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FACTS AND FANTASIES ABOUT COMMODITY FUTURES

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ABSTRACT

We construct an equally-weighted index of commodity futures monthly returns over the period between July of 1959 and March of 2004 in order to study simple properties of commodity futures as an asset class. Fully-collateralized commodity futures have historically offered the same return and Sharpe ratio as equities. While the risk premium on commodity futures is essentially the same as equities, commodity futures returns are negatively correlated with equity returns and bond returns. The negative correlation between commodity futures and the other asset classes is due, in significant part, to different behavior over the business cycle. In addition, commodity futures are positively correlated with inflation, unexpected inflation, and changes in expected inflation.

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1. Introduction

Commodity futures are still a relatively unknown asset class, despite being traded in the U.S. for over 100 years and elsewhere for even longer.[1] This may be because commodity futures are strikingly different from stocks, bonds, and other conventional assets. Among these differences are: (1) commodity futures are derivative securities; they are not claims on long-lived corporations; (2) they are short maturity claims on real assets; (3) unlike financial assets, many commodities have pronounced seasonality in price levels and volatilities. Another reason that commodity futures are relatively unknown may be more prosaic, namely, there is a paucity of data.[2]

The economic function of corporate securities such as stocks and bonds, that is, liabilities of firms, is to raise external resources for the firm. Investors are bearing the risk that the future cash flows of the firm may be low and may occur during bad times, like recessions. These claims represent the discounted value of cash flows over very long horizons. Their value depends on decisions of management. Investors are compensated for these risks. Commodity futures are quite different; they do not raise resources for firms to invest. Rather, commodity futures allow firms to obtain insurance for the future value of their outputs (or inputs). Investors in commodity futures receive compensation for bearing the risk of short-term commodity price fluctuations.

Commodity futures do not represent direct exposures to actual commodities. Futures prices represent bets on the expected future spot price. Inventory decisions link current and future scarcity of the commodity and consequently provide a connection between the spot price and the expected future spot price. But commodities, and hence commodity futures, display many differences. Some commodities are storable and some are not; some are input goods and some are intermediate goods.

In this paper we produce some stylized facts about commodity futures and address some commonly raised questions: Can an investment in commodity futures earn a positive return when spot commodity prices are falling? How do spot and futures returns compare? What are the returns to investing in commodity futures, and how do these returns compare to investing in stocks and bonds? Are commodity futures riskier than stocks? Do commodity futures provide a hedge against inflation? Can commodity futures provide diversification to other asset classes? Many of these questions have been investigated by others but in large part with short data series applying to only a small number of commodities.[3] An exception is Bodie and Rosansky (1980), who studied commodity futures over the period 1950 to 1976, using quarterly data.[4] In this primer we

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[1] Modern futures markets appear to have their origin in Japanese rice futures, which were traded in Osaka starting in the early 18th century; see Anderson, et al. (2001).

[2] For example, the University of Chicago Center for Research in Security Prices has no commodity futures data, nor does Ibbotson Associates. In addition, the well-known commodity futures indices either do not extend back very far or cannot be reproduced for various reasons.

[3] There is a very large literature on commodity futures. For example, see the papers collected in Telser (2000).

[4] Bodie and Rosansky (1980) obtained their data from a U.S. Department of Agriculture publication called Commodities Futures Statistics and from the Journal of Commerce.

construct a monthly time series of an equally-weighted index of commodity futures prices starting in 1959. We focus on an index because we want to address the above questions with respect to this asset class as a whole, rather than with respect to individual commodity futures. We produce some stylized facts to characterize commodity futures.

2. The Mechanics of an Investment in Commodity Futures

A commodity futures contract is an agreement to buy (or sell) a specified quantity of a commodity at a future date, at a price agreed upon when entering into the contract – the futures price. The futures price is different from the value of a futures contract. Upon entering a futures contract, no cash changes hands between buyers and sellers – and hence the value of the contract is zero at its inception.[5]

How then is the futures price determined? Think of the alternative to obtaining the commodity in the future: simply wait and purchase the commodity in the future spot market. Because the future spot price is unknown today, a futures contract is a way to lock in the terms of trade for future transactions. In determining the fair futures price, market participants will compare the current futures price to the spot price that can be expected to prevail at the maturity of the futures contract. In other words, futures markets are forward looking and the futures price will embed expectations about the future spot price. If spot prices are expected to be much higher at the maturity of the futures contract than they are today, the current futures price will be set at a high level relative to the current spot price. Lower expected spot prices in the future will be reflected in a low current futures price. (See Black (1976).)

Because foreseeable trends in spot markets are taken into account when the futures prices is set, expected movements in the spot price are not a source of return to an investor in futures. Futures investors will benefit when the spot price at maturity turns out to be higher than expected when they entered into the contract, and lose when the spot price is lower than anticipated. A futures contract is therefore a bet on the future spot price, and by entering into a futures contract an investor assumes the risk of unexpected movements in the future spot price. Unexpected deviations from the expected future spot price are by definition unpredictable, and should average out to zero over time for an investor in futures, unless the investor has an ability to correctly time the market.

What then is the return that an investor in futures can expect to earn if he does not benefit from expected spot price movements, and is unable to outsmart the market? The answer is the risk premium: the difference between the current futures price and the expected future spot price. If today's futures price is set below the expected future spot price, a purchaser of futures will on average earn money. If the futures price is set above the expected future spot price, a seller of futures will earn a risk premium.

[5] This is also true at the end of each day when the value of a futures contract is reset to be zero. Gains and losses during the day are settled by the two parties to the contract via transfers from their margin accounts.

Are there any theoretical reasons for the risk premium to accrue to either buyers or sellers of futures contracts? Keynes' (1930) theory of *normal backwardation* postulated that the risk premium would accrue to the buyers of futures. He envisioned a world in which producers of commodities would seek to hedge the price risk of their output. For example, a producer of grain would sell grain futures to lock in the future price of his crops and obtain insurance against the price risk of grain at harvest time. Speculators would provide this insurance and buy futures, but demand a futures price which is below the spot price that could be expected to prevail at the maturity of the futures contract. By "backwardating" the futures price relative to the expected future spot price, speculators would receive a risk premium from producers for assuming the risk of future price fluctuations.[6]

How is the risk premium earned? Do speculators have to hold the futures contract until expiration? The answer is no. Over time, as the maturity date of the futures contract draws close, the futures price will start to approach the spot price of a commodity. At maturity, the futures contract will become equivalent to a spot contract, and the futures price will equal the spot price. If futures prices were initially set below the expected future spot price, the futures price will gradually increase over time, rewarding the long position.

Whether Keynes' theory of normal backwardation is an accurate theory of the determination of the futures price is an empirical matter, and much of this paper will be devoted to examining the existence of a risk premium in commodity futures.[7] The above discussion of the mechanics of futures markets, however, serves to make the following important points about an investment in futures:

1. The expected payoff to a futures position is the risk premium. The realized payoff is the risk premium plus any unexpected deviation of the future spot price from the expected future spot price

2. A long position in futures is expected to earn positive (excess) returns as long as the futures price is set below the expected future spot price.

3. If the futures price is set below the expected future spot price, the futures prices will tend to rise over time, providing a return to investors in futures.

4. Expected trends in spot prices are not a source of return to an investor in futures.

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[6] Keynes (1930, p. 144) put it this way: "In other words, the quoted forward price, though above the present spot price, must fall below the anticipated future spot price by at least the amount of normal backwardation."

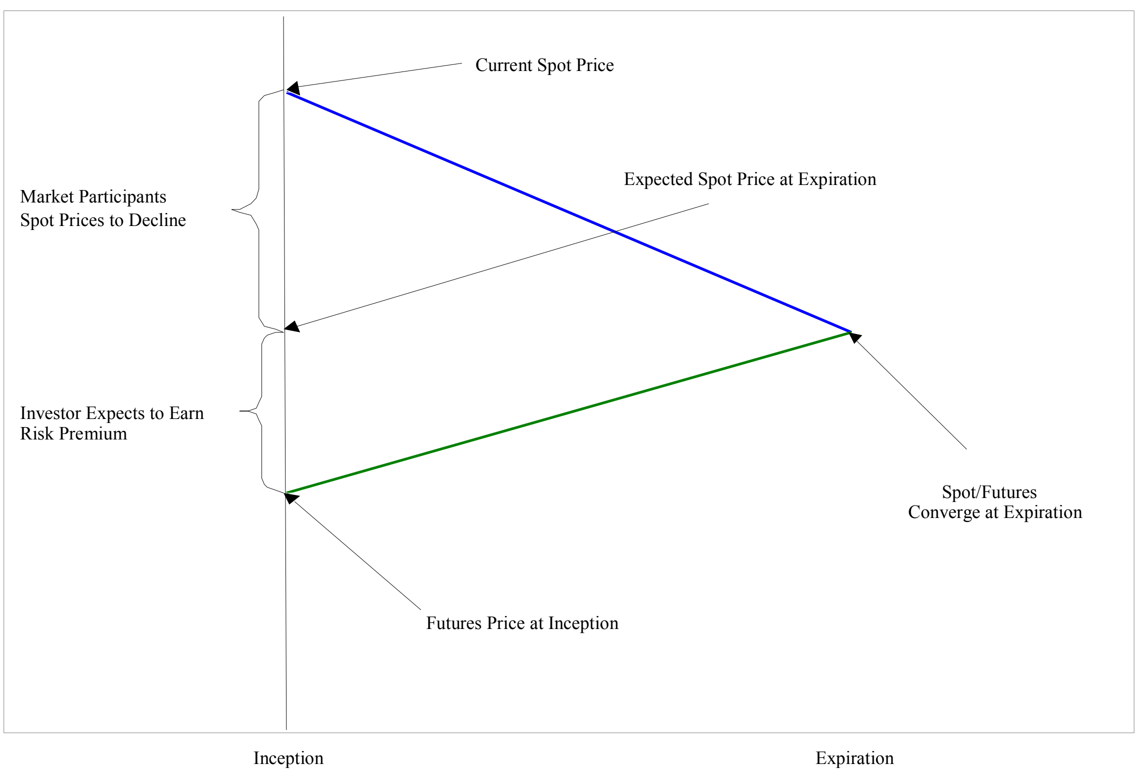
[7] Attempts to empirically measure the risk premium have yielded mixed results (for example, see Gray (1961), Dusak (1973), Jagannathan (1985), and Bessembinder (1992)). Part of the reason for the lack of success is no doubt the volatility of futures prices. This makes it difficult to accurately measure the risk premium using data covering short time intervals – a problem that is not unique to commodities; it is equally applicable to equities.

To further illustrate these points, consider a stylized example, adapted from Weiser (2003). The example is displayed in Figure 1 below. Assume that the spot price of oil is $30 a barrel and that market participants expect the price of oil to be $27 in three months. In order to entice investors into the market, the futures price is set at $25, which is a discount to the expected future spot price. The difference between the futures price and the expected future spot price, or $2, is the risk premium that the investor expects to earn for assuming short-term price risk.

Now suppose that at the time the contract expires, oil is trading at the expected price of $27. An investor in physical commodities, who cares about the direction of spot prices, has just lost $3 (i.e., $30 - $27). An investor in the futures contract, however, would have gained the difference between the final spot price of $27 and the initial futures price of $25, or $2.

The example above, and the figure, examine the case where the expected future spot price of $27 is, in fact, realized. But suppose the expectation of a price of $27 is *not* realized and instead the final spot price turns out to be $26. Then the realized return to the investor would be $1. This realized return can be broken down into the risk premium ($27 - $25 = $2), less the difference between the final spot price and the expected price ($26 - $25 = $1).

Figure 1: Futures versus Spot returns



The remainder of the paper will be devoted to empirical evidence on the historical performance of commodity futures as an asset class. One final remark needs to be made regarding the calculation of futures returns. At the beginning of this section, we explained that the value of a futures contract is zero at origination, and does not require any cash outlay for either the long or the short position. In practice, both the long and short position will have to post collateral that can be used to settle gains and losses on the futures position over time. The collateral is typically only a fraction of the notional value of the futures position, which implies that a futures position can involve substantial leverage.

In order to draw a meaningful comparison between the performance of futures and other asset classes, we need to control for leverage when calculating futures returns. We make the assumption that futures positions will be fully collateralized. When an investor buys a contract with a futures price of $25, we will assume that the investor simultaneously invests $25 in T-bills. The total return earned by the investor over a given time period, will therefore be the change in the futures price and the interest on the $25 (calculated daily), scaled by the $25 initial investment.

3. An Equally-Weighted Index of Commodity Futures

To investigate the long-term return to commodity futures we constructed an equally-weighted performance index of commodity futures. The source of our data is a database maintained by the Commodities Research Bureau, which has daily prices for individual futures contracts since 1959. We append these data with data from the London Metals Exchange. A detailed description of the data is given in Appendix 1, but a few general comments are in place.

Our index potentially suffers from a variety of selection and survivorship biases. First, the CRB database mostly contains data for futures contracts that have survived until today, or were in existence for extended periods during the 1959-2004 period. Many contracts that were introduced during this period, but failed to survive, are not included in the database. It is not clear how survivorship bias affects the computed returns to a futures investment. Futures contracts fail for lack of interest by market participants, i.e. lack of trading volume. See Black (1986) and Carlton (1984). While this may be correlated with the presence of a risk premium, the direction of the bias is not as clear cut as would be the case of the calculation of an equity index. Among other reasons, stocks do not survive because of bankruptcy, and excluding bankrupt firms would create a strong upward bias in the computed returns. Second, in order to avoid double counting of commodities, we selected contracts from a single exchange for inclusion in our index, even though a commodity might be traded on multiple exchanges. We based our selection on the liquidity of the contract, and it is therefore subject to a selection bias that may or may not be correlated with the computed returns. Finally, for each commodity, there are multiple contracts listed that differ by maturity. On each day, we selected the contract with the nearest expiration date (the shortest contract) for our index, unless the contract expired in that month, in which case we would roll into the next contract. In each month, we therefore hold the shortest futures contract that will not expire in that month.[8]

The performance index is computed as follows: at the beginning of each month we hold one dollar in each commodity futures contract. (If the futures price is $25, we hold 1/25th of a contract). At the same time we purchase $1 in T-bills for every contract that the index invests in. The index is therefore "fully collateralized" by a position of T-bills. The contracts are held until the end of the month, at which time we rebalance the index to equal weights. More detail is contained in Appendix 1.

There are many different ways in which we could have weighted individual commodity futures in our index.[9] By analyzing the returns of an equally-weighted index of commodity futures we can make statements about "how the average commodity future behaves during the average time period."

4. The Historical Returns on Commodities: Spot Prices, Collateralized Futures, and Inflation

We now turn to the empirical evidence on spot and future returns. What is the average return to commodity futures? Does the collateralized futures position outperform the spot return for the "average commodity future"? Figure 2a compares the equally-weighted total return index of commodity futures to an equally-weighted portfolio of spot commodities between 1959 and 2004. Both indices have been adjusted for inflation by deflating each series by the consumer price index (CPI). The index of commodity spot prices simply tracks the evolution of the spot prices, and ignores all costs associated with the holding of physical commodities (storage, insurance, etc). It is therefore an upper bound on the return that an investor in spot commodities would have earned. The main conclusions from examination of the figure are that:

1. There are large differences between the historical performance of spot commodity prices and collateralized commodity futures returns. The historical return to an investment in commodity futures has far exceeded the return to a holder of spot commodities.

2. Both commodity spot prices and commodity futures returns have outpaced inflation.

[8] The rolling itself is not a source of return. Because the futures price adjusts continuously, and gains and losses are settled daily, a futures contract has zero value at the end of each day. Even though a distant futures contract may have a different futures price than a near contract, the exchange of one for another has no cash flow implications.

[9] The popular traded indices of collateralized commodity futures sometimes use (a combination of) production and liquidity data as the basis for calculating weights (e.g., the Dow Jones AIG Commodity Index and the Goldman Sachs Commodity Index). The Reuters-CRB index uses equal weights, but does not rebalance like our index.

Figure 2a

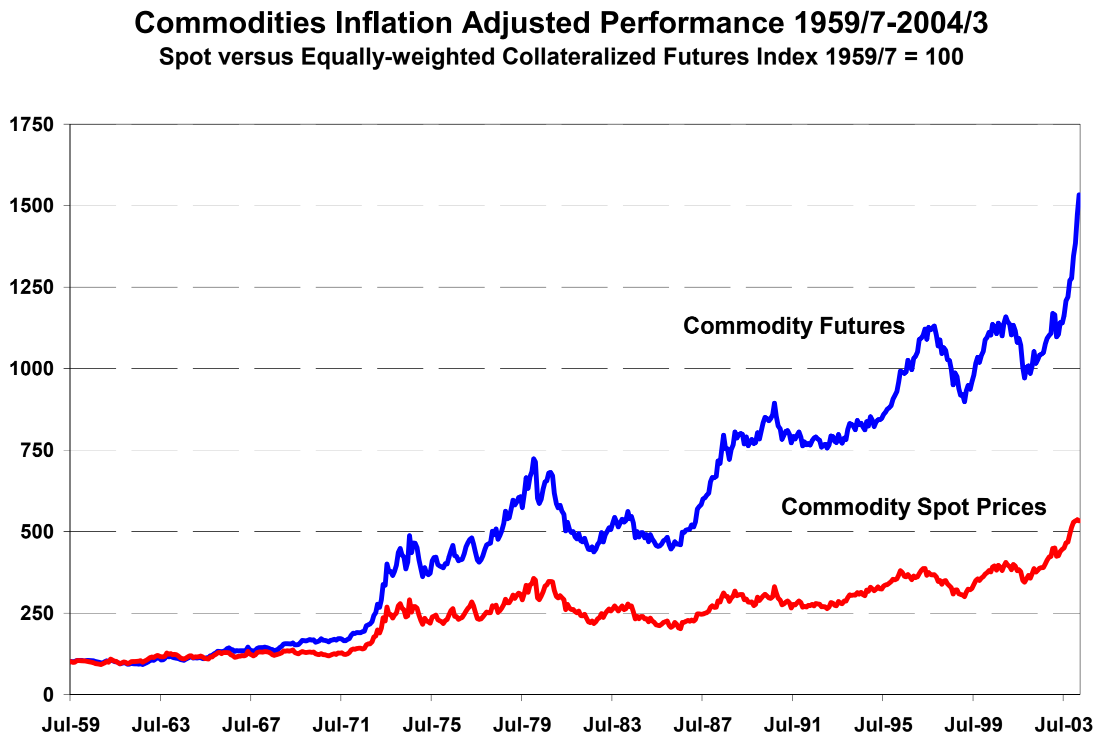
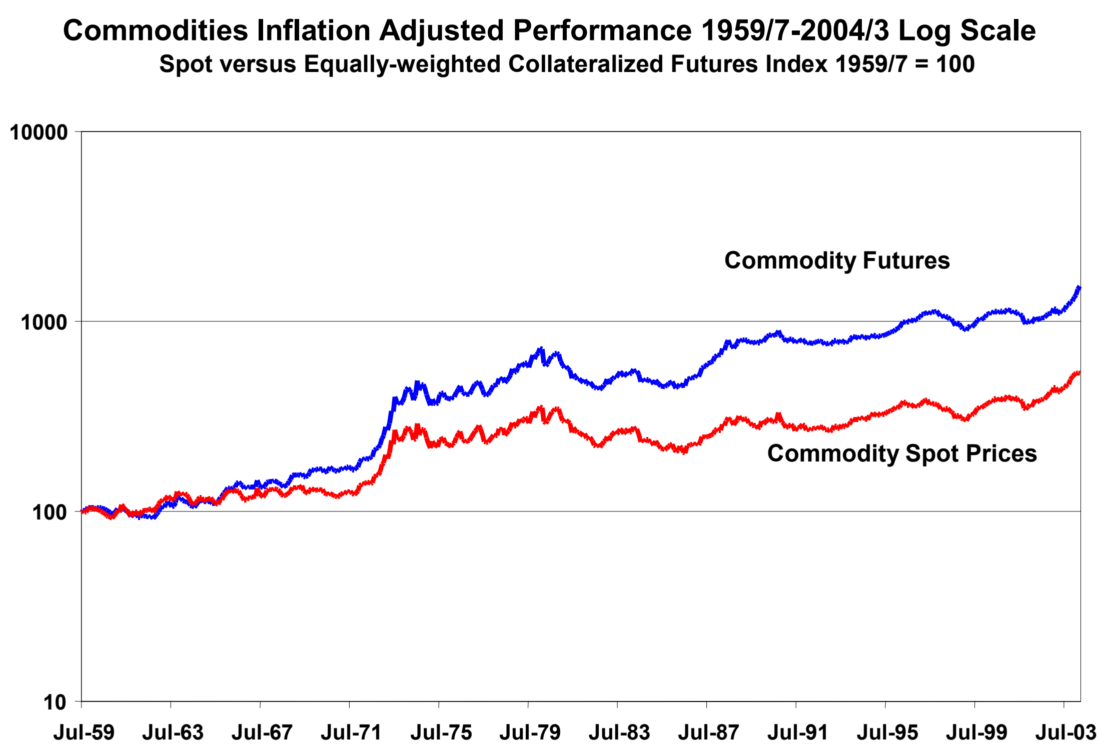


Figure 2b



What is perhaps not directly apparent from Figure 2a is that the return on the futures position is highly correlated with movements in the spot. As explained in Section 2, an investment in commodity futures benefits from unexpected increases in spot prices. Especially in times of high spot market volatility, the returns to spot and futures will be highly correlated. This is illustrated in Figure 2b. It presents the same data as Figure 2a of the graph, but the scale is in logs, which facilitates identification of proportional changes in series that differ in levels. What is clear from Figure 2b is that the two series are highly correlated, but diverge because of differing trends. The spot index includes trends in the spot price, which are excluded from the futures index. In turn the futures index rises with the risk free rate plus any risk premium earned by the futures position.

Figure 2a also gives a clue about the risk premium of commodity futures. Part of the return to collateralized futures is the return on collateral (T-bills). Because the historical inflation adjusted return to T-bills is about the rate of inflation, the (inflation adjusted) real return to collateralized commodity futures is an indication of the risk premium earned by investors. We will return to a discussion of the risk premium in the next sections.

5. The Risk and Return of Commodity Futures Compared with Other Asset Classes

Figure 3 compares the cumulative performance of the Ibbotson corporate bond index ("Bonds"), the SP500 index (Stocks), and the equally- weighted commodity futures index total return ("Commodity Futures") for the period July 1959 to the end of March of 2004. All series have been deflated by the CPI index, and therefore measure the inflation-adjusted performance of the three asset classes.

Figure 3 shows:[10]

1. Over the last 43 years, the average annualized return to a collateralized investment in commodity futures has been comparable to the return on the SP500. Both outperformed corporate bonds.

2. Stock and Commodity Futures have experienced higher volatility than Bonds.

3. Commodity Futures outperformed Stocks during the 1970s, but this performance was reversed during the 1990s.

Figure 4 gives the historical risk premiums (not adjusted for inflation) for the three asset classes. Next to each bar depicting the average risk premium is the *t*-statistic, which measures our confidence that the risk premium is different from zero.

[10] Summary statistics, including standard errors, are contained in Appendix 2.

Figure 3

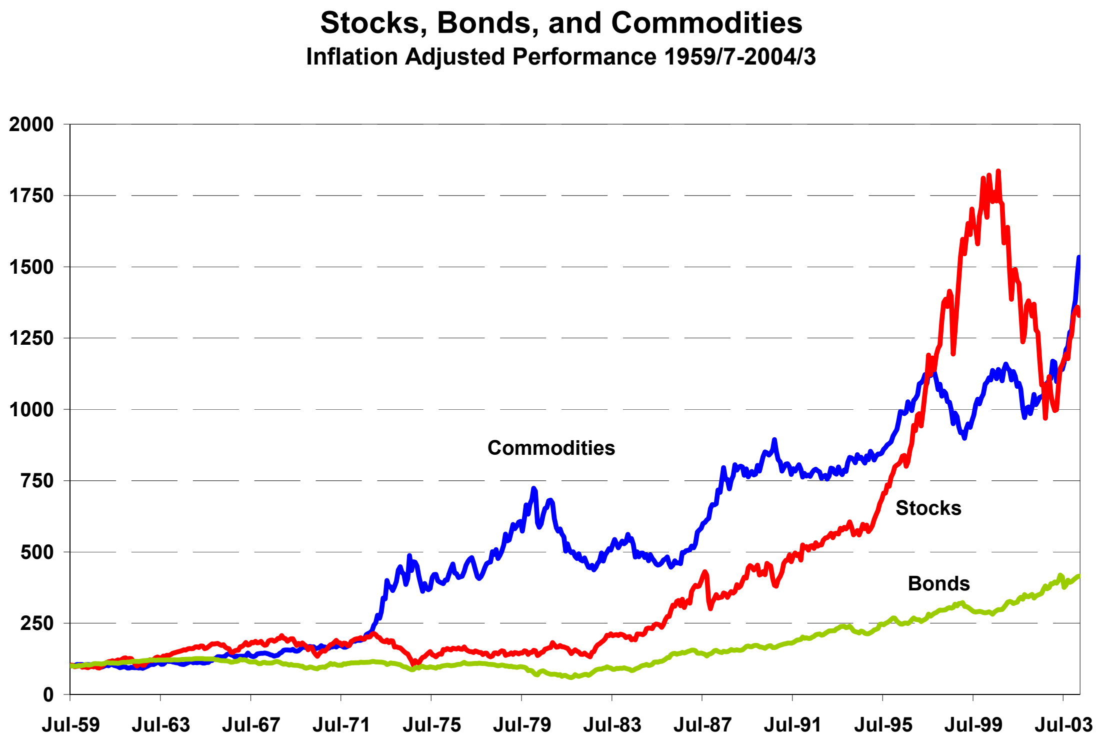
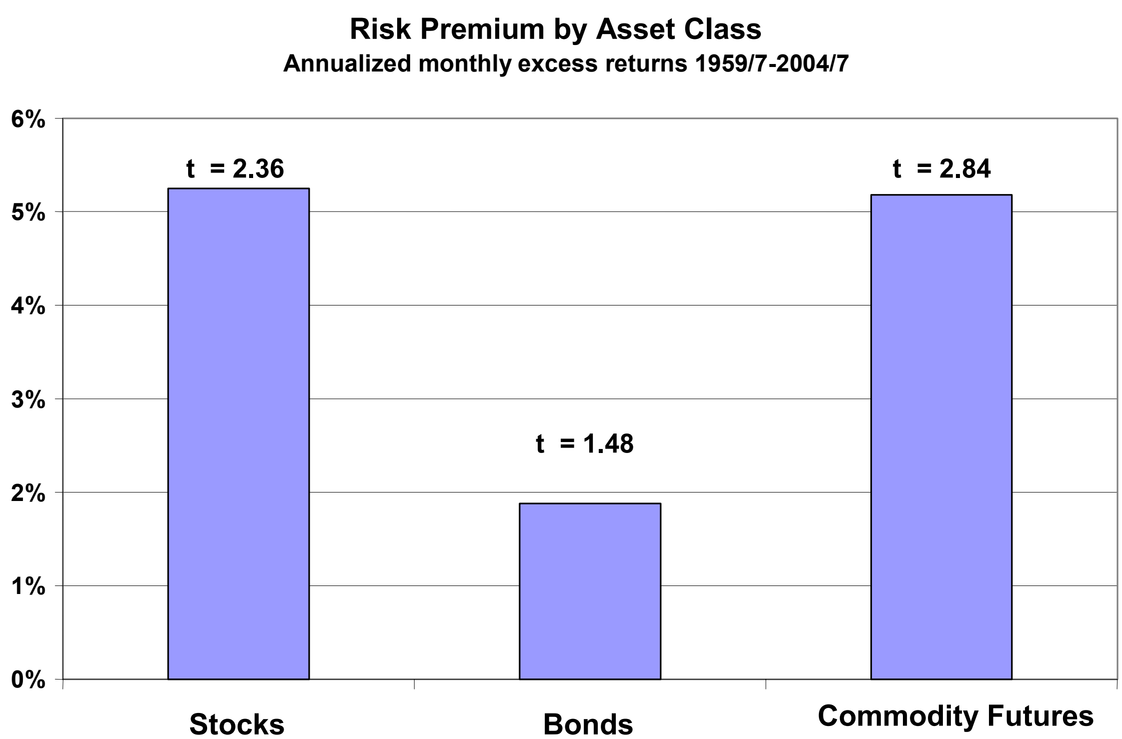


Figure 4



Two observations stand out:

1. The historical risk premium on Commodity Futures has been positive at about 5% during the 1959-2004 period, and significant in a statistical sense (*t*-statistic = 2.84)

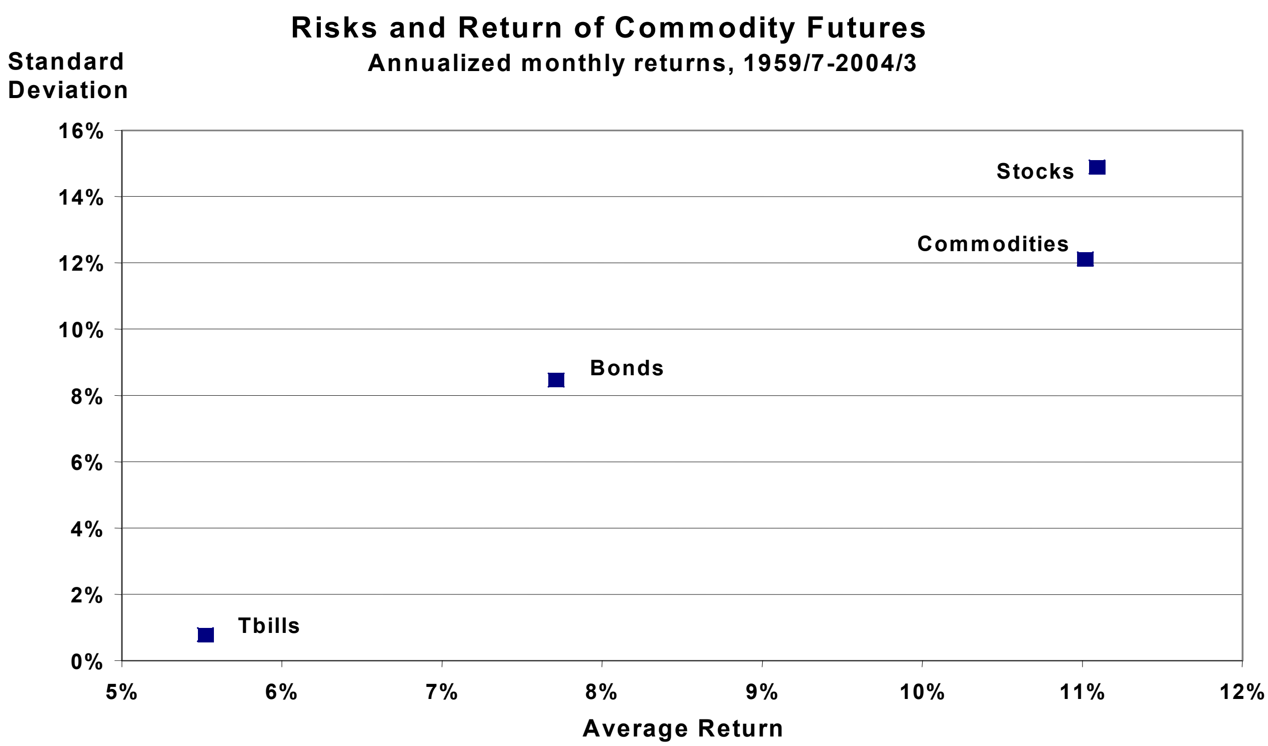
2. The historical risk premium on Commodity Futures is about the same as the risk premium on Stocks (SP500), and more than double the risk premium of Bonds.

As pointed out in Section 2, there has been much debate among economists about the existence of a risk premium in commodity futures. Keynes (1930) and Hicks (1939) assumed that hedgers outnumber speculators in the futures markets, which was the basis for the theory of *normal backwardation*. The estimated risk premium in Figure 4 is not only consistent with the theory of *normal backwardation*, but – more importantly – it also shows that the risk premium has been economically large and statistically significant.

Our commodities total return index covers a period of more than 40 years, and is diversified across many commodities. As such it provides a unique opportunity to examine the risk premium across a variety of commodities and time periods.

Figure 5 compares the performance (unadjusted for inflation) of stocks, bonds and commodities in the familiar average return – standard deviation diagram.

Figure 5

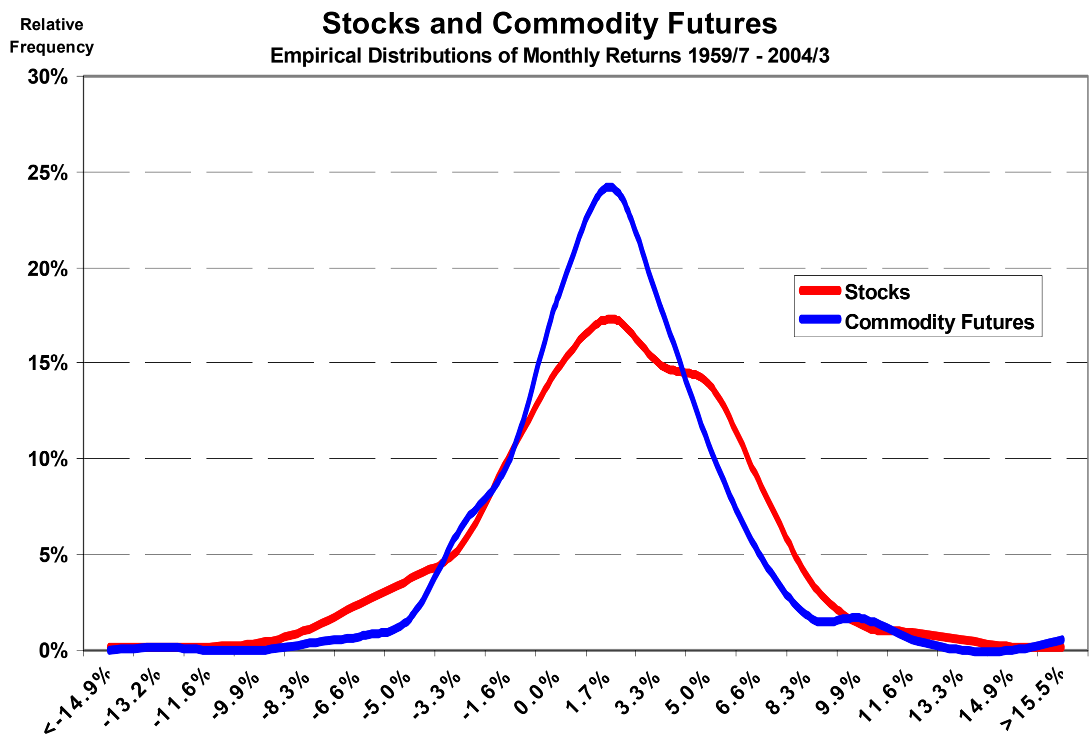


The volatility of the equally-weighted Commodity Futures total return is slightly below volatility of the SP500. So, the Sharpe Ratio has been slightly higher for Commodity Futures than for Stocks (also indicated by the higher *t*-statistics in Figure 4).

Financial returns are not completely characterized by the mean return and the standard deviation of returns. This is because, as is well known, the returns on financial securities are not normally distributed, but rather have "fat tails" compared to the Normal Distribution. This is also true of commodity futures. Commodity futures returns are positively skewed; stock returns are negatively skewed. Bodie and Rosansky (1980), and others, also note that commodity futures returns are considerably positively skewed compared to stock returns.

This is further illustrated in Figure 6, which compares the empirical distribution of monthly returns for the SP500 and our equally-weighted commodity futures index between 1959 and 2004.

Figure 6



Three observations stand out:

1. Commodity Futures and Stocks have about the same average return, but the standard deviation of stock returns is slightly higher.

2. The return distribution of equities has negative skewness, while the distribution of commodity returns has positive skewness. This means that, proportionally, equities have more weight in the left tail of the return distribution while commodities have more weight in the right tail.

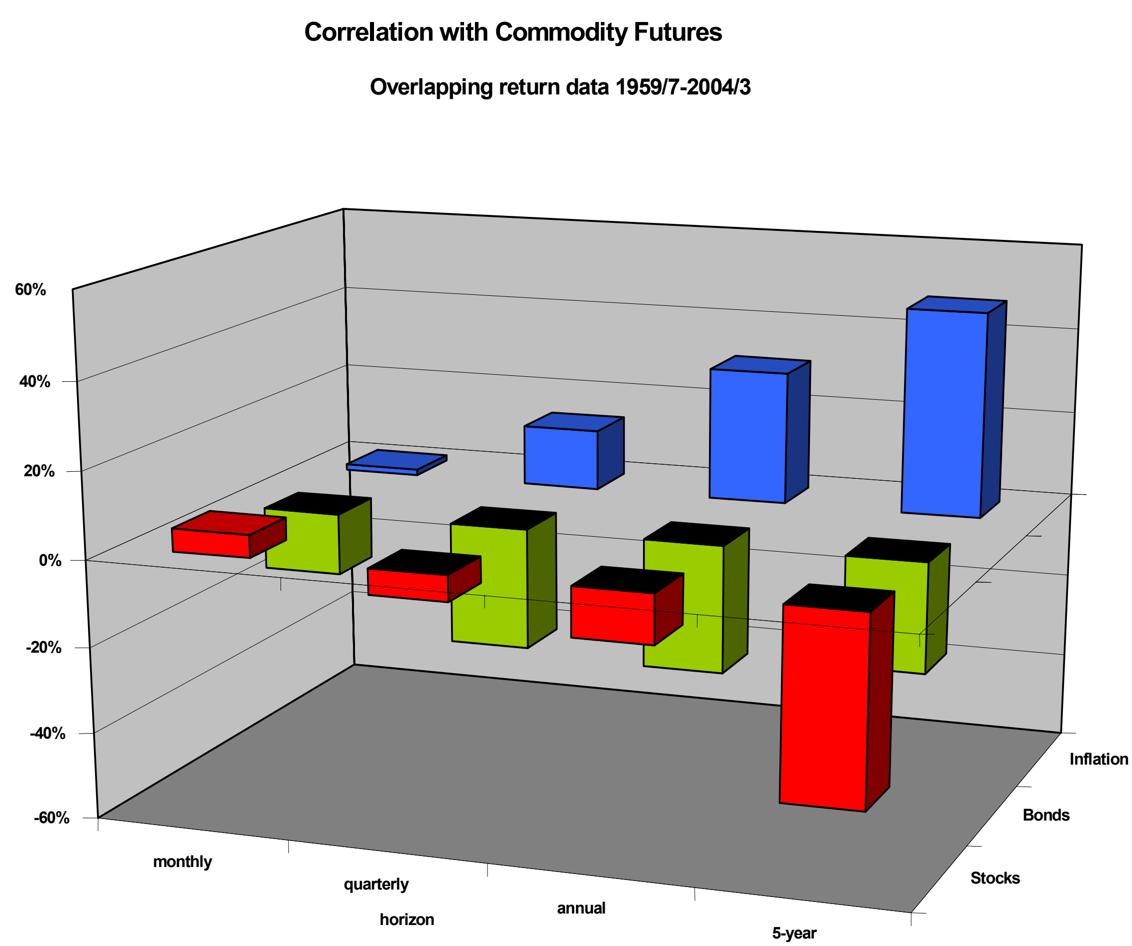
3. Both the return distributions have positive excess kurtosis, that is, they are "peaked" relative to the normal distribution.

The slightly higher variance of equities, and the opposite skewness, together imply that equities have more downside risk relative to commodities. For example, the 5% tail of the empirical distribution of equities occurs at –6.56% compared to –4.05% for commodities. From the perspective of risk management, an important question is whether these tail events occur simultaneously for both assets, or in isolation. We will turn to the question of correlation next.

6. The Correlation of Commodities with Other Asset Classes

We examine the correlation of Commodity Futures returns with Stocks and Bonds over various investment horizons. In addition to monthly returns, we report correlations computed using overlapping returns over quarterly, annual and 5-year intervals. Because asset returns are volatile, examining correlation over longer holding periods may reveal patterns in the data that are obscured by short-term price fluctuations. Figure 7 illustrates the correlations of Commodity Futures returns with Stocks, Bonds, and Inflation over the period between 1959 and 2004:

Figure 7



1. Over all horizons – except monthly – the equally-weighted Commodity Futures total return is negatively correlated with the return on the SP500 and long-term bonds. This suggests that Commodity Futures are effective in diversifying equity and bond portfolios.

2. The negative correlation between Stocks and Bonds tends to increase with the holding period. This suggests that the diversification benefits of Commodity Futures tend to be larger at longer horizons.

3. Commodity Futures returns are positively correlated with inflation, and the correlation is larger at longer horizons. Because Commodity Future returns are volatile relative to inflation, longer-term correlations better capture the inflation-properties of a commodity investment.

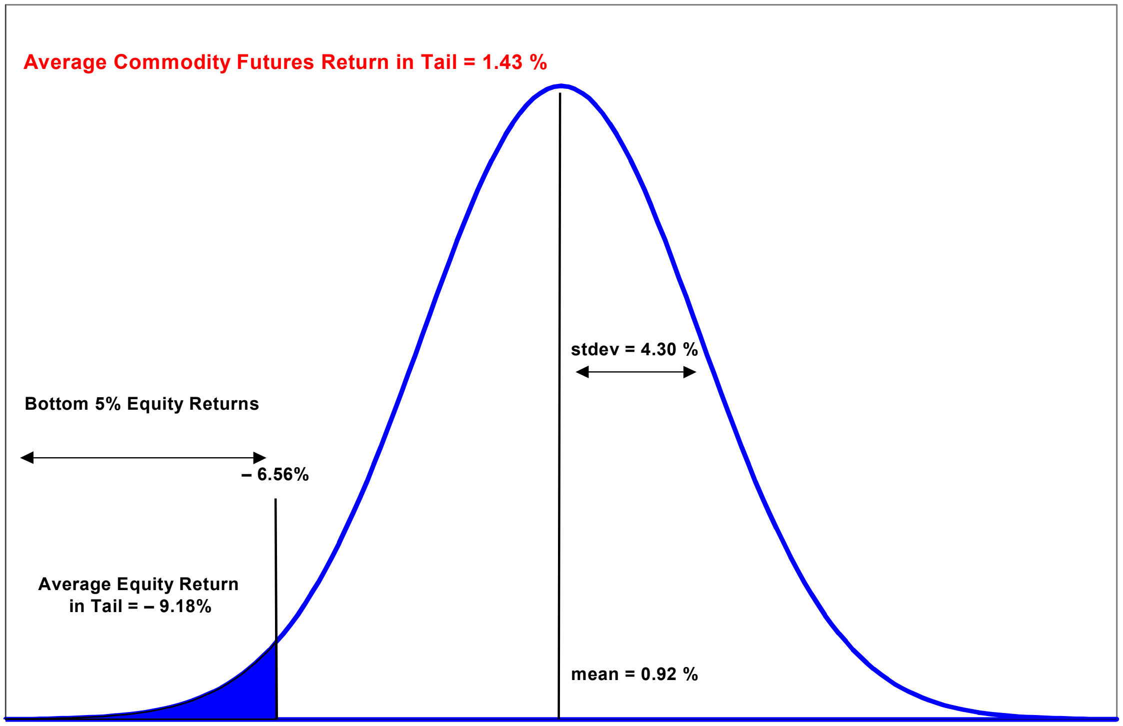
In Figure 5 we showed that equities contain more downside risk than Commodity Futures. So it is important to ask whether the negative correlation between equities and Commodity Futures holds up when equity returns are low – a time when diversification is especially valuable. We examined the returns to Commodity Futures during the months of lowest equity returns. The results are given in Figure 8a and 8b. Figure 8a shows the equity returns during the 5% of worth months of lowest performance. Figure 8b concentrates on the lowest 1% of realized equity returns. The figures show the following:

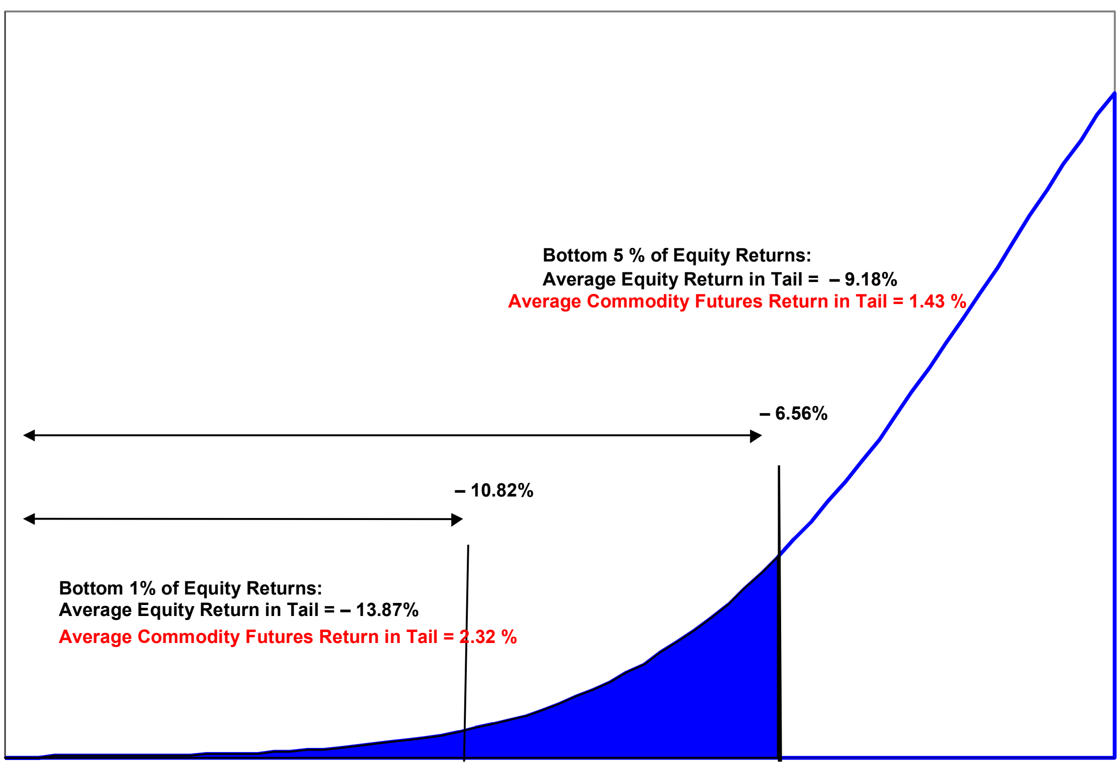
1. During the 5% of the months of worst performance of equity markets, when stocks fell on average by 9.18%, Commodity Futures experienced a positive return of 1.43%, which is slightly more than the full sample average return of 0.88% per month.

2. During the 1% of months of lowest performance of equity markets, when equities fell on average by 13.87%, Commodity Futures returned an average of 2.32%.

It seems that the diversification benefits of Commodity Futures work well when they are needed most. Consistent with a negative correlation, Commodity Futures earn above average returns when stocks earn below average returns

Figure 8: Commodity Futures Returns When Stock Returns are Low





7. Commodity Futures Returns and Inflation

Investors ultimately care about the real purchasing power of their returns, which means that the threat of inflation is a concern for investors. Many traditional asset classes are a poor hedge against inflation – at least over short and medium-term horizons.

Bonds are nominally denominated assets, and their yields are set to compensate investors for expected inflation over the life of the bond. When inflation is unexpectedly higher than the level investors contracted for, the real purchasing power of the cash flows will fall short of expectations. To the extent that unexpected inflation leads to revisions of future expected inflation, this loss of real purchasing power can be significant.

There are reasons to expect equities to provide a better hedge than bonds against inflation – at least in theory. After all, stocks represent claims against real assets, such as factories, equipment, and inventories, whose value can be expected to hold pace with the general price level. However, firms also have contracts with suppliers of inputs, labor and capital, that are fixed in nominal terms and hence act very much like nominal bonds. In addition, (unexpected) inflation is often not neutral for the real economy. Unexpected inflation is associated with negative shocks to aggregate output, which is generally bad news for equities. (See Fama (1981).) In sum, the extent to which stocks provide a hedge against inflation is an empirical matter.

Figure 7 suggested that commodity futures might be a much better inflation hedge than stocks or bonds. First, because commodity futures represent a bet on commodity prices, they are directly linked to the components of inflation. Second, because futures prices include information about foreseeable trends in commodity prices, they rise and fall with unexpected deviations from components of inflation. This is exactly why futures do well when stocks and bonds perform poorly.

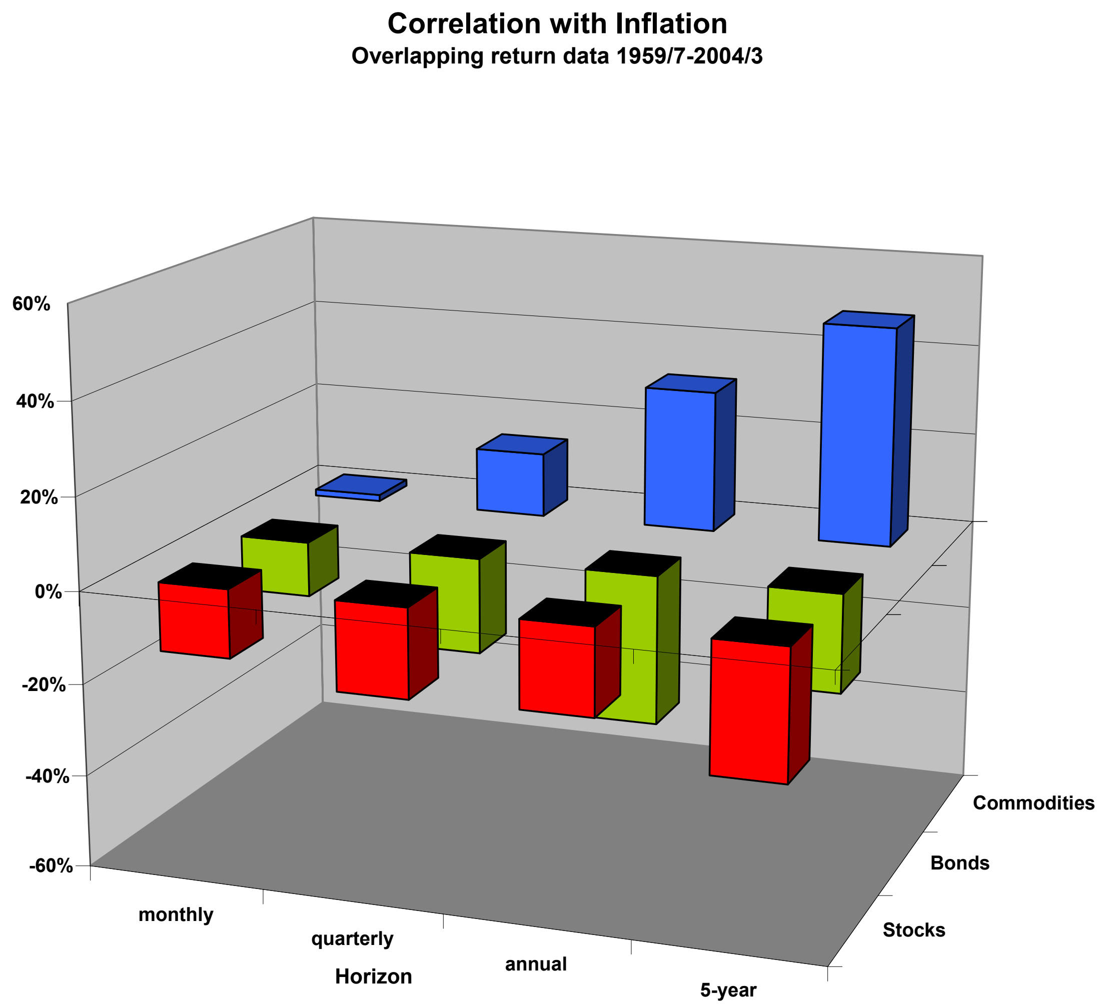
Figure 9 compares the correlations of stocks, bonds, and commodities with inflation. As before, correlations are computed over various investment horizons.

Several observations stand out from Figure 9:

1. Commodity Futures have an opposite exposure to inflation compared to Stocks and Bonds. Stocks and Bonds are negatively correlated with inflation, while the correlation of Commodity Futures with inflation is positive at all horizons.

2. In absolute magnitude, inflation correlations tend to increase with the holding period. The negative inflation correlation of Stocks and Bonds and the positive inflation correlation of Commodity Futures are larger at return intervals of 1 and 5 years than at the monthly or quarterly frequency.

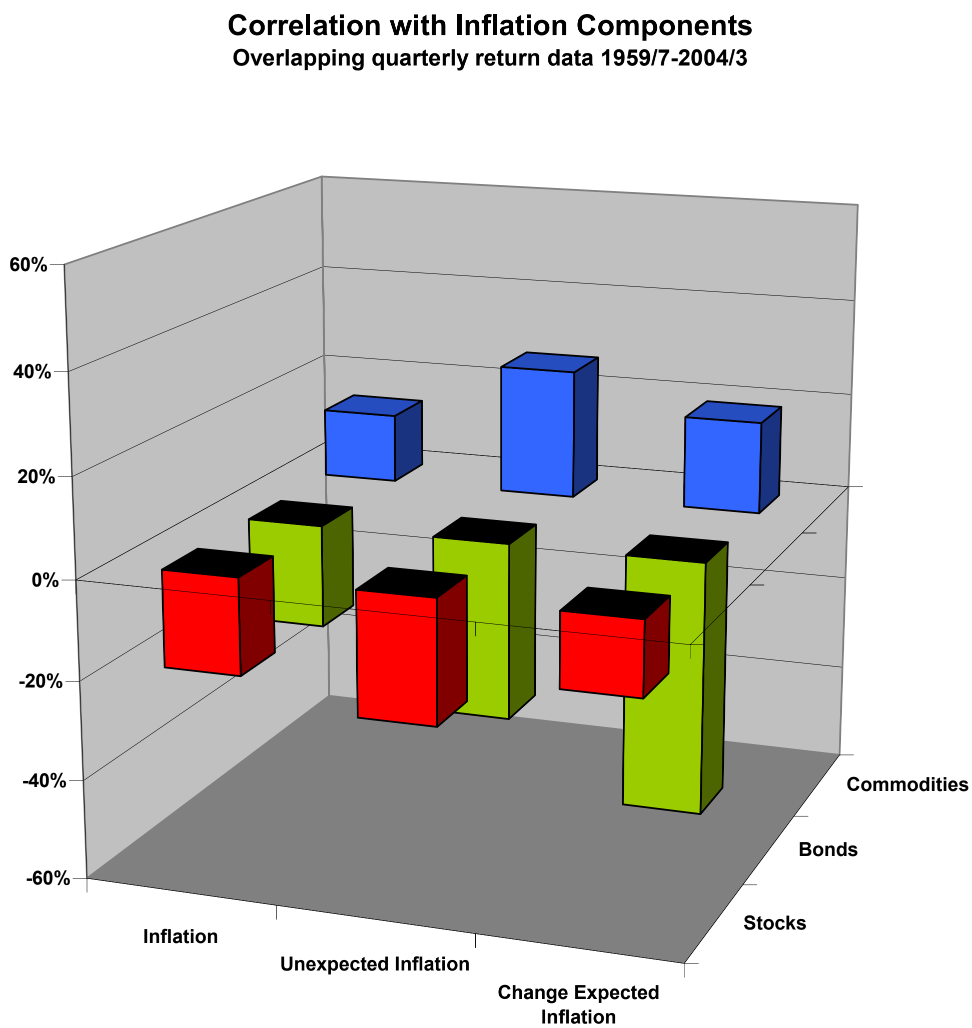
Figure 9



Our previous discussion suggested that stocks, and especially bonds, can be sensitive to *unexpected* inflation. In order to measure unexpected inflation, a model of expected inflation is needed. For this purpose we choose a very simple method that has been used by others in the past (e.g., see Fama and Schwert (1977) and Schwert (1981)). The short-term T-bill rate is a proxy for the market's expectation of inflation, if the expected real rate of interest is constant over time. Consequently, *unexpected* inflation can be measured as the actual inflation rate minus the nominal interest rate (which was known ex ante).

Because inflation is persistent over time, unexpected inflation often causes market participants to revise their estimates of *future* expected inflation. The *change* in expected inflation can be measured by the change in the nominal interest rate. This is not necessarily perfectly correlated with the unexpected inflation rate since investors may use more information than just the current rate of inflation to revise their expectations of future inflation.[11]

Figure 10



[11] Following the large literature on inflationary expectations, we choose the 30-day and 90-day T-bill yield as our measure of expected inflation for the next month, and quarter. See Fama and Schwert (1977) and Schwert (1981) for a discussion.

Figure 10 illustrates the correlations of Stocks, Bonds, and Commodity Futures returns with the components of inflation. These observations stand out:

1. The negative sensitivities of Stocks and Bonds to inflation stem mainly from sensitivities to *unexpected* inflation. The correlations with unexpected inflation exceed the raw inflation correlations.

2. Commodity Futures are also more sensitive to unexpected inflation, but (again) in the opposite direction.

3. Stock returns and (especially) Bond returns are negatively influenced by revisions about *future* expected inflation. Revisions about future inflationary expectations are a positive influence on Commodity Futures returns.

4. Unreported results show that these patterns in the exposures to unexpected inflation are stronger at the quarterly horizon than at the monthly horizon.

Commodity Futures returns are negatively correlated with stock returns. Commodity Futures have opposite exposures to unexpected inflation from Stocks and Bonds. It is tempting to put both together and ask: does the opposite exposure to unexpected inflation account for the negative correlation between Commodity Futures and Stocks and Bonds? Preliminary findings suggest that this only part of the story behind the negative correlations. If we isolate the portion of the returns of commodity futures, stocks and bonds that is unrelated to unexpected inflation and examine the correlations again, we find that the residual variation of commodity futures and stocks or bonds continue to be negatively correlated.[12] At the quarterly horizon, the correlation between futures and stocks increases from –0.13 to –0.09, while for bonds the correlation increases from –0.22 to –0.18. In other words there are additional factors that drive the negative correlation between futures returns and stocks and bonds. The next section describes one of these sources: business cycle variation.

8. Commodity Returns over the Business Cycle.

Modern finance theory identifies two components to asset returns: a systematic component and a nonsystematic, or idiosyncratic, component. Holding a portfolio of many different securities can diversify idiosyncratic components. But, the systematic component corresponds to movements in the market as a whole, and so is viewed as nondiversifiable. The nondiversifiable component, associated with beta in the Capital Asset Pricing Model, also corresponds to the business cycle since business cycle risk is nondiversifiable. Stock and bond returns are negative in (the early phase of) recessions, in particular.

[12] In other words, we examine the correlation of regression residuals from regressions of each asset class' returns on unexpected inflation.

Commodity future returns and equity returns are negatively correlated at quarterly, annual, and five-year horizons. This means that commodity futures are useful in creating diversified portfolios, with respect to the idiosyncratic component of returns.

But, importantly, there is also evidence of another "diversification effect." Commodity futures have a feature quite unique to this asset class, namely, commodity futures have some power at diversifying the systematic component of risk – the part that is not supposed to be diversifiable! Weiser (2003) reports that commodity futures returns vary with the stage of the business cycle.[13] In particular commodity futures perform well in the early stages of a recession, a time when stock returns generally disappoint. In later stages of recessions, commodity returns fall off, but this is generally a very good time for equities.

Figure 11: Business Cycle Phases

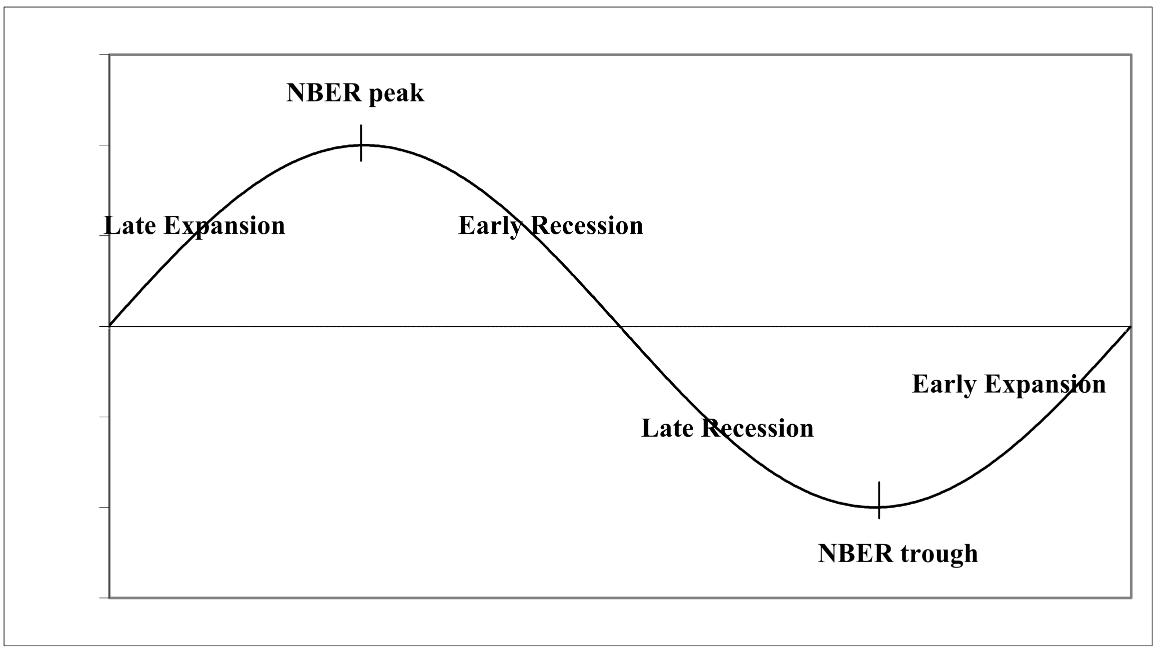


Figure 11 displays a business cycle, where the National Bureau of Economic Research (NBER) peak and trough are identified.[14] The NBER identifies peaks and troughs, but the figure further divides the cycle into phases. Phases are identified by dividing the number of months from peak to trough (trough to peak) into equal halves to indicate Early Recession and Late Recession (Early Expansion and Late Expansion). Clearly, the Early

[13] Weiser (2003) looks at the period 1970-2003, and determines business cycle dating in terms of the rate of change of the quarterly GDP growth rate. Vrugt (2003) also analyzes the period 1970-2003. He uses National Bureau of Economic Research (NBER) business cycle dating, and divides the business cycle into phases. We have used Vrugt's (2003) figure to show the phases.

[14] The NBER is a private, nonprofit, economic research consortium, which dates business cycles in the U.S. by identifying business cycle peaks and troughs. See http://www.nber.org/cycles.html .

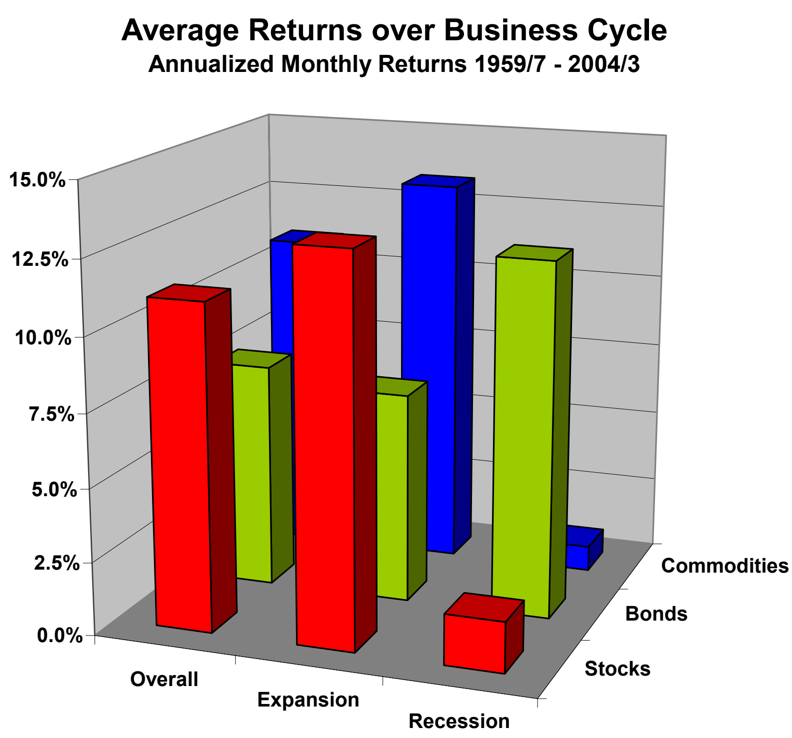
and Late Expansion phases correspond to an economic expansion, while the Early and Late Recession phases correspond to a recession.

In order to analyze the behavior of commodity futures over the business cycle, we would like to include as many business cycles as possible. The equally weighted commodity futures index that we constructed, detailed in Appendix 1, is useful for this.

Starting in 1959 allows us to analyze seven full business cycles, more than Weiser (2003) and Vrugt (2003). (The relevant NBER business cycle chronology for this period is shown in Appendix 3.)

Average annualized (monthly) returns for the major asset classes are given below in Figures 12 and 13. We examine the returns during expansions and recessions, and for the four phases of the cycle.

Figure 12



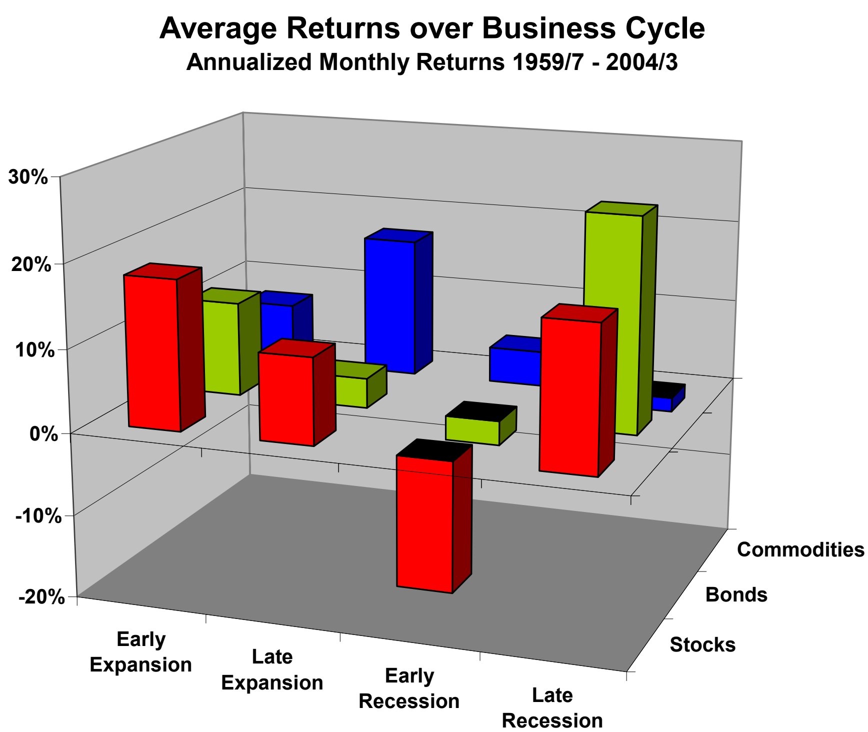
Looking at Figure 12, note the following:

1. Over the period July 1959 through March 2004, average monthly annualized returns on the S&P and the equally-weighted commodity futures total return are remarkably similar, 10.8% and 10.5%, respectively.

2. They are also remarkably similar over expansions, 12.8% on the S&P and 12.9% on the equally weighted commodity futures. Over recessions, the average monthly annualized returns for the S&P and the equally weighted commodity futures are 1.7% and 0.5%.

Based on these two observations, stocks and the commodity futures index appear to be very similar. But, these similarities obscure an important difference when the business cycle is examined in more detail in Figure 13.

Figure 13



3. During the Early Recession phase the returns on both stocks and bonds are negative, -15.5% and –2.9% respectively. But, the return on commodity futures is a positive 3.5%. During the Late Recession phase the signs of the returns reverse, stocks and bonds are positive, while commodity futures are negative.

4. The diversification effect is not limited to the early stages of recessions. Whenever stock and bond returns are below their overall average, in the Late Expansion and Early Recession phases, commodity returns are positive and commodities outperform both stocks and bonds.

The last two conclusions are not evident if the sample is confined to the period 1990-2004, a period which does not cover enough business cycles.

To explore this business cycle diversification effect just a bit further we ask whether there are certain individual commodity futures that are responsible for the result. A further breakdown by stage of the business cycle for individual commodity futures is shown below.

Stock, Bond and Individual Commodity Futures Performance over the Business Cycle, 7/1959 – 3/2004*

Avg. Monthly Annualized % Returns					Phase Avg.			
Data Series	**Starting Date of Data Series**	**Overall Avg.**	**Expansion Avg.**	**Recession Avg.**	**Late Expansion**	**Early Expansion**	**Early Recession**	**Late Recession**
Inflation	07/01/59	4.2%	4.0%	6.5%	4.6%	3.6%	7.6%	5.4%
S&P Total Return	07/01/59	11.1%	13.1%	1.7%	10.4%	18.1%	-15.5%	17.3%
Corporate Bonds TR	07/01/59	7.7%	7.2%	12.1%	3.6%	11.5%	-2.9%	25.7%
Eq. Wtd Futures TR	07/01/59	11.0%	13.4%	0.9%	16.9%	7.4%	4.3%	-1.7%
Equal Wt Spot	07/01/59	8.7%	10.8%	-2.0%	12.3%	7.7%	0.7%	-3.7%
Eq Wt Energy Futures	11/30/78	19.2%	14.7%	-0.8%	17.1%	6.0%	**5.4%**	**-7.8%**
Eq Wt NonEnergy Futures	07/01/59	10.2%	10.2%	-12.9%	15.7%	7.2%	**1.8%**	**0.5%**
Eq Wt Industrial Metals Futures	07/01/59	15.4%	18.4%	6.3%	27.2%	3.5%	**15.7%**	**-29.8%**
Eq Wt Industrial NonMetals Futures	01/05/60	7.7%	10.9%	-14.9%	13.5%	8.7%	-5.4%	-13.4%
Eq Wt Precious Metals Futures	11/06/63	9.4%	11.5%	-8.7%	17.9%	2.3%	0.1%	-10.5%
Eq Wt Animal Products Futures	09/19/61	11.8%	15.1%	-7.7%	17.9%	9.0%	-3.6%	5.8%
Eq Wt Other Food Futures	07/01/59	9.9%	6.4%	20.3%	11.7%	14.3%	15.7%	0.2%
Eq Wt Grain and Products Futures	07/01/59	8.0%	7.1%	0.4%	9.8%	5.1%	-2.8%	11.3%
Natural Gas Futures TR	04/05/90	16.4%	11.3%	-31.0%	10.3%	5.2%	-15.6%	-21.5%
Crude Oil Futures TR	04/04/83	19.1%	13.1%	4.5%	12.1%	4.4%	**26.3%**	**-21.3%**
Unleaded Gas Futures TR	12/04/84	21.0%	14.4%	4.4%	13.1%	3.2%	**23.6%**	**-15.7%**
Heating Oil Futures TR	11/15/78	16.4%	12.5%	6.1%	14.4%	3.0%	**15.6%**	**-7.1%**
Live Cattle Futures TR	12/02/64	13.2%	15.2%	1.3%	16.9%	11.1%	-1.1%	-2.7%
Lean Hogs Futures TR	03/01/66	15.0%	15.1%	2.0%	19.5%	16.3%	-10.8%	5.2%
Wheat Futures TR	07/01/59	4.5%	6.8%	-4.6%	7.1%	6.2%	-14.3%	2.4%
Corn Futures TR	07/01/59	3.6%	5.0%	-5.2%	6.0%	2.7%	-17.3%	5.3%
Soybeans Futures TR	07/01/59	11.5%	14.0%	3.8%	14.2%	6.9%	-3.9%	9.3%
Soybean Oil Futures TR	11/27/62	14.0%	11.4%	32.4%	9.4%	9.5%	37.2%	22.1%
Aluminum Futures TR	06/01/87	5.8%	4.3%	1.1%	4.6%	-0.6%	5.6%	-3.8%
Copper Futures TR	07/01/59	16.1%	18.7%	-6.0%	28.8%	2.3%	11.3%	-21.6%
Zinc Futures TR	01/03/77	9.3%	9.6%	-6.4%	11.9%	3.3%	-8.6%	-1.7%
Nickel Futures TR	04/23/79	16.6%	14.8%	-3.4%	14.1%	3.4%	6.9%	-11.2%

* Period after the last trough in November 2001 was included in overall average and expansion average, but was not included in Phase 4 or Phase 1 because the border between these two phases depends on the next peak, the timing of which is not known at this time.

Lead Futures TR	02/01/77	8.4%	9.2%	-16.6%	11.6%	2.6%	-16.0%	-9.7%
Tin Futures TR	07/03/89	2.7%	2.9%	-5.5%	-2.0%	1.5%	-1.3%	-5.1%
Gold Futures TR	01/02/75	4.9%	3.1%	7.8%	4.1%	-1.2%	-2.5%	14.0%
Silver Futures TR	11/06/63	7.3%	8.9%	-1.0%	13.9%	-2.0%	-1.1%	-0.2%
Platinum Futures TR	03/05/68	10.7%	14.1%	-11.7%	16.3%	5.0%	-2.5%	-20.2%
Sugar Futures TR	01/04/61	12.0%	6.5%	41.1%	11.0%	0.6%	54.3%	26.5%
Cotton Futures TR	01/05/60	9.9%	13.1%	-4.7%	11.0%	17.3%	-4.6%	-3.0%
Coffee Futures TR	01/03/73	14.6%	12.1%	5.5%	4.9%	22.7%	21.2%	-11.4%
Cocoa Futures TR	07/01/59	9.3%	13.2%	5.9%	8.0%	19.0%	18.6%	-2.5%
Lumber Futures TR	10/02/69	6.5%	9.7%	-12.6%	15.5%	0.0%	-7.0%	-23.6%
Propane Futures TR	09/01/87	25.2%	18.4%	-0.3%	11.1%	7.4%	16.5%	-14.8%
Butter Futures TR	09/05/96	18.0%	6.7%	-14.8%	7.0%	0.0%	9.4%	-9.9%
Milk Futures TR	01/11/96	9.8%	6.4%	-10.4%	3.8%	0.4%	6.3%	-2.7%
Orange Juice Futures TR	02/01/67	10.7%	11.1%	-24.1%	19.6%	12.3%	-22.1%	-2.4%
Oats Futures TR	07/01/59	3.3%	3.0%	-5.8%	0.1%	-0.2%	-1.3%	31.3%
Rough Rice Futures TR	09/02/86	-0.2%	9.1%	-10.6%	0.2%	0.8%	-7.8%	-6.8%
Soybean Meal Futures TR	07/01/59	14.6%	16.5%	-0.5%	22.4%	7.5%	-13.5%	4.6%
Feeder Cattle Futures TR	11/30/71	9.6%	8.0%	2.6%	11.8%	6.4%	-3.8%	0.4%
Pork Bellies Futures TR	09/19/61	9.6%	11.9%	4.9%	12.9%	0.7%	-5.9%	30.4%
Palladium Futures TR	01/03/87	15.6%	14.3%	-1.2%	21.1%	9.8%	-19.2%	-13.3%

There are many intriguing patterns in the table, too many to pursue in this study.[15] To highlight just a few, we note the following:

1. There are a number of commodity futures that perform well in the Early Recession, but not well in the Late Recession. In particular, crude oil futures, unleaded gas future, and heating oil futures display this pattern. Thus, an equally weighted energy futures index shows a positive return of 5.4% in the Early Recession, and a negative return of 7.8% in the Late Recession.[16]

2. But, this pattern of strong performance over the Early Recession phase, followed by weaker performance over the Late Recession phase, is not confined to energy futures. For example, Industrial Metals also appears to have strong cyclical features. This subgroup returns 15.7% on average over the Early Recession phase and –29.8% over the late Recession phase. Similarly, the index of Other Food Futures displays this pattern quite strongly.

3. Without energy, the equally-weighted *nonenergy* commodity futures return is still positive over the Early Recession phase (1.8%), and it is also positive over the Late Recession (0.5%).

[15] To conserve space the standard errors are not included in the table.
[16] Note that it starts in 1979 because this is when heating oil futures contracts started trading.

That energy is important for the commodity futures business cycle result is not surprising because the oil crises of the 1970s and 1980s are associated with major recessions. Notable examples are the Arab OPEC oil embargo associated with the Yom Kippur War of 1973, the oil price increase shocks of 1979-1980 and 1990-1991, and a major oil price collapse in 1986. See Hamilton (1985). Many researchers argue that oil shocks disrupt economic activity. That is, unexpected increases in oil prices are associated with declines in the macroeconomy, as measured by output or employment. For example, see Hamilton (2003, 1983). Essentially what happens during the Early Recession phase, generally speaking, is that oil and energy-related prices unexpectedly increase, causing a windfall gain to long futures investors. However, as noted, the results do not depend solely on energy futures. Also, keep in mind that energy futures are somewhat recent contracts, e.g., crude oil only started trading in 1983.

The fact that industrial metals and other foods are very cyclical is also interesting. In fact, the cross section behavior of different commodity futures over the business cyclical is an interesting subject for further research.

9. Commodity Future Returns, Backwardation, and Contango

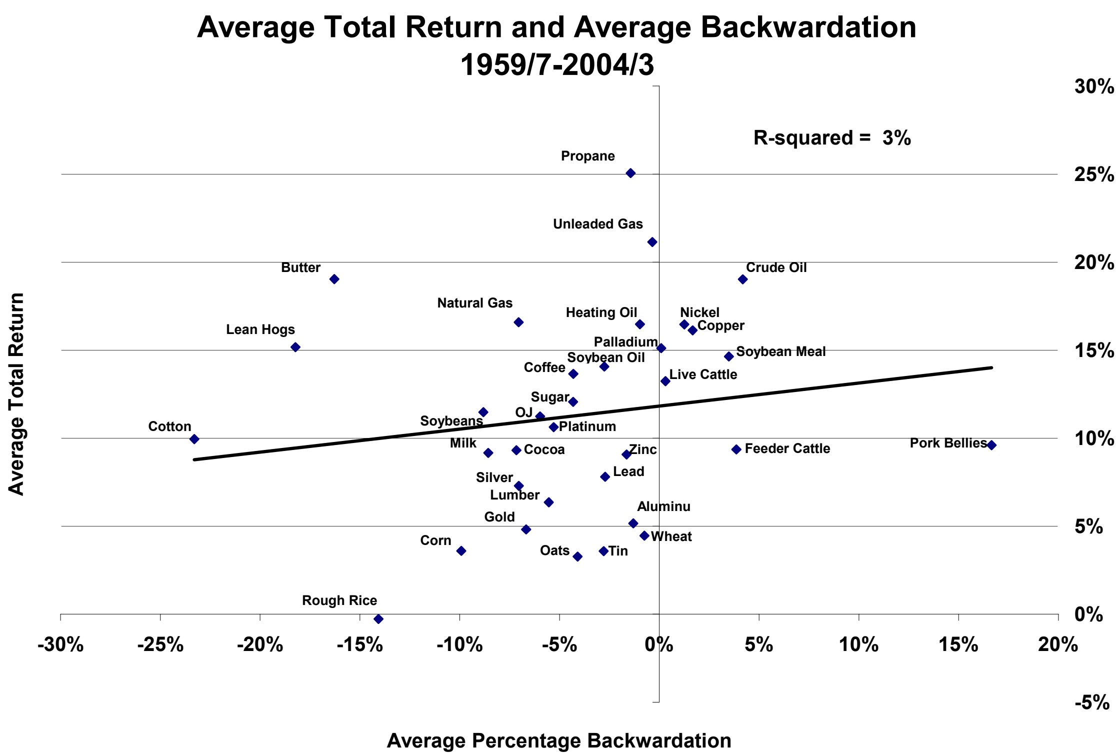
The empirical evidence presented in this paper is consistent with Keynes' theory of normal backwardation. He envisioned a world in which commodity producers use futures markets to transfer the price risk to speculators who are risk averse. To compensate speculators, hedgers agree to set the futures price below the expected spot price. As a consequence, the futures price is expected to appreciate over time, because the futures price has to equal the spot price at expiration of the contract.

The notion of normal backwardation involves a comparison of the futures price to the *expected spot price in the future*, which is unobservable when the futures price is set. In the practice of commodity trading backwardation is commonly used to describe the position of futures prices in relation to *current* spot prices (or to characterize the prices of futures contracts for the same commodity but with different maturities). A commodity is said to be "backwardated" if the prices for future delivery are below the price in the spot market. While "normal backwardation" in the sense of Keynes is equivalent to the existence of a positive risk premium, backwardation in the latter sense is not. For example, assume as in the example in Figure 1, that the current spot price of oil is $30. But now let's change the example and assume that market participants expect the future spot price to be $34, and that speculators and hedgers agree to set the futures price at $32, offering a $2 risk premium to speculators for assuming price risk. The market is in "normal backwardation" (futures below expected spot), but not backwardated in the second sense because the futures is above the current spot (contango).

The two definitions of backwardation are often used interchangeably – as if they were equivalent. But only backwardation in the sense of Keynes refers to the notion of a positive risk premium to investors in commodity futures. Where the futures contract trades relative to the *current* spot does not directly speak to the presence of a risk premium. In an efficient market, it is unlikely that trading on publicly available information will lead to abnormal profits.

In Section 5, above, we showed that on average the equally weighted commodity futures index displays a large risk premium. This is consistent with Keynes' idea. But, the second notion of backwardation should not have anything to do with a positive risk premium. To verify this we conducted two experiments. First, we computed for each commodity the average historical return and the average percentage of months that commodity was in backwardation. Figure 14 illustrates that there does not seem to be any systematic relationship between the two. A simple cross-sectional regression of average returns on average % backwardation has an R-squared of 3%. The slope coefficient is positive, but it is insignificantly different from zero. The conclusion from this figure is that commodities that have been more backwardated (by the second definition) have not earned larger historical returns.

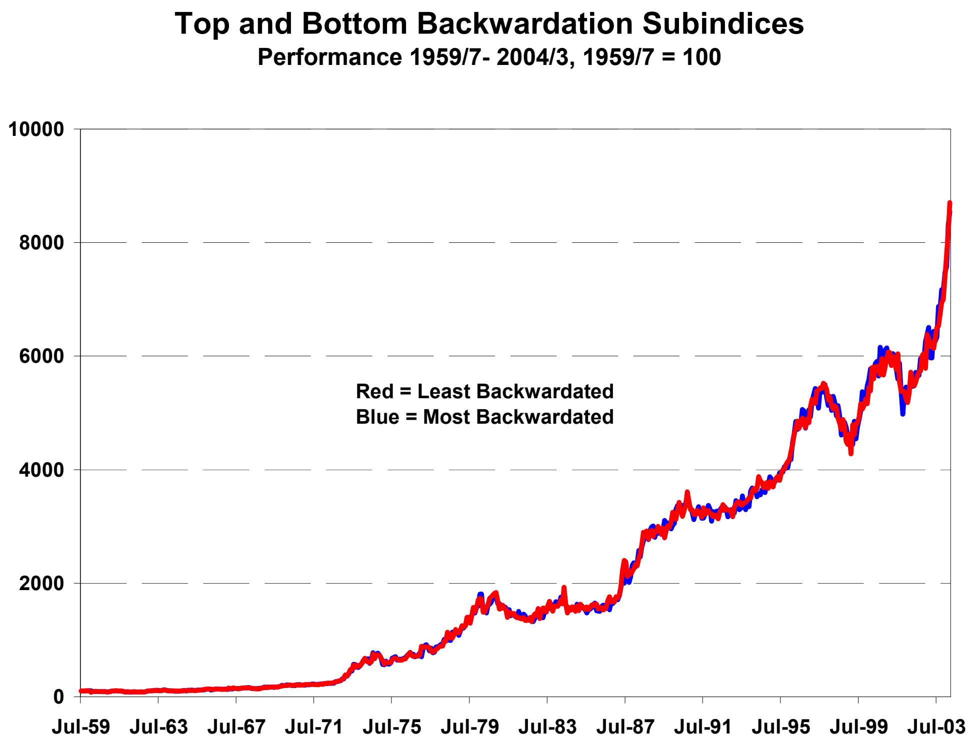
Figure 14



In the second experiment we examined whether a strategy that invests in the most backwardated commodities (by the second definition) outperforms a strategy that invests in the least backwardated commodities. We implement this as follows. At the end of each month since July 1959, we sort the available commodities based on their degree of backwardation, and divide them into two portfolios (highest and lowest backwardation). After each ranking, we hold our position for a month. At the end of the month we re-rank the commodities based on backwardation, and rebalance our portfolios for the next month.

Figure 15 shows the cumulative performance of these two portfolios. Consistent with market efficiency, there is no noticeable difference between the performance of the two indices. Backwardation – defined as the difference between the current futures price and the current spot price – carries no information about the relative attractiveness of investment in commodity futures.

Figure 15



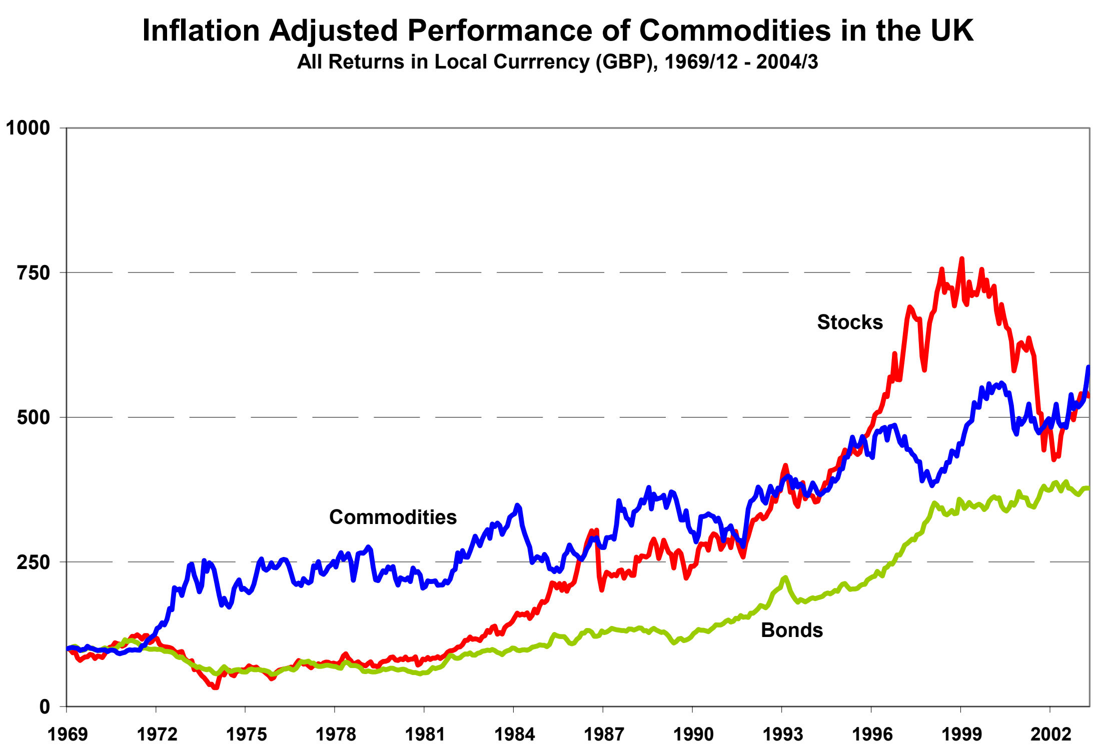
If instead of comparing the spot price to the nearest maturity futures price, two futures prices corresponding to different maturities are compared to determine backwardation, in the second sense, the above results do not change. To reiterate, none of this is surprising if futures markets are efficient, as it should not be possible to profitably trade on the basis of public information.

10. Commodity Futures in an International Setting

The majority of commodities in our index are traded on US exchanges – with the exception of some metals that are traded in London. Physical delivery takes place at a location within the contiguous 48 states, and settlement is in US dollars. The US markets for some commodities (gold, crude oil) are probably integrated with global markets, but prices of others are likely to be influenced by local conditions (natural gas, live hogs). It is conceivable that a common country-specific US factor has positively influenced both stock and commodity futures returns in the US. If that were the case, commodity futures might look quite different from the perspective of a foreign investor. Therefore, it is interesting to ask whether a Japanese or UK investor would draw the same conclusion as a US investor about the relative performance of these asset classes.

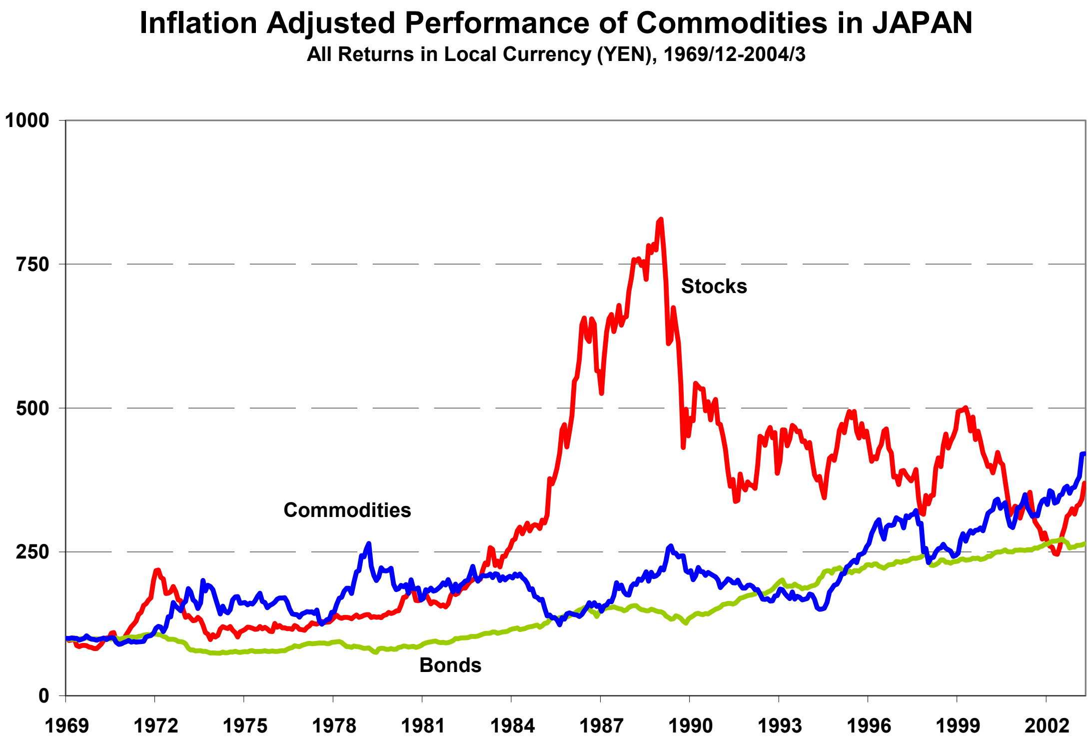
Figures 16 and 17 illustrate the performance of commodities from the perspective of UK and Japanese investors. The equity benchmarks we use are the total return indices from Morgan Stanley Capital International (MSCI) for the UK and Japan, and the cumulative performance of long-term government bonds in both countries published by the International Monetary Fund. All indices are computed in local currency (GBP and YEN), and deflated by the local CPI-index. Similarly, for commodity futures we compute the performance of the index measured in GBP and Yen, before deflating it by the local CPI.[17]

Figure 16



[17] The collateral for the futures position is US T-bills. It is possible to collateralize the futures position by local T-bills.

Figure 17



Three observations stand out from Figures 16 and 17:

1. Between 1970 and March of 2004 the historical performance of commodities has been similar to equities in both the UK and Japan. Commodity Futures have outperformed long-term government bonds

2. Commodity Futures have outpaced local CPI inflation in the UK and Japan.

3. The relative rankings of inflation-adjusted performance Stocks, Bonds, and Commodity Futures are the same in the Japan, the UK, and the US.

Our earlier conclusions about the relative performance of commodity futures have not been specific to the US experience. Foreign investors – evaluating performance in local currency, and relative to local inflation – would have drawn the same conclusions.[18]

11. Commodity Futures vs. Stocks of Commodity Producing Companies

It is sometimes argued that the equities of companies involved in producing commodities are a good way to gain exposure to commodities. In fact, some argue that the stocks of

[18] We are in the process of validating the hedging and diversification properties of commodity futures from the perspective of foreign investors.

such “pure plays” are a substitute for commodity *futures*. We can examine this argument by constructing an index of the stock returns on such companies and then comparing the performance of this index to an equally weighted commodity futures index. In order to make this comparison we need to identify companies that can be most closely matched with the commodities of interest. There is no obvious way to match companies with commodities since companies are almost never “pure plays,” but rather are involved in a number of businesses. We chose to match based on a simple rule, namely, with each commodity that can be associated with a four-digit SIC code, we take all the companies with that same four-digit SIC code. On this basis we can match 17 commodities with companies having publicly-traded stock. The details are in Appendix 4.

Figure 18a shows a significant difference between the average return of commodity futures and investment in commodity company stocks. Over the 41-year period between 1962 and 2003 the cumulative performance of futures has been triple the cumulative performance of “matching” equities.

A plot of the same indices on a logarithmic scale indicates that the two investments have limited correlation as well – the full-sample average monthly correlation is 0.38. The conclusion of Figure 18 is that an investment in commodity company stocks has not been a close substitute for an investment in commodity futures.

Figure 18a

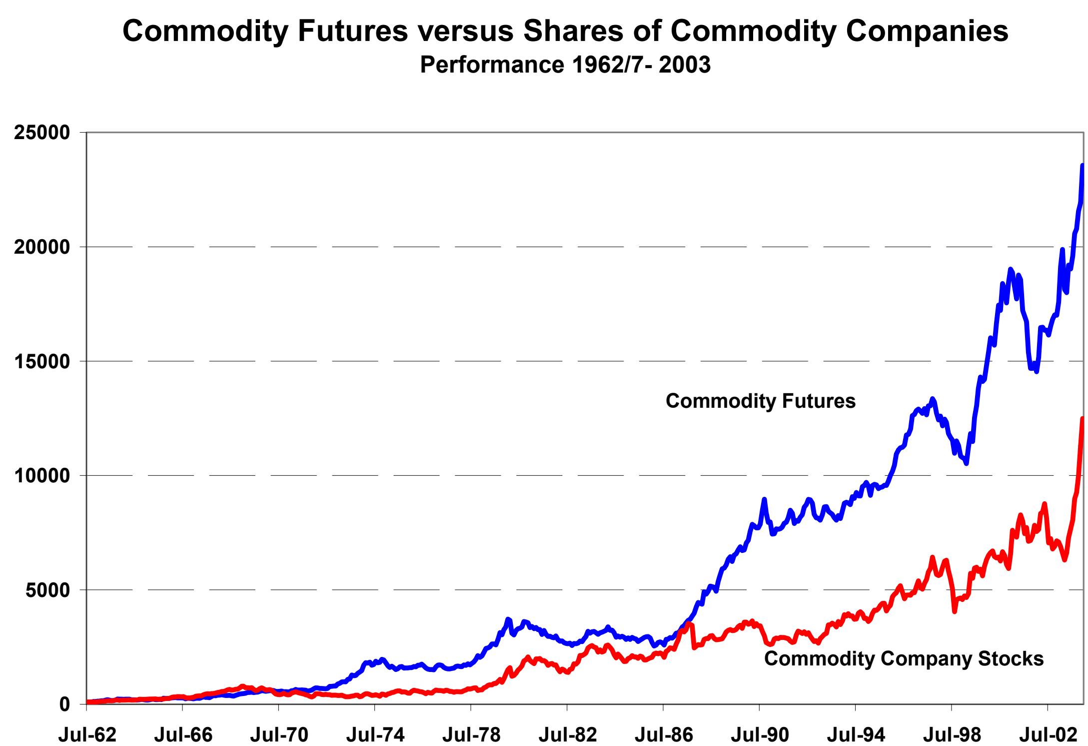
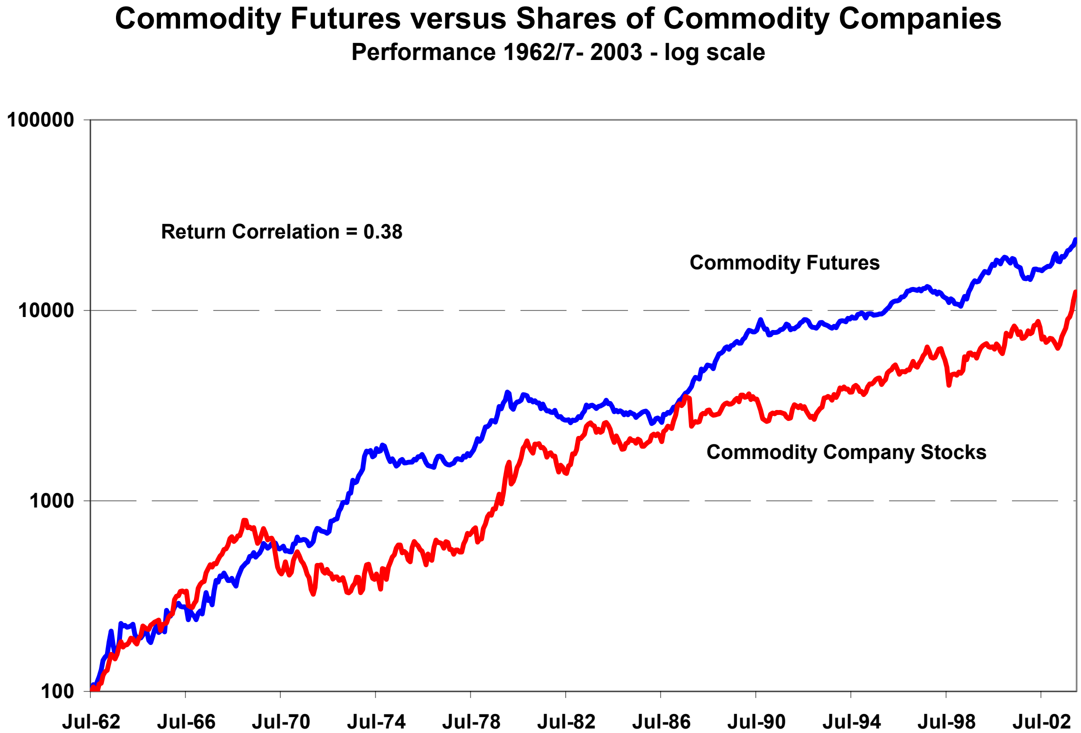


Figure 18b



12. Summary

This paper provides evidence on the long-term properties of an investment in collateralized commodity futures contracts. We construct an equally-weighted index of commodity futures covering the period between July 1959 and March 2004. We show empirically that there is a large difference between the historical performance of commodity futures and the return an investor of spot commodities would have earned. An investor in our index of collateralized commodity futures would have earned an excess return over T-bills of about 5% per annum. During our sample period, this commodity futures risk premium has been equal in size to the historical risk premium of stocks (the equity premium), and has exceeded the risk premium of bonds. This evidence of a positive risk premium to a long position in commodity futures is consistent with Keynes' theory of "normal backwardation".

In addition to offering high returns, the historical risk of an investment in commodity futures has been relatively low – especially if evaluated in terms of its contribution to a portfolio of stocks and bonds. A diversified investment in commodity futures has slightly lower risk than stocks – as measured by standard deviation. And because the distribution of commodity returns is positively skewed relative to equity returns, commodities have less downside risk.

Commodity futures returns have been especially effective in providing diversification of both stock and bond portfolios. The correlation with stocks and bonds is negative over most horizons, and the negative correlation is stronger over longer holding periods. We provide two explanations for the negative correlation of commodities with traditional asset classes. First, commodities perform better in periods of unexpected inflation, when stock and bond returns generally disappoint. Second, commodity futures diversify the cyclical variation in stock and bond returns.

On the basis of the stylized facts we have produced, two conclusions are suggested. First, from the point of view of investors, the historical performance of collateralized investments in commodities suggests that commodities are an attractive asset class to diversify traditional portfolios of stocks and bonds. Second, from the point of view of researchers, there are clearly challenges for asset pricing theory, which to date has primarily focused on equities.

Appendix 1: Construction of the Equally-Weighted Commodity Futures Index

The equally-weighted index is constructed using Commodity Research Bureau (CRB) data (http://www.crbtrader.com/crbindex/ndefault.asp) and data from the London Metals Exchange.[19] The CRB data set covers all commodity futures that are in existence today from the date of inception. Commodity futures contracts that were introduced, but later discontinued – due to lack of liquidity – are not covered by the CRB, and are not included in the equally-weighted index. As discussed in the main text, this omission is a type of survivor bias, but is fundamentally different from survivor bias in other asset classes, like mutual funds and stocks. In other asset classes, assets disappear because they had low returns or failed. Consequently, calculating returns that omit these assets biases the returns upwards. In the case of commodity futures, contract types do not disappear because of failure in the same sense. Rather, there is a lack of liquidity, not low returns. (See Black (1986) and Carlton (1984).) Therefore, this type of survivor bias is less of an issue here.

We construct the equally-weighted commodity futures index in steps.

First, we construct monthly returns on each commodity future using the nearest contract, which on the last business day of the month before expiration is rolled into the next nearest contract. The return is computed assuming that the futures position is fully collateralized and marked-to-market on a daily basis and earns interest on the daily basis (based on the current 91-day Treasury Bill auction rate).

Second, using monthly returns for each commodity, we construct the index by adding the monthly returns together each month and dividing by the number of commodities in the index that month. A commodity enters the index on the last business day of the month following its introduction date except the first seven commodities entered the index on 07/01/59, not 07/31/59. This corresponds to monthly rebalancing. The table below shows the introduction dates of the commodities. For Lean Hogs the contract specification changed in 1996 from Live Hogs to Lean Hogs. We used the CRB backfill of Lean Hogs to the introduction date of Live Hogs.

	Commodity Future	Date of Introduction
1	Wheat	07/01/59
2	Corn	07/01/59
3	Soybeans	07/01/59
4	Soybean Meal	07/01/59
5	Oats	07/01/59
6	Copper	07/01/59
7	Cocoa	07/01/59

[19] We used only the contracts listed in the table below. Before October 1993, we interpolate between cash and three month forward prices to get the futures price for the third Wednesday expiration for January, March, May, July, September, and November. After October 1993 we used data from the third Wednesday of January, March, May, July, September, and November.

8	Cotton	01/05/60
9	Sugar	01/04/61
10	Pork Bellies	09/19/61
11	Soybean Oil	11/27/62
12	Silver	11/06/63
13	Live Cattle	12/02/64
14	Lean Hogs	03/01/66
15	Orange Juice	02/01/67
16	Platinum	03/05/68
17	Lumber	10/02/69
18	Feeder Cattle	11/30/71
19	Coffee	01/03/73
20	Gold	01/02/75
21	Zinc	01/03/77
22	Palladium	01/03/77
23	Lead	02/01/77
24	Heating Oil	11/15/78
25	Nickel	04/23/79
26	Crude Oil	04/04/83
27	Unleaded Gas	12/04/84
28	Rough Rice	09/02/86
29	Aluminum	06/01/87
30	Propane	09/01/87
31	Tin	07/03/89
32	Natural Gas	04/05/90
33	Milk	01/11/96
34	Butter	09/05/96

Appendix 2: Summary Statistics for Commodity Futures Returns

Average Returns (monthly returns annualized (%)) 7/1959-3/2004

	T-bills	Stocks	Bonds	Commodity Futures
Mean	5.52%	11.02%	7.71%	11.02%
Std	0.78%	14.90%	8.47%	12.12%

Short-term return correlations
Above diagonal monthly returns \ below diagonal quarterly returns

(Newey-West corrected standard errors in parentheses)

	Inflation	Stocks	Bonds	Commodity Futures
Inflation		-0.15 (0.0455)	-0.12 (0.058)	0.014 (0.052)
Stocks	-0.20 (0.080)		0.31 (0.0.052)	0.052 (0.052)
Bonds	-0.21 (0.055)	0.30 (0.074)		-0.14 (0.038)
Commodity Futures	0.14 (0.085)	-0.06 (0.08)	-0.28 (0.04)	

Long-term return correlations
Above diagonal annual returns \ below diagonal 5-year returns

(Newey-West corrected standard errors in parentheses)

	Inflation	Stocks	Bonds	Commodity Futures
Inflation		-0.19 (0.14)	-0.33 (0.11)	0.31 (0.12)
Stocks	-0.28 (0.15)		0.34 (0.11)	-0.11 (0.12)
Bonds	-0.21 (0.18)	0.51 (0.13)		-0.30 (0.07)
Commodity Futures	0.48 (0.14)	-0.44 (0.14)	-0.26 (0.10)	

All returns are for overlapping periods.

Short-term return correlations with inflation components
Above diagonal monthly returns \ below diagonal quarterly returns

	Inflation (I)	Unexpected Inflation (U)	Change of Expected Inflation (DE)	Stocks	Bonds	Commodity Futures
I		0.72	0.06	-0.15	-0.12	0.01
U	0.56		0.18	-0.15	-0.19	0.06
DE	0.09	0.31		-0.04	-0.35	-0.01
Stocks	-0.20	-0.25	-0.15		0.31	0.05
Bonds	-0.21	-0.36	-0.51	0.30		-0.14
Commodity Futures	0.14	0.27	0.19	-0.06	-0.28	

Appendix 3: NBER Business Cycle Chronology, for the Period 1959-2004

		Contraction	Expansion	Cycle	
Peak	**Trough**	**Peak to Trough**	**Previous Trough to this Peak**	**Trough from Previous Trough**	**Peak from Previous Peak**
August 1957	April 1958	8	39	47	49
April 1960	February 1961	10	24	34	32
December 1969	November 1970	11	106	117	116
November 1973	March 1975	16	36	52	47
January 1980	July 1980	6	58	64	74
July 1981	November 1982	16	12	28	18
July 1990	March 1991	8	92	100	108
March 2001	November 2001	8	120	128	128

Source: NBER, http://www.nber.org/cycles.html .

Appendix 4: Matching Commodity-Producing Firms to Commodities

As mentioned in the main text, we chose to match companies with commodities based on associating with each commodity a four-digit SIC code. We then search the University of Chicago Center for Research in Security Prices monthly stock database for all the companies with that same four-digit SIC code. On this basis we can match 17 commodities with companies having publicly-traded stock. For all companies with same SIC code we form the equally weighted monthly stock return series, and then using these series we form the equally weighted commodity-producing firms stock index.

There were several exceptions to the general rule. In the case of Palladium, we looked at SIC codes 1099 and 1090, i.e., Misc. Metal Ores. This category includes companies mining palladium, but it also includes companies mining uranium and other metals. From the list of all these companies we found two palladium mining companies, namely, North American Palladium (PAL) and Stillwater Mining (SWC); the remaining companies were ruled out.

Silver does not occur in a pure form. It is usually found as a byproduct of either gold and copper ores or lead and zinc ores. SIC code 1044 "Silver Ores" contains very few stocks, especially in the recent period. There is, however, an SIC code 1040 – "Gold and Silver Ores". There are about 200 stocks with this SIC code. Among these stocks we were able to identify several companies specifically focusing on silver – Pan Amer Silver (PAAS), Silver Standard Resources (SSRI), Apex Silver Mines Ord (SIL), Helca Mining (HL), and Coeur d'Alene Mines (CDE). These stocks were added to silver stocks. The rest of the stocks in the 1040 SIC code "Gold and Silver Ores" were added to gold stocks.

In the case of Milk, we looked at SIC code 2020. From the SIC code 2020 "Dairy Products" we excluded all stocks that we could identify as ice cream producers – these are consumers of milk, not producers of milk. The remainder were taken as Milk stocks.

The table below provides the detail on the number of stocks for each commodity and the period covered. If there are zero stocks, then that commodity was not included because not matching company could be found.

Summary of Matches of Companies to Commodities

Commodity	Start	End	Matching SIC Codes	SIC description	Stocks Start	Stocks End	Number of Stocks	Comparison Start	Comparison End	2nd range start	2nd range end
Natural Gas	04/05/90	12/31/03	1310; 1311	Crude Petroleum and Gas Extraction	12/31/25	12/31/03	297	04/30/90	12/31/03		
Crude Oil	04/04/83	12/31/03	2910; 2911	Petroleum Refining	12/31/25	12/31/03	137	03/31/83	12/31/03		
Unleaded Gas	12/04/84	12/31/03	2910; 2911	Petroleum Refining	12/31/25	12/31/03	137	11/30/84	12/31/03		
Heating Oil	11/15/78	12/31/03	2910; 2911	Petroleum Refining	12/31/25	12/31/03	137	11/30/78	12/31/03		
Live Cattle	12/02/64	12/31/03	212; 5154	Beef cattle except feedlots; Livestock	8/31/83	3/31/86	2	08/31/83	03/31/86	3/31/02	12/31/03
Lean Hogs	03/01/66	12/31/03	213	Hogs			0				
Wheat	07/01/59	12/31/03	111	Wheat			0				
Corn	07/01/59	12/31/03	115	Corn	12/31/72	3/31/86	2	12/31/72	03/31/86		
Soybeans	07/01/59	12/31/03	116	Soybeans			0				
Soybean Oil	11/27/62	12/31/03	2075	Soybean Oil Mills	7/31/01	12/31/03	2	07/31/01	12/31/03		
Aluminum	06/01/87	12/31/03	3334	Primary Aluminum	8/31/91	12/31/03	6	8/31/91	12/31/03		
Copper	07/01/59	12/31/03	1020; 1021; 3331	Copper ores; Primary Copper	7/31/62	12/31/03	43	07/31/62	12/31/03		
Zinc	01/03/77	12/31/03	1030;1031	Lead and Zinc Ores	7/31/62	1/31/02	22	12/31/76	01/31/02		
Nickel	04/23/79	12/31/03	1061	Ferroalloy ores except vanadium	7/31/62	12/31/03	9	04/30/79	12/31/03		
Lead	02/01/77	12/31/03	1030;1031	Lead and Zinc Ores	7/31/62	1/31/02	22	01/31/77	01/31/02		
Tin	07/03/89	12/31/03					0				
Gold	01/02/75	12/31/03	1041;1040	Gold ores; Gold and silver ores	2/28/86	12/31/03	299	02/28/86	12/31/03		
Silver	11/06/63	12/31/03	1044; 1040	Silver ores	7/31/62	12/31/03	16	10/31/63	12/31/03		
Platinum	03/05/68	12/31/03					0				
Sugar	01/04/61	12/31/03	2061;2063	Raw cane sugar; Beet sugar	7/31/62	12/31/03	15	07/31/62	12/31/03		
Cotton	01/05/60	12/31/03	131	Cotton	10/31/75	8/31/85	1	10/31/75	10/31/77	10/31/81	8/31/85
Coffee	01/03/73	12/31/03					0				
Cocoa	07/01/59	12/31/03					0				

Lumber	10/02/69	12/31/03	2400; 2410; 2411; 810; 811	Lumber and Wood Products; Logging; Timber tracts	2/28/27	12/31/03	19	09/30/69	12/31/03
Propane	09/01/87	12/31/03	1320; 1321	Natural gas liquids	5/31/91	12/31/03	12	05/31/91	12/31/03
Butter	09/05/96	12/31/03	2021	Creamery butter			0		
Milk	01/11/96	12/31/03	240; 241; 2026; 2020	Dairy farms; Fluid milk; Dairy products	12/31/25	12/31/03	35	01/31/96	12/31/03
Orange Juice	02/01/67	12/31/03	174	Citrus fruits	9/30/70	11/30/99	4	09/30/70	11/30/99
Oats	07/01/59	12/31/03	119	Cash grains, n.e.c.			0		
Rough Rice	09/02/86	12/31/03	112	Rice	7/31/73	7/31/99	1	08/30/86	07/31/99
Soybean Meal	07/01/59	12/31/03	2075	Soybean Oil Mills	7/31/01	12/31/03	2	07/31/01	12/31/03
Feeder Cattle	11/30/71	12/31/03	211; 5154	Beef cattle, feedlots; Livestock	12/31/69	9/30/88	4	11/30/71	09/30/88
Pork Bellies	09/19/61	12/31/03	213	Hogs			0		
Palladium	01/03/77	12/31/03	PAL; SWC	Selected from 1090, 1099 Misc Metal Ores	11/30/93	12/31/03	2	11/30/93	12/31/03

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