



C A M B R I D G E A S S O C I A T E S L L C

COMMODITIES: AN INTRODUCTION

Copyright © 2003 by Cambridge Associates LLC. All rights reserved.

This report may not be displayed, reproduced, distributed, transmitted or used to create derivative works in any form, in whole or in portion, by any means, without written permission from Cambridge Associates LLC. Copying of this publication is a violation of federal copyright laws (17 U.S.C. 101 et seq.). Violators of this copyright may be subject to liability for substantial monetary damages. The information and material published in this report are confidential and non-transferable. This means that authorized members may not disclose any information or material derived from this report to third parties, or use information or material from this report, without the prior written authorization of Cambridge Associates LLC. An authorized member may disclose information or material from this report to its staff, trustees, or Investment Committee with the understanding that these individuals will treat it confidentially. Additionally, information from this report may be disclosed if disclosure is required by law or court order, but members are required to provide notice to Cambridge Associates LLC reasonably in advance of such disclosure. This report is provided for informational purposes only. It is not intended to constitute an offer of securities of any of the issuers that are described in the report. This report is provided only to persons that Cambridge Associates LLC believes to be "Accredited Investors" as that term is defined in Regulation D under the Securities Act of 1933. The recipient of this report may not provide it to any other person without the consent of Cambridge Associates LLC. Investors should completely review all Fund offering materials before considering an investment. No part of this report is intended as a recommendation of any firm or any security. Factual information contained herein about investment firms and their returns which has not been independently verified has generally been collected from the firms themselves through the mail. We can neither assure nor accept responsibility for accuracy, but substantial legal liability may apply to misrepresentations of results delivered through the mail. The CA Manager Medians are derived from Cambridge Associates LLC's proprietary database covering investment managers. Cambridge Associates LLC does not necessarily endorse or recommend the managers in this universe. Performance results are generally gross of investment management fees and do not include returns for discontinued managers.

Introduction

Commodities generally can be defined as raw materials used in the production of finished goods. The products range from oil, which has a disproportionate influence on inflation and world economic growth, to precious metals, which are relatively cheap to store and less important to economic vitality. Although directly investing in commodities represents a leveraged bet on the world economy or demand growth from a particular region, many institutions have had little success with opportunistic or long-term commodity allocations. In fact, investors in a diversified basket of commodities would have earned a negative real return during the last two decades, and the real price of most commodities has declined in the past two centuries, despite the world's increasing population and industrial development. Severe imbalances between supply and demand have proved relatively short-lived, and have been resolved by the addition of new capacity and/or by technological developments.

Given these concerns, why invest in commodities? First, commodities provide a hedge against unanticipated surges in inflation. Second, commodities are negatively correlated to stocks and bonds and therefore act as an efficient portfolio diversifier during periods of financial (not economic) stress. Finally, although direct investments in commodities have produced negative real returns over the past 30 years, commodity futures indices like the Goldman Sachs Commodity Index (GSCI) provide three complimentary sources of return: spot yield, roll yield, and collateral yield. Roll yield comes from the convergence of the spot and futures prices (or two futures prices of contracts with different expiration dates), while collateral yield is the cash equivalent return investors earn on their cash held as collateral. These two additional sources of yield have made commodity investing via long-only fully collateralized diversified baskets of commodities futures a viable and profitable endeavor, with returns comparable to those of equities. However, over shorter time horizons, commodities can underperform equities by a wide margin and investors should recognize that the greatest disparity may occur during the strongest periods for equities, and that they must be prepared to withstand the short-term pain this entails.

Sources of Return

There are three potential sources of return for each commodity futures contract: the change in spot prices, the roll yield, and the collateral yield, which is the interest earned on the assets posted as collateral for the obligation represented by the futures contract (usually Treasury bills).

Spot Prices

As consumable, or transformable assets, commodities are by definition the raw ingredients for most of the world's manufactured goods. Consequently, changes in commodity prices should eventually

flow through to the price of finished goods, providing protection against inflation. Conversely, the demand for finished goods should drive the demand for the constituent commodities, with prices moving in tandem. The relationship between current supply and current demand is therefore the primary determinant of spot prices, which are not directly affected, as are those of capital assets, by changes in interest rates, and can be highly volatile when current events upset the prevailing equilibrium.

Roll Yield

The roll yield is derived from the difference between the spot price of a commodity and the price of its futures contract (or from the difference between two futures contracts with different expiration dates). When the spot price is higher than that of the futures contract, the contract is said to be trading in backwardation. As the date of expiration of the futures contract approaches, the two prices will converge, and owners of the futures contract will earn a return as the price of the contract slowly "rolls" up to the spot price. Conversely, the spot price of a commodity can be less than that of the futures, and in this instance the contract is said to be trading in contango, or full carry. Under these circumstances, the roll yield is negative, since the price of the futures contract rolls *down* to that of the spot.

It should be noted, of course, that contracts trading in backwardation can still generate negative returns as a result of spot price changes, and contracts trading in contango can generate positive returns if prices move up. It is also possible, although rare, that a futures contract bought when prices were in backwardation could move into contango before expiration. In other words, not only are spot and futures prices dynamic, but the spread between them can also shift considerably over time.

Although some commodities tend to trade persistently in contango or backwardation, these relationships are unstable. Commodities that typically trade in backwardation are those with inventories that are not fully loanable, which prevents cash and carry arbitrage predicated on the assumption that a profit can be made buying a futures contract, short selling the underlying asset, and investing the proceeds from the short sale. Where such unlimited arbitrage opportunities do exist, the profit made by selling a futures contract and borrowing to purchase the underlying asset in the cash market is eliminated. If inventories are not fully loanable, however, these relationships cannot hold because the profit cannot be arbitrated out of the market. Moreover, in the case of commodities that are difficult or expensive to store, commodity consumers are more likely to prefer to purchase goods on a just-in-time basis, thereby driving up the spot price relative to that of the futures.

To the extent that the supply of a commodity matches or exceeds demand, consumers have no incentive to supply capital to hedge producers' remaining inventories. Consequently, in order to attract sufficient capital for hedging, producers often have to sell forward at a discount, which can be considered

an insurance premium against future price declines that would render their business unprofitable. In addition to the presence or absence of arbitrage opportunities, therefore, the supply and demand for hedging capital also helps determine whether a futures contract will sell in backwardation or contango.

Holding all else constant, rising demand for hedging capital, or insurance, increases its price, resulting in a wider spread between the spot and the futures price. Conversely, as the supply of this insurance, or hedging capital, increases, the insurance premium decreases, diminishing the roll yield. In sum, although backwardation—and, by extension, the probability of earning roll yield—should not be taken for granted, to the extent that the demand for hedging capital increases in tandem with institutional investor interest in commodities, backwardation should persist, continuing to provide investors with roll yield returns. (In the assumptions we developed for future long-term commodity index returns, we have assumed that investors earn only half the roll yield earned in the GSCI from 1970-99).

Collateral Yield

The collateral yield component of commodity index returns is the interest earned on the collateral posted as a good faith deposit for the futures contracts. In measuring this component of return, index managers assume that futures contracts are fully collateralized and that the collateral is invested in Treasury bills. However, active commodity managers, especially those with expertise in the bond market, often attempt to add value in the collateral yield portion of the portfolio. Such strategies typically involve low-risk bets in the swap market and can be expected to add 50 to 100 basis points (bps) above the Treasury bill yield if executed properly.

The Policy Argument for Commodities

There are two primary reasons for a policy allocation to commodities. First, commodities provide a hedge against unexpected surges in inflation, enabling institutions to sell off commodities to support spending without having to sell off stocks and bonds at distressed prices. Second, commodities provide significant diversification benefits, as they historically have been negatively correlated with stocks and bonds. While these benefits are widely recognized, the key question for investors is whether they believe they can invest in commodities without incurring significant opportunity costs relative to equity investments.

Historically, commodities have provided both diversification benefits and inflation protection: their correlations with other asset classes have been negative, particularly during periods of unanticipated inflation, when the diversification is needed most. Commodity-based investments provide dramatic

portfolio diversification benefits for the simple reason that an economic environment positive for commodity prices is generally negative for financial assets, and vice-versa. Declining commodity prices reduce the cost of raw materials and increase corporate profits, which in turn support higher share prices, while the reverse is true of rising commodity prices. In fact, the correlation of commodity returns with those of U.S. equities is most sharply negative during the worst periods for financial assets. However, when economic decline is the root cause for poor or highly volatile financial asset returns, commodities are likely to fare much worse than equity and bond markets.

The argument for a long-term policy portfolio allocation to commodities should not rest solely on the historical performance of the GSCI, as returns from 1970 to 1990 are simulated. In addition, viable and liquid futures contracts have been available for many commodities (most notably oil) for just ten to 15 years, and as a result the composition and characteristics of the indices have changed significantly over time as liquidity in certain futures markets has improved. For example, although the real AACRs of the GSCI and S&P 500 are both 6.1% from January 1, 1970 to June 30, 2002, we assume that investors in commodities would incur some opportunity cost relative to equities over the long term. For long-term modeling purposes, we use a real return assumption of 4.25% for commodities and 8.0% for U.S. stocks.

Historical Observations

Commodities are not Perfectly Correlated with Inflation

Commodities futures contracts serve as an inflation hedge because they provide an effective proxy for real economic assets whose value is independent of (but still denominated in) monetary units. As a result, the aggregate performance of the commodity markets tends to be positively correlated with inflation. The degree of that correlation, however, is variable over the business cycle, with the strongest correlations occurring in the mature phase of an economic expansion when capacity utilization rates are high.

The historical data indicate that the returns of commodity indices are by no means perfectly correlated with inflation. There are several reasons for this low correlation. Although commodity prices are a key component of inflation, other determinants (such as labor costs) carry significantly greater weight. In addition, commodity prices are a *leading* rather than a *coincident* indicator of inflation, with sharp changes in commodity prices flowing through to the CPI only after a lag of six to 12 months. Finally, the roll yield has been a significant component of commodity index returns, but it has not exhibited a positive correlation with inflation. What emerges from analysis of historical data on commodity index

returns is that the *direction* of inflation is more consequential than its absolute level: commodity index performance has been stronger in periods of *increasing* inflation (whatever the absolute level) and weaker in periods of *decreasing* inflation.

Correlation with Capacity Utilization

Commodities demonstrate a strong positive correlation to capacity utilization, while stocks and bonds have a negative correlation. Commodity prices are most likely to rise when an economy is running close to capacity, fueling inflationary pressures to the detriment of financial assets. Commodities demonstrate a strong positive correlation to capacity utilization, particularly when inventory levels are low. When capacity utilization rates are high and inventories are low, increases in demand tend to result in price increases until capacity can be expanded, or substitute goods, new technology, or a reduction in demand relieve pricing pressure. To the extent that demand can be met from existing inventories, commodity prices should not increase. However, the more expensive the maintenance of inventories, which is a function of real interest rates, the smaller the cushion against surges in demand or interruptions in supply. This is particularly evident in emerging economies, where the high cost of capital has encouraged the minimization of inventories, even at times when demand is growing.

Returns on Major Indices

Indices comprised of futures contracts have reduced the opportunity cost of investing in commodities. Direct investment in commodities exposes investors to changes in spot prices only, which are volatile and have a long-run expected return near zero. The opportunity cost of investing in commodities has been reduced due to the exposure to roll and collateral yields. Annual major index returns have been quite volatile, ranging from +127% to -35.7%. These indices have provided equity-like returns over their histories, but with higher standard deviations and negative correlations to equities. With regard to risk, it is worth noting that because commodity-based investments provide such striking diversification benefits when included in a portfolio of financial assets, efficient frontier models routinely attempt to allocate the maximum commodities weight permitted, even if one assumes significantly lower returns than seems plausible. There is a note of caution when reviewing these statistics. The actual return series on these indices are not very long, as the oldest of these indices, the GSCI, has only been in existence since 1991, with simulated returns dating back to 1970. In addition, viable and liquid futures contracts have been available for many commodities (most notably oil) for just ten to 15 years, and as a result the composition and characteristics of the indices have changed significantly over time as liquidity in certain futures markets has improved.

Commodity Indices

Measures of aggregate commodity prices such as the Commodity Research Bureau Index (CRB) and the Journal of Commerce Index (JOC) have existed for many decades. However, only in recent years has there been a concerted effort to develop investable indices designed to quantify the return available from a diversified basket of commodity futures contracts. Institutional investor interest has focused on the GSCI. To a lesser extent there has been interest in the Dow Jones-AIG Commodity Index (DJ-AIGCI) and the Rogers International Commodity Index (RICI). Indices like the CRB, ENMET (Energy and Metal Index), ICI (Investable Commodity Index), and the SPCI (S&P Commodity Index) are of limited interest because the relative weightings are computed by geometric averaging, resulting in the consistent understatement of returns from the markets they represent. Furthermore, the CRB and ICI equal-weight each commodity in the index, vastly overstating the relative importance of, for example, orange juice, and understating the significance of oil.

Dow Jones-AIG (DJ-AIG) Commodity Index

The DJ-AIG Commodity Index is composed of 20 physical commodities, the weightings of which are determined primarily by liquidity data (relative amount of trading activity in the given commodity) and tempered by dollar-adjusted production data. The index includes spot, roll, and collateral yields. Dow Jones reviews and determines the component weights each June, while the actual rebalancing and re-weighting takes place in January. The resulting changes are governed by two rules. First, no group of related commodities may comprise more than 33% and no single commodity may comprise less than 2% of the index. Currently energy and agriculture each comprise about one-third of the index. On November 16, 2001, the Chicago Board of Trade announced the listing of futures contracts on the DJ-AIG Commodity Index. Finally, it should be noted that the version of the DJ-AIG Commodity Index frequently quoted in the financial press only captures spot yields.

Goldman Sachs Commodity Index (GSCI)

The GSCI, which has evolved as the industry standard, was created in 1991 with simulated history going back to 1970. The composition has changed greatly over the past 15 years (oil was not added until 1987, natural gas in 1990), so care should be taken when drawing conclusions about historical performance. It captures all three components of yield, is composed of contracts on 26 different commodities, and is weighted according to the physical quantity of world production. Energy, with a particularly large allocation to oil, has historically comprised 50% to 66% of the value of the index. The index is reconstituted annually, so the composition may change significantly during the year. Index contracts are rolled monthly on the fifth to ninth business day of the month, with 20% of the contracts (number of contracts, not value of contracts) rolling each day at the end of the day.

Rogers International Commodity Index (RICI)

The RICI has an inception date of 1984 with simulated returns prior to 1997. It is composed of 35 fixed weight contracts based on worldwide consumption. Component weights are reviewed and set each December, with changes taking effect in January. The index is rebalanced monthly based on the fixed weights established at the beginning of the year. To determine the return, weights are multiplied by the price changes in nearby futures each contract month. Currently, energy and agriculture comprise nearly 75% of the index.

Standard & Poors' Commodity Index (SPCI)

Finally, Standard & Poors' developed a commodity index in 2001, based on 17 commodities with futures and options trading on the New York Board of Trade. The index has history available back to 1970, but a slight weighting change occurs in 1987—prior to 1987 the weights are based on all open interest in commodities, but post-1987 the weights are based on commercial open interest only. Despite excluding gold, its coverage of six major commodity sectors—energy, fibers, grains, livestock, metals, and soft—more or less mirrors the exposure of other commodity indices. However, the Standard & Poors index uses a geometric weighting system. This keeps the weights of individual commodities fixed throughout the year as the index is essentially rebalanced in real time, selling what rises in value and purchasing what falls in value. This also makes the S&P index more difficult and costly to replicate than other indices as managers tracking the SPCI would have to constantly buy and sell securities to match index weights, rather than let their holdings freely adjust with the market (and the index) between reconstitution dates. Other characteristics of the S&P Commodity Index include spot and collateral yields, as well as annual reconstitution in February, based on the average value of Commodities Open Interest for the 104 weeks prior to the last Friday in October. Energy made up 48% of the index as of June 30, 2002.

Commodities Indices with a Concentration in Energy

Commodity indices have varying degrees of energy exposure, with the GSCI generally having the highest concentration (60%+) and the DJ-AIG Index having the lowest concentration (approximately 40%). While all types of commodities generally provide diversification and inflation-hedging characteristics energy constitutes a special case, since it is both the largest component of most diversified baskets of commodities and the one commodity whose price changes ripple through every sector of a developed economy. An exclusive focus on oil and gas investments can therefore constitute a viable strategy for inflation hedging. However, holding a diversified basket of commodities provides investors with a greater assurance that they will be exposed to those commodities that are creating the inflationary

pressures. Supply shocks or inventory build-ups can dominate business cycles and inflation trends in any commodity type. Moreover, the patterns of economic growth in developing economies may be quite different from those for nations already industrialized; in the former, supply pressures are more likely to be felt in agricultural products, while in the latter, pressures are more likely to occur in industrial metals.

Investment Vehicles

Once investors decide to make a commodity allocation, implementation is no simple matter. The GSCI, DJ-AIG Commodity Index, and the recently created SPCI are the only commodity indices with exchange-traded options and futures, while other indices are available through structured notes and over-the-counter transactions. Various arrangements can also be made to enter into swaps or structured note contracts that seek to provide the return that would be achieved by passively holding the underlying futures contracts that comprise any of these indices. Although such arrangements are available through most major investment banking houses, each carries its own terms—and to be sure—its own (typically onerous) fee schedule. Despite the existence of the GSCI for more than a decade, there are only a handful of managers that offer to replicate one or more indices in both separate accounts and commingled fund vehicles. Most provide passive management, although a few will manage on an "enhanced index" basis. The latter approach replicates the contracts in the index but allows the manager the flexibility and discretion to seek additional return at the margin by actively managing both the cash collateral and the roll yield components of the return. Some managers may also request latitude to overweight or underweight their exposure to the constituent commodities in order to reflect their view of relative valuations. Lastly, very few managers (Morgan Stanley most notably) offer diversified portfolios of long-only commodity contracts based on proprietary valuation models. Beyond this level of active management, one encounters managers who trade on both the long and the short side of the futures market, and has crossed over into the realm of managed futures (see our 1998 report, *Managed Futures*).

The fees for passive commodity allocations tend to be higher than those of equity and bond index funds—commodities are less liquid and there are more transactions associated with replicating a commodity index than an index like the S&P 500. Although evaluating the performance of an index manager is typically straightforward, investors should also examine the popularity of and organizational support for the product, as several of the managers that established products shortly after the release of the GSCI have closed shop, as commodities dramatically underperformed U.S. equities and bonds following what was arguably the greatest bull market in U.S. financial assets in recorded history. Therefore, a careful analysis of the product's popularity and organizational support is particularly important. Second, even passive investors must be willing to accept fees of 40 bps to 75 bps per annum, as replicating an index like the GSCI requires more transactions than replicating a benchmark like the S&P 500.

Swap Agreements

This is an agreement between two parties to exchange cash flows in the future. Typically, the exchanges occur at multiple periods of time in the future, although not necessarily (e.g., a forward contract). In this case, the exchange of future cash flows will be determined by the value of an underlying commodity index. Fees on this type of arrangement can run up to the T-bill rate plus 100 bps, but the costs are largely contingent on the size of the investment.

Over-The-Counter Derivatives

These are options and futures contracts entered into without a medium of exchange. These derivatives provide greater flexibility in structuring and can be customized through negotiations with the issuing bank or securities firm. Liquidity is severely reduced due to the absence of exchange trading, and pricing of the derivative is the by-product of buyer/seller negotiations rather than broad market forces. Inherent in these obligations is the counterparty risk that either party to the contract will default on their obligation.

Exchange-Traded Index Futures/Options

These are options and futures contracts that are traded on a public exchange such as the Chicago Mercantile Exchange. The exchange acts as a clearinghouse for trades by establishing bid and ask prices, and relieving both participants in the transaction from counterparty risk. Prices are publicly quoted and liquidity is enhanced, although it may still be quite limited. The bid/ask cost of rolling the futures can be as high as 70 bps for experienced managers, and oversight could tax in-house staff. The downside to exchange-traded derivatives is the reduced flexibility in the structuring of the transaction.

Taxable Investors

This paper does not delve into all of the tax implications of investing using commodities futures. However, one of the main peculiarities of these investments is how the capital gains tax rates are imposed. For tax purposes, commodity futures are marked-to-market on the last trading day of the year, while gains and losses on futures contracts are taxed at the long-term capital gains rate on 60% of the gain/loss, and the short-term capital gains rate on the remaining 40%. The cash collateral is taxed at the ordinary income tax rate.

Exhibit 1

**SELECTING THE APPROPRIATE STRATEGY FOR
COMMODITY-BASED INVESTING**

Passive Versus Active Exposure

- Exposure to commodity indices can be achieved passively through an instrument that is pegged to the underlying index, or through "enhanced index" or actively managed products.
- Enhanced index managers seek to add value by timing contract roll dates, actively managing cash collateral, and reducing transaction and commission costs.
- Active managers will manage cash, roll dates, and transaction costs, and will also seek to add value by underweighting and overweighting certain commodity contracts according to the manager's assessment of relative value.

Sources of Value Added

Passive	"Enhanced"	Active
<<=====>>		
Hold Index	Outperform 3-Month T-Bills	Over/Underweight Contracts
Lower Transaction Costs		Manage Calendar Roll
<<=====>>		

Caveats of Active Exposure

- Active management does not guarantee higher returns than passively holding or replicating the index.
- Additional risk is assumed with active management:
 - credit risk
 - tracking error to underlying index
 - counterparty risk

Exhibit 2**SELECTING THE APPROPRIATE INVESTMENT VEHICLE FOR
COMMODITY-BASED INVESTING****Passive Versus Active Exposure to a Commodity Index****Passive Exposure****Over-the-Counter Investment Vehicles**

- | | |
|---|--|
| <ul style="list-style-type: none"> • Swap <ul style="list-style-type: none"> + Easy to understand and value - Credit risk - Interest rate risk - Expensive: paying LIBOR + spread - Locked into fixed maturity, illiquid - Cash settlement issues | <ul style="list-style-type: none"> • Structured Note <ul style="list-style-type: none"> + Tailored to suit institution's risk tolerance + May provide current income - Locked into fixed maturity, illiquid - Difficult to value - Credit risk - Expensive |
|---|--|

Exchange-Traded Index Futures/Options on a Commodity Index

- + Liquid, visible market
- + Inexpensive
- Only available on GSCI
- Oversight could tax in-house staff (daily settlement, monthly roll forward)

Active Exposure**Enhanced Management**

- + Cheapest alternative
- + Higher returns on cash collateral (relative to index)
- + Lower transaction costs (relative to index)
- + Higher roll yield (relative to index)
- Tracking error

Active Management

- + Benefits of enhanced management
- + Add value from over/underweighting commodities
- + Roll return enhancement from contract weightings *and* timing of roll
- Manager risk
- Expensive