Center for International Securities and Derivatives Markets

# The Benefits of Commodity Investment: 2006 Update

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**Abstract**

In recent years, investable 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.

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# 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 investable commodity indices and commodity-linked investments has increased. The purpose of this study is to:

1. Detail the various theoretical arguments for the risk and return advantages for commodity investment

2. Report on the relative performance of various commodity based investment vehicles (e.g. Goldman Sachs Commodity Index (GSCI), Standard & Poor's Commodity Index (S&PCI), or 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 investable 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, Standard and Poor's, and Goldman Sachs. 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 quantity of each commodity in the index is determined by the average quantity of production 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 re-weighted and re-balanced every January. Re-balancing and re-weighting is designed to reduce the exposure of the index to commodities that have appreciated in value and to increase the index's exposure to commodities that have underperformed. During the course of the year, commodity weights are free to increase or decrease as their 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. Therefore, to calculate returns prior to 1998, Dow Jones and AIG had to calculate index returns back in time using the index construction rules currently in place.

### Commodity Mutual Funds

Another way to gain exposure to commodities is through the 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). It is important to point out that these benchmarks primarily reflect active management into financial securities of firms' specializing in the commodity area. Mutual funds also exist which reflect the actual performance of direct

investment into commodities. However, recent regulatory concerns have resulted in the potential restructuring of these funds and they are not directly analyzed in this review.[1]

**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 this paper various S&P sector indices which reflect investment into the commodity area are used.

**Source of Returns**

Investor benefits of commodity or commodity-based products lie primarily in their ability to offer risk and 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 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.

[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.

## Empirical Results

In Exhibit 1 the annualized returns, standard deviations, Sharpe ratios, maximum drawdown, skewness, kurtosis and correlation to the GSCI Index and DJ-AIG CI Index for the sample of stock, bond, hedge fund and commodity indices over the period January 1995 through December 2005 are presented, both as stand-alone investments as well as in various portfolio groupings.

The annualized return, standard deviation, and Sharpe ratio for the GSCI composite index are 10.50%, 20.65%, and 0.32 respectively and similarly for the DJ-AIG CI composite index it is 9.25%, 13.38% and .40 respectively.

The decision to add an investment product to an existing portfolio depends on the relative means and variances of the various investment vehicles and their respective correlation. The low correlations of GSCI returns with returns to the S&P 500 of 0.00 and Lehman Gov/Credit of .06 suggest the potential diversification benefit of adding commodities to an equity/bond portfolio. As shown in Exhibit 1 when added to a domestic portfolio of stocks and bonds, the GSCI helps reduce the standard deviation of the portfolio from 7.77% to 7.51%. Additionally, risk-adjusted performance (Sharpe ratio) improves from 0.74 to 0.84.

**Exhibit 1**

| Commodity Index Performance 1995-2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation (GSCI) | Correlation (DJ AIG CI) |
| GSCI | 10.50% | 20.65% | 0.32 | -48.25% | 0.10 | 0.00 | 1.00 | 0.90 |
| DJ-AIG CI | 9.25% | 13.38% | 0.40 | -36.20% | 0.05 | -0.25 | 0.90 | 1.00 |
| | | | | | | | | |
| S&P 500 | 11.40% | 15.10% | 0.50 | -44.73% | -0.62 | 0.61 | 0.00 | 0.10 |
| Lehman Gov/Corp | 7.29% | 4.42% | 0.76 | -4.57% | -0.50 | 1.31 | 0.06 | 0.02 |
| Lehman HY | 7.64% | 7.12% | 0.52 | -12.01% | -0.70 | 3.62 | 0.00 | 0.08 |
| | | | | | | | | |
| Portfolio I | 9.68% | 7.77% | 0.74 | -16.07% | -0.38 | -0.07 | 0.01 | 0.11 |
| Portfolio II | 10.26% | 7.51% | 0.84 | -13.91% | -0.27 | 0.50 | 0.56 | 0.58 |
| Portfolio III | 9.78% | 7.03% | 0.83 | -11.85% | -0.41 | 0.49 | 0.48 | 0.00 |

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

## Commodity Sub-indices

Exhibit 2 shows the performance statistics for the GSCI and DJ-AIG component sub-indices. For the period of analysis, the GSCI energy sub-indices have reported both the highest annualized returns (17.37%) and highest standard deviations (32.35%) followed by GSCI industrial metals (annualized return of 4.92%) and standard deviation (16.19%) and GSCI precious metals (annualized return of 4.31%) and standard deviation (13.03%). 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 Subindexes (1995 - 2005) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation GSCI | Correlation DJ AIG CI |
| 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 |
| | | | | | | | | |
| 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 |
| | | | | | | | | |
| 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 |
| | | | | | | | | |
| 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 |
| | | | | | | | | |
| 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) | | |
|---|---|---|
| | **Unexpected Inflation** | **Level Of CPI** |
| | | |
| GSCI | 0.28 | 0.13 |
| DJ-AIG CI | 0.30 | 0.14 |
| | | |
| S&P 500 | 0.01 | -0.10 |
| Lehman Gov./Corp. Bond | -0.01 | -0.06 |
| Lehman High Yield | -0.01 | -0.08 |
| | | |
| GSCI Agricultural | 0.06 | -0.04 |
| DJ-AIG Grains | 0.00 | -0.08 |
| DJ-AIG Softs | 0.09 | 0.04 |
| | | |
| GSCI Energy | 0.26 | 0.12 |
| DJ-AIG Energy | 0.27 | 0.15 |
| DJ-AIG Petroleum | 0.28 | 0.11 |
| | | |
| GSCI Industrial Metals | 0.13 | 0.00 |
| DJ-AIG Ind Metals | 0.15 | 0.00 |
| | | |
| GSCI Livestock | -0.07 | 0.08 |
| DJ-AIG Livestock | -0.06 | 0.08 |
| | | |
| 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 above .45. Similarly, the correlation between the GSCI precious metals and industrial metals and the related S&P sectors are above .50. The correlation with the GSCI precious metals and industrial metals index and the related mutual fund index is generally below .50. The lower correlation for mutual funds and the 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 gold prices is 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**

| | 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 |
| | | | | | | | **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 |
| | | | | | | | **Correlation GSCI Precious 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 |
| | | | | | | | **Correlation GSCI Industrial 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 |
| | | | | | | | **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 that the convenience yield (option to hold) is viewed as source of roll return and as any option 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.

**Exhibit 5**

| GSCI Roll Return (1990 - 2005) | | | | | | |
|---|---|---|---|---|---|---|
| | 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 |

Monthly roll return on the GSCI Composite Index was ranked against the intra-month volatility of the GSCI Composite spot index and also with the corresponding sub-indices and divided into four portfolios. In Exhibit 6 the roll returns during the period of lowest intra-month volatility and highest intra month volatility is given as well as the return difference between the two portfolio returns. As seen in the rankings, mean roll returns for the Energy, Industrial Metals, Agriculture sub-indices, as well as the GSCI Composite increase by .62%, .18%, .17% and .13% respectively. The differential mean roll returns for the GSCI Energy is the most significant. In contrast, differential mean roll return for the Livestock sub-index decreases and is negative. In short, 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 Stdev | | | | | |
|---|---|---|---|---|---|
| **Ranking** | **GSCITOT roll return** | **GSCITOT intramo stdev** | | **GSENTOT roll return** | **GSENTOT intramo stdev** |
| **Lowest** | -0.10% | 11.78% | | -0.05% | 19.99% |
| **Highest** | 0.03% | 27.99% | | 0.57% | 41.44% |
| **Difference** | 0.13% | 16.21% | | 0.62% | 21.45% |
| | **GSINTOT roll return** | **GSINTOT intramo stdev** | | **GSPMTOT roll return** | **GSPMTOT intramo stdev** |
| **Lowest** | -0.24% | 10.93% | | -0.26% | 7.10% |
| **Highest** | -0.06% | 21.28% | | -0.18% | 20.11% |
| **Difference** | 0.18% | 10.34% | | 0.08% | 13.01% |
| | **GSLVTOT roll return** | **GSLVTOT intramo stdev** | | **GSAGTOT roll return** | **GSAGTOT intramo stdev** |
| **Lowest** | -0.53% | 9.12% | | -0.48% | 9.99% |
| **Highest** | -0.75% | 18.66% | | -0.31% | 20.99% |
| **Difference** | -0.22% | 9.54% | | 0.17% | 11.01% |

## Comparison Performance (1995-2000 and 2001-2005)

Returns to commodity investment are, of course, 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. While industrial metals and precious metals had superior performance in the most recent period (2001-2005), energy had superior returns in the prior six year period (1995-2000). The differential performance of these various subindices in different subperiods is indicative of the necessity of diversification across commodity classes.

**Exhibit 7**

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

## Recent Performance (2001-2005)

The positive relative 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. Results in Exhibits 8 and 9 show the performance of a number of assets and combinations of assets (traditional assets and commodity indexes) over the period 2001-2005. Results are consistent with that of the longer period, 1995-2005, in that adding the composite GSCI or DJ-AIG indices to an existing stock and bond portfolio increases the overall return to risk ratio. Results are also consistent with the relative underperformance of energy over this period, since the DJ-AIG composite with a lower relative weighting to energy outperforms that of the GSCI.

**Exhibit 8**

| Commodity Index Performance 2001-2005 | | | | | | |
|---|---|---|---|---|---|---|
| | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis |
| GSCI | 9.83% | 22.23% | 0.35 | -34.06% | -0.05 | -0.30 |
| DJ-AIG CI | 10.03% | 13.67% | 0.58 | -20.05% | 0.00 | -0.29 |
| S&P 500 | 0.54% | 14.94% | -0.11 | -38.87% | -0.37 | 0.15 |
| Lehman Gov/Corp | 6.10% | 4.86% | 0.82 | -4.57% | -0.81 | 1.38 |
| Lehman HY | 8.86% | 8.82% | 0.76 | -12.01% | -0.60 | 2.48 |
| | | | | | | |
| Portfolio I | 3.67% | 7.06% | 0.22 | -14.63% | -0.26 | -0.14 |
| Portfolio II | 5.33% | 7.05% | 0.45 | -12.90% | -0.34 | 0.08 |
| Portfolio III | 5.09% | 6.60% | 0.45 | -11.72% | -0.28 | -0.23 |

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

**Exhibit 9**

| Performance of GSCI & DJ-AIG CI Subindexes (2001 - 2005) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Annualized Returns | Standard Deviation | Sharpe Ratio | Maximum Drawdown | Skewness | Kurtosis | Correlation CISDM |
| GSCI Agriculture | -5.69% | 15.92% | -0.49 | -32.56% | 0.12 | -0.15 | 0.23 |
| DJ-AIG Grains | -2.92% | 20.81% | -0.24 | -43.25% | 0.11 | 0.34 | 0.17 |
| DJ-AIG Softs | 1.47% | 19.75% | -0.03 | -32.73% | 0.53 | 0.84 | 0.20 |
| | | | | | | | |
| GSCI Energy | 13.09% | 31.76% | 0.34 | -43.48% | 0.14 | -0.42 | 0.07 |
| DJ-AIG Energy | 16.81% | 33.03% | 0.44 | -39.91% | 0.30 | -0.26 | 0.10 |
| DJ-AIG Petroleum | 24.38% | 30.26% | 0.74 | -35.24% | -0.11 | -0.68 | 0.11 |
| | | | | | | | |
| GSCI Industrial Metals | 15.11% | 17.77% | 0.73 | -24.23% | 0.34 | -0.42 | 0.53 |
| DJ-AIG Ind Metals | 14.97% | 19.33% | 0.66 | -25.67% | 0.42 | -0.35 | 0.52 |
| | | | | | | | |
| GSCI Livestock | 2.70% | 15.08% | 0.04 | -28.46% | -0.99 | 1.80 | 0.00 |
| DJ-AIG Livestock | 1.41% | 15.57% | -0.05 | -30.73% | -0.51 | 0.13 | 0.01 |
| | | | | | | | |
| GSCI Precious Metals | 13.15% | 13.87% | 0.79 | -11.03% | -0.25 | 0.17 | 0.40 |
| DJ-AIG Prec Metals | 13.37% | 15.03% | 0.75 | -14.21% | -0.39 | 1.33 | 0.20 |

**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 that 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, investable 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 investable commodity indices under these economic conditions.

## Appendix 1: Alternative Commodity Indices

### Descriptive Statistics

| Alternative Commodity Index Performance 2004-2005 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Static Commodity Indices | | | | | Dynamic Commod. Indices | |
| **Descriptive Statistics** | GSCI | DJ-AIG CI | JCPI | Rogers International Commodities Index | DBLCI | AIA | DBLCI MR |
| Annualized Returns | 22.14% | 17.84% | 27.69% | 24.16% | 15.59% | 22.92% | 16.44% |
| Annualized Standard De | 21.45% | 13.33% | 13.73% | 13.20% | 13.03% | 12.93% | 13.17% |
| Sharpe Ratio | 0.93 | 1.18 | 1.86 | 1.67 | 1.03 | 1.61 | 1.09 |
| Maximum Drawdown | -14.34% | -7.01% | -7.49% | -6.48% | -7.98% | -6.71% | -7.98% |
| Skewness | -0.22 | -0.35 | -0.37 | -0.59 | 0.03 | -0.06 | -0.01 |
| Kurtosis | -0.08 | -0.36 | -0.30 | -0.06 | -0.82 | -0.15 | -0.91 |
| Correlation GSCI | 1.00 | 0.85 | 0.92 | 0.88 | 0.53 | 0.94 | 0.52 |
| Correlation DJ AIG CI | 0.85 | 1.00 | 0.94 | 0.91 | 0.65 | 0.92 | 0.65 |
| Correlation JCPI | 0.92 | 0.94 | 1.00 | 0.96 | 0.71 | 0.93 | 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

**GYRE/AIA:** This commodity index is comprised of fifteen commodity futures markets. The commodity weights are systematically adjusted depending on signals based on dynamic momentum based trading models.

## Appendix 2:

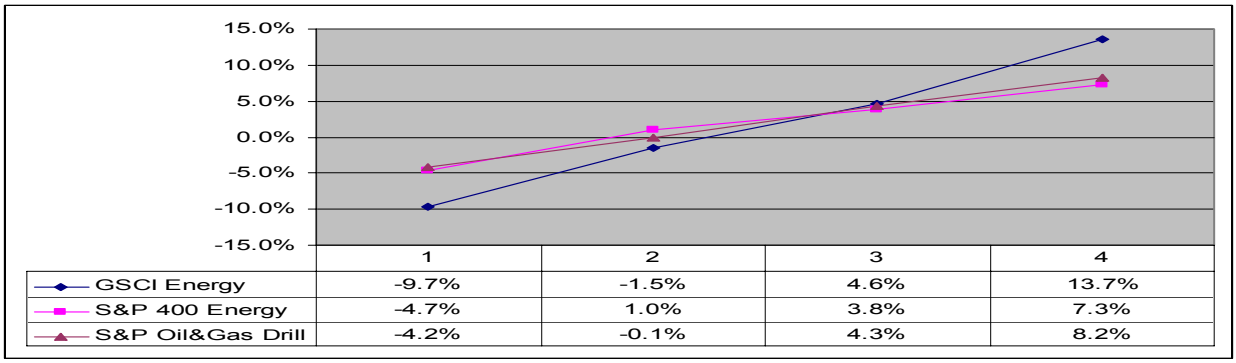
**Comparative Matrix of Index Constituent Markets**

| | | 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% | 3.50% |
| | 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% | 3.78% |
| | 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% | 9.74% |
| | GasOil | | | | 3.83% | | |
| | Heating Oil | 5.88% | 20.00% | 3.85% | 7.14% | 3.00% | 11.49% |
| | Natural Gas | 5.88% | | 12.28% | 10.29% | 3.00% | 17.65% |
| | Unleaded Gas | | | 4.05% | 7.90% | 3.00% | 10.32% |
| 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% | |
| | Corn | 5.88% | 11.25% | 5.94% | 4.11% | 4.00% | 4.96% |
| | Feeder Cattle | | | | 0.90% | | |
| | Lean Hogs | 5.88% | | 4.39% | 2.39% | 1.00% | 1.78% |
| | Live Cattle | 5.88% | | 6.15% | 3.74% | 2.00% | 5.03% |
| | Oats | | | | | 0.50% | |
| | Rice | | | | | 2.00% | |
| | Soybean Meal | | | | | 0.15% | 3.81% |
| | Soybean Oil | | | 2.67% | | 2.00% | 3.90% |
| | Soybeans | 5.88% | | 7.60% | 3.01% | 3.00% | 4.79% |
| | Wheat | 5.88% | 11.25% | 4.87% | 5.28% | 7.00% | 5.05% |
| 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% | 3.27% |
| | Coffee | 5.88% | | 3.02% | 0.68% | 2.00% | 3.36% |
| | Cotton | 5.88% | | 3.23% | 1.74% | 3.00% | 4.18% |
| | Sugar | 5.88% | | 2.93% | 1.26% | 1.00% | 3.39% |
| 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%** |

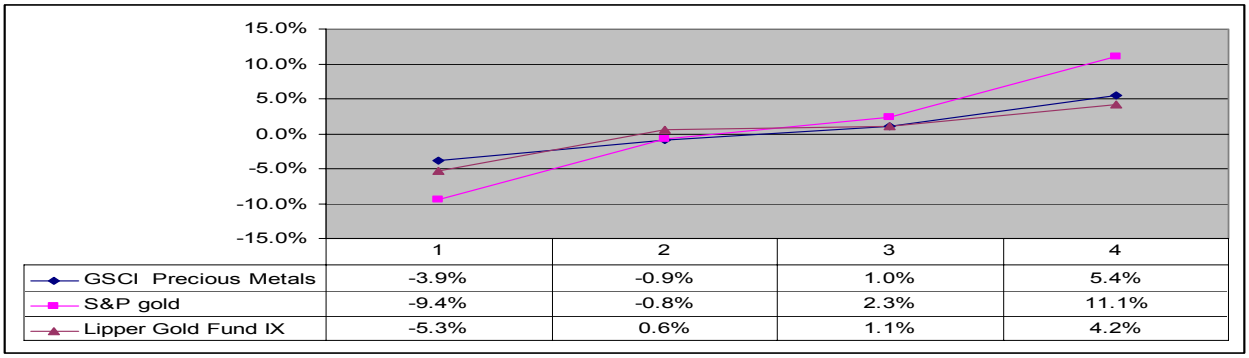
Source: (R. P Akey, Fall 2005)

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

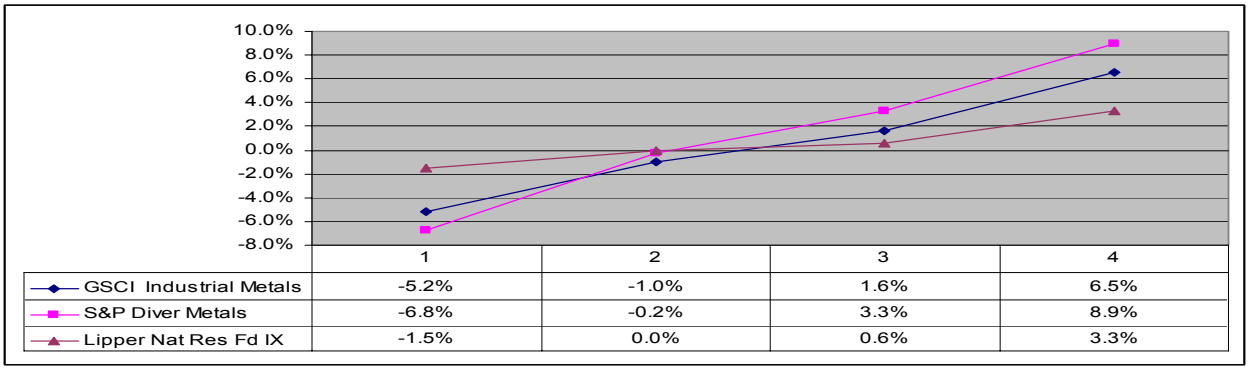
The following exhibits further support the use of traditional equity securities as commodity investment surrogates in periods of extreme commodity price movements with the exception of commodity agricultural or livestock prices.



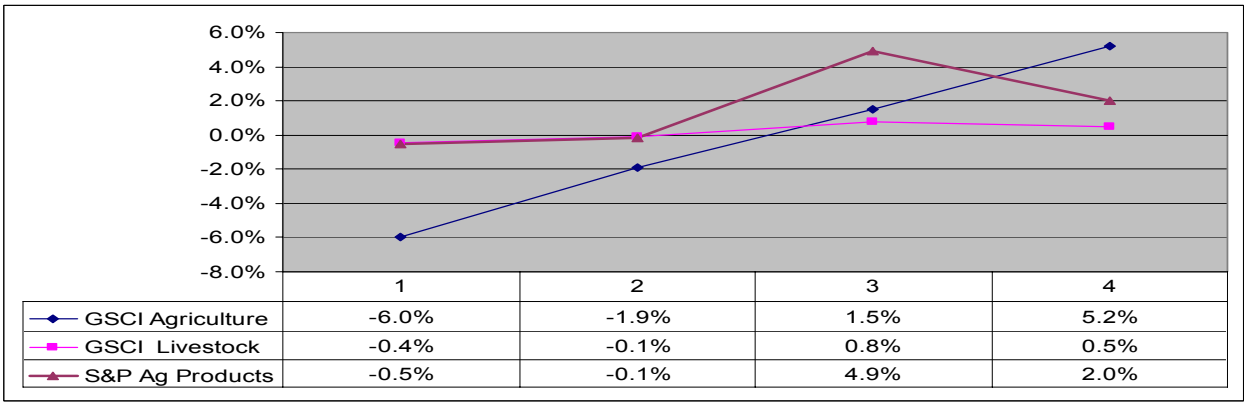

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| GSCI Energy | -9.7% | -1.5% | 4.6% | 13.7% |
| S&P 400 Energy | -4.7% | 1.0% | 3.8% | 7.3% |
| S&P Oil&Gas Drill | -4.2% | -0.1% | 4.3% | 8.2% |




| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| GSCI Precious Metals | -3.9% | -0.9% | 1.0% | 5.4% |
| S&P gold | -9.4% | -0.8% | 2.3% | 11.1% |
| Lipper Gold Fund IX | -5.3% | 0.6% | 1.1% | 4.2% |




| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| GSCI Industrial Metals | -5.2% | -1.0% | 1.6% | 6.5% |
| S&P Diver Metals | -6.8% | -0.2% | 3.3% | 8.9% |
| Lipper Nat Res Fd IX | -1.5% | 0.0% | 0.6% | 3.3% |




| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| GSCI Agriculture | -6.0% | -1.9% | 1.5% | 5.2% |
| GSCI Livestock | -0.4% | -0.1% | 0.8% | 0.5% |
| S&P Ag Products | -0.5% | -0.1% | 4.9% | 2.0% |

## 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 farthest 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 Unviersity

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