

The Benefits of Commodity Investment: 2006 Update

CISDM

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Abstract

In recent years, investible commodity indices and commodity linked assets have increased the number of available commodity-based products. This paper provides both theoretical and empirical basis for the inclusion of commodities in investor portfolios. Results show that direct commodity investment can provide significant portfolio diversification benefits to traditional stock and bond portfolios and can provide return opportunities beyond those achievable from commodity-based stock and bond investment. Results also show that direct commodity based investment provides return and risk opportunities beyond that of simple inflation hedging. The impact of current commodity based index products is shown to be dependent on both the relative structure of the index products (e.g., sector allocations and reweightings) as well as the degree to which the indices are static or dynamic (reweighted based on expected price movements). Lastly results also show the impact of roll return on potential returns to long bias commodity indices and the market conditions most conducive to positive roll return.

The Benefits of Commodity Investment

Introduction

Historically, direct commodity investments have been a minor part of investors' asset allocation decision. In contrast, indirect investment (e.g., equity or debt ownership of firms specializing in direct commodity market production) was the principal means of obtaining claims on commodity investment. In recent years, however, the number of investible commodity indices and commodity-linked investments has increased. The purpose of this study is to:

1. Detail the various theoretical arguments for the risk/return advantages for commodity investment, and
2. Report on the relative performance of various commodity based investment vehicles (e.g. Goldman Sachs Commodity Index (GSCI) and Dow Jones-AIG Commodity Index (DJ-AIG CI))

In the following sections, the theoretical basis for commodity investment is reviewed and the expected return and risk structure for various direct 'long-only' futures-based investible commodity indices are analyzed as part of a fully diversified portfolio (stocks, bonds, hedge funds, and real estate). Results indicate that the indices have sources of risk and return (e.g. roll return, real options) that are distinct from traditional assets such as stocks and bonds and offer investors an important area of diversification. The relative performance of these commodity based index products with other commodity based investments (e.g. stocks, bonds and mutual funds) are also analyzed. Conclusions and suggestions for future studies are discussed in the final section.

Commodity Investment: Alternatives

One of the most attractive aspects of commodity investment today is that there are now a number of alternative means of accessing commodity returns including 1) direct commodity investment through passive futures based commodity investment, 2) commodity based mutual funds, and 3) direct equity investment.

Commodity Indices

Commodity indices are generally based on the returns of futures contracts and/or cash markets. Included in this group are the Dow Jones-AIG, and Goldman Sachs Commodity Indices. These indices provide returns comparable to passive long positions in listed futures contracts. Commodity indices attempt to replicate the return available to holding long positions and short in agricultural, metal, energy, or livestock investment.

The two primary commodity indices used in this analysis are as follows:

GSCI: The Goldman Sachs Commodity Index (GSCI) is a world production-weighted commodity index that has become one of the premier global commodity benchmarks for

measuring investment performance in the commodity markets. The GSCI is a composite index of commodity sector returns, representing an un-leveraged, long-only investment in commodity futures that is broadly diversified across the spectrum of commodities. The returns are calculated on a fully-collateralized basis with full reinvestment. It is composed of 24 liquid exchange-traded futures contracts: six energy products, five industrial metals, eight agricultural products, three livestock products and two precious metals. The allocation of each commodity within the index is determined by the average production of the respective commodity in the last five years of available data.

Sub-indices are calculated for agricultural, energy, industrial, livestock, and precious metals contracts. Three GSCI indices are published: excess return, total return and spot. The excess return index measures the returns accrued from investing in uncollateralized nearby commodity futures, the total return index measures the returns accrued from investing in fully-collateralized nearby commodity futures and the spot index measures the level of nearby commodity prices. The GSCI was officially launched in 1992.

Dow Jones AIG: The Dow DJ-AIGCI is composed of futures contracts on 19 physical commodities. It maintains a long futures position. There are seven sub-indexes, representing the major commodity sectors within the index: Energy (including petroleum and natural gas), Petroleum (including crude oil, heating oil and unleaded gasoline), Precious Metals, Industrial Metals, Grains, Livestock and Softs.

To determine its component weightings, the DJ-AIGCI relies primarily on liquidity data and to a lesser extent on dollar-adjusted production data. All data used in both the liquidity and production calculations are averaged over a five-year period.

In addition, to insure diversified commodity exposure, the DJ-AIGCI relies on several diversification rules. Among these rules are the following:

- No related group of commodities (e.g., energy, precious metals, livestock and grains) may constitute more than 33% of the index.
- No single commodity may constitute less than 2% of the index.

The DJ-AIGCI is reweighted and rebalanced every January. Reweighting and rebalancing is designed to decrease (increase) the index's exposure to commodities that have appreciated (depreciated) in value over the course of the past year. After rebalancing, commodity weightings fluctuate freely as the underlying commodity values increase or decrease, subject to the two limits imposed above. Therefore, this index is a momentum-type index. The DJ-AIGCI was launched on July 14, 1998. To calculate returns prior to 1998, Dow Jones and AIG replicated the index using the same methodology currently in place.

Commodity Mutual Funds

Another way to gain exposure to commodities is through a commodity mutual fund. To reflect the performance of commodity-based mutual funds, two Lipper mutual fund indices are used (Lipper Gold and Lipper Natural resources). These benchmark indices primarily reflect active management into financial securities of firms' specializing in the commodity area. Mutual funds and ETFs also exist which reflect the actual performance of direct investment into various commodity indices. However, recent regulatory concerns have resulted in the potential

restructuring of these mutual funds and they are not directly analyzed in this review.¹ In addition, other means of investment into existing commodity indices commodities include ETFs. The underlying returns to commodity based ETFs currently reflect those of the underlying commodity indices and their performance is reviewed in other existing research.²

Equity Investment in Natural Resource Companies

Owning the securities of a firm that derives a significant part of its revenue from the sale of physical commodities is another way of gaining exposure to commodities. The disadvantage of this is that it provides the investor with significant stock market exposure. In addition to the underlying commodity risk associated with direct investment in a given commodity, an investor who take a position in the equity securities of companies engaged in the sale of physical commodities is also subjected to the company's underlying business risk. In this paper various S&P sector indices are used which reflect investment into various commodities.

Source of Returns

Investor benefits of commodity or commodity-based products lie primarily in their ability to offer risk/ return trade-offs that cannot be easily replicated through other investment alternatives. Academic research has examined the economic determinant of returns to commodity investment. For example, Fama and French [1988] and Schneeweis, Spurgin, and Georgiev [2000] identified a strong business cycle component in the variation of spot and futures prices of industrial metals. Fama and French [1987, 1988] perform tests of the theory of storage and present empirical evidence that in periods of increasing volatility and risk, convenience yields increase for a wide variety of metals prices (e.g., aluminum, copper, nickel and lead). The theory of storage splits the difference between the futures price and the spot price into the forgone interest from purchasing and storing the commodity, storage costs and the convenience yield on the inventory. Convenience yield reflects an embedded consumption timing option in holding a storable commodity. Further, the theory predicts an inverse relationship between the level of inventories and convenience yield – at low inventory levels convenience yields are high and vice versa. A related implication is that the term structure of forward price volatility generally declines with time to expiration of the futures contract – the so-called “Samuelson effect”. This is caused by the expectation that, while at shorter horizons mismatched supply and demand forces for the underlying commodity increase the volatility of cash prices, these forces will fall into equilibrium at longer horizons.

Litzenberger and Rabinowitz [1995] observe that oil futures prices are often below spot prices, that is, futures markets are backwardated. Strong backwardation occurs when futures prices are below current spot prices. In weak backwardation, discounted futures prices are below spot prices. Litzenberger and Rabinowitz explain the phenomenon with the existence of “real options” under uncertainty. They show that production occurs only if discounted futures are below spot prices and strong backwardation emerges if the risk of future prices is sufficiently

¹ In recent months, the Oppenheimer real asset fund announced that it was shutting off all new investments into its fund due to concerns raised by the IRS as to whether the securities held by the fund did not meet its definitions of securities. Oppenheimer and other similar firms with commodity type mutual funds are currently reviewing the various means by which their funds will be constructed in the future.

² Two current examples include ETFs on commodity indices offered by Barclays and Deutsche Bank.

high. A major consequence of a declining term structure of forward prices for investment in commodity futures is the opportunity to capture a positive roll return as investment in expiring contracts is moved to cheaper new outstanding contracts. For a full discussion of the pricing and the modeling of commodities and commodity derivatives returns see Geman (2005).

Empirical Results

Results in Exhibit 1 show the risk and return performance of the GSCI and DJ-AIG commodity indices, CISDM Equal Weighted Hedge Fund and CTA Indices, traditional equity and bond indices, and portfolio combinations which include traditional assets, hedge funds, CTAs, and commodities for the sixteen year period 1995-2005. During this period, the GSCI and DJ-AIG indices had annualized absolute returns inferior to those of the CISDM Equal Weighted Hedge Fund Index and the S&P 500, but superior to those of CISDM Equal Weighted CTA Index and traditional bond indices. Although these commodity indices have incurred roughly similar returns, they are significantly more volatile than most traditional asset class indices as well as the CISDM hedge fund and CTA indices. This higher volatility has resulted in commodity indices having lower risk-adjusted returns as measured by their respective Sharpe ratios.

The CISDM hedge fund and CTA indices are shown to have a weak positive correlation to commodity indices as seen in Exhibit 1. Additionally, there appears to be little-to-no correlation between commodities and traditional stock and bond asset classes. Despite commodities having higher volatility and lower corresponding Sharpe ratios, the weak correlations between them and hedge funds, CTAs, and traditional asset classes suggests additional diversification benefits can exist by adding commodities to an already diversified portfolio

Exhibit 1

| Commodity Index Performance 1995-2005 | | | | | | | |
|---|-------------|--------------|---------------------------------------|--------------------------------|-------------|-----------------|-------------------|
| | GSCI | DJ-AIG CI | CISDM Equal Weighted Hedge Fund Index | CISDM CTA Equal Weighted Index | S&P 500 | Lehman Gov/Corp | Lehman High Yield |
| Annualized Returns | 10.50% | 9.25% | 14.30% | 8.65% | 11.40% | 7.29% | 7.64% |
| Annualized Standard Deviation | 20.65% | 13.38% | 7.45% | 8.79% | 15.10% | 4.42% | 7.12% |
| Sharpe Ratio | 31.93% | 39.88% | 139.46% | 53.91% | 49.62% | 76.67% | 52.33% |
| Maximum Drawdown | -48.25% | -36.20% | -11.61% | -8.75% | -44.73% | -4.57% | -12.01% |
| Correlation GSCI | 1.00 | 0.90 | 0.19 | 0.20 | 0.00 | 0.06 | 0.00 |
| Correlation DJ AIG CI | 0.90 | 1.00 | 0.26 | 0.25 | 0.10 | 0.02 | 0.08 |
| Correlation JCPI | 0.95 | 0.94 | 0.28 | 0.18 | 0.10 | 0.02 | 0.10 |
| | Portfolio I | Portfolio II | Portfolio III | Portfolio IV | Portfolio V | Portfolio VI | |
| Annualized Returns | 9.68% | 10.26% | 9.78% | 10.15% | 10.42% | 10.16% | |
| Annualized Standard Deviation | 7.77% | 7.51% | 7.03% | 7.51% | 7.13% | 7.06% | |
| Sharpe Ratio | 0.74 | 0.85 | 0.84 | 0.83 | 0.91 | 0.89 | |
| Maximum Drawdown | -16.07% | -13.91% | -11.85% | -14.67% | -13.69% | -12.68% | |
| Correlation GSCI | 0.01 | 0.56 | 0.35 | 0.03 | 0.32 | 0.20 | |
| Correlation DJ AIG CI | 0.11 | 0.58 | 0.48 | 0.13 | 0.38 | 0.31 | |
| Correlation JCPI | 0.10 | 0.60 | 0.45 | 0.12 | 0.39 | 0.29 | |
| Note: | | | | | | | |
| Portfolio I: 50% S&P 500 and 50% Lehman Gov./Corp. Bond | | | | | | | |
| Portfolio II: 40% S&P 500, 40% Lehman Gov./Corp. Bond, and 20% GSCI | | | | | | | |
| Portfolio III: 40% S&P 500, 40% Lehman Gov./Corp. Bond, and 20% DJ-AIG | | | | | | | |
| Portfolio IV: 90% Portfolio I and 10% CISDM Equal Weighted Hedge Fund Index | | | | | | | |
| Portfolio V: 90% Portfolio IV and 10% GSCI | | | | | | | |
| Portfolio VI: 90% Portfolio IV and 10% DJ-AIG CI | | | | | | | |

As seen in Exhibit 1, the Sharpe ratios for portfolios (Portfolio V and VI) which include at least a 10% investment in commodities are found to dominate those that invest solely in traditional stock and bond investments or in stock, bond and hedge funds. Individual portfolio Sharpe ratios

are as follows: Portfolio I (0.74), Portfolio II (0.85), Portfolio III (0.84), Portfolio IV (0.83), Portfolio V (0.91), Portfolio VI (0.89). Given the low correlation between commodities and stock, bond, and hedge fund indices, when the GSCI or DJ-AIG Commodity Index is added to the S&P 500, Lehman Brothers Government/Credit bond Index, or a portfolio comprised of both the S&P 500, Lehman Bond Index and the CISDM Equal Weighted Hedge Fund Index, risk-adjusted returns are enhanced.

Commodity Sub-indices

Exhibit 2 shows the performance statistics for the GSCI and DJ-AIG component sub-indices for the 1995-2005 period. Both the GSCI energy sub-indices have reported both the highest annualized returns (17.37%) and standard deviations (32.35%) followed by GSCI industrial metals which has an annualized return of 4.92% and standard deviation of 16.19%, and GSCI precious metals with an annualized return of 4.31% and standard deviation 13.03%. The performance characteristics between GSCI and DJ-AIG sub-indices are found to be similar when compared based on commodity type. With exception to the DJ_AIG Energy and Petroleum sub-indices, each of the remaining sub-indices had lower risk-adjusted returns when comparing their respective Sharpe ratios to that of hedge funds, CTAs and traditional asset classes as found in Exhibit 1. The highest correlations are between sub-indices and composite commodity indices are in energy and metal-based commodities as seen in Exhibit 2 below. These high correlations can be attributed due to the significant weightings of the energy and metal commodities within the GSCI and DJ-AIG composite indices. The relatively greater return for energy and metals based commodity investment is consistent with the economic arguments that an underlying long term positive return is more likely to exist for commodities such as energy and metals for which supply may be constrained.

Exhibit 2

| Performance of GSCI & DJ-AIG CI Subindices (1995 - 2005) | | | | | | | | |
|--|--------------------|--------------------|--------------|------------------|----------|----------|------------------|-----------------------|
| Index | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation GSCI | Correlation DJ AIG CI |
| Agriculture | | | | | | | | |
| GSCI Agriculture | -4.68% | 15.47% | -0.56 | -63.87% | 0.00 | -0.27 | 0.21 | 0.41 |
| DJ-AIG Grains | -2.58% | 19.69% | -0.33 | -56.05% | -0.01 | -0.08 | 0.20 | 0.41 |
| DJ-AIG Softs | 0.65% | 18.00% | -0.18 | -58.31% | 0.64 | 0.80 | -0.01 | 0.15 |
| Energy | | | | | | | | |
| GSCI Energy | 17.37% | 32.35% | 0.42 | -61.27% | 0.32 | 0.55 | 0.98 | 0.84 |
| DJ-AIG Energy | 21.44% | 32.54% | 0.54 | -60.84% | 0.39 | 0.48 | 0.96 | 0.87 |
| DJ-AIG Petroleum | 22.02% | 31.89% | 0.57 | -61.80% | 0.23 | 0.57 | 0.92 | 0.79 |
| Industrial Metals | | | | | | | | |
| GSCI Industrial Metals | 4.92% | 16.19% | 0.06 | -36.77% | 0.25 | 0.43 | 0.22 | 0.43 |
| DJ-AIG Ind Metals | 6.07% | 17.69% | 0.12 | -34.69% | 0.41 | 0.55 | 0.23 | 0.46 |
| Livestock | | | | | | | | |
| GSCI Livestock | 1.25% | 13.97% | -0.19 | -38.71% | -0.79 | 1.03 | 0.06 | 0.12 |
| DJ-AIG Livestock | 0.76% | 14.40% | -0.22 | -40.35% | -0.54 | 0.11 | 0.06 | 0.14 |
| Precious Metals | | | | | | | | |
| GSCI Precious Metals | 4.31% | 13.03% | 0.03 | -29.14% | 0.58 | 1.63 | 0.16 | 0.33 |
| DJ-AIG Prec Metals | 4.20% | 14.07% | 0.02 | -27.73% | 0.28 | 1.43 | 0.12 | 0.31 |

Commodities as an Inflation Hedge

A significant part of the benefit of direct commodity investment is said to derive from unique fluctuations in commodity values as a function of shifting economic forces. One such aspect of

the return process of commodities is that commodity cash prices may benefit from periods of unexpected inflation, whereas stock and bond may suffer. This premise is tested by calculating the correlation of commodity index returns with both actual and unexpected inflation. Exhibit 3 suggests that there is little correlation between the GSCI and the DJ-AIG commodity sub-indices and either actual reported and unexpected inflation. In brief, while changes in commodity prices certainly affect particular goods and services directly related to the underlying commodity, there is little direct association between commodity prices or changes in commodity prices and more aggregate measures of inflation.

Exhibit 3

| Factor Correlations (1995 - 2005) | | |
|--|-----------------------------|---------------------|
| Index | Unexpected Inflation | Level Of CPI |
| GSCI | 0.28 | 0.13 |
| DJ-AIG CI | 0.30 | 0.14 |
| Traditional Asset Classes | | |
| S&P 500 | 0.01 | -0.10 |
| Lehman Gov./Corp. Bond | -0.01 | -0.06 |
| Lehman High Yield | -0.01 | -0.08 |
| Agriculture | | |
| GSCI Agricultural | 0.06 | -0.04 |
| DJ-AIG Grains | 0.00 | -0.08 |
| DJ-AIG Softs | 0.09 | 0.04 |
| Energy | | |
| GSCI Energy | 0.26 | 0.12 |
| DJ-AIG Energy | 0.27 | 0.15 |
| DJ-AIG Petroleum | 0.28 | 0.11 |
| Industrial Metals | | |
| GSCI Industrial Metals | 0.13 | 0.00 |
| DJ-AIG Ind Metals | 0.15 | 0.00 |
| Livestock | | |
| GSCI Livestock | -0.07 | 0.08 |
| DJ-AIG Livestock | -0.06 | 0.08 |
| Precious Metals | | |
| GSCI Precious Metals | 0.22 | 0.10 |
| DJ-AIG Prec Metals | 0.21 | 0.10 |

Direct Equity Investment

The potential benefits of commodity investment may also be accessed through direct investment in commodity-based equity firms as well as through mutual funds, which may invest directly in commodities or through commodity-related securities (e.g. stocks or bonds). Exhibit 4 shows that that direct investment into equity securities or mutual fund which specialize in particular commodity sectors have moderate correlations with the related commodity index. For instance, the correlation between GSCI Energy and the S&P 400 Energy sector and S&P Oil and Gas sectors are both above 0.45. Similarly, the correlation between the GSCI Precious Metals and Industrial Metals and the related S&P sectors are all above .50. In contrast, the correlations with the GSCI Precious Metals and Industrial Metals indices and their related Lipper mutual fund indices are below .50. The lower correlation for mutual funds indices and their related commodity index (in contrast to investment in the related S&P 500 sector) may be due in part to the greater diversity of stock ownership in the mutual fund than in the sector industry. The less than perfect correlation between commodity energy or metals indices and equity returns is consistent with academic research which emphasizes a firm's risk management practices. For

instance, previous research [Chung, 2000] has shown that for gold mining firms the relationship between equity returns and changes in gold prices are based in part on the degree to which the mining firm hedges current production.

Lastly, while the correlation between the GSCI metals and energy indices and their associated S&P sector index and mutual fund counterpart is generally above .50 the correlation between the GSCI agricultural and S&P 500 food and agricultural sectors are generally below .20. This low correlation is consistent with the S&P 500 food and agricultural sectors returns due primarily from direct sales of manufactured product in contrast to sale of the underlying commodity.

Exhibit 4

| Performance of GSCI & DJ-AIG CI Subindexes (1995 - 2005) | | | | | | | |
|--|--------------------|--------------------|--------------|------------------|----------|----------|--------------------------------------|
| Index | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation GSCI |
| GSCI | 10.50% | 20.65% | 0.32 | -48.25% | 0.10 | 0.00 | 1.00 |
| DJ-AIG CI | 9.25% | 13.38% | 0.40 | -36.20% | 0.05 | -0.25 | 0.90 |
| Energy | | | | | | | Correlation GSCI Energy |
| GSCI Energy | 17.37% | 32.35% | 0.42 | -61.27% | 0.32 | 0.55 | 1.00 |
| S&P 400 Energy | 18.29% | 33.20% | 0.43 | -63.46% | 0.18 | 1.81 | 0.53 |
| S&P Oil&Gas Drill | 17.15% | 41.92% | 0.32 | -70.72% | 0.11 | 0.55 | 0.47 |
| S&P Oil&Gas Expl | 13.41% | 30.13% | 0.32 | -47.97% | 0.60 | 1.56 | 0.53 |
| Precious Metals | | | | | | | Correlation GSCI Prec. Metals |
| GSCI Precious Metals | 4.31% | 13.03% | 0.03 | -29.14% | 0.58 | 1.63 | 1.00 |
| S&P gold | 2.94% | 37.93% | -0.03 | -70.01% | 1.16 | 5.96 | 0.70 |
| Lipper Gold Fund | -1.44% | 24.90% | -0.22 | -71.70% | 1.06 | 11.28 | 0.42 |
| Industrial Metals | | | | | | | Correlation GSCI Ind. Metals |
| GSCI Industrial Metals | 4.92% | 16.19% | 0.06 | -36.77% | 0.25 | 0.43 | 1.00 |
| S&P Diver Metals | 9.89% | 35.34% | 0.17 | -60.55% | 0.21 | 0.74 | 0.62 |
| S&P Alum | 8.24% | 33.23% | 0.13 | -53.53% | 0.55 | 1.82 | 0.54 |
| Lipper Nat Res Fd | 5.67% | 16.91% | 0.10 | -45.38% | -0.52 | 2.15 | 0.32 |
| Agriculture | | | | | | | Correlation GSCI Agriculture |
| GSCI Agriculture | -4.68% | 15.47% | -0.56 | -63.87% | 0.00 | -0.27 | 1.00 |
| GSCI Livestock | 1.25% | 13.97% | -0.19 | -38.71% | -0.79 | 1.03 | 0.08 |
| S&P Food Retail | 2.33% | 20.75% | -0.08 | -64.85% | -0.31 | 0.92 | 0.14 |
| S&P Food Dis | 14.62% | 19.99% | 0.54 | -23.68% | -0.14 | -0.09 | 0.18 |
| S&P Ag Products | 15.89% | 27.88% | 0.43 | -37.51% | -0.02 | 1.30 | 0.19 |

Roll Return

To the degree in which convenience yield (option to hold) is viewed as source of roll return with option-like characteristics, returns may be related to the underlying volatility of the product. As a result, increased roll returns may exist in periods of increased volatility of the underlying commodity. The GSCI Excess Return measures the return from investing in nearby GSCI futures and rolling them forward each month (on the 5th - 9th business days of each month) to keep the investments in nearby futures. Exhibit 5 shows the mean roll returns and standard deviations for the Composite index and the six sub-indices for the period 1995-2005. During this period, each of the GSCI indices incurred negative annualized returns and corresponding negative Sharpe ratios. The roll returns on the sub-indices have much lower standard deviations than observed for their respective sub-indices in aggregate as noted in Exhibit 4.

Exhibit 5

| GSCI Roll Return (1995 - 2005) | | | | | | |
|--------------------------------|--------------------|--------------------|--------------|------------------|----------|----------|
| Index | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis |
| GSCI Composite | -1.80% | 4.26% | -1.34 | -35.01% | 0.65 | 0.67 |
| GSCI Agricultural | -7.08% | 5.36% | -2.05 | -64.04% | 0.27 | 2.41 |
| GSCI Energy | -0.33% | 6.66% | -0.64 | -37.89% | 0.99 | 2.17 |
| GSCI Industrial Metals | -1.74% | 1.35% | -4.18 | -24.85% | 0.65 | -0.46 |
| GSCI Livestock | -5.19% | 6.77% | -1.34 | -47.34% | -1.23 | 2.73 |
| GSCI Non-Energy | -4.88% | 3.43% | -2.56 | -48.62% | 0.09 | 2.22 |
| GSCI Precious Metals | -2.90% | 1.27% | -5.37 | -27.63% | -1.15 | 1.79 |

The results shown in Exhibit 5 above do not take into consideration the impact differing levels of volatility on the underlying commodity can have on its roll returns. To consider the impact volatility has on roll returns, monthly roll returns on the GSCI Composite Index were ranked against the intra-month volatility of the GSCI Composite spot index. This same methodology was also applied to the GSCI commodity sub-indices. These ranked returns were then divided into four portfolios for comparison.

As seen in Exhibit 6, with the exception of the GSCI Livestock index, the monthly average roll returns for each of the indices are found to be higher in periods where higher intra-month volatility are observed. The differential mean roll returns for the GSCI Energy is the most positively impacted by volatility whereas the differential mean roll return for the GSCI Livestock sub-index is negatively impacted by volatility. As expected, the effect of intra-month volatility is more pronounced for supply-constrained commodities whose convenience yield may rise in periods of increased volatility and the potential option value of current supply.

Exhibit 6

| Monthly Average (1995-2005): Ranked by Intramonth Standard Deviation | | | | | | | | | | | | |
|--|----------------|---------------|-------------|---------------|------------------------|---------------|----------------------|---------------|----------------|---------------|------------------|---------------|
| Ranking | GSCI Composite | | GSCI Energy | | GSCI Industrial Metals | | GSCI Precious Metals | | GSCI Livestock | | GSCI Agriculture | |
| | Roll Return | Intramo Stdev | Roll Return | Intramo Stdev | Roll Return | Intramo Stdev | Roll Return | Intramo Stdev | Roll Return | Intramo Stdev | Roll Return | Intramo Stdev |
| Lowest Quartile | -0.10% | 11.78% | -0.05% | 19.99% | -0.24% | 10.93% | -0.26% | 7.10% | -0.53% | 9.12% | -0.48% | 9.99% |
| Highest Quartile | 0.03% | 27.99% | 0.57% | 41.44% | -0.06% | 21.28% | -0.18% | 20.11% | -0.75% | 18.66% | -0.31% | 20.99% |
| Difference | 0.13% | 16.21% | 0.62% | 21.45% | 0.18% | 10.34% | 0.08% | 13.01% | -0.22% | 9.54% | 0.17% | 11.01% |

Comparison Performance (1995-2000 and 2001-2005)

Returns to commodity investments in any given period are logically impacted by the underlying market conditions of that investment period. A comparison of the performance for two time periods 1995-2000 and 2001-2005 is shown in Exhibit 7. From the results in Exhibit 7, it is evident that various commodity indices perform differently over various time periods. Most notably, industrial and precious metals had significantly higher annualized returns from 2001-2005 when compared to 1995-2000 with a relatively small increase in volatility. As a result, Sharpe ratios for metals improved markedly in the 2001-2005 period. In contrast, energy had superior returns in the prior six-year period 1995-2000 as both absolute and risk-adjusted returns declined. The differential performance of these various sub-indices in different sub-periods is indicative of the necessity of diversification across commodity classes.

Exhibit 7

| Differential Descriptive Statistics (2001-2005) less (1995-2000) | | | | | | |
|---|---------------------------|---------------------------|---------------------|-------------------------|-----------------|-----------------|
| Index | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis |
| GSCI | -1.24% | 2.83% | 0.05 | 14.20% | -0.34 | -0.70 |
| DJ-AIG CI | 1.44% | 0.43% | 0.34 | 16.15% | -0.11 | -0.15 |
| Agriculture | | | | | | |
| GSCI Agriculture | -1.85% | 0.73% | 0.12 | 16.60% | 0.22 | 0.17 |
| DJ-AIG Grains | -0.62% | 1.95% | 0.17 | 7.02% | 0.26 | 0.89 |
| DJ-AIG Softs | 1.51% | 3.22% | 0.30 | 12.29% | -0.25 | 0.20 |
| Energy | | | | | | |
| GSCI Energy | -7.97% | -1.26% | -0.13 | 17.79% | -0.33 | -1.71 |
| DJ-AIG Energy | -8.64% | 0.70% | -0.18 | 20.93% | -0.18 | -1.51 |
| DJ-AIG Petroleum | 4.29% | -3.13% | 0.30 | 26.56% | -0.56 | -2.01 |
| Industrial Metals | | | | | | |
| GSCI Industrial Metals | 18.00% | 3.28% | 1.30 | 12.38% | 0.46 | -1.78 |
| DJ-AIG Ind Metals | 15.79% | 3.27% | 1.05 | 9.02% | 0.17 | -2.10 |
| Livestock | | | | | | |
| GSCI Livestock | 2.64% | 2.01% | 0.45 | 7.43% | -0.39 | 1.76 |
| DJ-AIG Livestock | 1.19% | 2.11% | 0.34 | 5.75% | 0.09 | 0.08 |
| Precious Metals | | | | | | |
| GSCI Precious Metals | 15.68% | 1.85% | 1.45 | 18.10% | -1.77 | -5.18 |
| DJ-AIG Prec Metals | 16.24% | 2.06% | 1.39 | 11.11% | -1.39 | -1.55 |

Recent Performance (2001-2005)

The recent performance of the composite commodity indices in Exhibit 8 is reflective of the potential of commodities in the recent five year period to provide positive return to risk attributes. Although commodity indices continued to have high volatility, the GSCI and DJ-AIG indices had higher annualized returns than the CISDM Equal Weighted Hedge Fund and CTA indices as well as traditional stock and bond indices during the 2001-2005 period. Furthermore, the risk-adjusted returns improved as Sharpe ratios for the GSCI (0.35) and DJ-AIG (0.58) indices were greater than that observed for the S&P 500 (-0.11). Correlations between commodity indices and hedge fund, CTA, and traditional stock and bond indices continue to remain weak. As previously found in Exhibit 1, given the low correlation to hedge fund, CTA and traditional asset classes, adding commodities to existing diversified portfolios continues to improve risk-adjusted returns for the 2001-2005 period.

Exhibit 8

| Commodity Index Performance 2001-2005 | | | | | | | |
|---|-------------|--------------|---------------------------|--------------|------------------|-------------------|--------------------------------|
| | CISDM Equal | | | S&P 500 | Lehman Gov./Corp | Lehman High Yield | |
| | GSCI | DJ-AIG CI | Weighted Hedge Fund Index | | | | CISDM CTA Equal Weighted Index |
| Annualized Returns | 9.83% | 10.03% | 9.11% | 7.05% | 0.54% | 6.10% | 8.86% |
| Annualized Standard Deviation | 22.23% | 13.67% | 5.10% | 8.71% | 14.94% | 4.86% | 8.82% |
| Sharpe Ratio | 0.35 | 0.58 | 1.37 | 0.56 | -0.11 | 0.82 | 0.76 |
| Maximum Drawdown | -34.06% | -20.05% | -5.29% | -8.75% | -38.87% | -4.57% | -12.01% |
| Correlation GSCI | 1.00 | 0.89 | 0.12 | 0.24 | -0.04 | 0.02 | 0.01 |
| Correlation DJ AIG CI | 0.89 | 1.00 | 0.31 | 0.27 | 0.14 | -0.03 | 0.12 |
| Correlation JCPI | 0.93 | 0.94 | 0.32 | 0.26 | 0.14 | 0.01 | 0.18 |
| | Portfolio I | Portfolio II | Portfolio III | Portfolio IV | Portfolio V | Portfolio VI | |
| Annualized Returns | 3.67% | 5.33% | 5.09% | 4.21% | 5.01% | 4.87% | |
| Annualized Standard Deviation | 7.06% | 7.05% | 6.60% | 6.77% | 6.43% | 6.44% | |
| Sharpe Ratio | 0.22 | 0.45 | 0.45 | 0.31 | 0.45 | 0.42 | |
| Maximum Drawdown | -14.63% | -12.90% | -11.72% | -13.32% | -12.55% | -11.98% | |
| Correlation GSCI | -0.04 | 0.60 | 0.33 | -0.03 | 0.32 | 0.16 | |
| Correlation DJ AIG CI | 0.13 | 0.67 | 0.53 | 0.15 | 0.45 | 0.35 | |
| Correlation JCPI | 0.15 | 0.71 | 0.52 | 0.16 | 0.48 | 0.35 | |
| Portfolio I: 50% S&P 500 and 50% Lehman Gov./Corp. Bond | | | | | | | |
| Portfolio II: 40% S&P 500, 40% Lehman Gov./Corp. Bond, and 20% GSCI | | | | | | | |
| Portfolio III: 40% S&P 500, 40% Lehman Gov./Corp. Bond, and 20% DJ-AIG | | | | | | | |
| Portfolio IV: 90% Portfolio I and 10% CISDM Equal Weighted Hedge Fund Index | | | | | | | |
| Portfolio V: 90% Portfolio IV and 10% GSCI | | | | | | | |
| Portfolio VI: 90% Portfolio IV and 10% DJ-AIG CI | | | | | | | |

Exhibit 9 shows the performance statistics for the GSCI and DJ-AIG sub-indices for the 2001-2005 period. Energy and Metal sub-indices incurred the highest annualized returns during the period, while the industrial and precious metals sub-indices incurred a considerable increase in risk-adjusted returns when compared to the 1995-2005 period. The energy and metals sub-indices outperformed the GSCI and DJ-AIG Composite indices traditional stock and bond indices on both an absolute and risk-adjusted basis as found in Exhibit 8. Agriculture and livestock sub-indices improved on a risk-adjusted basis from 2001-2005 when compared to 1995-2005; but continued to have lower Sharpe ratios than most other commodity, hedge fund, CTA and traditional stock and bond indices.

Exhibit 9

| Performance of GSCI & DJ-AIG CI Subindices (2001-2005) | | | | | | | | |
|--|--------------------|--------------------|--------------|------------------|----------|----------|------------------|-----------------------|
| Index | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation GSCI | Correlation DJ AIG CI |
| Agriculture | | | | | | | | |
| GSCI Agriculture | -5.69% | 15.92% | -0.49 | -32.56% | 0.12 | -0.15 | 0.07 | 0.33 |
| DJ-AIG Grains | -2.92% | 20.81% | -0.24 | -43.25% | 0.11 | 0.34 | 0.00 | 0.26 |
| DJ-AIG Softs | 1.47% | 19.75% | -0.03 | -32.73% | 0.53 | 0.84 | 0.01 | 0.24 |
| Energy | | | | | | | | |
| GSCI Energy | 13.09% | 31.76% | 0.34 | -43.48% | 0.14 | -0.42 | 0.99 | 0.83 |
| DJ-AIG Energy | 16.81% | 33.03% | 0.44 | -39.91% | 0.30 | -0.26 | 0.96 | 0.86 |
| DJ-AIG Petroleum | 24.38% | 30.26% | 0.74 | -35.24% | -0.11 | -0.68 | 0.94 | 0.79 |
| Industrial Metals | | | | | | | | |
| GSCI Industrial Metals | 15.11% | 17.77% | 0.73 | -24.23% | 0.34 | -0.42 | 0.23 | 0.47 |
| DJ-AIG Ind Metals | 14.97% | 19.33% | 0.66 | -25.67% | 0.42 | -0.35 | 0.24 | 0.50 |
| Livestock | | | | | | | | |
| GSCI Livestock | 2.70% | 15.08% | 0.04 | -28.46% | -0.99 | 1.80 | 0.01 | 0.04 |
| DJ-AIG Livestock | 1.41% | 15.57% | -0.05 | -30.73% | -0.51 | 0.13 | 0.00 | 0.06 |
| Precious Metals | | | | | | | | |
| GSCI Precious Metals | 13.15% | 13.87% | 0.79 | -11.03% | -0.25 | 0.17 | 0.16 | 0.36 |
| DJ-AIG Prec Metals | 13.37% | 15.03% | 0.75 | -14.21% | -0.39 | 1.33 | 0.13 | 0.33 |

Selected Recent Research in Commodity Analysis

- **Commodity Futures Performance: The underlying return to a fully vested commodity futures position should reflect the underlying returns to the comparison deliverable asset. Futures contracts therefore are often used as a basis for measuring the performance of various commodities over alternative market environments.**

The use of futures contracts to reflect the potential performance of commodity investment remains a primary approach for empirical research. For instance, Gorton and Rouwenhorst [2004] construct an equally-weighted index of 34 commodity futures markets for the period July 1959-December 2004 and measure this index against properties of traditional benchmarks, namely risk and return, correlation, and reaction to inflation and incorporate a segmented view over a variety of economic cycles. This study finds that the equally weighted futures index produced returns comparable to stocks, with equities having more downside risk than commodities. They also demonstrate limited to negative correlation of commodity returns relative to stocks and bonds suggesting commodity future as an effective diversifier to traditional portfolio. The study also finds commodity returns demonstrate a positive correlation to periods of inflation, in contrast to a negative correlation for both stocks and bonds, which is more pronounced when periods of unexpected inflation are isolated from overall periods of inflation. In contrast Erb and Harvey [2005] explore both the strategic and tactical opportunities that commodity investment present to investors. They claim that commodity investments are an inconsistent hedge against unexpected inflation. The authors state that usual risk factors are unable to explain the time-series variation in excess returns. They also suggest that historically high returns on commodity futures portfolio are largely driven by the choice of weighting schemes. The authors provide evidence that there are distinct benefits to an asset allocation overlay that tactically allocates using commodity futures exposures. The authors examine three trading strategies that use both momentum and the term structure of futures prices. They find that the tactical strategies provide higher average returns and lower risk than a long-only commodity futures exposure.

- **Distributional Characteristics: Most research concentrates on the absolute return and risk characteristics of commodity investments. It is important to point out that commodities may have other distributional characteristics.**

While mean and variance remain the primary distributional characteristics used in evaluating commodity performance, other research [Kat and Roel Oomen, 2006] have concentrated on other distributional characteristics. They also find that for many commodities, futures returns and volatility can vary considerably over different phases of the business cycle, under different monetary conditions as well as with the shape of the futures curve. Skewness in commodity futures returns is largely insignificant, whereas kurtosis is significantly positive and comparable to that of US large cap stocks. In almost all commodities they find significant degrees of autocorrelation, which affects the properties of longer horizon returns. However, as shown in this paper there is little

evidence of skewness or kurtosis for the Commodity indices and in addition we find little evidence of autocorrelation in the indices. For the period 1990-2005, first order autocorrelation for the DJ-AIG and GSCI are .05 and .08 respectively.

Conclusions

In recent years, investible commodity indices and commodity linked assets have increased the number of available commodity-based products. This paper has shown that direct commodity investment can provide significant portfolio diversification benefits beyond those achievable from commodity-based stock and bond investment. Adding a commodity component to a diversified portfolio of assets has been demonstrated to result in enhanced risk-adjusted performance. Future studies might consider the impact of alternative asset allocation strategies under varying market conditions (e.g., business cycle) and the impact of investment into commodity linked-products or investible commodity indices under these economic conditions.

Appendix 1: Alternative Commodity Indices

Descriptive Statistics

| Alternative Commodity Index Performance 2004-2005 | | | | | | |
|---|----------------|-----------|--------|--|---------------|----------|
| Descriptive Statistics | Static Indices | | | | Dynamic Index | |
| | GSCI | DJ-AIG CI | JCPI | Rogers International Commodities Index | DBLCI | DBLCI MR |
| Annualized Returns | 22.14% | 17.84% | 27.69% | 24.16% | 15.59% | 16.44% |
| Annualized Standard Deviation | 21.45% | 13.33% | 13.73% | 13.20% | 13.03% | 13.17% |
| Sharpe Ratio | 0.93 | 1.18 | 1.86 | 1.67 | 1.03 | 1.09 |
| Maximum Drawdown | -14.34% | -7.01% | -7.49% | -6.48% | -7.98% | -7.98% |
| Skewness | -0.22 | -0.35 | -0.37 | -0.59 | 0.03 | -0.01 |
| Kurtosis | -0.08 | -0.36 | -0.30 | -0.06 | -0.82 | -0.91 |
| Correlation GSCI | 1.00 | 0.85 | 0.92 | 0.88 | 0.53 | 0.52 |
| Correlation DJ AIG CI | 0.85 | 1.00 | 0.94 | 0.91 | 0.65 | 0.65 |
| Correlation JCPI | 0.92 | 0.94 | 1.00 | 0.96 | 0.71 | 0.70 |

Jefferies Commodity Performance Index: The Index was designed explicitly to address the needs of institutional investors seeking diversified commodity exposure. JPCI is not included in current analytics because the data before 2003 is pro forma.

The Rogers International Commodity Index: This index represents the value of a compendium (or "basket") of commodities employed in the global economy, ranging from agricultural products (such as wheat, corn and cotton) and energy products (including crude oil, gasoline and natural gas) to metals and minerals (including gold, silver, aluminum and lead). As of July 31, 1998, there were thirty-five different contracts represented in the Rogers International Commodity Index. The Rogers International Commodity Index selection and weighting of the portfolio is reviewed not less than annually, and weights are assigned in December.

DBLCI: The Deutsche Bank suite of commodities indices includes the Deutsche Bank Liquid Commodities (DBLCI) benchmark index, the DBLCI MR Strategy index and individual DBLCI commodity indices. The DBLCI index tracks the performance of six commodity futures: Sweet Light Crude Oil (WTI), Heating Oil, Aluminium, Gold, Wheat and Corn. These cover the biggest commodity sectors and are held in fixed notional amounts which reflect world production and inventories in these sectors

DBLCI MR: This index invests in the same six commodities as the DBLCI. The weights of the commodities in the DBLCI MR index are systematically adjusted depending on the relative richness or cheapness of each commodity. The commodity weight is linked to the ratio between a one-year and five-year moving average price. Relatively expensive commodities have lower weights; conversely, relatively cheap commodities have higher weights

Appendix 2:

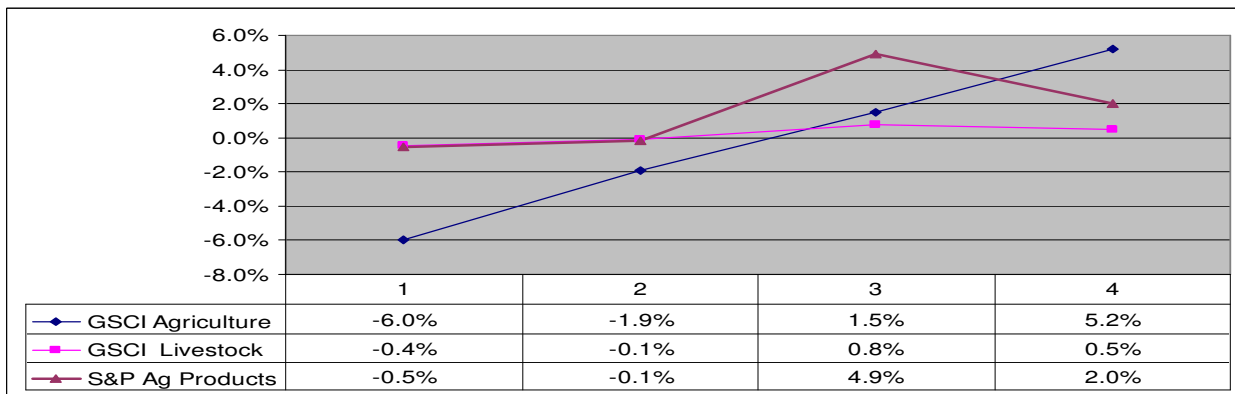
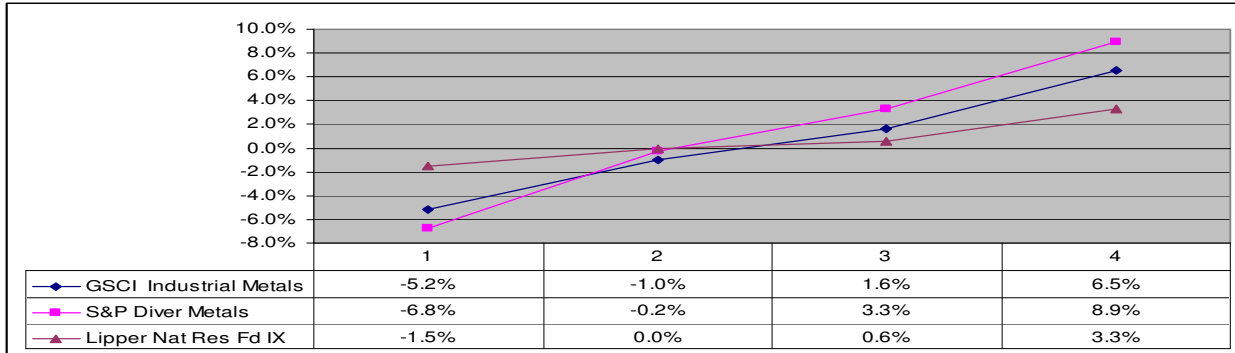
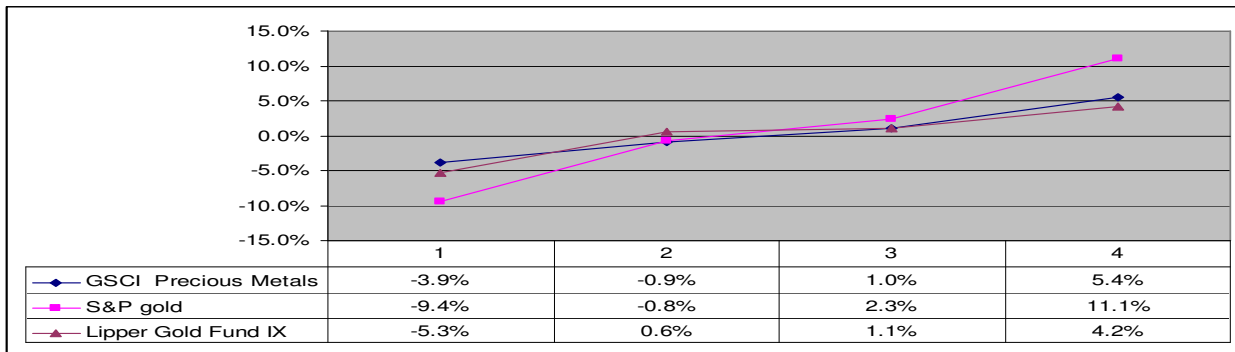
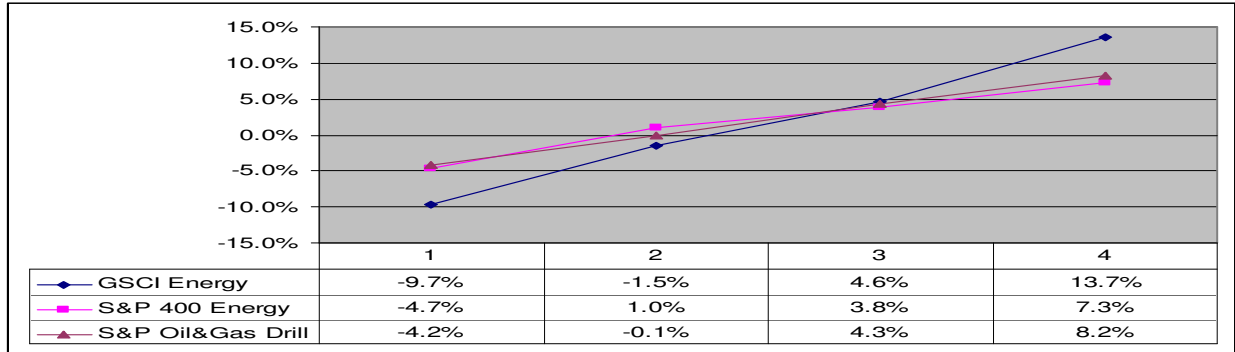
Comparative Matrix of Index Constituent Markets

| | CRB | DBLCI | DJ-AIG | GSCI | RRM | S&P |
|---------------------|-----------------|---------------|---------------|---------------|---------------|---------------|
| Metals | Aluminum | | 12.50% | 7.06% | 3.31% | 4.00% |
| | Copper | 5.88% | | 5.89% | 2.42% | 4.00% |
| | Gold | 5.88% | 10.00% | 5.98% | 2.12% | 3.00% |
| | Lead | | | | 0.31% | 2.00% |
| | Nickel | | | 2.61% | 0.93% | 1.00% |
| | Palladium | | | | | 0.30% |
| | Platinum | 5.88% | | | | 1.80% |
| | Silver | 5.88% | | 2.00% | 0.23% | 2.00% |
| | Tin | | | | | 1.00% |
| | Zinc | | | 2.69% | 0.57% | 2.00% |
| Sector Total | 23.52% | 22.50% | 26.23% | 9.89% | 21.10% | 7.28% |
| Energy | Brent Crude Oil | | | | 11.75% | |
| | Crude Oil | 5.88% | 35.00% | 12.81% | 25.79% | 35.00% |
| | GasOil | | | | 3.83% | |
| | Heating Oil | 5.88% | 20.00% | 3.85% | 7.14% | 3.00% |
| | Natural Gas | 5.88% | | 12.28% | 10.29% | 3.00% |
| | Unleaded Gas | | | 4.05% | 7.90% | 3.00% |
| Sector Total | 17.64% | 55.00% | 32.99% | 66.70% | 44.00% | 49.20% |
| Ags | Azuki Beans | | | | 1.00% | |
| | Barley | | | | 0.77% | |
| | Canola | | | | 0.67% | |
| | Com | 5.88% | 11.25% | 5.94% | 4.11% | 4.00% |
| | Feeder Cattle | | | | 0.90% | |
| | Lean Hogs | 5.88% | | 4.39% | 2.39% | 1.00% |
| | Live Cattle | 5.88% | | 6.15% | 3.74% | 2.00% |
| | Oats | | | | | 0.50% |
| | Rice | | | | | 2.00% |
| | Soybean Meal | | | | | 0.15% |
| | Soybean Oil | | | 2.67% | | 2.00% |
| | Soybeans | 5.88% | | 7.60% | 3.01% | 3.00% |
| Wheat | 5.88% | 11.25% | 4.87% | 5.28% | 7.00% | |
| Sector Total | 29.40% | 22.50% | 31.62% | 19.43% | 24.09% | 29.32% |
| Softs | Orange Juice | 5.88% | | | | 0.66% |
| | Cocoa | 5.88% | | | 0.30% | 1.00% |
| | Coffee | 5.88% | | 3.02% | 0.68% | 2.00% |
| | Cotton | 5.88% | | 3.23% | 1.74% | 3.00% |
| | Sugar | 5.88% | | 2.93% | 1.26% | 1.00% |
| Sector Total | 29.40% | 0.00% | 9.18% | 3.98% | 7.66% | 14.20% |
| Exotics | Lumber | | | | 1.00% | |
| | Rubber | | | | 1.00% | |
| | Silk | | | | 0.15% | |
| | Wool | | | | 1.00% | |
| Sector Total | 0.00% | 0.00% | 0.00% | 0.00% | 3.15% | 0.00% |
| TOTALS | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Source: (R. P Akey, Fall 2005)

Appendix 3: Ranking of the GSCI and the S&P Commodity Sub-indices

The following exhibits further support the use of traditional equity securities as commodity investment surrogates in periods of extreme commodity price movements with the exception of commodity agricultural or livestock prices.



Appendix 4: GSCI Index Description

The GSCI Spot Index tracks the price levels of principal physical commodities that are available in active, liquid futures markets. The commodities selected for this hypothetical portfolio are intended to be broadly representative of the entire spectrum of commodities available. By design, the GSCI reflects a passive portfolio of long positions in the selected commodity futures. But unlike a passive equity portfolio, a passive futures portfolio requires regular transactions, for the simple reason that futures contracts expire. Thus, the expiring futures contract for a commodity must be "rolled forward"- exchanged for the nearby futures contract (i.e., the contract next nearest to expiration) - for that commodity.

The GSCI Excess Return Index reflects the GSCI Spot Index returns plus any excess return resulting from the discount or premium an investor would receive by "rolling" the hypothetical positions in the contracts forward to the nearby futures contract as they approach delivery.

For comparison, the GSCI Total Return index represents the returns of the GSCI Excess Return index, plus the interest earned on the hypothetical, fully collateralized contract positions on the commodities included in the GSCI.

The Roll Period

The rolling forward of the portfolio's underlying futures contracts that are approaching expiration occurs once a month, on the 5th through 9th business days (the "roll period").

The simplest way to think of the process is as rolling from one basket of nearby futures (the first nearby basket) to a basket of futures contracts next furthest from expiration (the second nearby basket), incrementally over a five-day period. The GSCI portfolio is calculated as though these rolls occur at the end of each day during the roll period, at the daily settlement prices.

The portfolio is shifted from the first to the second nearby baskets at a rate of 20% per day for the five days of the roll period. So, during the first four business days of the month and just before the end of the 5th business day, the entire GSCI portfolio consists of the first nearby basket of commodity futures.

At the end of the 5th business day, the portfolio is adjusted so that 20% of the contracts held are in the second nearby basket (i.e., a basket of futures contracts that are next furthest from maturity), with 80% remaining in the first nearby basket. The roll process continues on the 6th, 7th, and 8th business days, with relative weights of first to second nearby baskets gradually shifting from 60%/40% weighting, to a 40%/60% weighting, to a 20%/80% weighting. At the end of the 9th business day, the last of the old first nearby basket is exchanged, completing the roll and leaving the entire portfolio in what we have been calling the second nearby basket.

At this time, this former second nearby basket becomes the new first nearby basket, and a new second nearby basket is formed for use in the next month's roll.

Appendix 5: Sample Academic Commodity Research Centers/Professional Organizations

<http://commodity.aem.cornell.edu/index.htm> - Cornell Commodity Promotion Research Program

<http://commodity.aem.cornell.edu/nicpre/nicpre.htm>-National Institute for Commodity Promotion Research and Evaluation's

<http://www.duke.edu/~whaley/force.htm> - The Futures and Options Research Center (FORCE) at Duke University's Fuqua School of Business

<http://www.farmdoc.uiuc.edu/agmas/> - Agricultural Market Advisory Services at the University of Illinois.

<http://fisher.osu.edu/fin/osudata.htm> - Fisher School of Management, FDF

<http://ianrhome.unl.edu> - The Institute of Agriculture and Natural Resources, University of Nebraska

<http://www.ccur.iastate.edu/> - Center for Crop Utilization Research at Iowa State University

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