Introduction

In recent years, a passive investment in commodities provided high, equity-like average returns, negative return correlations with traditional asset classes, and some protection against inflation. Augmenting a traditional portfolio with an allocation to commodity investments would have improved risk-adjusted portfolio returns. Consequently, interest in commodity investments has increased tremendously. This paper will describe the most popular means of passively investing in commodities—commodity futures indexes—and will discuss their role in a well-diversified portfolio.

Although historical returns serve as a useful guide, long-term asset allocation decisions must be based on forward-looking expectations about commodity returns. Detailed analysis of commodity futures index returns will identify key drivers needed to form those expectations. Commodity futures index returns may be broken down into collateral return (U.S. Treasury bills), spot return (the return from changes in commodity prices) and roll return (the return associated with rolling a futures contract forward). Over long periods, the spot return is on average not much higher than inflation, so the roll return is an important contributor to the equity-like returns achieved by some commodity investments.

Unfortunately, there is evidence that the roll return is declining or even disappearing in markets where it traditionally has been strongest (such as energy futures markets). So, although a small allocation to commodities may provide some diversification benefits, we caution against making an allocation to commodity investments based on extrapolations of historical returns.
Commodity investments and their historical return characteristics

Commodity futures indexes
In this article, we focus on passive investments in commodities. An investor can gain passive exposure to the commodities asset class by directly holding physical commodities or by investing in commodity sector equities, commodity spot indexes, and commodity futures indexes. Equity investments in commodity sectors do not represent pure commodities exposure, because many firms in these sectors hedge their commodity exposure and because stock returns are influenced by business conditions and other factors affecting corporate earnings. In contrast, commodity futures indexes are highly correlated with commodity spot indexes and are extremely liquid. Consequently, we define commodities asset class returns as returns earned from investing in fully collateralized commodity futures indexes.

Analysis of commodity futures indexes requires understanding of a few key concepts. Commodity futures indexes cannot use market-capitalization weighting (the rule most commonly used for traditional asset classes) because every futures contract has zero market capitalization. As a result, there is a lack of consensus on the best way to index commodity futures, and different providers use quite different indexing rules. Which rules produce the index with the most attractive investment characteristics? Unfortunately, it is too early to say—the short return histories of commodity futures indexes (see sidebar on page 3) together with their potential back-fill biases make comparison difficult. We have chosen to focus on the S&P GSCI Commodity Index (formerly known as the Goldman Sachs Commodity Index) because it uses a transparent, economically motivated indexing strategy; it’s liquid; it’s by far the most popular commodity futures index; and it has the longest (back-filled) history.

Taxation of commodity futures
Like the returns for other investments, the returns for commodities are commonly reported pre-tax. However, the taxation of commodity returns is significantly more burdensome and complicated than that of many other investments. For derivative-based portfolios, total returns can be taxed as 60% long-term capital gains and 40% short-term capital gains. For portfolios that hold the physical commodities—such as gold and silver bullion—returns may be taxed at 28%, like the profit from collectibles. As a result, an allocation to commodities may be suboptimal for taxable portfolios.

1 Two often-discussed active commodities strategies are a long-short momentum strategy and a strategy based on the Net Hedging Hypothesis that involves long positions in backwardated commodities and short positions in commodities in contango. Anecdotal evidence suggests that some market participants have engaged in a third potentially profitable strategy that involves front-running large futures indexes. Recently, for example, the slope of the futures curve for some commodities has been more negative on GSCI roll days (the fifth through ninth business days of each month), which suggests that traders are front-running the GSCI. See Erb and Harvey (2006) for more on long-short momentum and futures curve strategies, and Akey (2005) for more on the performance of active commodity futures fund managers.

2 In a fully collateralized futures index, assets (typically, 3-month Treasury bills) equal to the notional amount of the futures investment are set aside as collateral.

3 Two widely cited recent papers, Gorton and Rouwenhorst (2005) and Erb and Harvey (2006), also focus on commodity futures. By assigning a four-digit Standard Industry Classification code to each commodity, Gorton and Rouwenhorst were able to construct a commodity equity index and find that these equities had a 0.38 correlation with commodity futures and had much lower cumulative returns. They conclude that commodity sector equities do not provide pure exposure to the commodities asset class.

4 Black (1976) compares futures contracts to sports betting, in which every position has an opposite position and there is no net supply. Since there is zero net supply, the market capitalization of futures contracts is always zero.

5 Ideally, a commodities index could be created based on the spot price and the stock (reserves) of a commodity, establishing something analogous to a market capitalization. Unfortunately, there is no adequate measure of outstanding commodity reserves, as there is for outstanding company stock shares.

6 Although one could construct hypothetical return histories for commodity futures indexes to extend their short realized return histories, these return histories would be problematic for two reasons. First, because the providers have had to devise an indexing strategy for commodity futures, these constructed index histories potentially would suffer from back-fill bias. That is, since it’s plausible that the chosen indexing strategies were influenced by realized historical commodities futures returns, back-filled histories might be upwardly biased. Second, although some commodity futures contracts (such as those for agricultural commodities) have a long trading history, energy sector contracts (which are important today and have delivered high historical returns) started trading only in 1983.
A comparison of commodity indexes

The S&P GSCI Index uses a weighting rule that attempts to capture the rationale behind market-capitalization weighting. It weights each constituent commodity by a dollar estimate of the global production of that commodity. The Deutsche Bank Liquid Commodity Index considers both world production and world inventory. The Standard & Poor’s Commodity Index uses open interest on the futures contract but focuses on economic factors by attempting to filter out purely speculative interest. Because of the substantial differences in return characteristics and the low correlations across commodity futures sectors, different weighting rules result in very different return characteristics.

### Description of commodity indexes

<table>
<thead>
<tr>
<th></th>
<th>Reuters–Bank Commodity Research Bureau</th>
<th>Deutsche Bank Liquid Commodity Index</th>
<th>S&amp;P GSCI Index</th>
<th>Dow Jones–AIG Commodity Index</th>
<th>Rogers International Commodity Index</th>
<th>Standard &amp; Poor’s Commodity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indexing strategy</td>
<td>Equal-weighted</td>
<td>World production- and inventory-weighted</td>
<td>World production-weighted</td>
<td>Liquidity (trading activity) and dollar-adjusted production-weighted</td>
<td>“Price action of raw materials on a world-wide basis”</td>
<td>Commercial (excludes speculators) open interest, only U.S.- traded futures</td>
</tr>
</tbody>
</table>

Source: Vanguard.
Historical commodity return characteristics

Returns for the S&P GSCI Total Return Index over the past 36 years have been, on average, high, but very volatile, as displayed in Figure 1.

An analysis reveals that the remarkably high average returns for the five-year period from 1970 to 1974 were fueled by extraordinary returns in the commodity spot markets. For the GSCI Spot Index, the average annual return for 1970–1974 was 22.48%. However, these high spot returns did not persist; the average from 1970 through 2006 was below cash returns. Since the introduction of energy futures contracts in 1983, total returns have been driven not by a general rise in commodity prices but by the strong performance in the energy sector. This is particularly true in production-weighted indexes, such as the GSCI, where the energy weighting has been quite large—e.g., 69.46% as of April 25, 2007. The GSCI Total Return Index returns are shown in Table 1 with and without the energy sector.7

Table 1. S&P GSCI average annual returns: 1983–2006

<table>
<thead>
<tr>
<th>GSCI Total Return</th>
<th>GSCI Energy Total Return</th>
<th>GSCI Non-Energy Total Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.81%</td>
<td>18.30%</td>
<td>6.58%</td>
</tr>
</tbody>
</table>

Source: Thomson Datastream.

Note: Past performance is no guarantee of future returns. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index.

Figure 1. S&P GSCI Total Return Index annual returns: 1970–2006

Source: Thomson Datastream.

7 Returns were evaluated over the 1983–2006 period, rather than since the inception of the GSCI Total Return Index, because energy futures contracts were not part of the index prior to 1983.
Historically, commodity futures investments have exhibited the following return characteristics:

- Commodity futures contracts are highly volatile. The return volatility of 14 of the futures contracts in the S&P GSCI is substantially greater than that of a broad market stock index.\(^8\)

- Commodity futures returns have had low correlation across contract type. These low correlations have two important implications. First, some of the high individual contract return volatility is diversified away when contracts are combined to form a commodities portfolio. Even more volatility is diversified away when contracts are aggregated to the sector level; in fact, we find that only the energy (44\%) and industrial metals (26\%) commodity sectors exhibit substantially greater volatility than the broad stock market (18\%). Second, these low correlations across contracts highlight the importance of the rules chosen by commodity index providers. Differently constituted (and weighted) indexes may have very different return characteristics.

- Commodity futures investments have had reliably low correlations with traditional asset classes (see Figure 2). All the commodities sectors have low or negative return correlations with cash, stocks, and bonds. (The agricultural sector shows the highest degree of correlation with traditional asset returns, exhibiting annual correlations of 0.247 with stocks, 0.248 with bonds, and 0.135 with cash.\(^9\))

---

\(^8\) Dow Jones Wilshire 5000 Composite Index used as broad market benchmark.


Figure 2. Monthly correlations of S&P GSCI Total Return Index with stocks and bonds: 1988–2006
Finally, commodity futures indexes have provided some protection against inflation. During the period 1983–2006, the GSCI Total Return Index had approximately the same annual correlation with inflation as cash (about 0.5), but had a much larger inflation beta, as shown in Table 2. (Specifically, energy, livestock, and industrial metals had fairly large correlations with both inflation and unexpected inflation, defined as the change in the inflation rate.) In other words, if inflation rose 1%, we would expect the GSCI Total Return Index to have contributed over 1% to the value of a portfolio with a 10% allocation to that index (thereby preserving real value). It’s important to stress that we do not view commodities as a reliable hedge against inflation, but instead, as an asset class that is expected to provide high returns in high-inflation environments.

Portfolio construction implications of historical return characteristics
To examine the effect of adding commodities to well-diversified traditional portfolios, we analyzed historical risk-adjusted returns for three hypothetical allocations. Portfolio 1 is 60% stocks and 40% bonds, Portfolio 2 is 70% stocks and 30% bonds, and Portfolio 3 is 62.5% stocks, 27.5% bonds, and 10% S&P GSCI futures.

For the period from 1983 through 2006, Portfolio 1 would have provided an annualized geometric mean return of 11.3% with volatility of 10.5%. Over the same period, Portfolio 3—with a lower allocation to bonds but an added exposure to commodity futures—would have had a higher average annual return (11.8%), the same return volatility (10.5%), and a better worst year (~7.7% instead of ~8.4%). In short, the commodity exposure would have raised the average annual return by almost half a percentage point without increasing portfolio volatility.

Could these benefits have been achieved by replacing part of the bond allocation with stocks instead of commodities? Table 3 shows that Portfolio 2 had about the same average annual return (11.7%) as Portfolio 3 (11.8%), but with higher volatility (11.8% versus 10.5%) and a worse worst year (~11.5% versus ~7.7%). We conclude that for the period 1983–2006, an allocation to commodities could have helped increase average portfolio returns without increasing volatility. Please see the appendix for a more detailed analysis of the asset allocation implications of historical returns (derived using mean-variance optimization).

Table 2. Betas from univariate annual regressions of cash and GSCI on inflation: 1983–2006

<table>
<thead>
<tr>
<th></th>
<th>5th percentile</th>
<th>Median</th>
<th>95th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>0.30</td>
<td>1.06</td>
<td>1.82</td>
</tr>
<tr>
<td>S&amp;P GSCI Total Return</td>
<td>3.64</td>
<td>10.75</td>
<td>17.87</td>
</tr>
</tbody>
</table>

Source: Vanguard.

Note: Cash represented by Citigroup 3-Month Treasury Bill Index.

Table 3. Risk and return results for three hypothetical portfolios: 1983–2006

<table>
<thead>
<tr>
<th>Portfolio 1: 60% stocks, 40% bonds</th>
<th>Portfolio 2: 70% stocks, 30% bonds</th>
<th>Portfolio 3: 62.5% stocks, 27.5% bonds, 10% GSCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatility</td>
<td>10.5%</td>
<td>11.8%</td>
</tr>
<tr>
<td>Worst year</td>
<td>–8.4</td>
<td>–11.5</td>
</tr>
<tr>
<td>Geometric mean</td>
<td>11.3</td>
<td>11.7</td>
</tr>
<tr>
<td>Geometric mean</td>
<td>11.8</td>
<td></td>
</tr>
</tbody>
</table>

Source: Vanguard.

Table 3 shows that Portfolio 2 had about the same average annual return (11.7%) as Portfolio 3 (11.8%), but with higher volatility (11.8% versus 10.5%) and a worse worst year (~11.5% versus ~7.7%). We conclude that for the period 1983–2006, an allocation to commodities could have helped increase average portfolio returns without increasing volatility. Please see the appendix for a more detailed analysis of the asset allocation implications of historical returns (derived using mean-variance optimization).

10 We confirmed the historical robustness of the GSCI’s high inflation beta by estimating quarterly regressions over different sample periods.

11 Although we ignore costs, note that commodities investments would have to have costs of about 5% to completely erode this historical benefit.

12 Because of the positive correlation between inflation and commodities returns, this conclusion is even stronger when we consider inflation-adjusted returns.
To test whether our results were unique to the chosen sample period, we revised our computations using 1983 through 1997 as the historical base. As illustrated in Figure 3, for this 15-year period, Portfolio 3 (the portfolio with commodities) has a higher geometric mean and lower volatility than Portfolio 1 (60% stocks, 40% bonds), but a lower geometric mean and lower volatility than Portfolio 2 (70% stocks, 30% bonds). For most of the period, the cumulative return for Portfolio 2 was greater than that of Portfolio 3, but Portfolio 2 had a higher level of annual volatility. More strikingly, Portfolio 3 had a higher cumulative return than Portfolio 1 for most of the period, with about the same volatility.

**Components and drivers of commodity futures index returns**

**Dissecting commodity futures returns**

To form expectations about commodity futures returns, one must first understand the drivers of these returns. Commodity futures contracts have three sources of return: spot, collateral, and roll return.

- The spot return simply reflects change in the underlying commodity price. Spot prices are driven by the supply and demand characteristics of the particular commodity market and are volatile.

- Returns are also generated from collateral. Unlevered positions in commodity futures contracts require collateralization of the risk exposure of the contract. Collateralization is typically obtained through purchases of risk-free investments, generally U.S. Treasury bills.
Roll return is the gain (or loss) associated with rolling a futures contract forward. Contracts are sold as they approach maturity, and are replaced with new contracts to maintain risk exposure. If the price of the contract being sold is less than the price of the contract being purchased, a positive roll return results.

As shown in Figure 4, average long-term commodity spot returns, as measured by the S&P GSCI Spot Index from 1970 to 2006, have been just below cash returns but much more volatile. Roll returns have been small, but positive and relatively stable, with a quarterly standard deviation of only 3.03%.

**Figure 4. Quarterly commodity futures component returns: 1970–2006**

<table>
<thead>
<tr>
<th></th>
<th>GSCI Spot Return Index</th>
<th>GSCI Roll Return</th>
<th>Citigroup 3-Month Treasury Bill Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average quarterly volatility</td>
<td>9.32%</td>
<td>3.03%</td>
<td>0.72%</td>
</tr>
<tr>
<td>Average quarterly return</td>
<td>1.33</td>
<td>0.41</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Sources: Thomson Datastream, authors’ calculations.
Roll return is calculated as the difference between the S&P GSCI Excess Return and Spot Return Indexes.
To identify which of the GSCI return components historically have driven portfolio benefits, we reviewed the correlations of each component with stocks, bonds, and the Consumer Price Index (CPI). As shown in Figure 5, each component, including cash, has low to negative quarterly return correlations with stocks and bonds over the period 1970–2006. This result indicates a diversification benefit from a cash investment as well as a commodities investment, although the commodity spot return has the lowest correlation with stocks and bonds. More striking is the correlation between cash and the CPI, at 0.52. While the commodity spot return correlation with the CPI is also positive, it is much lower at 0.18, indicating that most of the GSCI Total Return Index’s inflation-hedging properties derive from its collateral component, not from the performance of the actual commodities.

We also reviewed correlation and beta for annual returns of these metrics over the 1970–2006 period (Table 4). Annual return results are similar to quarterly results. The correlations between cash and the CPI are higher than are the correlations for the GSCI spot return and the CPI. Likewise, both have low correlations with stocks and bonds. Three-year returns produce similar results.

### Table 4: Annual return correlations of S&P GSCI: 1970–2006

<table>
<thead>
<tr>
<th>Annual return correlation</th>
<th>GSCI Total</th>
<th>GSCI Spot</th>
<th>GSCI Roll</th>
<th>Cash</th>
<th>CPI</th>
<th>Stocks</th>
<th>Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSCI Total</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCI Spot</td>
<td>0.88</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCI Roll</td>
<td>0.43</td>
<td>-0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>-0.02</td>
<td>-0.18</td>
<td>0.04</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI</td>
<td>0.29</td>
<td>0.21</td>
<td>0.03</td>
<td>0.62</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stocks</td>
<td>-0.28</td>
<td>-0.28</td>
<td>-0.05</td>
<td>0.03</td>
<td>-0.18</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Bonds</td>
<td>-0.28</td>
<td>-0.41</td>
<td>0.17</td>
<td>0.19</td>
<td>-0.34</td>
<td>0.37</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Sources: Thomson Datastream, authors’ calculations.
Finally, to get at the magnitude of the inflation protection, we estimated linear regressions of annual returns to determine the beta of the GSCI spot return and cash with the CPI. The beta of the annual GSCI spot returns on CPI over the 1970–2006 period was 1.38, while the beta of cash on CPI over the same period was 0.58. These results, combined with the correlation results, indicate that commodities provided high returns in high-inflation environments but are not a reliable hedge against inflation.

Drivers of commodity futures return premiums
Futures return premiums are insurance premiums paid by commodity hedgers to commodity speculators. Participants in any commodity futures market may be classified as either hedgers or speculators. Hedgers, unlike speculators, have extra-market reasons to take a futures position. For example, the hedger may be a producer of an agricultural commodity who wishes to protect against a decrease in the price of that commodity. In this example, the hedger will take a short position to sell the agricultural commodity at a specified price in the future. Assuming there are no other hedgers, to complete the market, the specified price must be attractive enough for speculators to want to take the other side of the contract (i.e., the long position). In other words, to compensate the speculator for taking a risky position, the position must provide a positive expected return premium.

Extending this example to a market with several hedgers and speculators, where hedgers are net short, speculators must be net long; therefore, the futures price today must be less than the expected future spot price. In contrast, when hedgers are net long (i.e., hedgers benefit from low prices and wish to protect against price increases), speculators must be net short. Such is the case for a producer of finished products who may want to hedge price increases in raw-material inputs. The hedger will take a long position in the futures contract at a premium to expected future spot prices in exchange for eliminating price uncertainty on the raw material.

There are terms to describe markets in which current futures prices exceed expected future spot prices and vice versa. John Maynard Keynes originated the theory of normal backwardation\(^\text{13}\) in the late 1920s to describe a market in which the futures price is less than the expected future spot price. The term contango is used to describe a market in which the futures price is greater than the expected future spot price. Since uncertainty about the future spot price resolves as the contract maturity date approaches, if the market is persistently backwardated and the expected future spot price does not change, contracts with longer time to maturity have a lower price (that is, a higher implied insurance premium) than contracts with shorter time to maturity. Each theoretical market is illustrated in Figure 6.

---

13 Normal backwardation is different from a market that is currently in backwardation. A market is in backwardation at a point in time if a nearby futures price exceeds a distant futures price.
While the theory of normal backwardation is based on expected future spot prices, it is actual futures prices, and their difference over time, that determine whether a roll return is positive. In persistently backwardated markets, futures price curves are upward-sloping, because futures contract prices rise as maturity approaches. In these markets roll returns are positive, because the futures trading gains are accrued when buying longer time-to-maturity contracts and selling these contracts as the time to maturity declines. Conversely, if the market is persistently in contango, the futures price curve slopes downward. Roll returns from a long, passive strategy will be negative in contango markets, because the rolling process involves selling the short time-to-maturity contracts at a loss. Finally, if the market is neither backwardated nor in contango, the roll return would be close to zero. These concepts are illustrated in Figure 7.

![Figure 7. Roll return in markets with (persistently) upward-sloping, neutral, and downward-sloping futures curves](image)

An important aspect of the commodity futures market is that the speculator can profit in either a backwardated or a contango situation. In a contango market, the speculator profits by selling the futures contract at a premium. In a backwardated market, the speculator profits from buying the futures contract at a discount. As a result, there is no intuitive reason why either backwardation or contango should persist.

We estimated time-series regressions to determine which return components have been the primary drivers of return variation over time. As shown in Table 5, when spot and roll time-series returns are regressed on the GSCI indexes, R-squared is very low (0.09) for roll return and high (0.90) for spot return. This indicates that spot returns are the primary driver of return variation over time, and roll returns have had almost no impact on this variation.

Although return variation over time has historically been driven by the spot returns, return differences have not. Actual returns vary dramatically with contract type or sector. Cross-sectional returns—return differences among commodity contracts—have primarily been driven by roll returns and, consequently, by whether markets were backwardated. Over long

![Table 5. Time-series regression results for quarterly returns: 1970–2006](image)

14 This is analogous to the perhaps more familiar bond-market strategy of rolling down the yield curve. Normally the yield curve slopes upward (i.e., longer-term bonds have higher yields and lower prices than bonds with a shorter time to maturity). Rolling down the yield curve involves buying longer time-to-maturity bonds and selling them when the time to maturity shrinks and the price rises. Just as rolling down the yield curve delivers positive returns only when the curve is upward-sloping, the futures rolling strategy results in a positive return only when the market is backwardated. If the commodities market is in contango, then the rolling strategy results in rolling up the futures curve, and trading losses occur.
time frames, as a number of authors have shown, the
term structure of commodity futures contracts has
been the dominant driver of return differences among
commodity futures.

Nash and Shrayer of Morgan Stanley (2004) illustrated
how, over a single 21-year period, the roll returns of
commodity futures contracts were related to the
backwardation levels of the contracts. Over the period
1983–2004, the commodity futures contracts with the
highest returns were also those with the highest
levels of backwardation. Likewise, the contracts with
the highest levels of contango over this period
produced, on average, the lowest returns.

Erb and Harvey (2006) also examined the importance
of roll returns in explaining the cross-section of
individual commodity futures returns. Over the period
from December 1982 through May 2004, the authors
found that roll returns explained 91% of the long-run
cross-sectional variation of commodity futures excess
(spot plus roll) return.

Finally, Feldman and Till (2006) found evidence of
the power of backwardation to explain commodity
futures returns over long periods. They examined the
soybean, corn, and wheat futures markets over the
period 1950–2004 and determined that, while a
contract’s average level of backwardation explained
only 24% of return variance in futures returns over
one-year time frames, it explained 64% and 77% of
the variance over five- and eight-year time frames,
respectively.15

Future return expectations
Will the historically high average returns for
commodity futures persist? The primary driver of
differences among commodity futures contracts
has been the roll return. Whether the roll return
will be positive for a passive, long position in
commodity futures depends upon the persistence
of backwardation in the commodity futures markets.
Supply and demand for insurance against commodity
price fluctuations also influence the degree of
backwardation and the commodity market term
structure.16

The term structure in the commodities markets
is affected by any factor that influences hedging
demand, such as weather or storability. The term
structure depends upon the type of protection
sought by the majority of hedgers—whether they
want insurance against price increases or against
price decreases. In other words, whether the current
futures price is less than the expected future spot
price depends on whether short hedgers outnumber
long hedgers and vice versa. Markets with more
demand for hedging price decreases will have more
need to entice speculators with discounted futures
prices, resulting in backwardation. And those with
more hedging demand for price increases will tend
to be in contango.

For example, an important influence on the
market for commodity price insurance is storability.
If a resource is difficult to store—as oil is, for
example—it will likely trade in markets with greater
hedging demand. And if the demand is for hedging
price decreases, there will be a greater need to
entice speculators with discounted future prices,
and therefore a greater likelihood of backwardation.
In contrast, if hedgers are protecting against price
increases, as we saw beginning in 2004 in the
oil markets, the term structure will move
toward contango.

15 Percentage of explained variation measured by R-squared.
16 The term structure is simply the curve representing the relationship between contract price and time to maturity.
Another recent influence on term structure in the commodities markets is money flowing into long-only commodity index-linked products. These passive investments are consistently rolling out of expiring nearby contracts into the second-month contract. The resulting strong demand for second-month contracts pushes up prices. If strong enough, such demand could influence the term structure, as longer-term contract prices increase relative to short-term (nearby) contract prices. For a backwardated market, this situation equates to a flattening term structure.

While the increased level of investment in commodity index-linked products squeezes out profit for the long-only investor, the speculators are stepping up to benefit from these predictable changes in contract demand. In short, they can profit by betting against the certainty that commodity index investors’ positions will be rolled in a mechanical manner every month, in known patterns on particular days.

We question whether consistent excess returns are possible from a long-only commodity investment. As explained earlier, some of the strong historical drivers of excess return for a passive long investment in commodities have recently turned negative. In 2004, the energy markets—which represented nearly 70% of the S&P GSCI Total Return Index as of late April 2007—turned contango. The spot returns for energy were so high in 2004 and 2005 that they offset the negative roll returns, leaving excess returns positive. However, in 2006, the energy spot return was also negative, resulting in negative excess returns. Energy has been one of the most persistently backwardated markets since 1983 for a number of reasons, including storage issues. This change in term structure provides strong reason to doubt that any market will remain consistently backwardated, and therefore that any market will produce a consistent risk premium.

**Conclusion**

Commodity futures investments have attractive historical return characteristics: high average returns, high correlation with inflation, and low correlation with traditional asset classes. As a result, over the last 23 years through 2006, investors would have benefited from an allocation to a broad-market commodity futures investment.

A large contributor to differences in commodity futures returns is the return derived from rolling futures contracts before they expire. This roll return is positive when futures markets are backwardated and negative when markets are in contango. Many markets (such as those for energy contracts) have been consistently backwardated in the past. However, probably in part because of large long-only investor inflows, these markets were in contango beginning in 2004. Consequently, over the next few years, we do not expect average returns from a long-only passive commodity investment to be as high as they have been in the past.

While recognizing the historical portfolio diversification benefit of an allocation to commodities, we caution against making such an allocation on the basis of an extrapolation of historical commodity returns.

17 Please see the appendix for the asset allocation implications (derived using mean-variance optimization) of historical return characteristics and deviations from these characteristics.
References


Some key terms

Beta. A measure of the magnitude of a portfolio’s past share-price fluctuations in relation to the ups and downs of the overall market (or appropriate market index).

R-squared. A measure of how much of a portfolio’s performance can be explained by the returns from the overall market (or a benchmark index).

Mean. The simple mathematical average of a set of two or more numbers.

Regression. Regression analysis may be used to explain the nature and strength of the relationship between one dependent variable (Y) and one or more other independent variables.
**Appendix**

**Asset allocation implications: Results of mean variance optimization**

<table>
<thead>
<tr>
<th>Return assumptions</th>
<th>Portfolio objective</th>
<th>Annual benefit from including commodities (in basis points)</th>
<th>Asset Allocation</th>
<th>10-year annualized geometric mean</th>
<th>Annual volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Domestic stocks</td>
<td>International stocks</td>
<td>Bonds</td>
<td>Cash</td>
</tr>
<tr>
<td>Historical 1983–2006</td>
<td>Base</td>
<td>—</td>
<td>44%</td>
<td>16%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Boost</td>
<td>64</td>
<td>43%</td>
<td>16%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>Reduce volatility</td>
<td>—</td>
<td>35%</td>
<td>11%</td>
<td>35%</td>
</tr>
<tr>
<td>Historical 1983–2006</td>
<td>Boost</td>
<td>39</td>
<td>35%</td>
<td>13%</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td>Reduce volatility</td>
<td>—</td>
<td>41%</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Historical 1983–2006</td>
<td>Boost</td>
<td>14</td>
<td>45%</td>
<td>17%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>Reduce volatility</td>
<td>—</td>
<td>43%</td>
<td>15%</td>
<td>31%</td>
</tr>
<tr>
<td>Historical 1983–2006</td>
<td>Boost</td>
<td>0</td>
<td>44%</td>
<td>16%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Reduce volatility</td>
<td>—</td>
<td>44%</td>
<td>16%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Source: Vanguard.

Notes: Results derived using mean-variance optimization of historical returns and characteristics. Benchmarks used are: For stocks, Dow Jones Wilshire 5000 Index, January 1983–April 2005; MSCI US Broad Market Index, May 2005–December 2006. For bonds, Lehman Aggregate Bond Index. For cash, Citigroup 3-Month Treasury Bill Index.
Vanguard, Connect with Vanguard, and the ship logo are trademarks of The Vanguard Group, Inc. All other marks are the exclusive property of their respective owners.

Vanguard Investment Counseling & Research

Ellen Rinaldi, J.D., LL.M./Principal/Department Head
John Ameriks, Ph.D./Principal
Joseph H. Davis, Ph.D./Principal
Francis M. Kinniry Jr., CFA/Principal
Frank J. Ambrosio, CFA
Donald G. Bennyhoff, CFA
Maria Bruno, CFP®
Scott J. Donaldson, CFA, CFP
Michael Hess
Julian Jackson
Colleen M. Jaconetti, CFP, CPA
Karin Peterson Laberge, Ph.D.
Christopher B. Philips, CFA
Glenn Sheay, CFA
Kimberly A. Stockton
Yesim Tokat, Ph.D.
David J. Walker, CFA

© 2007 The Vanguard Group, Inc.
All rights reserved.

FLGCOMD 0607