constructing a return series for the second nearby contract, we roll from the second nearby contract into the third nearby contract on the first day of the nearby contract's expiry month. Returns on all non-USD denominated contracts are converted into USD.

[Insert Table 1 Here]

In what follows we report on the univariate properties of the daily and monthly futures returns obtained along the above lines. For brevity, we only present the results for the nearby contract, while restricting ourselves to a representative selection of 42 different commodities. Details on these contracts can be found in Table 1, where NC denotes the number of available contract maturities. In Kat and Oomen (2006b) we will investigate whether and how trading longer-dated futures contracts and/or trading in other locations changes the results presented here.

Question 1: Do Commodity Futures Offer a Risk Premium

One of the first questions to ask when considering investing in a new asset class is: "will the market compensate me for taking on this particular risk?". In other words, is there a risk premium to be earned? Whether commodities offer a risk premium depends on whether and how futures prices deviate from expected future spot prices. If they do, there can be a risk premium, if they don't, there won't. Note that this is very different from equity. Since the main reason to buy stocks is investment, for stocks it is plausible that prices are set such that the expected return exceeds the interest rate and is higher the more risky the stock. For commodity futures to offer a risk premium, we need hedging

[6] For some contracts in our database trading ceases before the first day of the expiry month. In those cases the rollover takes place one week before the last trading day.

demand to pull the futures price away from the expected future spot price. Hedging demand is likely to increase with volatility, but that doesn't tell us whether the expected return will be positive or negative as that depends on which way the pressure swings. Excess supply will put pressure on futures prices and generate a positive expected return, but excess demand will do the exact opposite. For a number of commodities there is a plausible tendency for hedgers to be predominantly on one side or the other. In live cattle or gasoline for example, producers tend to be in a more vulnerable position than consumers and are therefore more likely to hedge. As a result, the expected futures return is more likely to be positive than negative. In grains, the opposite situation may often occur, resulting in a negative expected futures return.

Hedging pressure may vary significantly over the year as well, as weather events can have a dramatic impact on supply or demand. Coffee production in Brazil for example is highly susceptible to winter frosts. Likewise, the key period for US corn is July. Any adverse weather in the Midwest during this time will seriously affect new crops. July is also an important month for natural gas. High temperatures may push air conditioning demand up very substantially and, with around 25% of total US natural gas consumption delivered to electrical utility plants, this will increase demand for gas. In all three cases it is likely that at least during some months of the year the expected futures return will be negative. We will discuss seasonality further in Kat and Oomen (2006b).

It is important to note that, although it surely makes it less attractive, a zero or even negative risk premium is not necessarily a reason to refrain from allocating to a particular asset class. It very much depends on what the remainder of the return distribution looks like. As long as the lack of expected return is compensated by significant positive skewness and/or low or even negative correlation with other asset classes, it may still make sense to invest in it, despite the low expected return.

Since theoretically it is impossible to say whether expected futures returns will be significantly different from zero, the question of the existence of a commodity futures risk premium is primarily an empirical matter. To test for the presence of a risk premium, we calculated, for all commodity futures in Table 1, the average daily return over three different sample periods. We also calculated bootstrapped significance levels, based on 10,000 replications. Table 2 resports annualized excess returns in percentages with one and two asterisks indicating significance at a 10% and 5% level respectively.

[Insert Table 2 Here]

Table 2 shows large variation in average futures returns. Most notably, the majority of estimates are not significantly different from zero, meaning that for most commodities one cannot reject the hypothesis that there is no risk premium to be earned. The lack of significance is of course partly due to the high volatility (see later) of commodity futures returns. As a result, even an average return as high as 10% or as low as –10% may turn out statistically insignificant.

For a large number of commodities the average futures return has been negative over time. Over the period 2000–2005, 13 out of 42 commodities produced a negative futures return. Over the period 1987–2005, the number of commodities with a negative average futures return rises to 16 out of 29. Especially agricultural commodities did not do well. Energy shows the opposite pattern though. Crude oil, heating oil, gasoline, propane, and kerosene all exhibit sizeable and statistically significant positive excess returns.

Comparing the average futures return with the average excess return (over the short rate) on the Dow Jones Industrial Average (DJIA), we see that, although equity seriously underperformed over 2000–2005, over longer periods of time the DJIA has done better than the average commodity. Again, this signals the lack of a risk premium in commodities. The most noteworthy exception is again energy, which shown very impressive performance, over 1987–2005 as well as over 2000–2005.

The above results clearly show how dangerous it is to draw general conclusions about the risk premium in commodity futures by only looking at the returns on one specific index, as is done in Gorton and Rouwenhorst (2005) for example. A portfolio overweighted towards agricultural commodities will lead one to conclude that commodity futures offer a negative risk premium. A portfolio heavily weighted towards energy on the other hand, such as the extremely popular Goldman Sachs Commodity Index (GSCI) for example, will lead on to believe that commodity futures offer a very significant positive risk premium. In this context it is interesting to note that Gorton and Rouwenhorst (2005, p. 7) motivate their use of an index as follows: ”The advantage of studying commodities at the portfolio level is that diversification helps to reduce the noise inherent in individual commodities data. Among other things, this noise may obscure the detection of a risk premium”. Obviously, their basic premise is that all commodities offer a similar risk premium, which, as we have clearly shown, is definitely not the case.

[Insert Table 3 Here]

Contrary to stocks, which are driven by longer-term economic prospects, commodity prices are primar-

ily determined by current economic activity. This suggests that commodity spot prices will be at their lowest towards the end of a recession and at their highest towards the end of an expansion phase. To investigate whether this is also reflected in commodity futures returns, we classified our results based on ex-post business cycle conditions. For the business cycle, we used the usual NBER dating[7], distinguishing between four subperiods: start of recession (SR), end of recession (ER), start of expansion (SE), and end of expansion (EE). The results for 29 commodities over the period 1987–2005 can be found[8] in Table 3, with one and two asterisks denoting whether the difference with the 1987–2005 benchmark period is statistically significant at either 10% or 5% respectively.

Although not many differences are statistically significant, Table 3 does suggest that futures returns indeed tend to be different in different phases of the business cycle. Energy, meat and livestock seem to perform especially well during the start of a recession, while during the same period many agricultural commodities and metals exhibit their worst returns. Energy does particularly bad during the end of a recession. The same is true for the soybean complex.

Given their dependence on the business cycle, commodity returns are also likely to be different in different monetary and inflationary environments, as strong economic growth will tend to push up inflation and interest rates.[9] To investigate whether commodity futures do better in a restrictive than an expansive monetary environment we distinguished between three different monetary regimes, namely (i) an expansive regime (EM), defined as a period during which the most recent policy rate change over the past 3 months was a cut, (ii) a restrictive regime (RM), defined as a period during which the most recent policy rate change over the past 3 months was a hike, (iii) an awaiting regime (AM), defined as a period during which the policy rate was left unchanged for at least 3 months. The results can again be found in Table 3, which shows that monetary conditions play an important role as well. Energy and industrial metals tend to perform particularly well in a restrictive and particularly bad in an expansive monetary environment. Meat and livestock on the other hand do particularly bad in a restrictive monetary environment.

[7] See www.nber.org/cycles.html.

[8] Over this sample period there are 191 days in SR, 187 days in ER, 2047 days in SE, and 1944 days in EE. Because the number of days covered by the different business cycle phases is far from equal, the recession statistics can be expected to be relatively volatile.

[9] In a way, higher commodity prices and higher inflation are two sides of the same coin as commodity prices are an important component of producer and consumer price indices. We therefore concentrate on the monetary environment.

It is interesting to compare the performance of commodity futures with that of the DJIA again. Stocks perform worst during the start of a recession and are at their best during the end of a recession. Commodities like oats, cocoa, orange juice and Azuki beans show a similar pattern. Others, however, like live cattle, hogs, lumber, rapeseed, and especially energy show the exact opposite pattern. Turning to the monetary regime classification, we see a similar picture. It is well documented that equity does better in an expansive regime. However, commodity behaviour is mixed and much less clear-cut. In all, this strongly suggests that some commodities will be better at diversifying equity and bond portfolios than others. We will investigate this further in Kat and Oomen (2006a).

[Insert Table 4 Here]

One could argue that both the above classifications are essentially the same as during an expansion (recession) the monetary regime is more likely to be restrictive (expansive). Table 4 therefore shows the link between the business cycle phase and the monetary regime over the period 1965–2005. From the table we see that there is indeed some overlap, with an expansive monetary regime most common during the end of a recession or the start of an expansion phase, and a restrictive regime most common during an expansion.

[Insert Table 5 Here]

It is customary to distinguish between situations where the futures curve is upward sloping and where the curve is downward sloping. In the first case, we speak of "contango", while in the second case the market is said to be in "backwardation". Defining backwardation as a situation where the nearby futures price is higher than the next nearby price,[10] and contango as the opposite case, Table 5 shows the backwardation frequencies (i.e. the percentage of days the futures market was in backwardation) for a selection of 29 commodities, over the benchmark period 1987–2005 as well as in different economic phases. Table 5 shows that over time futures markets for most commodities are sometimes in backwardation and sometimes in contango. The only exceptions are gold and silver, which are (virtually) always in contango. In addition, backwardation frequencies do not seem to depend on the state of the economy or the monetary regime.

[Insert Table 6 Here]

[10] Classifications based on maturities going further out yielded similar results and are therefore not reported.

Next, we classified futures returns based on the shape of the futures curve. Although it is impossible to say whether the expected futures return is positive or negative without knowing the expected future spot price, it is sometimes suggested that the shape of the futures curve provides similar information. The results can be found in Table 6, which not only provides information on average futures returns, but also on average spot and roll returns. The R^2 column shows the R^2 of a regression of futures returns on roll returns[11].

From Table 6 we see that, not surprisingly, average roll returns are positive when the market is in backwardation and negative when the market is in contango. The shape of the futures curve appears to make quite a difference for the futures return, although not too many cases are statistically significant. Average futures returns closely follow average roll returns; positive when the market is in backwardation and negative when the market is in contango. The R^2 values confirm that in many cases roll returns dominate spot returns. On average roll returns explain about half the variation in futures returns. For a number of commodities, like the soybean complex for example, the link is much stronger, however. In these cases the futures market very much leads its own live, with spot prices typically being much more stale than futures prices.

The finding that a backwardated market tends to offer a positive and a contango market a negative expected futures return is quite surprising. A priori there is no particular reason why it should be like this. Expected futures return depends on where the futures price is relative to the expected future spot price, not the current spot price. Could it be that when spot prices are relatively high or low, the market systematically overestimates the extent of a likely price drop or rise? We will return to this issue when discussing active trading strategies in Kat and Oomen (2006c).

Question 2: Are Commodity Futures Excessively Volatile?

Largely due to the extensive media coverage given to large price movements, such as recently seen in crude oil and copper for example, commodities are often thought to be extremely volatile. Indeed, some commodity prices may exhibit large swings over short periods of time in response to weather related events, supply shocks (incl. news about existing reserves) and speculative trading (e.g. Enron).

[11] These regressions are quite stable over different sub-periods. We therefore only report estimates over the longest periods available.

The theory of storage, which dates back to Kaldor (1939), tells us that volatility is also inversely related to the level of inventories. When there are little or no inventories to buffer, imbalances in supply and demand may result in dramatic price changes. In addition, prices and volatility will be positively correlated as both are negatively related to inventories. Of course, not all commodities are easily storable. Soybean meal, hogs, cattle, and gasoline for example are either not storable at all or tend to be prohibitively expensive to store.

For agricultural commodities (uncertainty about) natural variation in supply is an important source of volatility. Although planted area is largely a function of market prices, the yield from that area depends very much on the weather, with some areas, like Australia for example, prone to huge yield swings. Livestock production, such as pigs and poultry for example, can be more easily adjusted, but this often results in a classic boom and bust cycle, with high prices leading to oversupply followed by depressed prices and vice versa. In addition, meat and poultry can be seriously affected by (fears for) the outbreak of mad-cow disease, bird flu, salmonella, etc.

Currency movements can also be a source of commodity price volatility. Commodities, as real assets, typically rise (drop) in price when the currency in which they are quoted depreciates (appreciates). As most commodities trade in USD, this means commodity prices tend to be inversely related to the US dollar. In fact, the 15% drop of the US dollar since 2001, together with a stronger world economy, supply constraints, and a sharp rise in demand from China, is part of the reason for the current commodity bull market.

[Insert Table 7 Here]

To provide some insight in the volatility of commodity futures returns, using daily returns on the nearby contract for the same commodities as before, Table 7 shows the following volatility measures:

(1) The minimum, maximum, and 2.5 and 97.5 percentiles.

(2) The annualised standard deviation (σ_C).

(3) The ratio of the commodity standard deviation and the average standard deviation of all 30 stocks in the DJIA (σ_R).

(4) The sum of the GARCH (1,1) autoregressive and innovation parameter (i.e. $\gamma = \alpha + \beta$), which measures the level of persistence in commodity futures return volatility[12].

Table 7 also shows the average value of each of the above for the 30 stocks in the DJIA[13]. These will be our benchmark values for deciding whether commodity futures returns are indeed excessively volatile, compared to the average large cap stock. Note that, apart from providing information on volatility, the minimum, maximum, and 2.5 and 97.5 percentiles can also be interpreted from a skewness and/or VaR perspective.

The results in Table 7 confirm that commodity futures may exhibit relatively large price swings at times. The average volatility is 27.8% (annualised), but some commodities, like sugar, coffee, energy and broilers for example, have volatilities far higher than that. Compared with the average DJIA stock, things are not too bad though. The average ratio of commodity futures volatility to common stock volatility is a mere 0.89, indicating that the average commodity future is actually less volatile than the average US large cap stock (27.8% versus 29.5%). From the GARCH parameter, which for many commodities is 0.9 or higher, we see that volatility shocks in the commodity futures markets tend to persist for quite some time. Put another way, when volatility goes up (down), it can be expected to stay high (low) for a while. The average beta of 0.976 implies a half-life of a shock to volatility of about a month. These figures are, again, very much in line with those typically found for stock returns.

[Insert Table 8 Here]

As before, we also studied whether and how the above results depend on the business cycle, monetary conditions, and the shape of the futures curve. Using the same classification and commodities as before, the results can be found in Table 8, which shows the differences between futures return volatilities in the various subperiods and the 1987–2005 benchmark period. From the table we see that especially the volatility of energy futures varies quite a bit over different phases of the business cycle and different monetary environments. Energy is most volatile during recessions and least volatile during the start of an expansion phase. Expansive monetary conditions also appear to boost energy volatility. Finally, most commodities tend to be more volatile when the forward curve is in backwardation than when it is in contango. Interpreting backwardation as an indication of scarcity, this is not completely unsurprising.

[12] See for example Bollerslev, Engle, and Nelson (1994) for a review of the GARCH literature

[13] See www.djindexes.com for details on the composition of the DJIA.

Combining the results in Table 3 and 8, we see that high volatility and high excess returns do not necessarily go hand in hand. Cocoa volatility for example seems highest during the start of a recession, but that is also when excess returns are at their lowest. In energy we observe a similar pattern. Energy volatility is at its highest during the end of a recession, exactly when excess returns are at their lowest. The same phenomenon is observed in the averages over all commodities. During a recession, average commodity volatility is relatively high and average futures return relatively low.

Question 3: Are Commodity Futures Returns Skewed?

Although standard portfolio theory only looks at volatility as the appropriate risk measure, with alternative investments it is highly advisable to also look at higher moments such as the skewness and kurtosis of the return distribution. Intuitively, skewness measures whether there is an increased probability of a pleasant (positive skewness) or nasty (negative skewness) surprise. Of course, ceteris paribus, people will prefer positive over negative skewness.

Given that commodity prices are known to spike upwards every now and then, one might be inclined to think that commodity futures returns are positively skewed. On the other hand, futures returns do not need to display the same properties as spot returns. This is also the message from Table 7, where a comparison of the reported 2.5 and 97.5 percentiles suggests that there is little skewness to be found in daily commodity futures returns. To investigate this further, we looked at the daily returns on the nearby contract for the same commodities as before and calculated the following three skewness measures:

$$\begin{aligned} \text{Skew–I} &= \frac{1}{T}\sum_{t=1}^{T}\left(\frac{R_t-\widehat{\mu}}{\widehat{\sigma}}\right)^3 \\ \text{Skew–II} &= \frac{\widehat{P}_{75}+\widehat{P}_{25}-2\widehat{P}_{50}}{\widehat{P}_{75}-\widehat{P}_{25}} \\ \text{Skew–III} &= T\frac{\widehat{\mu}-\widehat{P}_{50}}{\sum_{t=1}^{T}|R_t-\widehat{P}_{50}|} \end{aligned}$$

where $\widehat{\mu} = T^{-1}\sum_t R_t$, $\widehat{\sigma}^2 = T^{-1}\sum_t (R_t-\widehat{\mu})^2$, and $\widehat{P}_\alpha$ denotes the estimated $\alpha-$percentile of R. Skew-I is the conventional skewness measure. Because Skew-I is known to be sensitive to outliers we also compute Skew-II and Skew-III, which are more robust.[14] Intuitively, Skew-II and III measure

[14] See Kim and White (2004) for further details. Note that Skew-I is unbounded, while Skew-II and Skew-III are bounded

the asymmetry in distribution mass to gauge skewness. In addition, for every commodity we estimate a GARCH(1,1) model with innovations following a skewed Student-t distribution. The above three skewness measures (all multiplied by 100) as well as the estimated GARCH skew parameters can be found in Table 9. Significance levels[15] relative to zero are indicated as before. For all statistics, positive values indicate positive skewness, and vice versa.

[Insert Table 9 Here]

Table 9 provides mixed results. Some commodities exhibit positive, while others exhibit negative skewness. In addition, different measures often point in different directions. For only 8 out of 42 commodities do all three skewness measures have the same sign. Of course, outliers will have a disproportionate impact on the traditional skewness measure (Skew-I). The negative Skew-I figures for heating oil, crude oil, gasoline and propane for example are to a large extent due to the US invasion of Iraq on January 17, 1991 ("Operation Desert Storm"), when the price of crude oil dropped 40%, heating oil 39.1%, propane 38.9% and gasoline 31% in a single day[16]. Without these outliers daily energy returns appear hardly skewed at all, which is consistent with the results of the other two skewness measures. Overall, Table 9 indicates that, ignoring the outliers, there is little skewness to be found in daily futures returns. This conclusion sharply contrasts with the popular idea that because commodities have positive exposure to supply shocks, futures returns will typically be positively skewed. It also underlines the fact that spot returns and futures returns do not necessarily need to share the same properties.

Question 4: Do Commodity Futures Returns Exhibit Fat Tails?

Kurtosis is also an important statistic to look at when evaluating an asset or asset class' investment merits. The fatter the return distribution's tails, the higher the probability of an extreme outcome, and vice versa. Investors who are primarily after steady long-term growth will typically prefer low kurtosis.

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between $+1$ and -1.

[15]Throughout this paper we use bootstrapped significance levels, based on 10,000 replications. It is noted that when we do so for statistics involving high order moments like skewness and kurtosis, the conditions of the bootstrap may be restrictive (in that certain required moments may not exist) and one should be careful interpreting the results. See for instance Horowitz (2001) for further details.

[16]The building up and subsequent collapse of a so-called "war premium" is not uncommon in crisis and conflict situations. See Looney (2003).

Since commodities are well known for their sometimes aggressive price swings, it seems plausible that kurtosis in most commodities will be above normal. To investigate whether this is also the case for commodity futures, we calculated, again using daily returns on the nearby contract, the following three kurtosis measures:

$$\begin{aligned}
\text{Kurt–I} &= \frac{1}{T}\sum_{t=1}^{T}\left(\frac{R_t-\widehat{\mu}}{\widehat{\sigma}}\right)^4 - 3 \\
\text{Kurt–II} &= \frac{\widehat{P}_{87.5}-\widehat{P}_{62.5}+\widehat{P}_{37.5}-\widehat{P}_{12.5}}{\widehat{P}_{75}-\widehat{P}_{25}} - 1.23 \\
\text{Kurt–III} &= \frac{\widehat{P}_{97.5}-\widehat{P}_{2.5}}{\widehat{P}_{75}-\widehat{P}_{25}} - 2.91
\end{aligned}$$

Kurt-I is the conventional excess kurtosis measure. Because this measure is again quite sensitive to outliers, we also report Kurt-II and Kurt-III. The latter statistics are more robust since they rely on return percentiles, rather than fourth powers of returns. Intuitively, Kurt-II and III measure the "fat-tailedness" by comparing the distribution mass in the tails relative to that in the center of the distribution. When returns are truly leptokurtic, all measures will yield positive values. In addition, for every commodity we also estimate the number of degrees of freedom for a GARCH(1,1) model with innovations following a skewed Student-t distribution. A large number of degrees of freedom means a distribution close to normal. A small number implies fat tails. The motivation for computing the GARCH-based kurtosis measure is to gauge to what extent time varying volatility is accountable for the fat tails in the marginal return distribution. The results can be found in Table 10.

[Insert Table 10 Here]

From Table 10 we see that virtually all commodities studied exhibit excess kurtosis, i.e. relatively fat tails. This holds even after accounting for time varying volatility, as is clear from the estimated degrees of freedom in the GARCH innovations. The only exceptions are cattle, hogs, cocoa, Azuki beans, rubber and silk, for which there is little, and pork bellies, lumber and eggs for which there appears to be no excess kurtosis. Comparing the commodity futures results with the results for the average stock in the DJIA index, we see that kurtosis in daily commodity futures returns is not too different from that in US large cap stocks.

Question 5: Are Commodity Futures Autocorrelated?

So far, we have concentrated on daily returns. But what about weekly or monthly commodity returns? When daily returns are independent, the properties of weekly and monthly returns can easily be derived from those of daily returns. Monthly volatility for example will be equal to $\sqrt{22}$ times daily volatility. The big question therefore is whether daily commodity futures returns are indeed independent. To investigate this, we calculated autocorrelation coefficients ($\times 100$) for lags of 1–4 days, as well as the Box-Ljung test statistic including 10 lags (95% critical value of 18.31). The results can be found in Table 11.

[Insert Table 11 and Table 12 Here]

Table 11 shows that most commodities indeed exhibit significant autocorrelation, implying that futures returns from one day to the next are in some way connected. With positive autocorrelation, a rise (fall) in one day is more likely to be followed by a further rise (fall) the next day. The result is that, when calculated from daily data, true volatility is underestimated to some extent. Table 12 shows the volatility, skewness, and kurtosis of daily as well as monthly returns, which confirms that volatilities calculated from monthly futures return data tend to be higher than volatilities calculated from daily data. The problem seems especially acute for agricultural commodities. From daily corn futures returns, for example, one would calculate a volatility of 20.7%. Monthly corn futures returns, however, yield an estimate of 23.3%.

From Table 12 we also see that, in line with the Central Limit Theorem, high kurtosis levels go down when we move from daily to monthly returns. Unlike what one would expect, in 21 out of 29 cases Skew-I (in absolute terms) increases if we move from daily to monthly returns. In addition, in a number of cases, we notice a rather remarkable change in sign. This is especially evident in energy. Of course, much of this is again the result of a few outliers. This is confirmed by the second skewness measure as well as by re-calculating skewness while leaving out the largest two observations (not reported). Overall, it seem safe to conclude that monthly skewness is in line with daily skewness and quite low.

Conclusion

In this paper we have studied some key features of the marginal return distribution for a variety of commodity futures, showing that daily and monthly commodity futures returns are a lot better behaved that one might expect. Volatility and kurtosis are comparable to that of US large cap stocks. Expected returns are lower, but skewness is higher. In sum, the answers to the questions raised in the introduction are as follows:

A1. With the notable exception of energy, commodity futures do not appear to generate a consistent risk premium. This underlines how deceptive the returns on commodity indices can be. The higher the energy allocation, the higher the index returns and the more investors will be inclined to believe that all commodities are capable of generating a positive risk premium.

A2. Contrary to popular perception, volatility of commodity futures is not excessive and comparable to that of typical US large cap stocks. This finding holds, even after correcting for the bias in volatility estimates due to the presence of serial correlation in daily futures returns.

A3. Skewness in commodity futures returns is minimal and largely insignificant. This is clearly at odds with the popular idea that because commodities have positive exposure to supply shocks, commodity futures returns will be positively skewed.

A4. The distribution of commodity futures return has fat tails, which are in part generated by time-varying volatility. Overall, however, the level of kurtosis and volatility persistence is comparable to that found in US large cap stocks.

A5. Daily commodity futures returns exhibit positive autocorrelation, which might be symptomatic of behavioral biases, prolonged impact of shocks, contagion in events, etc. Volatility from daily futures return data will tend to underestimate true volatility.

In addition, we have shown that commodity futures returns and volatility may vary considerably over different phases of the business cycle, under different monetary conditions as well as with the shape of the futures curve. This suggests that a purely passive investment in commodities may not be optimal and, given the differences in behaviour of different commodities, that some commodities will be better at diversifying equity and bond portfolios than others.

Characterized by a very significant risk premium, relatively high volatility, and strong variation between different business cycle phases and monetary enviroments, the energy sector turns out to be quite a special case. The properties of heating oil, crude oil, gasoline, propane and kerosene are very similar amongst each other, but quite different from all other commodities. When analysing commodities in general it is therefore advisable to treat energy as a separate class.

A final remark concerns the extent to which our results can be extrapolated into the future. As mentioned before, commodity futures markets are currently experiencing a shift in clientele. Although some investors, including CTAs, have always been active in commodities, the recent interest in commodities as a new asset class as well as the increasing interest and growth of the hedge fund industry could have a significant impact on price formation and thereby on the properties of commodity futures returns. Part of the return on commodity futures stems from hedging pressure pushing futures prices away from expected future spot prices. As more capital comes to the market, however, the displacement of futures prices required to absorb hedging demand may become smaller and smaller, thereby eliminating any premium that historically may have been available. As always, too much capital chasing too few opportunities is likely to spoil things for everybody.

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Table 1: Overview of commodity contracts

	Contract	Exchange	Futures	NC	CUR	Spot		Contract	Exchange	Futures	NC	CUR	Spot
1.	Corn	CBOT	65–05	5	USD	65–05	23.	Palladium	NYMEX	77–05	2	USD	83–05
2.	Oats	CBOT	65–05	4	USD	70–05	24.	Heating Oil No.2	NYMEX	79–05	8	USD	78–05
3.	Platinum	NYMEX	65–05	4	USD	77–05	25.	Light Crude Oil	NYMEX	83–05	7	USD	83–05
4.	Frozen Pork Bellies	CME	65–05	4	USD	66–05	26.	Unleaded Gasoline	NYMEX	85–05	8	USD	84–05
5.	Soybeans	CBOT	65–05	6	USD	65–05	27.	Liquified Propane	NYMEX	87–05	4	USD	88–05
6.	Soybean Meal	CBOT	65–05	7	USD	65–05	28.	Azuki Red Beans	TGE	84–05	5	JPY	
7.	Soybean Oil	CBOT	65–05	7	USD	66–05	29.	Rough Rice	CBOT	87–05	4	USD	
8.	Wheat	CBOT	65–05	4	USD	66–05	30.	Crude Palm Oil	MDEX	92–05	5	MYR	
9.	Live Cattle	CME	66–05	5	USD	66–05	31.	Rubber	TCE	92–05	5	JPY	
10.	Cocoa	CSCE	66–05	6	USD	66–05	32.	Raw Silk	YCE	94–05	5	JPY	
11.	Copper	COMEX	66–05	5	USD		33.	Greasy Wool	SFE	95–05	8	AUD	
12.	Lean Hogs	CME	66–05	5	USD	66–05	34.	Western Barley	WCE	96–05	4	USD	83–05
13.	Sugar	CSCE	66–05	5	USD	66–05	35.	Butter	CME	96–05	3	USD	
14.	Cotton	NYCE	67–05	6	USD	73–05	36.	Milk	CME	97–05	8	USD	
15.	Orange Juice	NYCE	67–05	5	USD		37.	Yellow Maize	SAFEX	98–05	4	ZAR	
16.	Silver	COMEX	67–05	6	USD	67–05	38.	Aluminium	COMEX	99–05	9	USD	
17.	Flaxseed	WCE	70–05	2	CAD		39.	Electricity	NYMEX	99–05	9	USD	
18.	Lumber	CME	70–05	4	USD	77–05	40.	Kerosene	TCE	99–05	6	JPY	
19.	Rapeseed	WCE	70–05	2	CAD	72–05	41.	Broilers	KCX	00–05	6	JPY	
20.	Feeder Cattle	CME	71–05	4	USD	77–05	42.	Eggs	CCX	00–05	5	JPY	
21.	Coffee	CSCE	72–05	5	USD	73–05							
22.	Gold	COMEX	75–05	8	USD	75–05		DJIA Index				USD	62–05

Table 2: Historic average futures returns

	Contract	1970–2005	1987–2005	2000–2005		Contract	1970–2005	1987–2005	2000–2005
1.	Corn	–6.63**	–8.78**	–18.3**	23.	Palladium		0.71	–25.7*
2.	Oats	–6.58*	–9.90*	15.6	24.	Heating Oil No.2		16.1**	17.5
3.	Platinum	2.27	2.39	16.5*	25.	Light Sweet Crude Oil		14.1*	25.9*
4.	Frozen Pork Bellies	–4.41	–4.97	13.4	26.	Unleaded Gasoline		21.4**	25.0*
5.	Soybeans	–1.17	–1.30	3.23	27.	Liquified Propane		16.2**	20.0*
6.	Soybean Meal	1.12	5.49	10.6	28.	Azuki Red Beans		–3.46	–17.8**
7.	Soybean Oil	1.47	–4.75	0.76	29.	Rough Rice		–14.2**	–19.3*
8.	Wheat	–4.86	–8.53*	–14.5	30.	Crude Palm Oil			1.46
9.	Live Cattle	4.45*	5.10*	9.28	31.	Rubber			2.87
10.	Cocoa	2.57	–8.00	14.9	32.	Raw Silk			0.74
11.	Copper	2.65	8.16*	8.25	33.	Greasy Wool			12.7
12.	Lean Hogs	5.18	2.22	0.76	34.	Western Barley			7.86
13.	Sugar	–7.72	5.79	12.7	35.	Butter			0.10
14.	Cotton	1.21	–6.85	–23.6*	36.	Milk			3.74
15.	Orange Juice	–1.57	–7.56	–13.5	37.	Yellow Maize			–3.51
16.	Silver	–3.59	–6.02	3.40	38.	Aluminium			2.39
17.	Flaxseed	0.49	1.36	16.5**	39.	Electricity			–55.2**
18.	Lumber	–2.99	–0.94	–5.96	40.	Kerosene			23.4**
19.	Rapeseed	–1.33	–3.30	–0.84	41.	Broilers			–28.4
20.	Feeder Cattle		4.75*	9.82*	42.	Eggs			2.54
21.	Coffee		–5.97	–18.3		Commodity average	–1.02	0.15	1.04
22.	Gold		–4.74*	6.45		DJIA index	0.27	3.03	–2.56

Table 3: Expost classification of historic average futures returns

		Benchmark	Business cycle conditions				Monetary conditions		
	Contract	87–05	SR	ER	SE	EE	EM	RM	AM
1.	Corn	–8.78	–42.9*	–7.75	–6.19	–8.26	–18.5	–30.5**	2.04*
2.	Oats	–9.90	–25.1	73.0**	0.44	–27.3**	15.2*	–13.5	–17.1
3.	Platinum	2.39	–33.5*	–34.9	9.31	2.17	–3.20	21.4*	–2.34
4.	Frozen Pork Bellies	–4.97	29.0	8.93	–8.68	–5.72	6.73	–16.9	–4.78
5.	Soybeans	–1.30	–5.32	–27.4	4.42	–4.41	–16.1*	–15.0	8.43*
6.	Soybean Meal	5.49	4.08	–14.5	5.40	7.65	–7.03	–6.42	13.8
7.	Soybean Oil	–4.75	–14.2	–15.4	3.27	–11.3	–19.7*	–11.2	2.52
8.	Wheat	–8.53	–49.7**	–3.68	2.05	–16.1	–8.49	–20.0	–4.54
9.	Live Cattle	5.10	12.1	–7.93	6.13	4.59	7.42	–1.31	6.55
10.	Cocoa	–8.00	–37.0	35.7	–3.53	–13.9	11.4	–10.1	–13.8
11.	Copper	8.16	–11.3	–1.39	9.95	9.08	–13.3**	40.1**	4.26
12.	Lean Hogs	2.22	22.6	–0.02	0.34	2.43	0.09	–3.39	4.89
13.	Sugar	5.79	–20.8	–31.5	13.7	3.58	–16.0	20.6	7.93
14.	Cotton	–6.85	–45.7	1.48	–0.98	–9.97	–35.4**	–1.29	0.77
15.	Orange Juice	–7.56	–42.5	11.5	–10.4	–2.88	–1.23	13.1	–16.8
16.	Silver	–6.02	–37.2*	–19.3	6.50*	–14.9	2.99	–10.1	–7.63
17.	Flaxseed	1.36	4.23	–32.0**	2.61	3.00	–9.68*	–5.77	7.43
18.	Lumber	–0.94	11.0	–43.4*	4.90	–4.20	26.9**	–23.6**	–2.47
19.	Rapeseed	–3.30	13.9	–5.44	0.73	–9.02	–4.39	–15.6	1.37
20.	Feeder Cattle	4.75	15.5	2.96	5.69	2.87	4.34	–3.97	7.91
21.	Coffee	–5.97	–42.1	–36.7	0.15	–5.95	–29.6*	15.8	–5.63
22.	Gold	–4.74	1.54	–8.10	3.50**	–13.7**	1.28	–1.08	–8.04
23.	Palladium	0.71	–93.5**	–64.5*	–4.86	22.1**	–20.1	14.4	2.99
24.	Heating Oil No.2	16.1	71.6	–58.9	11.9	22.2	–22.4**	38.0	21.4
25.	Light Sweet Crude Oil	14.1	60.9	–77.5	19.8	12.2	–6.69	38.4*	12.6
26.	Unleaded Gasoline	21.4	82.2	–37.6	18.7	24.0	–0.03	48.0*	19.4
27.	Liquified Propane	16.2	26.4	–58.1	25.0	12.8	–31.7**	32.0	26.8
28.	Azuki Red Beans	–3.46	–94.3**	31.0	0.65	–2.04	10.4	19.2**	–15.9*
29.	Rough Rice	–14.2	–40.7	–31.1	–6.11	–18.5	–22.6	–19.7	–9.49
	Commodity average	0.15	–9.68	–15.6	3.95	–1.36	–6.88	3.16	–1.47
	DJIA Index	3.03	–26.2	6.05	5.51	2.90	9.85	–9.41	4.99

Table 4: Monetary regime over the business cycle in number of months (1965–2005)

	Expansive Regime	Restrictive Regime	Awaiting Regime	Total
Start of recession	9	7	21	37
End of recession	21	0	13	34
Start of expansion	60	39	106	205
End of expansion	13	73	121	207
Total	103	119	261	483

Table 5: Ex-post classification of backwardation frequencies (1987–2005)

			Business cycle conditions				Monetary conditions		
	Contract	benchmark	SR	ER	SE	EE	expansive	restrictive	awaiting
1.	Corn	12.6	22.0	–	10.1	15.6	9.51	6.21	15.9
2.	Oats	24.2	23.0	39.6	23.3	23.9	28.6	19.1	24.6
3.	Platinum	48.3	50.0	47.3	54.5	41.6	54.0	56.1	43.6
4.	Frozen Pork Bellies	57.0	62.3	88.8	52.9	57.6	65.1	54.1	55.2
5.	Soybeans	26.7	27.7	13.4	30.6	23.9	22.1	28.5	27.7
6.	Soybean Meal	54.5	48.2	50.3	46.4	64.0	53.8	49.4	56.5
7.	Soybean Oil	18.2	11.0	–	35.4	2.52	5.27	35.8	16.4
8.	Wheat	26.3	–	–	33.9	23.6	21.5	21.4	29.7
9.	Live Cattle	48.2	61.8	43.3	54.7	40.5	44.3	49.6	49.1
10.	Cocoa	16.7	23.0	17.7	22.2	10.1	26.9	19.1	12.4
11.	Copper	52.2	50.0	49.5	49.1	55.9	41.7	59.6	53.1
12.	Lean Hogs	50.6	73.3	57.8	47.2	51.2	45.8	43.1	54.8
13.	Sugar	57.3	87.4	69.6	53.5	57.1	77.9	37.5	57.3
14.	Cotton	26.8	39.5	41.7	30.6	20.2	29.0	30.5	24.8
15.	Orange Juice	34.6	43.7	7.82	18.8	52.9	22.2	35.3	38.5
16.	Silver	1.22	–	–	0.69	2.02	1.04	0.11	1.67
17.	Flaxseed	24.8	21.8	21.0	18.8	31.8	21.7	13.4	29.7
18.	Lumber	39.2	34.6	23.5	33.7	47.0	31.2	35.7	43.1
19.	Rapeseed	22.3	12.2	23.7	26.6	18.7	18.0	20.9	24.3
20.	Feeder Cattle	63.4	77.0	77.5	76.8	46.5	67.1	55.1	65.0
21.	Coffee	24.1	–	–	9.95	43.5	12.1	13.7	31.6
22.	Gold	–	–	–	–	–	–	–	–
23.	Palladium	42.6	–	0.54	27.0	67.1	25.9	46.7	46.7
24.	Heating Oil No.2	37.4	34.7	48.9	27.3	47.2	33.2	35.5	39.5
25.	Light Sweet Crude Oil	58.8	43.2	62.0	58.6	60.2	57.1	73.0	54.4
26.	Unleaded Gasoline	60.8	92.6	51.6	56.2	63.4	61.1	66.0	58.9
27.	Liquified Propane	33.9	9.47	49.2	37.2	31.3	42.3	39.6	29.0
28.	Azuki Red Beans	45.1	13.2	38.3	46.0	47.9	32.4	56.1	45.5
29.	Rough Rice	16.2	44.5	–	13.4	17.8	11.2	10.2	19.9
	Commodity average	35.3	34.7	31.8	34.3	36.7	33.2	34.9	36.2

Table 6: Ex-post classification of average future, spot, and roll returns

		Benchmark (1987–05)				Backwardation			Contango		
	Contract	Future	Spot	Roll	R^2	Future	Spot	Roll	Future	Spot	Roll
1.	Corn	–8.78**	0.93	–9.71**	80.9	–19.6	–29.5**	9.98**	–7.41	5.15	–12.6
2.	Oats	–9.90*	0.30	–10.2**	41.9	39.6**	1.18	38.4**	–25.6**	0.09	–25.7**
3.	Platinum	2.39	2.59	–0.20	37.8	15.0**	9.48	5.54	–9.50**	–3.94	–5.56
4.	Frozen Pork Bellies	–4.97	2.26	–7.23	9.49	17.1**	0.64	16.5*	–34.4**	4.14	–38.6*
5.	Soybeans	–1.30	0.09	–1.39	87.0	–2.83	–15.2	12.4**	–1.02	5.40	–6.42**
6.	Soybean Meal	5.49	–0.46	5.95**	83.8	14.9	–0.55	15.5**	–6.21*	–0.74	–5.47**
7.	Soybean Oil	–4.75	1.25	–6.00**	91.1	8.90	3.22	5.68**	–7.86	0.74	–8.60*
8.	Wheat	–8.53*	1.36	–9.89**	72.8	9.15**	–3.74	12.9**	–15.1	2.90	–18.0**
9.	Live Cattle	5.10*	1.68	3.42	0.67	8.39	12.9**	–4.53	1.82	–9.00*	10.8
10.	Cocoa	–8.00	–0.71	–7.29**	72.4	43.7**	24.5	19.2**	–18.6*	–5.97	–12.6*
12.	Lean Hogs	2.22	2.12	0.10	4.00	11.8*	2.91	8.92	–8.08	0.83	–8.91
13.	Sugar	5.79	2.58	3.21	51.9	16.5	–2.77	19.2**	–7.00	11.2	–18.2**
14.	Cotton	–6.85	–2.70	–4.15	73.4	15.3**	–8.82	24.1**	–14.8	–0.31	–14.5**
16.	Silver	–6.02	–0.38	–5.64*	51.1	147**	126*	21.4	–8.14	–2.17	–5.97
18.	Lumber	–0.94	4.02	–4.96	0.17	28.1**	25.8*	2.25	–20.0**	–10.4*	–9.61
19.	Rapeseed	–3.30	0.82	–4.12*	68.8	4.18	4.41	–0.23	–5.97	–0.73	–5.24
20.	Feeder Cattle	4.75*	1.65	3.10	0.25	10.0*	5.52**	4.48	–4.55**	–5.27**	0.73
21.	Coffee	–5.97	–0.31	–5.66	30.9	32.8**	12.8	20.0**	–17.5	–3.73	–13.8
22.	Gold	–4.74*	–0.32	–4.42*	28.0	–	–	–	–4.87	–0.45	–4.42
23.	Palladium	0.71	2.04	–1.33	55.8	35.4**	31.1**	4.33	–24.9**	–19.4**	–5.53
24.	Heating Oil No.2	16.1**	5.70	10.4**	66.3	71.4**	27.5	43.8**	–17.9**	–8.32*	–9.58**
25.	Light Sweet Crude Oil	14.1*	5.43	8.67**	78.6	61.1**	32.7**	28.4**	–53.9**	–34.4**	–19.5**
27.	Unleaded Gasoline	21.4**	5.60	15.8**	60.6	53.5**	17.6	35.9**	–29.2**	–13.9	–15.4**
28.	Liquified Propane	16.2**	6.90	9.30	41.2	38.4	–7.01	45.4**	4.36*	13.5	–9.16**
	Commodity average	0.84	1.77	–0.93	49.5	27.5	11.3	16.2	–14.0	–3.11	–10.9

Table 7: Variability of daily commodity futures returns

	Contract	min	2.5%	97.5%	max	σ_C	σ_R	γ		Contract	min	2.5%	97.5%	max	σ_C	σ_R	γ
1.	Corn	–8.79	–2.82	2.84	6.98	20.6	0.70	0.995	23.	Palladium	–18.9	–4.33	4.00	15.3	31.7	1.06	0.986
2.	Oats	–11.0	–3.86	3.78	11.1	29.0	0.98	0.990	24.	Heating Oil No.2	–39.1	–4.32	4.42	14.0	33.8	1.11	1.000
3.	Platinum	–16.8	–3.87	3.51	10.8	26.8	0.91	0.994	25.	Light Sweet Crude Oil	–40.0	–4.37	4.51	14.0	36.2	1.17	1.000
4.	Pork Bellies	–7.60	–4.03	4.01	8.32	33.7	1.14	0.989	26.	Unleaded Gasoline	–31.0	–4.53	4.47	12.3	35.8	1.14	0.993
5.	Soybeans	–15.3	–3.26	3.14	12.5	23.5	0.80	0.992	27.	Liquified Propane	–38.9	–4.15	4.10	23.1	35.2	1.11	1.000
6.	Soybean Meal	–15.1	–3.72	3.57	16.0	27.1	0.92	0.993	28.	Azuki Red Beans	–6.30	–3.40	3.24	7.77	25.6	0.82	0.974
7.	Soybean Oil	–7.37	–3.43	3.65	9.18	26.7	0.90	0.988	29.	Rough Rice	–9.10	–3.24	3.27	9.26	24.3	0.77	0.993
8.	Wheat	–9.51	–3.16	3.20	9.08	23.8	0.81	0.990	30.	Crude Palm Oil	–11.4	–3.17	3.21	12.1	25.2	0.79	0.979
9.	Live Cattle	–6.36	–2.28	2.22	4.26	16.8	0.57	0.996	31.	Rubber	–12.4	–4.51	4.26	8.65	33.4	1.06	0.968
10.	Cocoa	–10.0	–3.82	3.79	12.6	30.6	1.04	0.995	32.	Raw Silk	–6.79	–4.19	4.02	7.64	31.1	0.94	0.944
11.	Copper	–12.5	–3.39	3.31	9.14	25.5	0.86	0.995	33.	Greasy Wool	–8.63	–2.77	2.80	7.35	21.9	0.65	0.884
12.	Lean Hogs	–6.88	–3.26	3.07	6.88	24.3	0.82	0.990	34.	Western Barley	–5.23	–2.02	2.22	5.08	16.1	0.46	0.961
13.	Sugar	–23.4	–5.45	5.14	14.2	41.0	1.39	0.995	35.	Butter	–7.52	–3.34	3.57	7.52	24.3	0.70	0.882
14.	Cotton	–8.64	–3.00	2.94	11.3	23.1	0.78	0.996	36.	Milk	–6.53	–2.69	2.65	6.25	19.7	0.55	0.920
15.	Orange Juice	–13.5	–3.62	3.47	23.9	27.6	0.94	0.987	37.	Yellow Maize	–8.66	–3.79	3.90	12.8	30.0	0.82	0.981
16.	Silver	–19.4	–3.92	3.64	9.24	28.2	0.96	0.994	38.	Aluminium	–6.92	–1.90	2.14	5.31	16.1	0.45	0.973
17.	Flaxseed	–7.34	–2.79	2.89	9.38	21.2	0.71	0.969	39.	Electricity	–28.5	–6.70	6.66	26.2	56.1	1.62	0.992
18.	Lumber	–4.55	–3.21	3.20	5.05	26.0	0.88	0.998	40.	Kerosene	–12.9	–2.90	3.08	11.8	24.9	0.69	0.967
19.	Rapeseed	–9.30	–2.85	2.88	15.9	21.4	0.72	0.980	41.	Broilers	–25.9	–6.75	6.24	62.6	62.7	1.75	0.822
20.	Feeder Cattle	–6.01	–2.10	2.04	3.87	15.8	0.53	0.995	42.	Eggs	–3.61	–2.13	2.16	3.92	16.8	0.47	0.964
21.	Coffee	–15.0	–4.50	4.54	23.8	35.7	1.20	0.997		Commodity average	–13.6	–3.58	3.53	12.3	27.8	0.89	0.976
22.	Gold	–9.91	–2.72	2.42	9.74	19.3	0.65	1.000		DJIA components	–24.8	–3.46	3.91	19.1	29.5	1.00	0.985

Table 8: Expost classification of daily futures return volatility

		Benchmark	Business cycle conditions				Monetary conditions			Futures curve	
	Contract	87–05	SR	ER	SE	EE	EM	RM	AM	BW	CT
1.	Corn	20.7	0.65	–3.17**	–1.84**	1.98**	–3.38**	–0.05	1.01**	3.79**	–0.61**
2.	Oats	30.2	2.67	4.46**	0.41	–1.24**	–0.78	–2.62**	1.10**	4.79**	–1.77**
3.	Platinum	20.2	2.26	9.33**	–3.03**	1.55**	0.07	2.49**	–0.97**	1.76**	–1.82**
4.	Frozen Pork Bellies	35.0	1.05	–3.79**	–3.10**	3.23**	–1.35*	–2.65**	1.31**	–0.51	0.59
5.	Soybeans	21.2	–1.62*	–3.15**	–0.31	0.75*	–4.06**	1.78**	0.57	3.88**	–1.60**
6.	Soybean Meal	22.9	–0.61	–3.67**	–0.99**	1.37**	–3.34**	2.06**	0.29	2.01**	–2.68**
7.	Soybean Oil	21.7	–1.59	0.37	0.15	–0.04	–2.69**	1.90**	0.16	3.20**	–0.78**
8.	Wheat	23.0	–1.01	–2.11**	0.39	–0.14	–1.35**	–0.96*	0.76*	–1.82**	0.61*
9.	Live Cattle	13.8	–3.29**	–1.47**	0.96**	–0.63**	–0.96**	1.09**	–0.08	–0.62**	0.55**
10.	Cocoa	30.9	8.38**	1.06	0.25	–1.33**	1.05	2.45**	–1.27**	5.65**	–1.30**
11.	Copper	25.6	–3.19**	–6.56**	–4.06**	4.41**	–7.51**	2.06*	1.34**	3.57**	–4.65**
12.	Lean Hogs	23.4	–2.92**	0.69	–0.59*	0.81*	2.68**	–0.51	–0.78**	–2.30**	2.13**
13.	Sugar	33.3	2.06	–1.34	–2.30**	2.18**	–0.99	–0.08	0.35	0.98	–1.36*
14.	Cotton	24.1	4.22	1.26	2.37**	–3.43**	2.11**	2.02**	–1.53**	–0.00	–0.02
15.	Orange Juice	30.3	–1.02	0.31	–0.19	0.28	0.81	2.36	–1.15*	–0.07	–0.15
16.	Silver	23.5	–3.40**	1.40	0.83	–0.75	–3.03**	1.50	0.42	20.1**	–0.37
17.	Flaxseed	17.9	–0.43	–3.07**	–1.20**	1.45**	–2.92**	–0.67	1.08**	0.71*	–0.26
18.	Lumber	26.5	1.43	1.33	2.78**	–3.60**	1.55**	–0.18	–0.50*	–1.33**	0.76**
19.	Rapeseed	18.6	–0.27	–5.29**	0.78**	–0.38	–2.72**	2.34**	–0.01	1.65**	–0.50**
20.	Feeder Cattle	12.3	–3.44**	–2.27**	0.34	0.13	–1.52**	0.77**	0.20	–0.46**	0.74**
21.	Coffee	39.5	–9.89**	–4.86*	–1.00	2.27**	–6.53**	10.4**	–2.13**	5.50**	–1.93**
22.	Gold	13.4	5.61**	3.65	–1.09**	0.03	–0.07	1.62**	–0.58*	–13.4**	0.00
23.	Palladium	29.9	–0.67	9.34**	–3.02**	1.91*	1.75*	–0.99	–0.27	2.64**	–2.22**
24.	Heating Oil No.2	36.3	21.2**	33.0**	–4.85**	–2.56**	7.18**	0.11	–2.83**	5.62**	–4.00**
25.	Light Sweet Crude Oil	36.8	22.1**	39.5**	–7.87**	–1.22*	8.18**	–2.61**	–2.26**	0.41	–1.01
26.	Unleaded Gasoline	35.7	20.9**	27.6**	–3.53**	–2.86**	6.05**	0.26	–2.39**	–1.04*	1.34
27.	Liquified Propane	35.2	20.4**	34.4**	–9.59**	1.30	6.52	–5.36**	–0.72	13.0**	–9.05**
28.	Azuki Red Beans	25.7	3.48**	–2.24**	1.72**	–2.20**	–1.00*	–0.32	0.41	0.58	–0.48
29.	Rough Rice	24.3	4.82*	–3.01**	1.37**	–1.79**	–1.50*	1.90**	–0.19	3.81**	–0.81**
	Commodity average	25.9	3.03	4.19	–1.25	0.05	–0.27	0.69	–0.30	2.14	–1.06
	DJIA components	31.7	2.41	3.88	–1.59	4.06	2.50	5.58	–0.45		

Table 9: Skewness of daily commodity futures returns

		Skewness			GARCH			Skewness			GARCH
	Contract	I	II	III	$t-skew$	Contract	I	II	III	$t-skew$
1.	Corn	4.61	–2.20*	–2.61**	2.83**	23. Palladium	–11.4	2.04	0.32	–2.17
2.	Oats	–4.31	–1.42	–1.80*	–2.52	24. Heating Oil No.2	–103	0.95	–0.01	–1.53
3.	Platinum	–23.4**	4.37**	0.67	–5.49**	25. Light Sweet Crude Oil	–122**	1.52	–0.38	–3.90**
4.	Frozen Pork Bellies	–0.22	–0.64	–0.84	–0.90**	26. Unleaded Gasoline	–66.4**	–1.04	–1.81	–5.93**
5.	Soybeans	–21.6*	2.41	–0.12	–3.02*	27. Liquified Propane	–138	9.26**	4.90**	–3.47**
6.	Soybean Meal	6.00	2.14	1.24	4.12**	28. Azuki Red Beans	–1.29	1.61	–0.56	–3.31**
7.	Soybean Oil	14.4**	–1.52	1.26**	6.47**	29. Rough Rice	7.51	–6.07*	–3.85*	2.52
8.	Wheat	10.5**	–3.63**	–1.99*	1.02*	30. Crude Palm Oil	25.4	0.05	1.24	1.29
9.	Live Cattle	–11.8**	6.17*	2.58	–4.91**	31. Rubber	–17.5**	0.02	–2.21*	–4.55**
10.	Cocoa	12.1**	–0.18	0.45	1.09**	32. Raw Silk	3.65	–3.14	–1.96	2.42
11.	Copper	–19.7**	2.97*	1.14	–2.09	33. Greasy Wool	3.65	–1.81	–1.43	–4.16*
12.	Lean Hogs	–8.72**	5.29**	2.08*	–4.67**	34. Western Barley	25.1**	1.73	6.62	8.73**
13.	Sugar	–24.3**	–0.66	–1.75	–2.12	35. Butter	1.47	17.7**	6.04**	0.23
14.	Cotton	1.58	1.05	–0.12	–0.13	36. Milk	–23.7*	8.83**	3.45	–1.26
15.	Orange Juice	57.9**	–0.65	0.01	–2.69**	37. Yellow Maize	28.5*	4.20	3.36	2.92
16.	Silver	–38.3**	2.58	–1.40*	–3.67**	38. Aluminium	–51.2*	4.19	1.03	4.16
17.	Flaxseed	13.0**	–0.35	0.23	2.63**	39. Electricity	5.24	–9.86*	–4.78	–0.10
18.	Lumber	1.91	–1.55	–1.02	2.22**	40. Kerosene	–17.2	5.51	3.19	1.41
19.	Rapeseed	17.5	2.19*	1.93**	0.81**	41. Broilers	361	–8.26	–4.73	–1.63
20.	Feeder Cattle	–12.8**	4.05**	1.08	–5.25**	42. Eggs	–5.24	–5.50	–3.57	–9.33**
21.	Coffee	27.7	1.83	0.42	–2.29	Commodity average	–2.32	1.08	0.11	–0.85
22.	Gold	–3.95	1.36*	–1.68	0.62	DJIA components	–2.17	2.75	4.18	5.91

Table 10: Kurtosis of daily commodity futures returns

		Kurtosis			GARCH			Kurtosis			GARCH
	Contract	I	II	III	$t-d.f.$	Contract	I	II	III	$t-d.f.$
1.	Corn	2.42**	0.20**	1.32**	7.57**	23. Palladium	5.73**	0.38**	1.62**	4.57**
2.	Oats	1.98**	0.30**	1.14**	7.91**	24. Heating Oil No.2	21.4**	0.26**	1.35**	6.39**
3.	Platinum	3.60**	0.32**	1.57**	5.36**	25. Light Sweet Crude Oil	22.7**	0.28**	1.37**	6.15**
4.	Frozen Pork Bellies	–0.09**	0.06**	–0.11**	>50	26. Unleaded Gasoline	9.88**	0.15**	0.75**	8.61**
5.	Soybeans	4.09**	0.27**	1.49**	9.59**	27. Liquified Propane	35.3**	0.33**	1.96**	4.59**
6.	Soybean Meal	5.39**	0.24**	1.60**	7.42**	28. Azuki Red Beans	0.82**	0.22**	0.61**	12.5**
7.	Soybean Oil	1.25**	0.16**	0.93**	11.8**	29. Rough Rice	2.72**	0.31**	1.29**	5.85**
8.	Wheat	1.97**	0.08**	0.81**	11.0**	30. Crude Palm Oil	4.28**	0.16**	0.81**	7.23**
9.	Live Cattle	1.01**	0.22**	0.99**	32.3*	31. Rubber	1.33**	0.15**	0.65**	11.5**
10.	Cocoa	1.37**	0.12**	0.37**	11.8**	32. Raw Silk	0.95**	0.36**	1.16**	8.00**
11.	Copper	2.81**	0.14**	0.85**	7.62**	33. Greasy Wool	2.55**	0.12**	0.58**	8.04**
12.	Lean Hogs	0.99**	0.21**	0.83**	16.3*	34. Western Barley	2.78**	0.12**	0.98**	6.52**
13.	Sugar	3.40**	0.20**	0.95**	6.22**	35. Butter	2.14**	1.56**	3.29**	4.10**
14.	Cotton	2.42**	0.29**	0.96**	7.21**	36. Milk	3.80**	0.47**	2.09**	4.10**
15.	Orange Juice	11.3**	0.25**	1.48**	4.10**	37. Yellow Maize	2.87**	0.23**	0.90**	6.52**
16.	Silver	4.10**	0.34**	1.40**	5.33**	38. Aluminium	5.47**	–0.00	0.44**	5.49**
17.	Flaxseed	2.52**	0.31**	1.32**	7.10**	39. Electricity	14.4**	1.05**	2.76**	4.10**
18.	Lumber	–0.34**	0.17**	0.04	>50	40. Kerosene	5.71**	0.16**	0.40**	8.47**
19.	Rapeseed	3.14**	0.19**	0.91**	13.8**	41. Broilers	61.1**	1.04**	2.10**	4.10**
20.	Feeder Cattle	1.16**	0.31**	0.95**	17.9	42. Eggs	0.19	0.07*	0.31**	>50
21.	Coffee	7.45**	0.23**	1.11**	5.89**	Commodity average	6.56	0.30	1.15	7.32
22.	Gold	7.58**	0.40**	2.15**	4.10**	DJIA components	12.0	0.17	0.93	5.63

Table 11: Serial correlation of daily commodity futures returns

		Serial correlation							Serial correlation				
	Contract	1	2	3	4	BL(10)		Contract	1	2	3	4	BL(10)
1.	Corn	6.37**	–2.10**	–0.32	2.03**	65.2**	23.	Palladium	9.07**	0.81	–1.57*	1.61*	64.2**
2.	Oats	5.31**	–3.13**	1.61*	–0.06	50.4**	24.	Heating Oil No.2	1.03	–2.47**	–3.03**	1.56	35.8**
3.	Platinum	2.74**	1.78**	1.70**	–1.88**	35.8**	25.	Light Crude Oil	3.39**	–4.29**	–2.95**	2.92**	49.0**
4.	Frozen Pork Bellies	6.65**	1.62*	1.17	3.32**	77.8**	26.	Unleaded Gasoline	4.29**	–0.40	–3.64**	–0.52	33.0**
5.	Soybeans	5.71**	–0.01	1.74**	3.20**	49.7**	27.	Liquified Propane	14.2**	2.17*	0.48	0.57	126**
6.	Soybean Meal	5.99**	–2.89**	1.97**	4.23**	76.2**	28.	Azuki Red Beans	13.2**	5.66**	–0.76	–0.31	109**
7.	Soybean Oil	6.85**	0.71	2.51**	3.47**	72.1**	29.	Rough Rice	15.5**	–0.95	3.18**	1.81	132**
8.	Wheat	2.36**	–4.06**	0.25	1.51*	43.7**	30.	Crude Palm Oil	0.10	0.69	7.42**	0.77	46.9**
9.	Live Cattle	5.29**	1.81**	3.45**	5.23**	94.3**	31.	Rubber	6.94**	1.10	0.77	–5.93**	38.7**
10.	Cocoa	4.02**	–2.59**	2.60**	–1.12	35.1**	32.	Raw Silk	13.7**	7.20**	5.80**	4.58**	86.5**
11.	Copper	0.45	–2.73**	2.12**	0.69	34.4**	33.	Greasy Wool	–2.58*	0.06	1.85	6.08**	23.2**
12.	Lean Hogs	2.41**	–1.46*	2.35**	4.99**	66.9**	34.	Western Barley	7.62**	3.56*	–7.18**	–0.41	37.9**
13.	Sugar	0.80	–4.09**	3.43**	2.53**	40.9**	35.	Butter	35.4**	18.7**	8.68**	–0.42	353**
14.	Cotton	5.10**	–5.00**	–0.26	2.29**	67.4**	36.	Milk	17.0**	4.89**	5.00**	8.88**	97.5**
15.	Orange Juice	4.08**	–2.34**	2.75**	6.02**	81.5**	37.	Yellow Maize	–5.97**	–4.40**	–6.16**	3.69*	31.8**
16.	Silver	4.96**	3.73**	4.48**	1.16	64.5**	38.	Aluminium	–7.05**	–5.58**	0.80	–3.10	23.1**
17.	Flaxseed	13.1**	0.50	–0.17	1.84**	159**	39.	Electricity	5.33**	–4.72*	1.81	–5.43**	19.5*
18.	Lumber	10.3**	–1.95**	1.99**	3.53**	129**	40.	Kerosene	4.90**	0.58	2.11	0.17	13.4
19.	Rapeseed	7.06**	–3.03**	1.99**	1.87**	65.6**	41.	Broilers	28.1**	12.6**	5.85**	4.88**	132**
20.	Feeder Cattle	9.28**	2.17**	4.37**	3.85**	113**	42.	Eggs	13.1**	4.93**	11.3**	4.08*	55.0**
21.	Coffee	2.67**	–2.11**	2.54**	1.61*	32.5**		Commodity average	6.83	0.43	1.76	1.68	71.6
22.	Gold	–1.86*	3.03**	1.80*	–5.03**	45.5**		DJIA components	2.61	–3.32	–2.28	–1.52	44.9

Table 12: Return characteristics at daily and monthly frequency (1987–2005)

		Daily						Monthly					
	Contract	σ	skew-I	skew-II	kurt-I	kurt-II	BL(10)	σ	skew-I	skew-II	kurt-I	kurt-II	BL(10)
1.	Corn	20.7	2.28	–2.90	2.74	0.09	45.6**	23.3	51.1	11.0	4.66	0.02	4.85*
2.	Oats	30.2	–5.97	–3.54	2.14	0.30	58.5**	33.1	170	–6.25	11.0	0.17	12.3
3.	Platinum	20.2	–17.5	1.24	4.14	0.15	33.8**	18.1	–15.9	7.09	0.12	–0.10	8.21
4.	Frozen Pork Bellies	35.0	1.37	–1.01	0.12	0.15	35.5**	39.7	–0.66	10.4	1.26	0.09	5.34*
5.	Soybeans	21.2	–23.7	0.99	2.80	0.04	18.4*	22.5	–50.0	8.50	2.37	0.33	24.6**
6.	Soybean Meal	22.9	–8.28	1.52	2.84	0.17	34.4**	24.5	–13.5	13.4	2.40	0.21	13.1
7.	Soybean Oil	21.7	12.9	–0.16	1.40	0.05	37.2**	24.0	1.23	–7.04	1.39	0.22	24.9**
8.	Wheat	23.0	14.1	–1.07	2.29	0.01	17.6*	22.4	23.3	–13.0	0.58	–0.15	12.0
9.	Live Cattle	13.8	–15.2	5.72	1.88	0.18	61.3**	13.6	–113	0.97	6.12	0.04	17.9*
10.	Cocoa	30.9	21.2	1.92	2.35	0.08	14.2	29.6	45.2	11.1	1.17	0.24	6.58
11.	Copper	25.6	–30.1	3.32	4.34	0.15	16.7	27.1	43.5	–0.55	2.20	0.04	9.92
12.	Lean Hogs	23.4	–15.3	0.13	1.41	0.12	40.7**	26.7	–53.2	7.56	2.37	0.04	8.41
13.	Sugar	33.3	–33.5	2.77	4.17	0.17	28.3**	31.1	35.2	–36.0	0.82	0.37	7.20
14.	Cotton	24.1	1.39	2.65	2.47	0.20	38.4**	26.2	–4.70	–3.39	0.46	0.36	12.4
15.	Orange Juice	30.3	94.3	–3.71	16.1	0.20	32.0**	29.1	44.7	–2.38	1.53	–0.00	8.53
16.	Silver	23.5	–48.6	0.41	6.04	0.27	22.8**	22.2	–19.1	12.4	1.47	0.55	20.8**
17.	Flaxseed	17.9	11.4	–0.26	2.04	0.19	47.8**	19.6	55.5	–0.16	4.01	0.08	10.1
18.	Lumber	26.5	0.91	0.13	–0.30	0.23	99.9**	31.4	31.1	–20.2	0.99	0.23	7.58
19.	Rapeseed	18.6	–12.9	0.77	1.41	0.11	57.4**	20.1	–27.5	14.4	1.74	–0.09	7.60
20.	Feeder Cattle	12.3	–22.8	6.57	2.46	0.21	65.3**	12.7	–133	–15.5	7.47	0.00	13.0
21.	Coffee	39.5	34.5	–1.43	7.82	0.26	24.3**	39.6	56.6	–8.49	1.30	0.01	7.07
22.	Gold	13.4	–7.83	3.69	11.0	0.34	23.6**	12.8	32.0	–2.46	1.02	0.09	24.4**
23.	Palladium	29.9	6.79	–2.33	7.37	0.33	86.5**	31.0	15.7	3.01	2.01	0.21	7.47
24.	Heating Oil No.2	36.3	–124	1.71	22.3	0.14	18.2*	36.2	64.4	–13.8	2.82	0.01	8.86
25.	Light Sweet Crude Oil	36.8	–134	1.38	24.3	0.14	34.7**	35.2	24.2	–14.4	0.65	0.16	14.9
26.	Unleaded Gasoline	35.7	–76.9	–1.12	10.8	0.14	34.4**	34.6	35.5	0.71	1.52	0.05	12.5
27.	Liquified Propane	35.2	–138	9.18	35.2	0.32	126**	50.4	213	8.61	18.8	0.49	11.0
28.	Azuki Red Beans	25.7	0.43	2.00	0.87	0.23	95.6**	29.7	–44.3	–12.1	1.85	0.16	9.25
29.	Rough Rice	24.3	5.22	–7.20	2.53	0.29	114**	28.7	40.6	14.2	2.94	0.25	7.66
	Commodity average	25.9	–17.5	0.74	6.38	0.18	47.0	27.4	17.5	–1.12	3.00	0.14	11.7
	DJIA components	31.8	–30.5	3.40	13.7	0.15	31.4	28.4	–56.7	–1.95	2.36	0.05	15.8