

Investing in Commodities: Issues and Current Research

A well-known aphorism in statistics states: “If you torture data long enough, it will confess to anything.” Perhaps nowhere is this truer than in the study of the risks and returns of commodity-related investments.

Historically, investors viewed investment in commodities as a highly speculative venture advocated by salespeople using questionable—if not fraudulent—methods of promotion.¹ Recently, however, not only individuals but also institutional investors have turned their attention towards commodities. The reasons for the increased interest include:

1. The recent disappointments in equity returns (primarily associated with the meltdown in technology sector stocks and the lackluster performance of the S&P 500 stock index);
2. The sharply rising price of many commodities (especially in the energy sector);
3. The availability of investment programs and products offered by vendors (mutual fund companies, brokerage houses, etc.) with a better reputation for respectability and honest dealing;
4. The emergence of commodity indexes that provide suitable benchmarks for investment manager evaluations; and,
5. The appearance of several academic studies suggesting that ownership of commodities can provide significant economic benefits.

In some respects, it is the movement of institutional investors into commodity-related investment programs that has fueled both much of the current discussion as well as much of the uncertainty regarding future risk/reward expectations. The interest in and promotion of commodity-related investing also parallels the marketing of hedge funds, venture capital / private equity deals and other “alternative asset class” investments, although hedge funds and private equity deals remain ‘dicey’ for many institutional investors because of their lack of transparency and difficulty of performance evaluation vis-à-vis an objective benchmark.²

A brief chronology of sales pitches for commodity investments is instructive.³ In the 1970’s and early 1980’s, promoters recommended commodities as good investments because they acted as a “store of value” that preserved purchasing power against the

¹ See, for example, “Investor Alert. Commodity Investments,” North American Securities Administrators Association website [<http://www.nasaa.org>] (July 31, 2006) discussing how commodity sales frauds work.

² One hears some promoters speak as if the ownership of alternative investments is somehow divorced from capital market risk/return considerations because their programs offer “Pure Alpha.” However, such a marketing approach may be nothing more than a myth: “...a financial air ball, cold fusion with other people’s money!” Waring, Barton M., & Siegel, Laurence B., “The Myth of the Absolute-Return Investor,” *Financial Analysts Journal* (March/April 2006), p. 16.

³ This discussion draws from Till, Hilary & Eagleye, Joseph, “The Risks of Commodity Investing,” available at the website of Premia Capital Management (<http://www.premiacap.com>) and originally published in the 2003 Euromoney Book, The New Generation of Risk Management for Hedge Funds and Private Equity Investments.

ravages of inflation (or, in a more recent variation of this theme, against declines in the U.S. dollar). As inflation subsided in the mid 1980's commodity investments lost much of their luster (the diamond and precious gem trading companies that occupied space in most every office building on Montgomery Street in San Francisco have completely disappeared). However, the market crash of 1987 generated a renewed enthusiasm for the doomsday portfolio: long commodities (especially gold and energy sector commodities), Swiss Francs, and non-US government guaranteed bonds / short the U.S. dollar and both U.S. and international stocks.⁴ Enthusiasm for the doomsday portfolio arises periodically due to war and terrorism scares as well as other macro-economic uncertainty ["Yes, the doomsday portfolio has been a poor past performer—but this time is different"]. In the mid 1990s, promoters of commodity investments alleged that they provided a "pure play" on the growth of third-world markets (especially China and India) where it was risky or impossible for a U.S. investor to own direct investments.⁵ Finally, in response to the NASDAQ's dramatic decline in value at the beginning of this century, commodity-related investments were recommended as valuable tools for portfolio diversification and risk reduction.⁶ Often, several of the above-listed propositions are presented concurrently in an attempt to build a persuasive and elegant argument for this type of investment program.

Usually, one would be inclined to listen politely (for a short time) to the investment promoters; check their claims; and, having confirmed that they are nothing more than chimeras and Disneyland fancies, go about the serious business of designing, implementing and monitoring a prudent and suitable investment portfolio. Indeed, there is a lot not to like about the commodity investment sales pitches. However, despite—or because of—the fact that the "rapture index" [measuring "prophetic activity" signifying the end of the world doomsday] was recently at an all time high, there may be a legitimate case for including commodities within an investment portfolio. The motivation for a review of the scholarly literature also, in part, comes from the fact that promoters of these investment programs are currently quoting a jointly-authored, pro-commodity investment research paper than comes from the heart of the ivory tower—the

⁴ We suspect that commodity-related investments may be politically correct and culturally appropriate for a segment of the population that is radically libertarian and does not wish to allocate capital either to multinational corporations or to finance the operations of state and federal government. The historical roots of commodity-based wealth building / anti-government sentiment are traceable to the earliest years of the republic. For example, in farming communities almost every farmer owned a still so that crops (e.g., corn, rye, etc.) that were difficult to transport to distant markets could be distilled into a form that was easier to transport. In 1791 Congress passed an excise tax that legalized the ownership of stills but made the conversion of crops to alcohol less profitable [ownership of stills became illegal upon adoption of the Eighteenth Amendment to the Constitution]. Rather than pay the tax, farmers operated their stills at night making "moonshine." The tension between the anti-tax commodity processors ("moonshiners") and the government "revenueurs" still resonates in today's politics.

⁵ See, for example, Rosenberg, David & Badlani, Ajay, "Commodities In Trust portfolios," Trusts & Estates (June, 2006), p. 34: "Compelling evidence suggests that commodities' out-performance is the result of a secular shift in the global economy. The key, driving force is a soaring demand for raw materials as China and India converge with the developed economies of the world."

⁶ Or, in academic terms: "Clearly, commodities produce orthogonal alpha." Ryan, Robert P., & Lu, Zimin, "Commodities: An Orthogonal Asset Class," An Investor Guide to Commodities (Deutsche Bank, April, 2005), p. 50.

Wharton School at the University of Pennsylvania and the International Center for Finance at Yale.⁷ The academic evidence is mixed and the case for investing in commodities cannot simply be dismissed as nothing more than fraud or humbug.

A review of current research indicates intense debate and vigorous discussion regarding such fundamental issues as the nature of a commodity investment, the sources (determinants) of return for assuming commodity investment risk, the legitimacy and usefulness of existing commodity-returns indexes, whether commodity-related investments represent an asset class (i.e., are appropriate for consideration in a plan of asset allocation), whether they provide a hedge against inflation; and whether they are best considered in the class of activities that include sports bets and weather prediction. It is the intention of this essay to touch briefly on the current thinking regarding these issues so that investors can better determine the suitability of a commodities-related investment for their portfolio.

Nature of a Commodity Investment

Some members of the academic professoriate do not like commodities. They are not financial assets. Issuing corporations use stocks and bonds to raise capital to finance business operations which, if successful, will generate cash. Bonds are the debt obligations of corporations that borrow capital. A bond promises the investor a stream of income (including ultimate repayment of principal) that can be discounted to a single present value—i.e. the current price of the bond. A stock represents a residual claim (direct investment) on a company's future cash flows (profits either paid out as dividends or retained for generate future growth in share price) after all payments have been made to bond owners. Commodities, however, are not financial claims on operating businesses. They are real assets—'stuff.' Commodities are not tractable to traditional cash-flow valuation methods or to market-oriented risk/reward analysis such as the Capital Asset Pricing Model [CAPM].⁸ Although they are the fundamental building blocks of a society (food, industrial materials, building materials, energy, etc.), they are difficult to value; and, unlike financial assets, have prices that sometimes exhibit extreme seasonality.

It is important to distinguish between an investment in commodities (physical stuff like gold bars, oil stored in tanks, live hogs, corn housed in silos, etc.) and derivative financial instruments known as commodity futures contracts. Academics like derivative financial instruments because economists offer an extensive toolkit of mathematical formulae for contract analysis. Furthermore, for most investors, a direct investment in commodities is impractical. Either the commodity is perishable (cattle ready to be delivered to market) or is difficult to store in economically significant quantities (lumber, gasoline, natural gas).

⁷ Gorton, Gary & Rouwenhorst, Geert, "Facts and Fantasies about Commodity Futures," Financial Analysts Journal (March/April, 2006), pp. 47-68.

⁸ "The Capital Asset Pricing Model does not apply to a bushel of corn." Greer, Robert J., "Commodity Indexes For Real Return & Efficient Diversification," An Investor Guide to Commodities (Deutsche Bank, April 2005), p. 24.

Given the impracticality of direct investment in commodities, a reasonable alternative is to purchase or sell contracts known as commodity futures. A futures contract is an obligation to buy or sell a set amount of a well-defined commodity (e.g., so many board feet of a specific type of lumber with a minimum quality grade) at a specified price. The date of sale (“delivery”) is also stipulated in the contract. However, no money changes hands at contract inception because the specified transaction date occurs in the future. Each contract to buy in the future is matched with a contract to sell in the future (for standardized contracts, this is regulated through a institutional commodity exchange); each party pledges money (puts up a good-faith security deposit known as “margin”) at the time of contract inception; and, further, pledges to adjust the margin over time (keep a “maintenance margin”) so that there is a reduced risk that they will default on their buy or sell obligation.⁹ As the price of the commodity changes, either the contract buyer (the “long” position) or the contract seller (the “short” position) will realize a relative advantage. At the end of each day, each party’s margin account is adjusted (“marked to market”) by adding or subtracting funds in proportion to the commodity’s change in price. One important consequence of this system is that a standard future’s contract position has, at the time of its inception, a capital market valuation of zero—i.e., the long and short positions exactly offset each other. Furthermore, because the contracts are marked to market on a daily basis, they have an aggregate ongoing valuation of zero. A later section of this essay discusses how valuation of capital market instruments at zero complicates asset allocation decisions.

The agreed upon future delivery price is known as the “futures price.” The current price of the commodity is known as the “spot price.” The term “basis” is used to describe the differential between:

- (a) The spot price at the termination of the contract [a value that is not yet known] and futures price [agreed upon at contract inception] at the termination of the contract, and
- (b) The spot price [a value that is known—it is today’s price] and the agreed upon futures price at the time of contract inception.

Entering into a commodity futures contract is called “speculation on the basis” because it is the change in relative pricing relationships that govern the profitability of both long and short positions.¹⁰

⁹ For standard futures contracts, the exchange clearinghouse acts as the legal counterparty for both buyers and sellers. Exchange member firms are required to contribute capital to a self-insurance fund that acts as a backstop source of funds should one of their trading customers default on the unpaid balance of a contract. This system enhances the liquidity and safety of the contracts. See, Reilly, Frank K., & Brown, Keith C., Investment Analysis and Portfolio Management, Sixth Edition (The Dryden Press, 2000), pp. 938-942.

¹⁰ Note the similarity to a sports bet where one lays money at today’s odds for a future contest wherein the odds (i.e., value of the bet) may change as time unfolds. In 1968 a bet on the New York Mets to win the 1969 World Series could be made at very favorable odds; by September 1969, however, the “value” (i.e., change in odds) of the bet would have increased dramatically. Also note the similarity between the sports betting market, which nets the pro and con bets (with vigorish going to the bookie), and the netting of commodity futures positions (with commissions going to the broker).

Much of today's discussion regarding the nature of the commodity futures market stems from the classic 1978 textbook authored, in part, by Nobel Prize winner William Sharpe. Sharpe, drawing upon earlier treatises by J.M. Keynes, Paul Cootner, and others, sketched a brief overview of a stylized market using wheat futures as the example. The 1990 version of the text is as follows:

A [wheat] farmer might note today that the market price for a wheat futures contract with delivery around harvest time is \$4 per bushel, a price high enough to ensure a profitable year. Although the farmer could sell wheat futures today, alternately the farmer could wait until harvest and sell the wheat on the spot market at that time. However, waiting until harvest entails risk because the spot price of wheat could fall by then, perhaps to \$3 per bushel, which would bring personal ruin to the farmer. In contrast, selling wheat futures today will allow the farmer to lock in a \$4-per-bushel selling price. Doing so would remove an element of risk from the primary business of the farmer, growing wheat. Thus, a farmer who sells futures is known as a hedger or, more specifically, a short hedger.¹¹

The farmer, according to Sharpe, is best seen as a producer seeking to hedge risk by participating (selling or shorting his wheat crop) in the futures market. By contrast, consumers of wheat can also hedge their risk in the futures markets. Sharpe uses an example of a baker:

Currently, the baker has enough wheat in inventory to last until harvest season. In anticipation of the need to replenish the inventory at that time, the baker could buy a wheat futures contract today at \$4 per bushel. Alternately, the baker could simply wait until the inventory runs low and then buy wheat in the spot market. However, there is a chance that the spot price will be \$5 per bushel at that time. Should this happen, the baker would have to raise the selling price of bread and perhaps lose sales in doing so.¹²

The baker (consumer), according to Sharpe, also hedges risk by participating (buying or taking the long position in wheat) in the futures market. However, the likelihood that, at all times, the exact number of short hedgers matches the number of long hedgers is highly improbable. This leaves room for a third group of market participants known as "speculators" who must be induced to take positions on the weak side of the market. The speculator will be keenly interested in forecasts of future prices as well as in forecasts of future inventories and will demand sufficient compensation for taking the risk of 'completing' the market (going long in the face of excess demand from producers/farmers; going short in the face of excess demand from consumers/users). In a nutshell, the speculator is an insurance salesman and expects to receive a risk premium for providing a critical market service (allowing producers and consumers to transfer their risks).

¹¹ Sharpe, William F. & Alexander, Gordon J., Investments, Fourth Edition (Prentice Hall, 1990), pp. 594-595.

¹² Ibid., p. 595.

Thus, for the average investor, a commodity investment can take two forms: (1) actual ownership of the commodity in which case the change in the spot price (less costs of ownership such as insurance and storage) will determine the investor's profit; or, (2) purchase of a long or short position in a commodity futures contract in which case the differential change in pricing relationships between spot and futures prices will determine the investor's profit. It is critical to realize that the profit function of the direct ownership form is largely determined by the change in spot price. If the spot price of the commodity does not rise, profit is not possible. However, the profit function of futures contract ownership is more complicated; and, although counterintuitive, it may be the case that a long position in a futures contract will be profitable even if the spot price of the commodity decreases over time.

These observations lead to a model of the commodity futures market that envisions three types of spot/futures pricing relationships.

- In the cases where the number of producers and users/consumers are in equilibrium, the futures price will equal the market consensus of the expected future spot price on the date of delivery. This is known as the “expectations hypothesis” [$P_f = E(P_s)$] where P_f is the current purchase price of the futures contract and $E(P_s)$ is the expected spot price of the commodity on the delivery date. There will be little or no demand for speculators in this type of market and, therefore, investors should expect little or no risk premium.
- The second type of market is characterized by a surplus of producers wishing to hedge (sell short) the risks of their positions. In this market, producers must entice speculators to enter the market by setting futures prices lower than the spot prices expected to prevail at the date of contract delivery [$P_f < E(P_s)$]. Thus, the insurer/speculator will have the expectation of buying low and selling high as the contract moves closer and closer to delivery. This type of market is known as “normal backwardation.” Note that commodity market analysts refer to the term structure of commodity pricing relationships in way that is similar to fixed income analysts' references to the term structure of interest rates.
- The third type of market is characterized by a surplus of consumers (bakers) over producers (wheat farmers). In this market, speculator/insurers must be induced to take short positions so that the consumers/users will be able to offload the risk that they will have insufficient inventory to satisfy sales demands at reasonable prices [$P_f > E(P_s)$]. As the spot price converges towards the cheaper futures price, the short position will make a profit as the basis pricing relationship change in a favorable direction. This type of market is known as “normal contango.”¹³

Historically, theoreticians have assumed that the commodities market is usually in backwardation—that is, the purchaser of a long-futures position has the expectation of making excess profits (profits above the risk free rate) at the expense of the commodity producer. It is difficult to confirm this theory because the expected future spot price is unobservable; and, therefore, we can never know with certainty whether the futures price is set above or below this bogey. However, the term structure of futures prices is observable and the terms backwardation and contango are often used to describe the

¹³ *Ibid.*, pp. 609-611.

commodity futures “trading” environment (shape of the price curve) faced by investors instead of the theoretical spot/future relationships. The difficulty of confirming the true theoretical state of the market, however, also gives rise to difficulties in determining the persistent sources of return to commodity futures investors.

Determinants of Return for Commodity Futures

Investors can participate in the commodity futures market (assuming purchase of a standard contract on an organized exchange) by agreeing to buy or sell a specified amount of a well-defined commodity at an agreed upon date. At the time the investor enters the contract no money is exchanged. Instead, as noted, investors establish a margin account that is only a fraction of the nominal (“notional”) value of the contract’s delivery price. Therefore, futures contracts are highly leveraged—provided that maintenance margins are sustained, large profits or losses can be booked with only a relatively small amount of initial capital invested in the contract. This is not the case for stocks and bonds because these securities are usually purchased without leverage.¹⁴ In order to compare fairly the historical returns of commodity futures with stock and bond returns, the futures contracts must be “deleveraged.” This is accomplished by assuming a collateral account funded at the risk-free rate (i.e., with short-term U.S. Treasuries). For each dollar invested in the commodity by means of a futures contract, a second dollar equal to the notional value of the investment is allocated to T-Bills.

Most academic research papers compare returns from stock and bond indexes with returns from deleveraged commodity indexes. Just as a stock index like the S&P 500 U.S. stock index holds a wide cross section of securities, a commodity index holds a cross-section (not necessarily market weighted) of available futures contracts. These contracts are often grouped into sectors such as building materials, industrial materials, precious metals, energy, agricultural/livestock, etc. The pattern of returns generated by these commodities are often strikingly different and there is some debate over whether returns of individual commodity futures contracts are so heterogeneous that commodities can even be legitimately thought of as an asset class. Can orange juice be mixed with oil?

The potential sources of return from a fully collateralized commodity futures index are:

1. The return earned by the collateral—the T-Bill rate¹⁵;

¹⁴ Confusingly, the term “margin” or “margin account” is often used on stock and bond brokerage account statements. On the brokerage account statement, margin refers to the amount of equity that must initially come from the investor’s own funds; and, after the time of purchase, the amount that must be maintained (these two amounts may differ). The balance (i.e. amount other than margin) is an amount of money that is borrowed from the broker by collateralizing the loan with the value of the securities in the account. In commodity trading, however, margin refers not to the amount of owner equity, but to the amount of required good faith deposit made on an obligation maturing in the future.

¹⁵ The risk-free T-Bill rate historically reflects the underlying real rate of return (long-term economic growth rate) in the economy plus expected inflation. See, Greer, Robert J., “The Nature of Commodity Index Returns,” *The Journal of Alternative Investments*, (Summer, 2000), p. 48.

2. The diversification return—a return achieved because individual contract gains and losses do not move synchronously;
3. The return earned by insurance—the inducement to speculators to enter the market;
4. The rebalancing return—achieved by periodically selling higher priced contracts to purchase lower priced contracts which, in certain types of markets (e.g., characterized by mean reverting return series) may capture additional return;
5. The expectational variance return which is hypothesized as deviations (plus or minus) in the actual but unknown expected future spot price from the futures price specified at the contract's inception.¹⁶
6. The convenience yield—based on a theory of inventory valuation that posits a premium (economic advantage) for having inventory on hand (especially for high demand products such as oil) which tends to keep spot prices higher than futures prices (which give the investor in the long position merely the right to future delivery).

However, other than items 1 and 2, (and, possibly, item 6) there is little academic consensus on the likelihood of persistence in returns. This is a critical issue because if a source of past return is not 'systematic,' the investor cannot expect to receive it in the future. As one paper puts it: "Avoiding naïve extrapolation of historical returns and striking a balance between dependable sources of return and possible sources of return is important."¹⁷

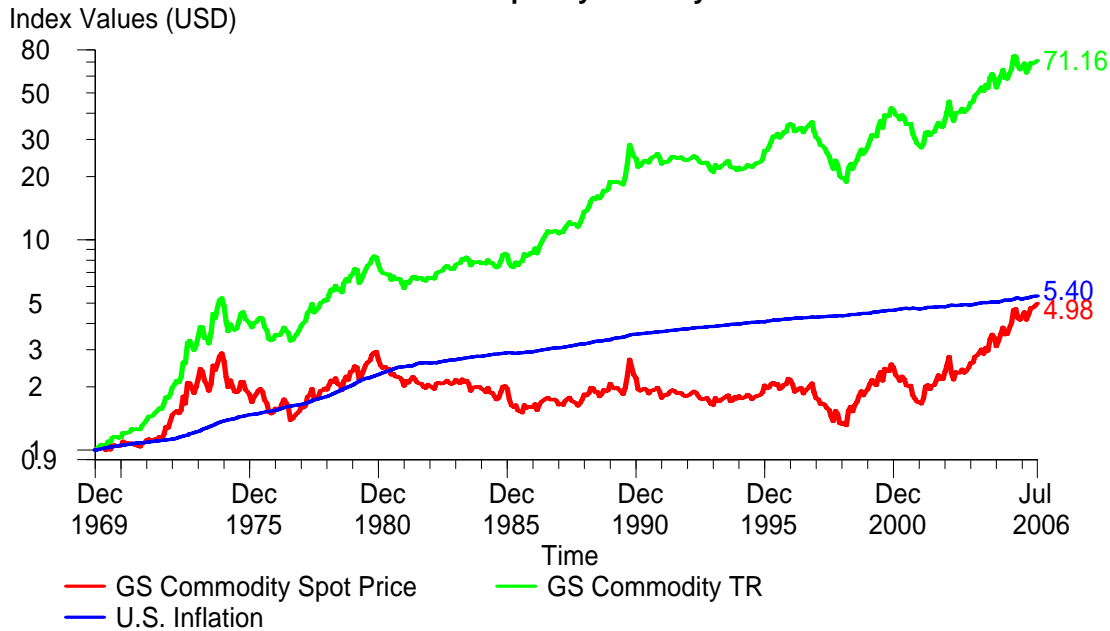
The Historical Record

What is the historical record of commodity returns? The following graph compares the history of two types of commodity indexes: (1) a spot price index; and (2) a fully collateralized commodity futures index based on comparable commodity exposures. The comparison is over the period 1970 (beginning 12/31/69) through July of 2006 and the data series consist of the Goldman Sachs Spot Index and the Total Return Goldman Sachs Futures Index [GSCI--a fully collateralized index]. The charts depict the growth of \$1 invested at the beginning of the period; and the values are graphed on a logarithmic scale. The ending value of the futures index is approximately fourteen times the value of the comparable spot price index.

¹⁶ Much academic research suggests that the consensus but unobservable future spot price reflects all known information regarding expected price; and, therefore, that commodities are yet another market that is relatively efficient: "Because foreseeable trends in spot markets are taken into account when futures prices are set, expected movements in the spot price are not a source of return to an investor in futures....A futures contract is thus 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; for an investor in futures, the deviations should average out to zero over time..." *Op. Cit.*, Gorton & Rouwenhorst, p. 48.

¹⁷ Erb, Claude B. & Harvey, Campbell R., "The Tactical and Strategic Value of Commodity Futures," *Working Paper* Unabridged Version (Duke University, January 6, 2006), p. 1.

GSCI Spot Price Index v. Total Return Futures Index Frequency: Monthly

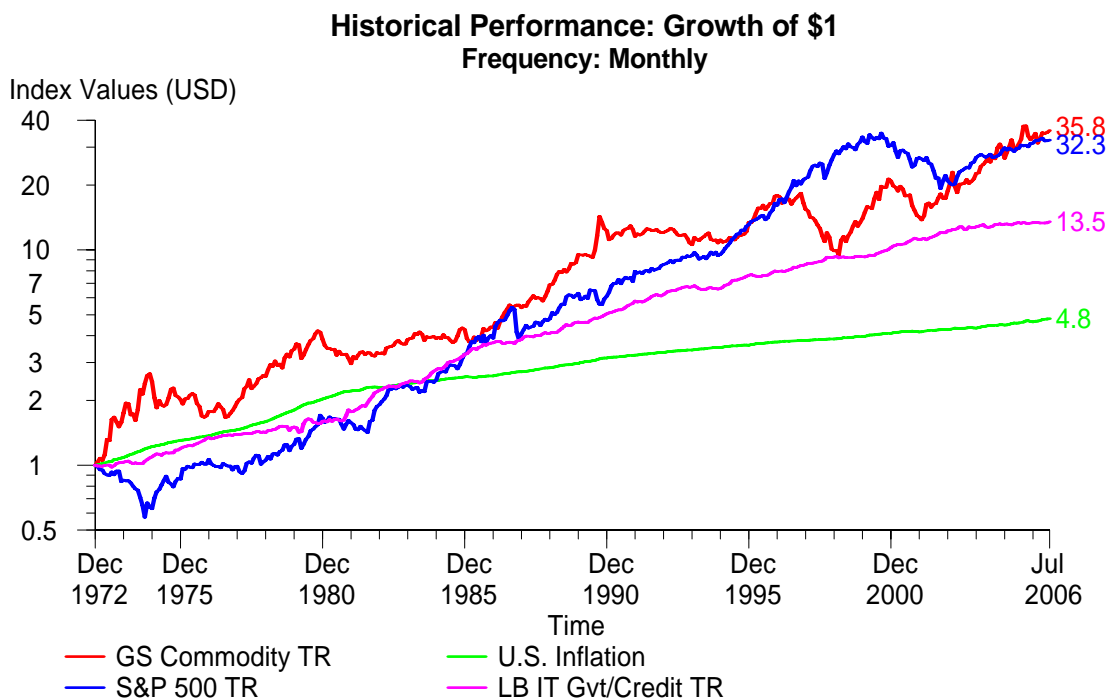


Given the multiple sources of return for a commodity futures index, it is no surprise that its performance results over the sample period were more attractive than those generated by the spot price index.¹⁸ It is also noteworthy that the commodity spot price index failed to keep pace with inflation during the period. The critical question, however, is whether

¹⁸ Although a thorough analysis of the determinants of return for commodity spot price indexes is beyond the scope of this essay, the reader should be aware of the Prebisch-Singer hypothesis: "...owing to the low income elasticity of demand for commodities and because total factor productivity increases have been smaller for manufactured goods than for primary commodities, the price of commodities relative to manufactured goods should decrease over time." Cashin, Paul & McDermott, C. John, "The Long-Run Behavior of Commodity Prices: Small Trends and Big Variability," *International Monetary Fund Staff Papers* (2002), p. 176. The Cashin/McDermott study indicates that the hypothesis can be neither proven nor rejected because commodity price variability relative to historical trends is too high: "this makes forecasting future commodity prices a difficult exercise." Statistical data indicates "the real price of industrial commodities...has a downward trend over nearly 140 years..." (p. 187). However, "...trends appear to be widely variable and largely uncertain, and cannot be relied upon as a basis for making forecasts of future commodity prices." (p. 188). This data should give investors wishing to get rich quick through commodity spot price forecasting pause: "...real commodity-price movements have become more variable over time—volatility first increased around 1899 and then again in the early 1970s. The first increase was due to price movements with bigger amplitudes. The second increase was due to a rise in the frequency of large price movements, which consequently reduced the duration of large price cycles.... Long-run trends in real commodity prices are small in comparison with annual variability in prices, making short-run movements in commodity prices highly unpredictable. In terms of its economic (and statistical) significance, price variability completely dominates long-run trends." (p. 193). The extreme variability of commodity return series makes tests of statistical significance very problematic. For example, one study asserts: "given the return and risk of the energy sector, for instance, it would take about 78 years for the excess returns to pass conventional tests of statistical significance. Given the return and risk of the GSCI, it would take about 57 years of data to feel comfortable that the returns of the GSCI were significant." Op. Cit., Erb & Harvey, p. 27.

the collateralized futures index outperformance attributable to these extra factors will be forthcoming in the future. The argument for investing in a commodity futures index rests largely on the assumption that a systematic risk premium is available to future investors. The validity of this argument, in turn, rests on something more than merely demonstrating that commodity futures earned more than the risk-free rate over a past sample of returns.

The following graph compares the returns of the GSCI commodity futures index with those of the S&P 500 U.S. stock index and the Lehman Brothers intermediate term U.S. Bond index. In this sample period (January 1973 through July 2006), the commodity futures index provided a positive real return, and evidenced a risk premium greater than that achieved by domestic stock and bond investors.



However, as suggested by the spot price vs. futures index chart, the attractive past returns of commodity futures indexes stand in contrast to the returns of their constituent building blocks—the individual commodity futures contracts (wheat, copper, orange juice, soy beans, natural gas, etc.) “The average compound, geometric excess return of the average commodity futures has, historically, been close to zero.”¹⁹ The commodity futures return puzzle is addressed in a follow-on section.

¹⁹ *Op. Cit.*, Erb & Harvey, p.2.

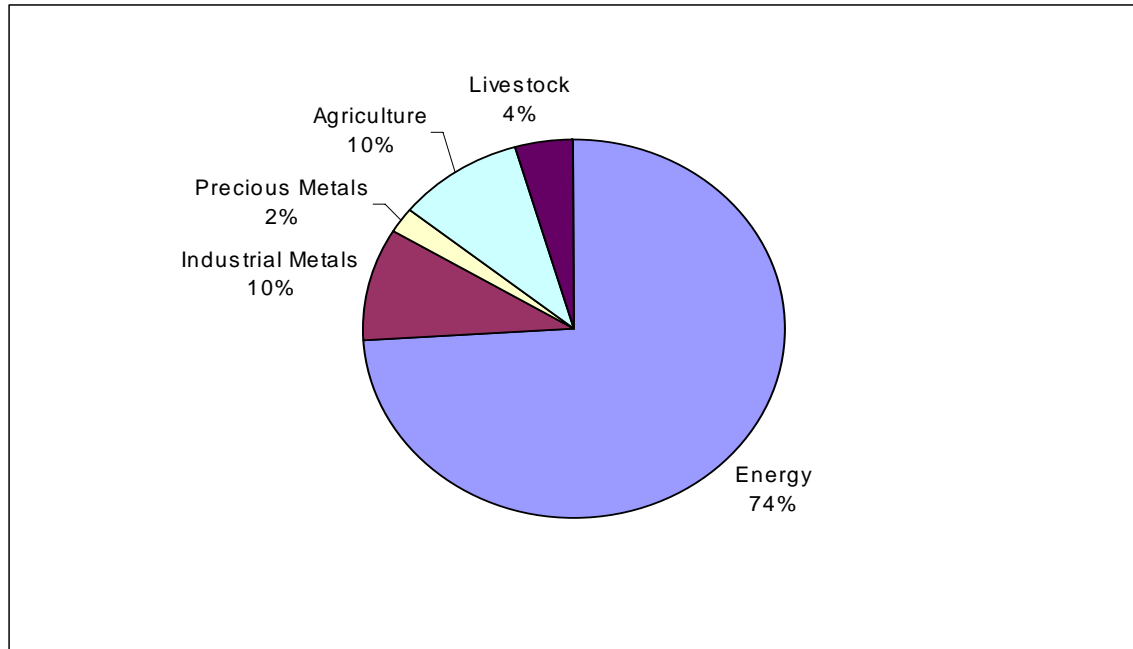
Commodity Index Construction: Does the Past contain Useful Information for the Future?

It is well known that many return series suffer from survivorship bias; and that failure to account for such bias is a serious methodological research flaw. For example, some studies of equity manager skill reported large positive excess returns for actively managed U.S. large stock mutual funds. Although the data was correct, the conclusion (the superiority of active management) was suspect. This is because the studies used a database that included results only for surviving mutual funds. The record of funds that had merged or that had gone out of business was no longer recorded in the database. Thus, the results were seriously skewed upwards; and the conclusions were no longer credible. A similar problem exists in long-term commodity databases. Commodity contracts are listed or delisted on exchanges based on sales volume. If an exchange does not find it profitable to offer a contract (from lack of interest on the part of traders), the contract will be withdrawn and no longer available for sale. If the low sales volume reflects an aversion rooted in poor performance, and if the database no longer reflects commodity transactions, there may be bias in an index's performance results. The extent of such bias in the reported results of commodity indexes is not well understood and remains a subject for future academic research.

What is well understood, however, is that there has been a phenomenal worldwide growth both in the number of commodity trading exchanges as well as in the types of commodity contracts available for trading.²⁰ The rapidly expanding set of offerings makes the reported performance history of indexes (especially indexes using backdated information from periods prior to their initiation) problematic. To see the problem, consider the Goldman Sachs Commodity Index [GSCI] first published in January 1991.²¹ The August 23, 2006 Goldman Sachs website indicates that the index consists of contracts written on 25 commodities divided into 5 categories with a dollar weighting as follows:

²⁰ Lewis, Michael, "The History & Development of Commodity Exchanges," An Investor Guide to Commodities (Deutsche Bank, April 2005), pp. 11-17.

²¹ A good overview of construction rules for commonly used commodity indexes is found in Idzorek, Thomas M., Strategic Asset Allocation and Commodities (Ibbotson, 2006), p. 10-13. Detailed information on the GSCI is provided on the Goldman Sachs website (www2.goldmansachs.com). The GSCI is traded on the Chicago Mercantile Exchange and represents the majority of commodity index trading activity.

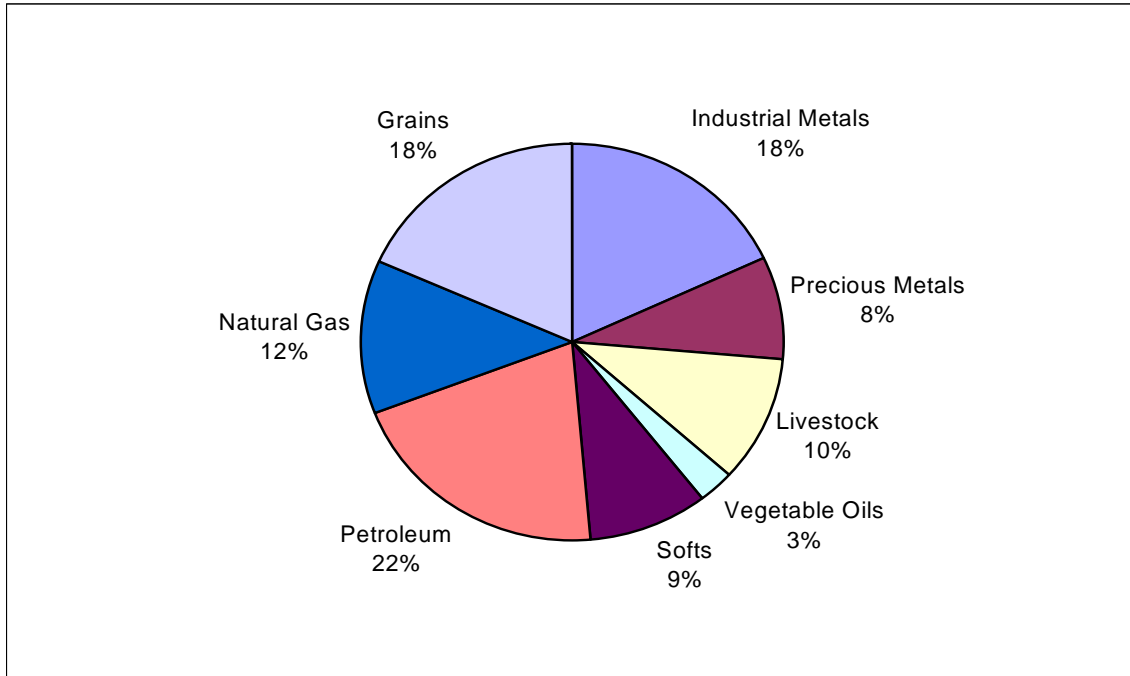


However, the GSCI backdates performance to 1970. The 1970 backfilled index consists of four commodity futures: cattle, corn, soybeans and wheat; and, throughout the 1970s, cattle represented the largest exposure. Crude oil, for example, did not enter the index until 1987.²² Therefore, if we base either statistics (e.g., average historical correlation, and standard deviation of returns) or future return expectations on the historical series of index returns, how confident can we be that past return provides an adequate basis for future expectations?

The Dow Jones-AIG Commodities Index (DJ-AIG) is an index offering exposure to 19 commodity futures contracts. Some consider it to be a more representative (i.e., balanced) index of investment opportunities in the commodities trading market. The August 23, 2006 DJ-AIG website provides a dollar weighted allocation as of January 1, 2006.²³

²² Op. Cit., Erb & Harvey, pp. 11-12.

²³ <http://djindexes.com>. "Softs" are futures contracts on commodities like coffee and sugar. A detailed comparison of commodity indexes, including the GSCI, the DJ-AIG index, the Chase Physical Commodity Index, the Mount Lucas Management Index, the JP Morgan Commodity Index and the CRB index is found in Anson, Mark J.P., "Investing in Commodity Futures," Handbook of Alternative Assets (John Wiley & Sons, 2002), pp. 213-223.



Erb and Harvey, for example, argue that, unlike equity and bond indexes, commodity indexes are *strategies*. The indexes (GSCI, Dow Jones AIG index, and Reuters-Jeffries CRB index) are organized on different construction principles, employ different rebalancing conventions, and have markedly different weightings of individual commodity futures. The authors contend:

“The composition of these three indices differ from one another because there is no agreed upon way to define the composition of the aggregate commodity futures market as there is with the aggregate equity market or the aggregate bond market.... The outstanding value of long and short futures contracts is exactly offsetting and as a result there is no commodity futures market capitalization. Lacking a market capitalization based portfolio weighting scheme, commodity indices can best be thought of as commodity portfolio strategies.”²⁴

As the number of commodity exchanges increases worldwide and as the number of types of futures contracts continues to expand (or contract) as new technologies change demand for various commodities, extrapolation of past returns into the future becomes, according to the authors, more uncertain.

At first blush, it seems as if the GSCI is more of an “energy play” than the DJ-AIG. Additionally, one might be tempted to dismiss the recent spectacular returns of the GSCI as merely a sample-dependent reflection of significant dislocations in the world’s energy markets. Is the DJ-AIG index the more “prudent” alternative? Should prudence be decided by consideration of each index on a stand-alone basis or from the portfolio

²⁴ Op. Cit., Erb & Harvey p. 11.

context?²⁵ The answers to these questions take us back to a consideration of the six sources of possible return in a fully collateralized commodity futures index.

Sources of Collateralized Commodity Futures Index Return: Systematic or Sample Specific?

Any discussion about possible sources of return for a commodity futures index should make it clear that return is not a function of a predicted increase in spot commodity prices. This fact may be surprising because many radio and TV adds tell the audience how they can make a fortune buying gold or heating oil futures based on predicted spot price increases. We have already noted that, in general, long-term commodity spot prices have trended downwards since at least the beginning of the previous century. The expectations hypothesis, discussed below, provides further insight into the relationship between changes in spot prices and profitability of a commodity futures contract.

Collateral Return

The returned earned by the T-Bill collateral is, of course, a secure and recurring source of future returns. It is worth noting that some investment program vendors collateralize commodity future index positions with TIPS. Over the long run, this should provide investors with a risk-free real return although short-run nominal losses may be expected. The combination of TIPS and commodity futures may also have implications for the investment product's effectiveness as an inflation hedge.

Diversification Return

The 'diversification return' is also systematic in the sense that it is a mathematical principle of portfolio geometric compounding over time. Indeed, this principle explains, in large measure, why a portfolio composed of building blocks (individual commodity futures contracts) that have an average return close to zero can generate positive compound wealth.

The diversification return is related to the 'variance drain' principle. This states that compound wealth (the product of geometric return) can be approximated by the following formula:

$$\text{Compound return} = [\text{mean return} - \frac{1}{2}(\text{variance of return})]$$

Compound return equals *geometric* average return and mean return equals *arithmetic* average return.

²⁵ For a further discussion of the characteristics of a suitable commodity futures benchmark, see Beenen, Jelle, "Commodities As A Strategic Investment for PGGM," *An Investor Guide to Commodities* (Deutsche Bank, April 2005), p. 62. PGGM, located in the Netherlands, is the third largest pension fund in Europe. The author reports that the fund's independent investigation found that only the DJ-AIG and GSCI Indexes met their investment suitability criteria.

The intuition behind this formula is straightforward. If you invest \$1 and the dollar loses 50% in period one and gains 100% in period two, the arithmetic average (or mean) return equals $(-50\% + 100\%)/2 = 25\%$. However, compound wealth equals \$0 because the geometric average is $(25\% - 1/2(50\%)) = 0\%$. As variance (a measure of the variability of return) increases, dollars “drain out” of the investment even though arithmetic return remains positive. Therefore, all else equal, if the net result of adding an investment to a portfolio of assets is to reduce the portfolio’s variance, there will be a positive benefit for future compound wealth. The difference between the “average compound geometric excess return of the average commodity futures” and the average compound geometric excess return of an index built from many such futures contracts, is, in large measure, the result of the diversification benefit. As stated, the principle of a diversification return benefit is applicable to all investment portfolios not just to commodity investments.²⁶ This is not merely another way of stating that diversification reduces risk—it may also enhance return. The importance for investors lies in the fact that the portfolio design process inevitably reaches a point where the investor is better off by reducing portfolio risk (variance) than by reaching for additional return (which is likely to increase variance). Naïve investors miss this critical point and are clobbered when their concentrated investment bets turn bad.

Erb & Harvey characterize the diversification return as “turning water into wine.” The diversification return increases as the variance of individual assets increases, as the correlation between the individual assets falls, and as the number of assets within the portfolio increases. The authors review previous studies of commodity future index returns; and, depending on the period under evaluation, estimate an historical yearly diversification return ranging from approximately 3% to 7%.

The Insurance Return

The insurance return derives from a hypothesized risk premium payable to investors in the commodity futures market. The classic commodity market model, previously described, assumes that the commodity market is usually in backwardation (the futures contract price is lower than the unobservable consensus future spot price) because commodity producers wish to trade a small part of expected future profits for eliminating the risk of large future losses. The classic market theory assumes that backwardation is the normal state of the market because producers, in general, may not have the same degree of flexibility in the timing of transactions as consumers/users of their commodities. If this theory is correct, then “...normal backwardation provides a rationale that a long-only portfolio of commodity futures is an efficient way to allocate capital.”²⁷ Should the need for consumer/users to hedge their price risk exceed that of commodity producers, the consumers will be wish to trade a small portion of their expected sales profits for eliminating the risk of large disruptions in sales if their products cannot be manufactured and brought to market. Under these conditions, the futures contract price is higher than the unobservable consensus future spot price and the market

²⁶ Gorton, Gary B. & Rouwenhorst, K. Geert, “A Note on Erb and Harvey,” Yale International Center For Finance Working Paper (January, 2006), pp. 3-5.

²⁷ Op. Cit., Erb & Harvey, p. 19.

is in contango. In a contango market, the short position will profit at the expense of the long position, all else equal.

Although it is difficult to test the normal backwardation theory directly (consensus future spot prices are unknown), if the classic market model is correct empirical evidence should demonstrate a fairly consistent excess profit (consisting, in part, of the hypothesized insurance risk premium) to long positions in commodity futures. In fact, however, this is not the case.²⁸ There appear to be some futures contracts that are normally in contango; and, as a matter of further interest, it appears that gold futures are almost always in contango. In most cases, commodity futures alternate between contango and backwardation suggesting that, in some periods, profits will accrue to the long position while, in others, profits will flow to the short position. This may seem surprising to “gold bugs” who are seldom, if ever, advocates of shorting gold.²⁹

If certain commodity futures markets are primarily in contango, holding long positions in an index that heavily weights these commodities may not be wise. Normally, one of the characteristics of an index is that it fairly represents the broad capital market that it reflects. However, investment products based on commodity futures index construction principles may be detrimental to investors if they require long positions in futures that are likely to be profitable only when held short.

One of the more interesting topics in this area is “weather fear premia.” This is a source of return that may systematically accrue to short positions in certain commodity futures. A weather fear risk premium causes the futures price to be overvalued relative to the spot price.³⁰ This situation is prevalent in certain grain, cotton and tropical products futures markets. Unfavorable weather, despite a low probability of occurrence, may cause severe disruptions in the supply of or demand for the commodities. This fear means that the long position is constantly ‘buying high’ because of the overvalued futures price and ‘selling low’ as the time period in which the feared event can occur becomes smaller and smaller. Despite the fact that the feared event will occasionally occur, a systematic profit is available to the short position if, during the majority of time, the overvaluation profits are sufficient to compensate investors for the rare large loss. While it is undeniable that the long position will sporadically make large gains (while suffering many smaller losses), these gains are synchronized to the weather; and it is difficult to see how they can act as a hedge against poor returns from financial assets.³¹

²⁸ Kolb, Robert W., “Is Normal Backwardation Normal?” Journal of Futures Markets (February, 1992), pp. 75-90.

²⁹ Lewis, Michael, “Convenience Yields, Term Structure & Volatility Across Commodity Markets,” An Investor Guide to Commodities (Deutsche Bank, April 2005), p. 21 notes: “It would take many years for the world to exhaust available gold reserves on current demand trends if every gold mine in the world were to close tomorrow.... In the absence of additional new mine supply the world would consequently only run out of gold after 16,500 days or sometime in 2050.”

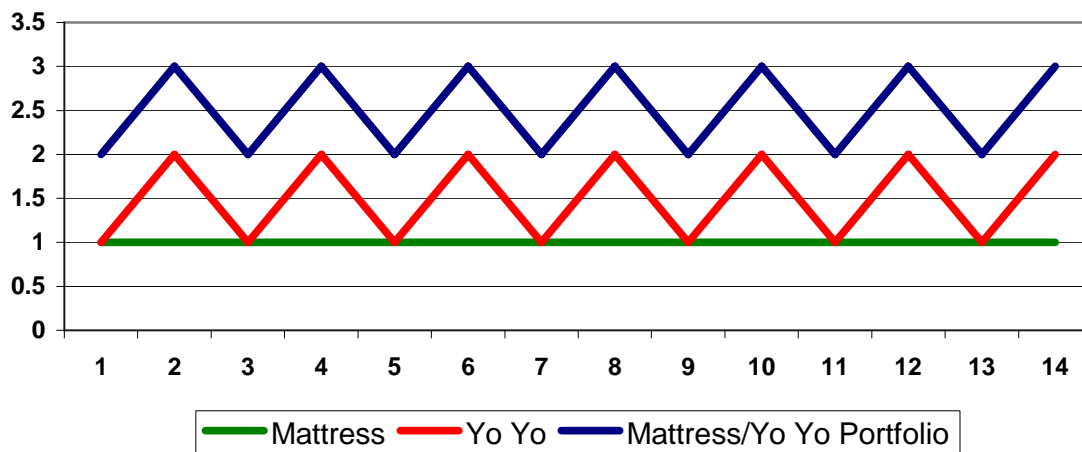
³⁰ Op. Cit., Till & Eagleye, “The Risks of Commodity Investing,” pp. 13-14: “A price is regarded as ‘overvalued’ when an analysis of historical data shows that one can make statistically significant profits from being short the commodity futures contract during the relevant time period.”

³¹ Are weather catastrophe futures an “asset class” with valuable portfolio diversification properties?

Rebalancing Return

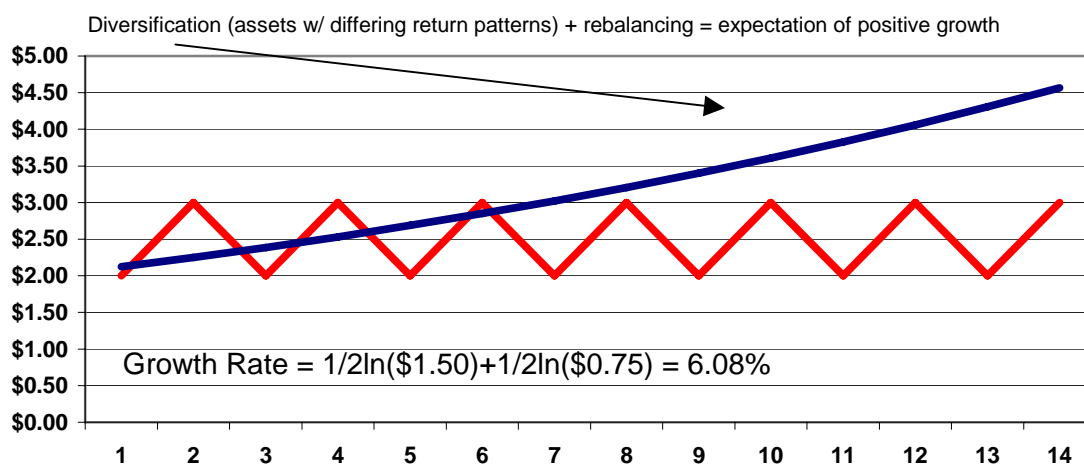
In financial markets that are characterized by mean reversion or high upside and downside volatility, investors may be able to generate return by following a rebalancing strategy in which the investor takes profits from current winning positions in favor of reinvesting into lagging investment positions. The reverse is generally true in trending markets where reinvesting in lagging positions simply truncates profits or exacerbates underperformance. The following charts demonstrate the concept. The first chart depicts portfolio of two investments each of which have a long-term return of zero percent. The first investment (“the mattress”) earns a zero percent return in each period. The second (“the yoyo”) loses a dollar and gains a dollar with equal periodicity. The blue line represents a portfolio that combines the two assets into a “mattress/yoyo” portfolio.

**Mathematics and Portfolio Management:
Zero growth functions with no Periodic Rebalancing**



However, as the next graph illustrates, a periodic rebalancing strategy, under highly stylized market conditions, generates a positive geometric return of over 6%.

Wealth Accumulation with Zero Growth Functions: Impact of Portfolio Rebalancing



Many commodity futures indexes employ periodic rebalancing and, in some cases, limit the maximum and/or minimum exposures permitted for individual contract positions. This is one reason why Erb and Harvey view these indexes as “strategies.” Thus returns from rebalancing may be largely sample specific rather than systematic. The magnitude of the future rebalancing return is, of course, unknown and depends on the volatility of future market conditions. Volatility, however, is not constant over time and, therefore, future estimation of a rebalance return is highly uncertain.³²

Change in Spot Price: The Expectations Hypothesis

Although it is the expected value of the future spot price that is the starting point for setting the futures contract price, the futures contract price is not an unbiased estimate of the future spot price. Indeed, the futures market may not be primarily “a forecasting agency,” because its critical functions are to facilitate “risk sharing and the efficient allocation of resources. To expect futures prices to only reflect predictions of future prices ignores its other functions.”³³ Any consensus predicted increase in spot prices cannot be a source of profit because the consensus is already embedded in the current futures price.³⁴ Of course, it is unlikely that the expected (i.e., consensus) future spot price (an unknowable value) will, in fact, transpire. Changes in the spot return, however, are driven by unpredictable events and the extent to which the actual future spot price comes close to the (unknown) consensus future spot price is neither predictable nor verifiable. All that can be said is that changes in the current spot price will be positively correlated with expected changes in the future spot price.

³² Volatility is not the same as “seasonality” because seasonality is a foreseeable aspect of the spot price evolution. For an in depth discussion of rebalancing, see our White Paper entitled “Risk, Return & Rebalancing” located at www.schultzcollins.com.

³³ *Op. Cit.*, Till and Eagleye, p. 14.

³⁴ *Op Cit.*, Gorton & Rouwenhorst, p. 48.

Convenience Yield: The Theory of Storage

The concept of a convenience yield is complementary to the theory of an insurance risk premium. Whereas the insurance risk premium presupposes a commodity producer willing to offload his *price risk* by entering into an agreement to transact in the future at a price sufficiently favorable to induce a counterparty to take the corresponding long position, the theory of storage presupposes that a consumer/user of a commodity is willing to pay a premium to mitigate his *inventory risk*.³⁵ The benefit of having an inventory of a commodity at hand assumes that a business venture would suffer from severe production disruptions or sales interruptions as a result of “stockouts.” The convenience yield accrues to the owner of a physical inventory and not to the owner of a contract for delivery in the future. However, the benefit of having inventory on hand increases the spot price and, all else equal, creates conditions favorable to market backwardation.

If storage of a commodity is easy (i.e. gold, silver, corn, sugar, etc.), then significant economic disruptions (price spikes) are not likely and, furthermore, the right to a near term delivery of an additional amount of the commodity may not be especially valuable. If, however, a commodity is heavily used in the economy, and if is difficult to store at a reasonable level of cost and convenience (oil, live cattle & hogs, soybeans, etc.), then there is a “convenience yield” accruing to the firms that can secure an uninterrupted supply of the critical commodity. The critical and difficult-to-store commodities have often centered on the world’s food and energy needs.

The insurance premium return theory assumes that the commodity market trading environment is normally in backwardation. Although this may be correct for some commodities, the trading environment for other commodities is almost always in contango. Gold, for example, is a commodity market that usually exhibits a term structure of prices in which the spot price is higher than the futures price. This means that a long position in a gold futures contract can be profitable only if the unexpected (i.e., unpredictable) forces driving a change in the spot price increase the spot price over time so that it becomes greater than the agreed upon futures contract price. The right to buy gold in the future at a higher price than the realized future spot price means that the long position investor holds a contract that is worthless.

The convenience yield theory, by contrast, is more appealing than the insurance premium return theory because it does not require the assumption that the market for all commodity contracts is in backwardation for the majority of the time. The convenience yield theory suggests that markets for difficult-to-store commodities will be more likely to exhibit backwardation (i.e., all else equal, the long position will be profitable); and that

³⁵ Till, Hilary & Eagleye, Joseph, “Commodities – Active Strategies for Enhanced Return,” The Handbook of Inflation Hedging Investments (McGraw Hill, 2006), p. 7: “Commodity futures markets exist to facilitate the transfer of exceptionally expensive inventory risk. Moreover, commodity futures markets allow producers, merchandisers, and marketers the benefit of laying off inventory price risk at their timing and convenience.”

markets of easy to store commodities may most often exhibit contango (i.e., all else equal, the short position will be profitable). In this respect, the convenience yield theory is a way to account for the high proportion of market contango and is an alternate or complementary explanation for why the spot price or near-term futures price of certain commodities is generally higher than the long-term futures price.³⁶

Although a discussion of inventory theory may seem remote from the practical concerns of investors, it has an important bearing on the selection of an investment product designed to track a fully collateralized commodity futures index.³⁷ However, if one recognizes that a construction principle of the majority of commodity futures indexes requires the index to hold a long position only in the futures contracts, a foreseeable result is that, in any given time period, futures price curves exhibiting backwardation are more likely to be profitable than those exhibiting contango. But backwardation requires the spot and near-term futures price to be greater than the longer-term futures price. One important driver of high spot prices is the convenience yield accruing to those who hold inventories of difficult-to-store commodities. In this case, a bird in the hand may be worth two in the bush.

Although the expected futures spot price is unobservable; and, hence, can never be known with certainty, there is strong empirical evidence suggesting that it is the subset of hard-to-store commodities that often exhibit backwardation and generate the most excess return for investors. But these are the commodities that dominate the GSCI index³⁸; thus providing further validity to the aforementioned thesis of Erb and Harvey that, unlike stock and bond indexes, commodity futures indexes are primarily investment strategies. The historical payoffs to the GSCI index may thus represent a conditional payoff to a strategy rather than an unconditional payoff to an asset class.

However, if the convenience yield is a systematic source of return (i.e. an inventory risk premium), the investor may expect to be rewarded in the future for bearing the risk exposure of volatile (hard-to-store) assets. In periods of abundance, easy-to-store commodities can be placed back into inventory in order to balance supply and demand. However, there is no such balancing mechanism with hard-to-store commodities. Price volatility can become extreme because there is no ready supply or reserve upon which to

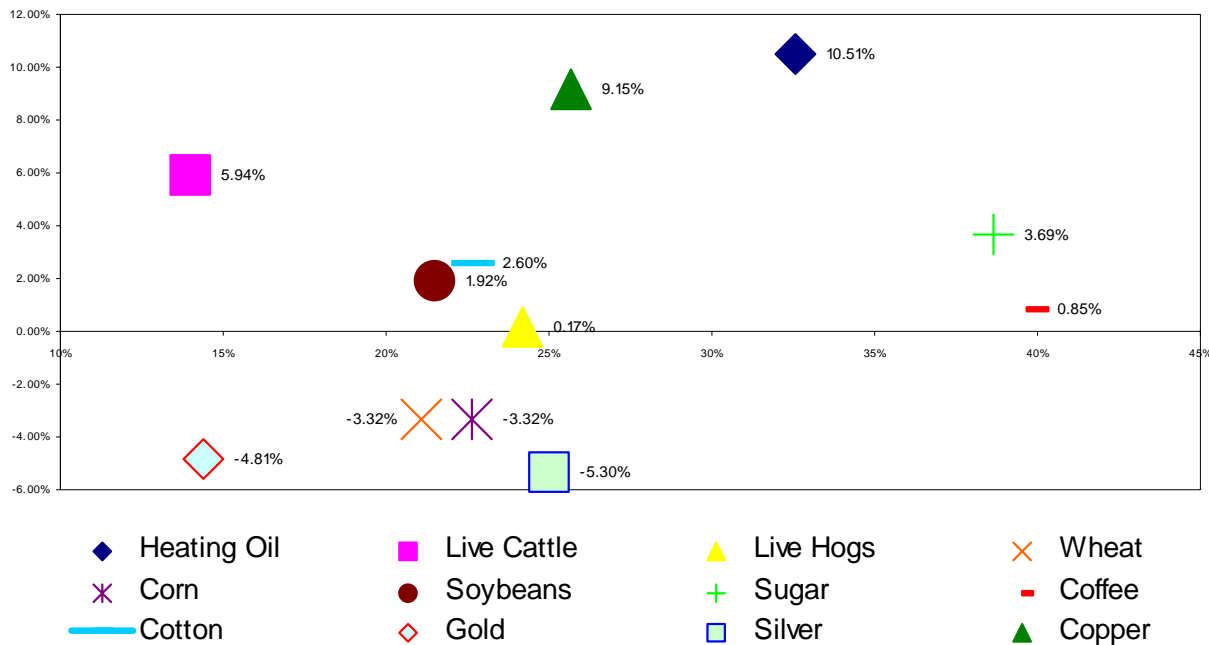
³⁶ *Op Cit.*, Erb & Harvey, pp. 21: "...the convenience yield can be thought of as a risk premium linked to inventory levels....In contrast, the theory of normal backwardation is a belief that producers' risk aversion regarding commodity price risk yields a positive expected return, a risk premium, from owning a commodity futures contract."

³⁷ For example, PIMCO offers a mutual fund designed to track the GSCI collateralized by taking an investment position in TIPS; Barclays Bank offers an exchange-traded note [not a registered investment fund] designed to track the DJ-AIG index collateralized by short-term treasury bills; as well as an exchange traded note designed to track the GSCI collateralized by short-term treasury bills. Barclays also offers a registered investment fund [exchange traded fund] tracking the leveraged GSCI. ***This paper is not an endorsement for or inducement to purchase these products, or any other commodity-related investment program.***

³⁸ Till, Hilary & Gunzberg, Jodie, "Absolute Returns in Commodity (Natural Resource) Futures Investments," Edhec Risk and Asset Management Research Centre (April, 2005), p. 9: "...for the petroleum complex, the financing of inventories remains prohibitively expensive. For metals, the cheapest place to store them is still in the ground. And finally, livestock, by their very nature, are not storable."

draw.³⁹ But it is in the volatile markets where sudden price spikes can greatly benefit the holders of long futures positions; and, if such price spikes do not occur, can benefit the long position by virtue of the backwardation shape of the futures price curve. Backwardation creates the possibility of capturing “roll yield”—a phenomenon described in a later section of this paper.

Consider, for example, the following chart which graphs the returns (on the vertical axis) of individual commodity futures contracts and the risk (standard deviation) of returns on the horizontal axis.⁴⁰ In general, the contracts with the highest returns are for those commodities that have been identified as the most difficult or most costly to store: Heating Oil, Copper, and Live Cattle.



One possible implication of this theory is that ownership of the GSCI, when considered in the portfolio context, may be more prudent than ownership of the seemingly better balanced DJ-AIG index. As noted, when considered in isolation the GSCI index may appear to be primarily a bet on the energy markets. However, when the GSCI is decomposed, its construction tends to weight those commodities that have had the best long-term returns. This may be an artifact of a momentum investment strategy or a reflection of a genuine risk premium based on the theory of storage.

³⁹ *Op. Cit.*, Till & Egleye, “The Risks of Commodity Investing,” pp. 10-13.

⁴⁰ Data from December 1982 to May 2004 reproduced from Erb & Harvey, p. 15.

The Future of Commodity Futures Index Return

Given the controversies surrounding many of the historical determinants of a fully collateralized commodity futures index's return, it is no surprise to learn that there is little academic consensus regarding the sustainability and consistency of future excess return. The two studies receiving most attention are, in many respects, at loggerheads. The Gorton & Rouwenhorst study identifies a large and statistically significant risk premium over the period 1959 to 2004 to commodity investors. The study implies, although the authors do not explicitly state, that investors will continue to be rewarded for commodity risk exposures. In counterpoint, the Erb & Harvey study suggests that there is no guarantee that many historical sources of return will persist into the future.

Although it is difficult to apply many of the tools and techniques of modern portfolio theory to non-financial assets, the debate among financial economists continues.⁴¹ For example, it is well known that under an equilibrium pricing model such as CAPM, any orthogonal (correlation statistic value close to zero) or "zero beta" asset such as commodities is expected to generate returns close to the risk-free rate.⁴² Thus, a portfolio of commodities should not evidence a return in excess of risk-free treasuries and, because treasuries embody expected inflation, should not outperform inflation. Indeed, this is exactly the case for commodity spot price indexes. In the Gorton & Rouwenhorst study, for example, the buy and hold geometric return for the spot index (July 1959 through December 2004) lagged the inflation rate (3.47% vs. 4.13%). Only an investment that carries an expectation of positive excess return is valuable for a portfolio.⁴³ However, a recent study by Ibbotson Associates proclaims "...we believe commodities offer an inherent or natural return that is not conditional on skill. Coupling this with the fact that commodities are the basic ingredients that build society, we believe commodities are a unique asset class and should be treated as such."⁴⁴ The Ibbotson study reviews the historical sources of return to collateralized commodity futures indexes and concludes: "we believe most of these return drivers are likely to persist in the future and contribute to an inherent return for commodities."⁴⁵ However, other than strong, albeit subjective, statements of belief, the study offers little direct evidence in support of the assertion.⁴⁶

⁴¹ Just as CAPM does not assign a place in the world capital market to the aggregate value of sports betting, so, also, the CAPM cannot comfortably accommodate valuation of commodity futures. However, much of the theory behind asset allocation requires that such a valuation exist.

⁴² Litterman, Bob, "The Value of Uncorrelated Sources of Return," *Modern Investment Management* (John Wiley & Sons, 2003), p. 152: "In the CAPM equilibrium, assets whose returns are not correlated with the market portfolio have zero expected excess return....if one reduces risk by switching from assets that have positive expected return into assets that do not, then the diversification has not improved the characteristics of the portfolio."

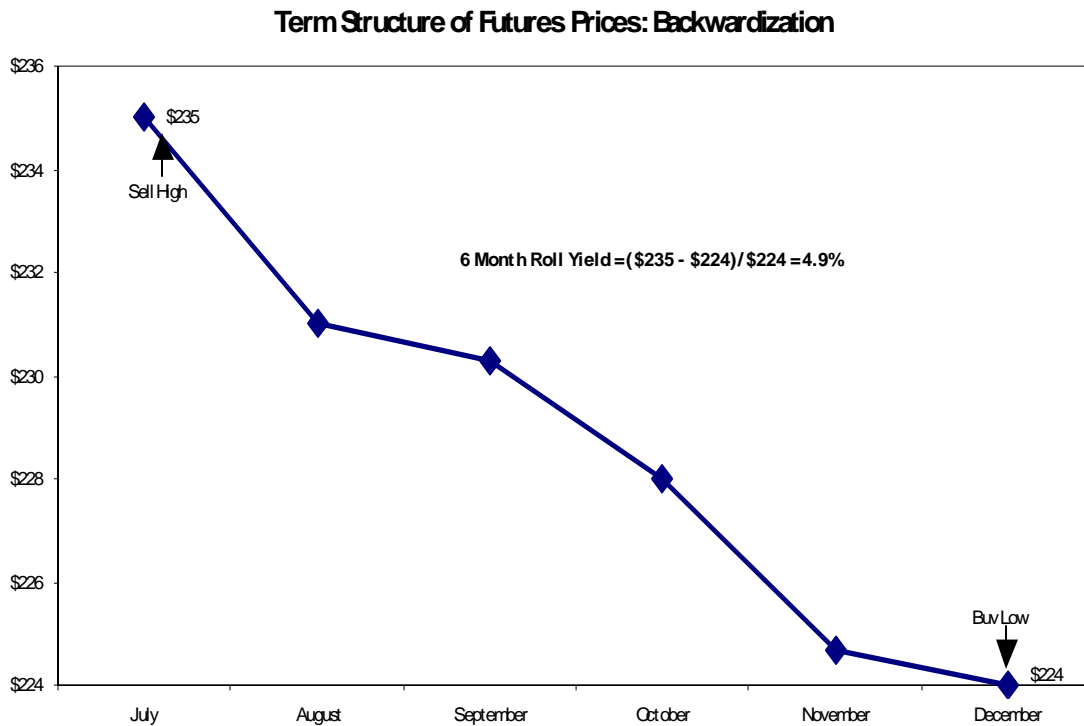
⁴³ The fact that under consumer choice theory, more choice cannot make leave a consumer in a worse position with respect to solving an optimization problem means that the addition of a new asset into a small-sample universe will always increase a portfolio's Sharpe Ratio. The test for inclusion must involve additional tests for statistical and economic significance; or, in the words of Litterman: "...adding value to a portfolio is a function not of risk characteristics per se, but rather of the relationship between expected excess return and risk." *Ibid.*, p. 154.

⁴⁴ *Op. Cit.*, Idzorek, p. 4.

⁴⁵ *Ibid.*, p. 29.

⁴⁶ Like many academic studies of commodity futures, this paper "reverse engineers" a CAPM model based on the Black-Litterman approach. The Black-Litterman model has three variables (asset allocation/world

Other than the return earned by T-Bill collateral, commodity futures investors in the long position generate money through what is known as the “roll yield.” The roll yield refers to the opportunity to buy high and sell low. This opportunity presents itself when the series of futures prices stipulated at the time of entering the contract is lower than the prevailing spot price at contract initiation. The reader will recognize this market as one that is in backwardation. The following chart provides a stylized picture of this market condition. The near term (spot price) for the commodity futures index is \$235; the 6-month futures contract price is \$224. The expected semi-annual roll yield equals 4.9%.



The roll yield is generated by the arbitrage principle that, at the time of contract expiration, the futures price must converge to the spot price prevailing at the time of contract expiration. Although the expected roll yield equals 4.9%, the realized profit

market capitalization; variance/covariance matrix; and expected returns) two of which are estimated so that the model can solve for the third. In this case, the author solves for the expected return of commodities in an asset allocation framework. However, the Black-Litterman model is subject to several practical (as well as theoretical) shortcomings that make its use problematic in these circumstances. For example, if there are only two assets, A and B, with no correlation and equal volatility, then should expected return really be dependent on the relative market cap of each? Let's say A is Universal Energy, Inc. and has a market cap of \$1 billion while B is Greeting Cards Inc. and has a market cap of \$100 million. Is it reasonable to believe that A must have a much higher return simply because the opportunity is bigger? Based on the Black-Litterman formula, the equilibrium return for A has to be almost 10 times higher than B! The model is prone to trade one improbable outcome (goofy portfolio allocations) for another (goofy return assumptions).

depends on the dynamic price differential between the current spot price and future (unknown) spot price (speculation on the basis). The uncertainty regarding the profitability of (long) commodity investing through collateralized futures indexes is, in part, a function of the likelihood of market backwardation continuing in the future. This, in turn, is a function of the continuation of several of the determinants of return reviewed in the previous section—especially, the insurance risk premium and the convenience yield. Empirical verification of these theoretical determinants, however, is difficult because the theories are based on unobservable prices.

As the chart suggests, the roll yield becomes available to investors under conditions of market backwardation.⁴⁷ In some respects it is comparable to the yield available to bond investors who hold long-term bonds in an upwardly sloping yield curve environment. As time passes, the long maturity bonds become shorter maturity bonds; and, all else equal (e.g., no unfavorable change in the shape of the yield curve or default risk premium), investors will eventually profit by owning short term, high-yield bonds. This strategy is known as “rolling down the yield curve.” Historically, for commodity futures, the combination of collateral yield and roll yield has accounted for much of the realized return, and has helped investors overcome the general downward trend in commodity spot prices. However, if the roll return does not persist into the future, commodity futures index returns may approach those of other zero beta assets, as predicted under the CAPM model.

Thus, the critical question for investors becomes one of future return persistency. As Mark Twain noted, prediction is highly uncertain, especially when it concerns the future. Some thorny issues faced by investors include:

- The degree of confidence in the roll yield for commodity markets usually in backwardation. For example, Till points out that crude oil futures contracts, although typically in backwardation, are now persistently characterized by a market in contango because of large increases in precautionary storage despite high costs: “It appears that there [has] been a structural change in the crude oil markets.”⁴⁸ As prices of a commodity rise, the market adjusts by creating supply cushions, finding alternative sources (e.g., shale oil), taking steps to decrease demand, and exploring development of new technologies that mitigate the economy’s reliance on the commodity. These developments may trigger downward pressures in commodity prices over longer time periods. Investors may face prolonged contango for an Index such as the GSCI which is heavily weighted towards energy sector futures contracts. As Till notes: “...from late 1997 until early 1999, the GSCI futures curve was in contango, and this index-based investment lost about 50% of its value.”⁴⁹
- The continued existence of an insurance risk premium sufficient to compensate investors for the risks of investing in volatile assets. Ironically, the entrance of

⁴⁷ Lewis, Michael, *Op. Cit.*, Convenience Yields, Term Structures & Volatility Across Commodity Markets,” pp. 18-23.

⁴⁸ Till, Hilary, “Commodities at the Cross-Roads: Where to Now? Edhec Risk and Asset Management Research Centre (March, 2006), p. 7.

⁴⁹ *Op. Cit.*, Till & Eagleeye, “The Risks of Commodity Investing,” p. 22.

large institutional investors into the commodity futures marketplace may be contributing to price levels that eradicate the possibility of economically significant risk premia.⁵⁰ This is a significant worry because even if a futures index investment provides diversification, without generating cash in excess of the risk-free rate, the benefits of diversification may be gutted. Furthermore, the entrance big money investors may be changing the structure of the marketplace itself in ways that remain opaque. Large hedge funds may be trading directly with brokerage firms rather than on the futures exchanges. The nature of the trading is not clearly understood and may involve complex combinations of options, futures and other derivative financial instruments.⁵¹ Until recently, most participants in the commodity futures market were not investors. However, institutional participation may change the market's dynamics making reliance on past performance foolhardy.

- The uncertainty of “characteristic-based” investment strategies. Erb & Harvey point out that historical payoffs to certain characteristics of commodity futures markets may not continue. Specifically they list payoffs to term structure characteristics (backwardation), monetary policy timing, and momentum-based strategies. The authors caution investors: “...it is difficult to judge the dependability [of] characteristics-based investing.”⁵²

The uncertain nature of commodity futures index returns is perhaps best compared to the chore of waiting for a bus “...after an unpredictable but usually long wait, they arrive in bunches. On average, they are always on schedule, but seldom on schedule when standing in the rain.”⁵³

Diversification

The proposition that a commodity futures investment provides a diversification benefit for portfolios consisting primarily of domestic and foreign stocks and bonds is based on a combination of several arguments: (1) economic; and, (2) statistical. The following section briefly outlines evidence for each position.

⁵⁰ See, for example, Chernoff, Joel, “Commodity futures’ hot streak could stall,” Pensions & Investments (December 26, 2005): “One concern is the sheer volume of money that’s flooding into the asset class. As institutional investors pour billions of dollars into commodity futures, the risk premium is bound to shrink.”

⁵¹ Till, Hilary & Eagleye, “Commodities—Active Strategies for Enhanced Return,” Edhec Risk and Asset Management Research Centre (November, 2005), p. 6. Ryan & Lu, Op. Cit., p.54, report “...some managers run their portfolio optimization programs ‘backwards’ to see what the implied return on commodities works out to, given the allocations they have actually made. Typically, most (but not all) managers allocate less than 5% of total assets to commodities, implying a negative expected return to commodities. Nonetheless, the optimization model still will allocate to commodities, given the orthogonal nature of the returns they produce.”

⁵² Op. Cit., Erb & Harvey, p. 3.

⁵³ Quoted in Ilkiw, John H., “Collateralized Commodity Futures: Good Portfolio Diversification & The Prospect of Equity-Like Returns,” An Investor Guide to Commodities (Deutsche Bank, April, 2005), p. 47.

Economic Argument

The diversification benefits of a commodity futures index rests on the observations that commodities are not financial assets; and, more importantly commodity returns are not driven by the factors that exhibit explanatory value for stock and bond returns.⁵⁴ Mark Anson outlines three economic arguments for including commodities in a broadly diversified portfolio:

1. Commodities have a unique relationship with inflation. Many commodity prices are, in fact, an underlying source of inflation and have a direct influence on the consumer price index. Additionally, in an index collateralized by short-term treasuries, a higher inflation rate is reflected in higher interest yields after only a short time lag. Commodities are a valuable portfolio diversifier because they have shown a positive correlation with inflation in counter distinction to financial assets which have tended to decline during periods of rising inflation.
2. Commodity prices move differently than stock and bond prices over the various stages of a business cycle: “When the economy is below capacity (as measured by long-run GDP), equity returns have been at their highest, but commodity prices have been at their lowest. This occurs at the bottom of an economic cycle. As economic growth accelerates, stock prices begin to decline but commodity prices increase. When the economy heats up and exceeds long-run GDP, the return to commodity futures exceeds that for stocks.” The intuition behind this argument is, according to Anson, that stocks and bonds are primarily anticipatory. When the economy is in poor shape, the prospects for improvement in the future are the highest and the returns are the greatest. Commodities, however, are primarily reactionary and reflect the level of current economic activity. When the economy is at its worst, the returns on commodity futures are also low.⁵⁵
3. The primary inputs to economic production are capital, labor, and raw materials. This said, the combined returns to these factors should equal the cost of production. When labor costs are relatively stable, an increase in the return to capital (i.e., returns on financial investments) must be offset by a corresponding decrease in the return to raw materials, and vice versa.

Of the three above-listed propositions, the inflation argument receives the most attention in both sales-oriented literature and academic study. It is helpful to distinguish between hedging inflation and out-performing inflation. Stocks (e.g., the S&P 500 U.S. stock index) have generally outperformed inflation over the long term. Thus, in one sense, one could state that stock ownership is a good way to fund future inflation-adjusted liabilities. An inflation hedge, however, implies that the (at the limit, instantaneous) change in the value of the investment offsets the change in the rate of inflation. Thus, if inflation increases by $x\%$, the return of the investment increases proportionally (i.e., exhibits

⁵⁴ For example, Erb & Harvey examine multiple stock and bond market risk factors including factors for market beta, value stock premium, small stock premium, fixed income term spreads, bond default risks and foreign exchange rate exposures. They find “...there are no uniformly positive or negative sensitivities to these risk factors across individual commodities. Nor are there any risk factors that seem to be more important than others in explaining the time series variation of individual commodity futures returns.” *Op. Cit.*, p. 35.

⁵⁵ See, also, Brown, Stephen P., “The Commodity Question,” *CFA Magazine* (January/February, 2006), pp. 44-45; and, *Op. Cit.*, Gorton & Rouwenhorst, pp. 56-57.

perfect positive correlation). Perfect positive correlation—a perfect hedge—is, of course, important if the portfolio must sustain cash distributions. To the extent that distributions can be timed or are lacking altogether, the value of a perfect hedge diminishes as the investor’s concern shifts to preserving wealth by matching or exceeding inflation over the long haul.

“Real return” is a return that is adjusted for the inflation rate. An investment’s real return can be negative (if it fails to keep up with inflation) or positive (if it beats inflation). Although asset classes vary, over time, in their ability to provide a positive real return, “historically, no asset class has provided a hedge against inflation.”⁵⁶ Some asset classes have provided a positive long-term real return; but the distinction between a real return strategy and an inflation-hedging strategy is critical. In the presence of cash flow demands, no real return strategy is able to guarantee that the portfolio will preserve the purchasing power of wealth. Indeed, historical stock and bond returns have tended to be inversely related to changes in the rate of inflation.⁵⁷ This means that if inflation drives up liability values, the amount of cash that must be distributed from the portfolio will increase at the very time the value of the assets necessary to support the cash flow decreases. Cash flows multiply the detrimental affects of investment declines and cap the beneficial affects of investment gains. Studies which focus on the utility of commodity investments in a static mean-variance framework may provide a misleading picture concerning the benefits of adding a commodity-related investment to a portfolio. It is one thing to claim that a portfolio for investors with quadratic utility has a higher Sharpe Ratio in a single-period optimization; it is quite another to suggest that commodity investments significantly enhance the probability of a portfolio’s ability to discharge dynamic liabilities as they evolve over multiple periods.

The recent Vanguard study, for example, states:

*Judged solely by contemporaneous correlations, commodities have provided a slight hedge against inflation, rising in price when inflation increased. [There is] a correlation of about +0.1 between the Goldman Sachs Commodities Total Return Index and the CPI-U [Urban].*⁵⁸

However, a further decomposition of index return reveals that most of the modestly positive correlation is the result of the performance of the collateral (short-term U.S. Treasuries) rather than the result of the commodity futures returns. The report hypothesizes that the lack of strong positive correlation flows from the discrepancy between the components of CPI-U (primarily food & beverages, apparel, medical care, energy, housing, tuition, and child care) and the GSCI, which has a heavy weighting in the energy sector commodity futures.⁵⁹ In fact, when the collateral return is removed

⁵⁶ Bennyhoff, Donald G., “Preserving a Portfolio’s Real Value: Is There an Optimal Strategy?” The Vanguard Group Investment Counseling & Research Analysis (April, 2005), p. 2.

⁵⁷ Ibid., p. 7.

⁵⁸ Ibid., p. 13.

⁵⁹ A similar conclusion was reached in a more recent study. Op. Cit., Erb & Harvey: “the mismatch between the composition of a commodity futures index, such as the GSCI, and an inflation index, such as the CPI, limits the ability of commodity futures to be an effective CPI inflation hedge.” (p. 29.)

from the time series of GSCI returns, the sign of the correlation statistic changes from slightly positive to slightly negative.⁶⁰ These results held throughout the period under evaluation (1970 through 2004) for both contemporaneous as well as for leading and lagged returns. Vanguard concludes: “this would suggest that T-bills have been an equally good, if not better, source for the same inflation-hedging benefits provided by commodities in the past, and with less volatility.”⁶¹

Statistical Argument

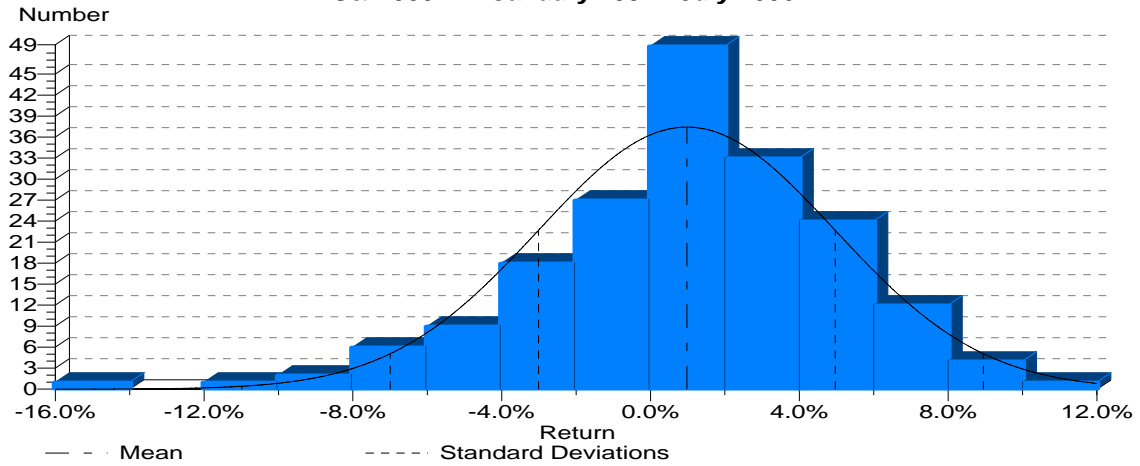
In general, quantitative analysis of collateralized commodity futures indexes indicate that their returns manifest several statistical properties valued by investors. Compare, for example, three distributions of monthly returns over a comparable period. The return series are the S&P 500 index of U.S. stocks, the GSCI index and the DJ-AIG Commodity Futures index. Superimposed on each is a graph of a normal distribution (bell curve) that is fully described by its mean (average return) and variance (dispersion away from the mean).

Furthermore, the authors examine the “inflation betas” of individual commodity futures as well as the GSCI. They note that many commodities have a negative inflation beta (signifying an inability to hedge inflation. The time-varying value of the statistical parameters is so great that, in the author’s opinion, “there is no reason to believe that the magnitude or the sign of the inflation coefficients will remain constant in the future....it is hard to find empirical evidence that all commodity futures are good inflation hedges or that the average commodity futures is a good inflation hedge.” (p. 31).

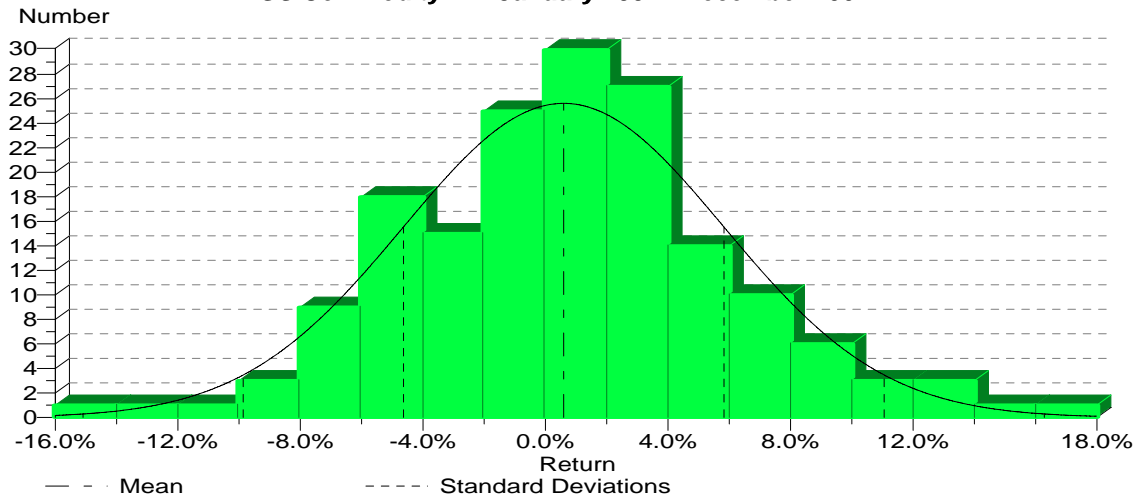
⁶⁰ The sign of the correlation statistic is also highly sensitive to the sampling period, the period measure (monthly, quarterly, yearly), and to the methods used to estimate the covariance of return series. See, for example, Kaplan, Paul D., & Lummer, Scott L., “GSCI Collateralized Futures As a Hedging and Diversification Tool For Institutional Portfolios: An Update,” *Journal of Investing* (December, 1997). Kaplan & Lummer suggest that collateralized commodity futures indexes are “an even better diversifier for bonds than for stocks.”

⁶¹ *Op. Cit.*, Bennyhoff, p. 15.

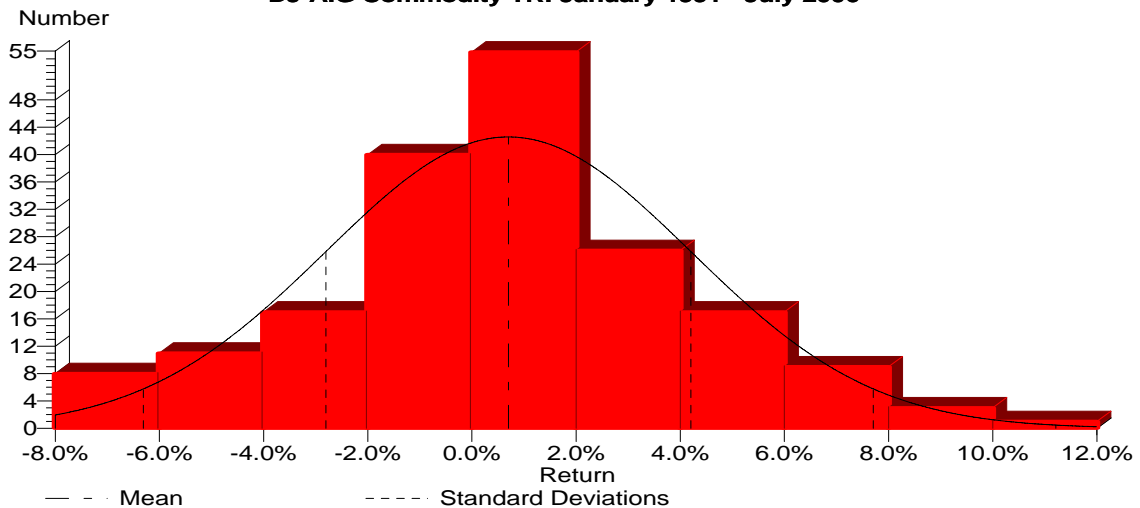
Distribution of Monthly Returns
S&P 500 TR: January 1991 - July 2006



Distribution of Monthly Returns
GS Commodity TR: January 1991 - December 2004

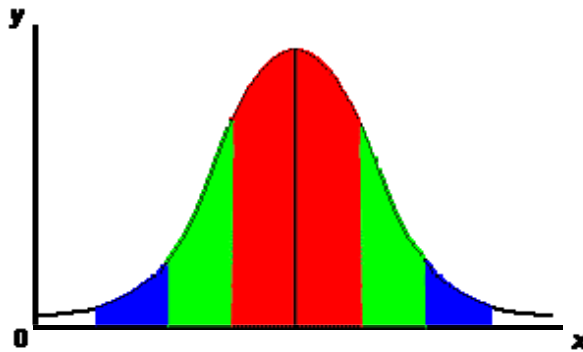


Distribution of Monthly Returns
DJ-AIG Commodity TR: January 1991 - July 2006



During this admittedly small sample period (187 months of data), it is obvious that none of the distributions match up perfectly with a normal bell curve. The S&P generates a yearly arithmetic mean of 12.36% with a standard deviation⁶² of 15.43%. The sample contains 123 positive return months and 64 negative return months. The Sharpe ratio⁶³ value is 0.24. Of greater interest, however, are the higher moment measures. The viewer may notice that there is slightly more “data mass” to the left of the mean of the S&P 500 distribution than to the right. In this case, the value of the skew statistic is -0.49 indicating a greater likelihood of producing below average returns when compared to a normal distribution.⁶⁴ Also of interest is the value of the kurtosis statistic (the fourth moment of a distribution). In this case, the S&P 500 index, during the period in question, has an excess kurtosis value equal to 1.00.⁶⁵ This suggests that the return series has a

⁶² A quantitative measure of investment risk. The standard deviation is a measure of dispersion around the arithmetic average monthly return.



In a normal, or ‘bell-shaped,’ return distribution, one standard deviation away from the average in either direction on the horizontal axis (the red area on the chart above) includes roughly 68 percent of monthly returns. Two standard deviations away from the mean (the red and green areas together) include roughly 95 percent of monthly returns. Three standard deviations (the red, green and blue areas) account for about 99 percent of monthly returns.

⁶³ A reward to risk measure calculated by dividing the numerator (mean return – t-bill return) by the denominator (variance of return). Investors prefer higher ratio values because higher values evidence the fact that excess return (above the risk-free rate available during the period) were generated without undue amounts of risk.

⁶⁴ If a distribution of returns is perfectly symmetrical around its average return (is, i.e., a ‘bell-curve’ distribution) it does not tilt either to the left or right. Thus, a normal distribution has a skew of 0.00. If skew is positive, the average magnitude of returns above the mean is greater than the average magnitude of returns below the mean, and vice versa if skew is negative. Investors generally prefer positive skew, because the distribution has a long right-side tail, indicating a greater than normal expectation of achieving very large, albeit somewhat infrequent, positive returns.

⁶⁵ A measure of the “peakedness” of a distribution. The greater the kurtosis of a distribution, the more peaked is its curve, as compared with that of the normal distribution shown above. Low kurtoses are generally undesirable, unless the distribution is also positively skewed. A distribution of returns with a positive excess kurtosis (i.e., over and above the kurtosis for a normal distribution, which is 3.00) has both more returns clustered towards the average; and more returns clustered in the tails of the distribution (“fat” tails). Although a distribution with a negative excess kurtosis has fewer returns at or near the average, nevertheless such a distribution is characterized by “skinny” tails. Fat tails signify a high probability of achieving extreme results; skinny tails signify a low probability of achieving extreme results. Generally,

greater likelihood of producing extreme returns when compared to a normal distribution. That is to say, the distribution has “fat tails.” The following table lists the values for the statistics of interest for each of the three distributions.

	Mean	Standard Deviation	# Positive Months	# Negative Months	Skew	Excess Kurtosis	Reward to Risk Ratio
S&P 500	12.36%	15.43	123	64	-0.49	1.00	0.24
DJ-AIG	8.72%	13.15	111	76	0.11	0.12	0.20
GSCI	8.94%	20.29	108	79	0.48	0.48	0.13

Looking beyond return (mean) and standard deviation, the table provides insight into other useful information concerning the three distributions. Specifically, during the period under evaluation, the stock return series produced the most extreme results (excess kurtosis). Although it also produced a greater amount of below average returns (negative skew value), this was mitigated during the sample period because of a higher value of the mean (12.36%). By contrast, the two commodity futures return series manifest positive skew⁶⁶ and a lower value for excess kurtosis—both generally desirable characteristics.

Investors usually do not complain about extreme returns on the right side of the distribution because these events generate above average profits. It is the frequency and magnitude of left tail events that are of greatest concern.⁶⁷ The following table details the 59 quarterly returns over the period extending from the end of 1991 through mid 2006. The S&P 500 stock index return series was negative approximately 27% of the time (16 negative quarters). The range of negative returns extends from a low of -0.03% to a high of -17.28%. The DJ-AIG commodity index exhibits a maximum downside risk magnitude of -13.02%; and the GSCI exhibits a downside risk magnitude of -17.73%. More to the point, however, is the fact that, with only three exceptions, commodity returns were positive in the quarter in which stock returns were negative. The small data sample suggests a tendency for commodity futures indexes to produce a conditional return with a positive sign during periods of stock market declines.⁶⁸ More recent history (since 3rd quarter 1998) however, suggests that the investor should not bet the farm on this outcome.⁶⁹

investors prefer more certainty and, therefore, prefer skinny tailed distributions exhibiting negative excess kurtosis

⁶⁶ Greer argues that commodity futures indexes will continue to exhibit positive skew because “...the ‘surprises’ that create expectational variance are more likely to be surprises that unexpectedly shrink supply rather than the reverse. Events like cartel action, drought, freeze, and war all would be more likely to drive prices up unexpectedly. This pattern would tend to give a commodity index some positive skew.” *Op. Cit.*, “The Nature of Commodity Index Returns,” p. 47. Finance theory suggests that investors may be willing to accept a negative expected return in the presence of positive skew. See, Fabozzi, Frank J., Focardi, Sergio M. & Kolm, Petter N., *Financial Modeling of the Equity Market* (John Wiley & Sons, 2006), p. 131.

⁶⁷ Although, as a distribution approaches normal, long-term results become symmetrical; and right-tail events carry significant information for long-term risk assessment. High returns are rarely risk free!

⁶⁸ The Ibbotson study provides a more in depth look at correlations during periods of negative stock and bond returns. The author concludes: “Historically, commodities act as a form of portfolio insurance and are excellent diversifiers.” *Op Cit.*, Idzorek, pp. 16-17.

⁶⁹ The 2005-2006 data put into question the strong conclusions of Gorton & Rouwenhorst: “During the 5 percent of the months of worst performance of equity markets, when stocks fell by 8.98 percent a month, on average, commodity futures experienced a positive return of 1.03 percent... Apparently, the

Quarter	S&P 500	DJ-AIG	GSCI
Dec-91	8.36%	-5.76%	-8.27%
Mar-92	-2.55%	2.94%	2.76%
Jun-92	1.97%	4.69%	5.18%
Sep-92	3.10%	0.05%	-0.16%
Dec-92	5.10%	-3.82%	-3.23%
Mar-93	4.28%	3.44%	4.52%
Jun-93	0.51%	-1.20%	-6.84%
Sep-93	2.56%	-2.35%	0.21%
Dec-93	2.31%	-0.87%	-10.15%
Mar-94	-3.81%	3.13%	4.53%
Jun-94	0.41%	10.64%	6.71%
Sep-94	4.92%	-1.18%	-6.03%
Dec-94	-0.03%	3.42%	0.45%
Mar-95	9.74%	1.76%	-0.36%
Jun-95	9.49%	0.30%	0.37%
Sep-95	7.95%	4.67%	5.23%
Dec-95	5.96%	7.85%	14.34%
Mar-96	5.44%	7.76%	10.59%
Jun-96	4.51%	4.25%	9.01%
Sep-96	3.06%	3.89%	1.82%
Dec-96	8.37%	5.53%	9.10%
Mar-97	2.62%	3.82%	-6.72%
Jun-97	17.49%	-3.60%	-2.53%
Sep-97	7.52%	4.30%	9.43%
Dec-97	2.87%	-7.44%	-13.64%
Mar-98	13.95%	-3.67%	-8.58%
Jun-98	3.30%	-8.18%	-10.60%
Sep-98	-9.95%	-5.15%	-4.44%
Dec-98	21.30%	-13.02%	-17.73%
Mar-99	4.98%	5.30%	11.99%
Jun-99	7.05%	3.11%	4.78%
Sep-99	-6.24%	13.26%	16.76%
Dec-99	14.88%	1.11%	2.85%
Mar-00	2.29%	8.30%	12.61%
Jun-00	-2.66%	7.91%	18.04%
Sep-00	-0.97%	3.68%	5.09%
Dec-00	-7.83%	8.80%	7.20%
Mar-01	-11.86%	-6.90%	-10.29%
Jun-01	5.85%	-2.69%	-5.04%
Sep-01	-14.68%	-5.57%	-9.89%
Dec-01	10.69%	-5.90%	-11.33%
Mar-02	0.28%	12.32%	14.74%
Jun-02	-13.40%	0.37%	0.01%
Sep-02	-17.28%	7.27%	11.53%
Dec-02	8.43%	4.11%	3.19%
Mar-03	-3.15%	2.92%	4.59%
Jun-03	15.40%	2.59%	3.09%
Sep-03	2.64%	4.66%	0.55%
Dec-03	12.18%	12.15%	11.35%
Mar-04	1.70%	11.77%	10.01%
Jun-04	1.71%	-4.25%	2.46%
Sep-04	-1.87%	6.75%	16.63%
Dec-04	9.23%	-4.46%	-10.79%
Mar-05	-2.15%	12.04%	21.98%
Jun-05	1.37%	-4.99%	-4.49%
Sep-05	3.61%	17.60%	21.49%
Dec-05	2.09%	-3.05%	-11.30%
Mar-06	4.21%	-2.40%	-1.40%
Jun-06	-1.44%	6.13%	6.74%

diversification benefits of commodity futures were at work just when they were needed most.” Op. Cit., Gorton & Rouwenhorst, p. 55.

Asset Allocation: Are Commodities an Asset Class?

Initially, we define an asset class as a group of assets that evidence common statistical, economic, and fundamental characteristics. We expand the definition to capture three additional concepts:

1. An investor in a risky asset class must have an unconditional expectation of receiving future excess return—that is a return in excess of the return on cash.
2. The excess return expectation comes from assuming the risk exposure inherent in the asset class and not from any specific investment strategy or asset manager skill. Thus, a stock market investor expects unconditionally that, on average, stocks have higher returns than cash. The expected excess return can be obtained at low cost by purchasing a replicating indexed investment. Further, a stock market investor can buy an actively managed investment program the returns of which are conditional on the skills of the manager or on the strategies used in the investment program. That is to say, the attempt to “beat the market” is conditional on assuming certain non-market risk and active manager skill risk.
3. Not only are the assets within the asset class sufficiently homogeneous (e.g., legal contracts like bond indentures, with highly correlated return series, and subject to common interest rate risk exposures); but, also, must be sufficiently uncorrelated with other asset classes so that “the risk premium must arise from economic exposures that can neither be diversified, nor generated from other asset classes.”⁷⁰

Asset Allocation is the determination of the appropriate weighting (i.e., risk exposure) of an asset class within the investor’s portfolio. Approaches to asset allocation, in general, fall into asset-only portfolio design; or, into asset-liability matching portfolio design. An asset-only allocation algorithm may select asset classes that improve the “efficiency” (i.e., risk/reward tradeoff, or Sharpe Ratio) of a portfolio’s terminal wealth; an asset-liability matching algorithm may select asset classes that minimize failure rates with respect to ongoing required cash flows. There are a variety of methods and approaches to the asset allocation problem; however, the subject is beyond the scope of this essay.⁷¹

Although most tests for increased investor utility from an allocation to commodities focus on the asset-only side of the question, nevertheless, from an investor’s point of view, there are several practical criteria to consider:

⁷⁰ Scherer, B., “Commodities as an Asset Class: Test for Mean Variance Spanning under Arbitrary Conditions,” An Investor Guide to Commodities (Deutsche Bank, April 2005), p. 35. A general discussion of the defining characteristics of an asset class is found in Greer, Robert J., “What is an Asset Class, Anyway?” Journal of Portfolio Management, (Winter, 1997), pp. 86-91. The distinction between a sector and an asset class is explored in DeLisle, James R., Real Estate: A Distinct Asset Class or an Industry Sector? Runstad Center for Real Estate Studies (University of Washington, October 2002), arguing that Real Estate should be considered to be a separate asset class. One commentator describes the situation as follows: “the commodities asset class is a collection of economically unique assets, while equity and bond asset classes are a collection of economically similar assets.” Op. Cit., Idzorek, p. 28.

⁷¹ The recent study by Ibbotson Associates notes: “despite considerable academic research, no definitive conclusions regarding the role of commodities in a strategic asset allocation exist.” Op. Cit., Idzorek, p. 1.

“First, the asset should increase the expected utility of a portfolio. Utility is often defined in terms of the Sharpe ratio—any asset that increases the risk-adjusted return of the portfolio deserves some allocation in the portfolio. However, there are some assets that may increase the utility of a portfolio without increasing the Sharpe ratio. This is because a highly risk-averse investor may wish to add assets that offer positive cash flows in market conditions that are expected to offer the lowest returns to the remainder of the portfolio. The other criterion for an asset class is that the returns cannot be replicated with combinations of other assets.”⁷²

Fundamentally, with respect to commodities, the asset allocation question boils down to issues of *existence* (does a commodity index represent an asset class); *uniqueness* (can the risk/return exposures of a commodity index be replicated by some combination of exposures synthesized from other asset classes; and *utility* (is there a realistic expectation of economically significant excess future reward). This should not be surprising because solutions to traditional asset allocation problems depend on the existence of a variance/covariance matrix with unique properties (positive, semi-definite, invertible matrix the elements of which span the risk/return space). The core concept of modern portfolio theory (the “efficient frontier”) is a mapping of various asset allocations that illustrates the maximum feasible utility for investors.

Unfortunately, it is wrong to conclude that an investment that earns positive excess return, has little correlation with other portfolio asset classes, and does not have returns that can be replicated by combinations of asset classes must be a separate asset class. For example, it is possible to create a portfolio wherein “noise” (return patterns from buying lotto tickets, purchasing weather catastrophe futures, or gambling on the outcome of coin flips) satisfies the above-listed criteria for an asset class.⁷³ The key is to recognize that correlation plays a secondary role while the tests of replication (“spanning tests”) may yield greater insight.⁷⁴ Formally, the excess return of the dependent variable (commodity return series) is regressed on the sum of excess returns for the independent variables (every other asset class currently within the portfolio). If the regression constant (alpha) is statistically significant, the independent variable can be considered a separate asset class. If the excess return is economically significant, the increase in investor utility (often tested at various confidence intervals through changes in the portfolio’s Sharpe Ratio) may warrant the inclusion of the commodity investment.⁷⁵

⁷² Op. Cit., Greer, pp. 45-46.

⁷³ This is especially the case where your historical sample includes, by chance, a larger percentage of winning bets than losing bets. See, Scherer, Op. Cit., pp. 35-42. One may also note that “active management” is an exposure to uncorrelated [active management] risk but does not constitute a separate asset class under most definitions of the term.

⁷⁴ An introduction to spanning set theory can be found in most linear algebra texts. See, for example, Fraleigh, John B. & Bearegard, Raymond A., Linear Algebra Third Edition (Addison-Wesley Publishing Company, 1995), pp. 190-200. The minimum spanning set is the basis for the return vector space just as the ‘x’ and ‘y’ axis vectors are the basis for the Cartesian co-ordinate plane (i.e., every vector can be synthesized or replicated by some linear combination of the basis vectors).

⁷⁵ Correlation is the square root of the coefficient of determination (R^2). The spanning test, however, focuses on the significance level of the intercept coefficient. Statisticians will recognize that the confidence level for the intercept is, in turn, a function of the variance of the error term in the regression. The more variance (risk) in the commodity return series that cannot be explained by existing asset classes

Spanning tests, in and of themselves, must also be viewed critically. Addition of an asset class into small sample opportunity sets will always yield improvement in the portfolio's Sharpe Ratio (i.e., the efficient frontier is moved upward and to the left in risk/return space). All test results are, therefore, highly sample dependent. Furthermore, the tests can produce markedly different results depending on the frequency of data. Test results based on daily returns may be much different from results based on weekly or monthly returns. Usually the tests are more robust when they use high frequency (daily) data; but the "noise" element is also most prevalent in this type of data.

The research published by Scherer suggests that (1) investment products based on several commonly used indexes do not permit rejection of the null hypothesis (commodities are not a separate asset class) at a reasonable level of significance; and, (2) much of the utility of holding a commodities position is subsumed by including a TIPS (Treasury Inflation Protected Securities) position within the portfolio. Furthermore, "...it is more natural to think of TIPS as an asset class..." in that they permit the investor to target inflation directly and "...therefore have a unique economic exposure."⁷⁶ However, where commodity return indexes created by European vendors were included in portfolios, (for investor's operating under short-sale constraints) the Beta of the commodity return vectors relative to U.S. stocks and bonds were both negative and small (at a statistically significant level) implying that "commodities live a life of their own." Additionally, for many levels of risk aversion, commodity investments improved investor utility at an economically significant level.

In a similar vein, a recent study by Huang and Zhong of Penn State University employs spanning tests (including a test incorporating short sale constraints) on daily data to determine whether TIPS, REITs (Real Estate Investment Trusts) and Commodities (GSCI) are substitutes for each other in portfolios comprised of U.S. stocks and bonds and foreign stocks and bonds. Additionally, they test the portfolio diversification benefits of each of the three asset classes, as well as combinations of the three, by calculating the statistical significance of improvement in the portfolio's Sharpe Ratio. Based on the change in Sharpe ratio, they are able to rank the asset classes in terms of their diversification benefits. Finally, they break the sample period (January 1999 through December 2005) into sub periods in order to study whether diversification benefits change over time.⁷⁷ The authors discuss the importance of defining accurately the nature of the correlation statistic. Most promoters of commodity investments use a long-term average correlation value ('unconditional correlation'). However, like any statistical value, there can be substantial deviations from the average. One way of tracking these deviations is to calculate rolling correlations to determine how the correlations act dynamically over the sample period. If, for example, correlations increase during periods

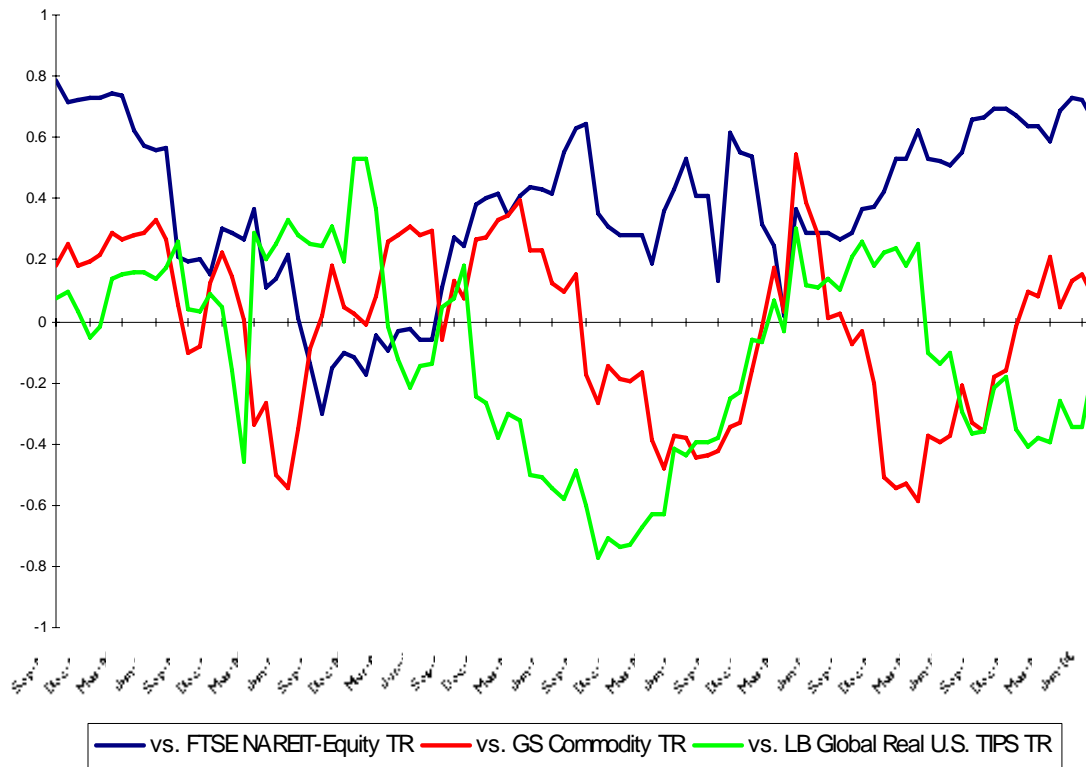
(i.e. the *lower* the correlation), the more unlikely it is that the tester can accept positive intercept values at a high confidence level. Low average historical correlation is suggestive but never determinative.

⁷⁶ Scherer, *Op. Cit.*, p. 42.

⁷⁷ Huang, Jing-zhi & Zhong, Zhaodong, "Time-Variation in Diversification Benefits of Commodity, REITs, and TIPS," *Working Paper*, Department of Finance (Penn State University, July 11, 2006).

of market uncertainty, the actual diversification benefit will be lower than that suggested by the unconditional correlation value.⁷⁸

We illustrate these concepts in the following graph based on rolling twelve month correlations of monthly data. The graph illustrates the correlation of three asset classes (Real Estate proxied by the NAREIT Index; TIPS proxied by the Lehman Brothers Global Real US TIPS Index; and, Commodities proxied by the Goldman Sachs Commodities Index) with the S&P 500 U.S. stock index over the period September 1998 through July 2006.



The unconditional correlations values (where 1 equals perfect positive correlation, and -1 indicates perfect negative correlation) are as follows:

Real Estate: 0.63

TIPS: -0.49

Commodities: 0.15.

However, one is struck by the dynamically changing nature of these values through time. For example, visual inspection indicates that, over the entire period, TIPS was the most effective portfolio diversifier. However, if one isolates the 2000-2001 period of extreme

⁷⁸ Another method of calculating correlation is termed 'constant correlation' and is the average of all historical pairwise correlations. The Huang & Zhong study employs a correlation measure derived from a dynamic conditional correlation calculation. This measure estimates correlation through a generalized autoregressive and conditional heteroskedastic process that accounts for time varying volatility and autocorrelated values within the regression equations.

market volatility, it appears that commodities and real estate provided the greatest benefits.

As indicated, the Huang & Zhong study uses advanced econometric analysis to look at data over the 1999 through 2005 period for a more broadly diversified portfolio of US and foreign stocks and bonds. The reader is, again, cautioned that test results are highly sample specific. However, the authors conclude that during the period under evaluation TIPS were ranked as the most effective diversifier, REITs the next, and commodities the least. The results of spanning tests, as well as related ‘intersection’ tests (the asset class risk/return characteristics can be replicated only for a specific point on the efficient frontier) under short sale constraints strongly rejects the null hypothesis (that the three return series, when introduced into the portfolio either in isolation or in combination, are not asset classes) throughout the entire sample period. However, for certain subperiods, it becomes more difficult to reject the null hypothesis. This is suggestive of their follow on conclusion—the diversification benefits of each asset class change over time. The authors conclude:

“We find that the three asset classes are not substitutes for each other based on the analysis in a full sample. However, there is evidence on the substitution effect in certain sub-periods (quarters) when the analysis is done on a quarterly basis. In most of such cases commodity is redundant. Based on the increase in the tangent portfolio’s Sharpe ratio after the addition of an asset and the asset’s weight in the tangent portfolio, TIPS dominate REITs which in turn dominate commodity.”

However, because the diversification benefits of the three asset classes vary significantly over time, the authors find that each of the three asset classes benefited a portfolio of traditional stocks and bonds.

Conclusion

Commodity investment is an interesting and complex topic about which much future research needs to be done. We believe that, given the current state of the academic discussion, investment decision making with respect to commodities reflects personal beliefs and political and social mores as much as it reflects considered and expert deliberation on portfolio construction issues. That is to say, commodity futures may or may not be an asset class that may or may not provide valuable diversification benefits and inflation protection; and that may or may not generate attractive future investment returns at either low or high risk.

As to which types of personalities are best suited for commodity investing, we offer a poetic exploration of this issue in the form of “Wanda the Worrywart” in Appendix A. This poem, written and published⁷⁹ by Carol Collins, is one of a series of ‘occupational’ and ‘personality’ profiles for each letter of the alphabet (full series entitled “Children from A to Z: What They Grew Up To Be”).

⁷⁹ Collins, Carol E., “Wanda The Worrywart,” PKA's Advocate (February/March 2000).

APPENDIX A

Wanda the Worrywart

Wanda was a worrywart
Though somewhat tall instead of short
She wouldn't try for any sport
But shied away from field or court
Foreseeing scrapes of every sort

For when she saw a ball was tossed
She kept her toes and fingers crossed
Her skin would chill and hair would frost
To win a game at any cost—
A coach's words on her were lost

Wanda worried she'd be hurt
Or couldn't scramble worth a squirt
Or worse she'd end up eating dirt
So she would always stay alert
And run five miles a game to skirt

When she stopped to drink some water
She'd cross her legs much like Buddha
Sitting in a pose from yoga
She'd meditate and sigh her quota
Beads in hand while bending over

Wanda's worries it was said
Turned her beads from white to red
She'd work them till her fingers bled
And wrap her hands 'fore going to bed
By morn her skin was bumpy and dead

Then she'd worry that her mother
Would come upstairs and make a bother
Or send her down to see her father
She'd almost hear his dreadful holler
"I won't give her one more dollar!"

And yet her fears were worse than fact
Like nightmares in her head they sacked
And though not one of them attacked
She never wavered, never slacked
And always kept her knapsack packed

When she got into a car
She never cracked her window far
She brought her hat and sunscreen jar
And Roloids pack and nutrient bar
To ward off rays and air and tar

She could have been a good Girl Scout
And once she dared to try it out
She loved the hikes there is no doubt
But creepy crawlies all about
And things at night just made her pout

Of school she also had a fear
Could she get A's? Would others sneer?
New teachers found her rather dear
And she made a new friend every year
But old ones had it—'up to here!'

Wanda wouldn't see a movie
For fear that she might catch a cootie
Kids began to think her snooty
And some would feel it was their duty
To elbow her or make her sooty

So after school she'd go upstairs
And clean her room and eat some pears
And read a book to numb her cares . . .
The day a story turned to bears
She shut the book and said her prayers

When nighttime came she didn't sleep
For guilty thoughts began to creep
She lit her lamp so she could peek
Into the book she'd have to keep
Since her report was due that week!

She read with skill, but read right past
The part where all the bears had passed
Still when she closed her eyes at last
She felt she'd earned a good night's rest
But found her mind was much too stressed

With eyelids closed she had a dream
Which was so real it surely seemed
Her coverlet of brown and green
Was forest thick with bears all mean

Who grinned to mock her self-esteem

There they circled all around
Where she was sitting on the ground
But she had heard at old campground
That if you waved and made some sound
You could walk away while gaze was down

When she raised her eyes again
To see a pasture rich with grain
And smell clean air refreshed by rain
She sped toward it down the lane—
But her long stride suddenly stopped in pain!

A bull had butted her derriere
Nothing could have been scarier
She started to run but he carried her
And frightened the bears who had followed her
The rest of the dream is much blurrier

When she awoke she went to school
And stood before the class real cool
For she had learned a golden rule
To worry is to play the fool
For fears themselves are just a tool

To spur you on to great exploits
Like microbe hunting or probes at court
Or doctoring tiny broken joints
Or mothering little worrywarts
Who might one day excel in sports

But this was very long ago
When little Wanda began to grow
And now she is, if you must know
A commodities trader who's quite a show
Where bulls and bears come and go

On bearish days on the floor
Long calfskin gloves wave for more
While eyes look sideways at the board;
On bullish days above the roar
Sometimes she's carried toward the door
To charge through traffic to the bead store

Her father, it is said, will call

Saying "How's my girl grown so tall?
Oh, by the way, should I put or call?"
And on meeting his cronies at the hall
He brags: "My Wanda's on the ball!"
And I'd tell you more but I've told all.

Carol E. Collins